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SLR

Burundi – DRC - Rwanda
Ruzizi III Hydroelectric Power Project

Environmental & Social Impact Assessment

Vol. II: Main Report

Prepared for

REL
Ruzizi III Energy Limited

Draft Report (version E)
26 September 2024

Making Sustainability Happen

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ISSUE AND REVISION RECORD

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C	16 June 2023	Nicholas Bukowski Jessica Hughes Clément Repussard Camilla Angelotti Matthew Scott See full list in Annex A	Nicholas Bukowski	Third draft issue for EGL Review
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E	26 September 2024		Nicholas Bukowski	Draft Report for Public Disclosure

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Contents

Volume I – ESIA Summary (Separate Document)

Volume II – ESIA Main Report

Section 1: **Introduction**

		Page
1.1	Purpose of this Document	1-1
1.2	Objectives and Rationale of the Project	1-1
1.3	Project Location and Overview	1-1
1.4	The Project Proponent	1-2
1.5	ESIA Team	1-4
1.6	Facilities & Activities Included in the ESIA Scope	1-4
1.7	ESIA Report Structure	1-5

Section 2: **Legal and Administrative Framework**

2.1	National Environmental Policies	2-1
2.2	Institutional Frameworks	2-4
2.3	National Legal Frameworks for Environmental Management	2-7
2.4	Legislation on Expropriation in the Public Interest	2-17
2.5	Legislation on Indigenous People	2-26
2.6	International Legal Framework	2-26

Section 3: **ESIA Process and Methodology**

3.1	ESIA Process and Dates	3-1
3.2	Baseline Surveys	3-1
3.3	Area of Influence and Approach for Assessment	3-4
3.4	Impact Assessment Methodology	3-9

Section 4: **Project Description**

4.1	Generalities	4-1
4.2	Permanent Project Components	4-8
4.3	Components for Construction Only	4-24

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

4.4 Construction Activities and Reservoir Filling 4-30
4.5 Operation and Maintenance 4-37
4.6 Associated Facilities 4-42
4.7 Decommissioning 4-45

Section 5: **Analysis of Alternatives**

5.1 Project Needs and Objectives 5-1
5.2 Alternative Power Production Technologies 5-1
5.3 Alternative Site Layout, Design and Mode of Operation 5-4
5.4 Do Nothing Alternative 5-9
5.5 Comparative Assessment of Alternatives 5-9
5.6 Selection of the Preferred Alternative 5-13

Section 6: **Public Participation and Engagement**

6.1 Introduction 6-1
6.2 Stakeholder Identification 6-1
6.3 Engagement Activities Undertaken to Date 6-3
6.4 Future Consultation Programme 6-19
6.5 Disclosure of the ESIA Documentation 6-25

Section 7: **Environmental Baseline Situation**

7.1 Climate 7-1
7.2 Geology 7-4
7.3 Hydrogeology 7-15
7.4 Geomorphology 7-17
7.5 Water Quality 7-33
7.6 Hydrology 7-36
7.7 Aquatic Ecology 7-70
7.8 Terrestrial Ecology 7-119

Section 8: **Social Baseline Situation**

8.1 Methodology 8-1
8.2 Demography 8-14

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

8.3	Land Tenure	8-36
8.4	Land Use	8-40
8.5	River Uses	8-47
8.6	Economic Activities	8-51
8.7	Community Health	8-70
8.8	Community Infrastructure	8-80
8.9	Gender	8-86
8.10	Security and Human Rights	8-95
8.11	Vulnerable Groups	8-97
8.12	Cultural Heritage	8-103
8.13	Ecosystem Services: Provisioning and Cultural Services	8-111

Section 9: **Critical Habitat Assessment**

9.1	Introduction	9-1
9.2	Assessment of Natural and Modified Habitats	9-14
9.3	Critical Habitat Assessment	9-20

Section 10: **Environmental Flow Assessment**

10.1	Introduction	10-1
10.2	Preparatory Activities	10-3
10.3	Eco-Hydraulics	10-5
10.4	Assessment of EFlows	10-11
10.5	Summary and Conclusion	10-69

Section 11: **Impact Assessment and Mitigation**

11.1	Introduction	11-1
11.2	Climate Change Vulnerability	11-2
11.3	Greenhouse Gas Emissions	11-8
11.4	Air Quality, Dust and Odour	11-17
11.5	Noise and Vibration	11-21
11.6	Soils, Groundwater and Surface Water	11-27
11.7	Hydrology	11-35

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

11.8	Geomorphology and Sediment Transport	11-41
11.9	Wastes	11-46
11.10	Aquatic Habitats and Biodiversity	11-50
11.11	Terrestrial Habitats and Biodiversity	11-71
11.12	Impacts on Local Communities' Livelihood	11-84
11.13	Labour and Working Conditions	11-91
11.14	Community Health and safety	11-101
11.15	Human Rights	11-117
11.16	Gender-Specific Risks and Impacts	11-119
11.17	Cultural Heritage	11-123
11.18	Ecosystem Services	11-133
11.19	Landscape and Visual Amenity	11-142
11.20	Positive Impacts and Benefits	11-150
11.21	Impacts on Historically Marginalised People	11-152
11.21	Recap of Impacts and Mitigation Measures	11-152

Section 12: **Cumulative Impact Assessment**

12.1	Introduction	12-1
12.2	Study Area Context	12-4
12.3	Projects and Regional Development	12-8
12.4	Environmental Stressors and External Factors	12-19
12.5	CIA Temporal and Spatial Boundaries	12-21
12.6	Identification of VECs	12-22
12.7	Assessment of Cumulative Impacts on Ruzizi River Hydrology VEC	12-32
12.8	Assessment of Cumulative Impacts on Ruzizi River Geomorphology VEC	12-37
12.9	Assessment of Cumulative Impacts on Fish & Aquatic Habitat VEC	12-42
12.10	Conclusions and Mitigation and Monitoring Framework	12-48

References

Volume III– Annexes (Separate Document)

Volume IV – ESMP (Separate Document)

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Volume V – RAP (Separate Document)

Volume VI – Quarries RPF (Separate Document)

Volume VII – GBVH Action Plan (Separate Document)

Other documents included in the ESIA Documentation (separate stand-alone documents)

Local Area Development Plan (LADP)

Stakeholder Engagement Plan (SEP)

Environmental and Social Commitments Plan (ESCP)

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Abbreviations and Acronyms

Acronym	Full text
ABAKIR	Lake Kivu and Ruzizi River Basin Authority
ACE	*Agence congolaise de l'environnement* (Congolese Environment Agency)
ADCP	Acoustic Doppler Current Profiler
ADEPR	Association des Eglises de Pentecôte au Rwanda
AFD	*Agence Française de Développement* (French Agency for Development)
AfDB	African Development Bank
AKFED	Aga Khan Fund for Economic Development
AoI	Area of Influence
AOO	Area of Occupancy
asl	Above sea level
ASPT	Average Score per Taxon
AVEC	Association villageoise d'épargne et de crédit
BAP	Biodiversity Action Plan
BDI	Biological Diatom Index
BI	Biodiversity Importance
BMP	Biodiversity Management Plan
BOOT	Build, Own, Operate, Transfer
CAURWA	Community of Indigenous People of Rwanda
CECA	Communautés des Eglises Chrétiennes en Afrique
CELPA	Communautés des églises libres pentecôtistes en Afrique
CEPAC	Communautés des églises pentecôtistes au Congo
CESMP	Construction Environmental and Social Management Plan
CH	Critical Habitat
CHA	Critical Habitat Assessment
CH-q	Critical Habitat-qualifying biodiversity features
CI	Conservation Importance
CIA	Cumulative Impact Assessment
CNDD	*Conseil national de l'environnement et du développement durable* (National Council for Environment and Sustainable Development)
CPEDD	*Coordination provinciales pour l'environnement et le développement* durable (Provincial Coordination Units for the Environment and Sustainable Development
CR	Critically Endangered
CRSNE	*Centre de recherche en sciences naturelles et en environnement* (Research Centre in Natural Sciences and Environment)
CUEDD	*Coordination urbaine pour l'environnement et le développement durable* (Urban Coordination Units for the Environment and Sustainable Development)
DD	Data Deficient
DECC	*Département des forêts et le Département de l'environnement et du changement climatique* (Forestry Department and the Environment and Climate Change Department)
DO	Dissolved Oxygen
DRC	Democratic Republic of Congo
DRISHA	Développement rural d'Ishamba
E&S	Environmental and Social
EAA	Ecological Area of Analysis
EBA	Endemic Bird Areas
ECGLC	Economic Community of the Great Lakes Countries
EDPRS	Economic Development and Poverty Reduction Strategy
EFlow	Environmental Flow
EFMP	Environmental Flow Management Plan
EGL	Energy of the Great Lakes
EHS	Environment, Health and safety
EIA	Environmental Impact Assessment

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

EIB	European Investment Bank
EN	Endangered
EOO	Extent of Occurrence
EPC	Engineering, Procurement and Construction
ESCP	Environmental and Social Commitments Plan
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standard
FEOW	Freshwater Ecosystems of the World
FI	Functional Importance
FNPSS	*Fonds national pour la promotion des services sociaux* (National Fund for the Promotion of Social Services)
FPIC	Free Prior Informed Consent
FS	Feasibility Study
FSL	Full Supply Level
GBIF	Global Biodiversity Information Facility
GBV	Gender-based Violence
GBVH	Gender-based Violence and Harassment
GCM	General Circulation Model
GEEC	*Groupe d'évaluation environnementale du Congo* (Congo Environmental Assessment Group)
GEF	*Global Environment Facility*
GEM	Global Environmental Multiscale Mode
GHG	Greenhouse Gas
GIP	Good Industry Practices
GRF	*Groupe de réflexion sur les conflits Fonciers*
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HEPP	Hyro Electric Power Project
HESG	Hydropower Sustainability Environmental, Social and Governance Gap Analysis Tool
HFO	Heavy Fuel Oil
HIV	Human Immunodeficiency Viruses
HMP	Historically Marginalized People
HMPDP	Historically Marginalized People Development Plan
HPP	Hydropower Project
HSP	Human Settlement Policy
IBA	Important Bird Area
ICCN	*Institut Congolais pour la Conservation de la Nature*
ICOLD	International Commission on Large Dams
IFC	International Finance Corporation
IHA	International Hydropower Association
InSAR	Interferometric Synthetic Aperture Radar
IPP	Independent Power Project
IPS	Industrial Promotion Services
ISS	Ishamba Start Security
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resource Management
JIU	Joint Implementation Unit
KBA	Key Biodiversity Area
KfW	*Kreditanstalt für Wiederaufbau* (German Development Bank)
LADP	Local Area Development Plan
LC	Least Concern
LiDAR	Light Detection and Ranging
MEAE	*Ministère de l'Environnement, de l'agriculture et de l'élevage* (Ministry of Environment, Agriculture and Livestock)
MEDD	*Ministère de l'Environnement et du développement durable* (Ministry of the Environment and Sustainable) Development
MIDIMAR	Ministry of Disaster Management and Refugees Affairs
MoE	Ministry of Environment
MUSO	Mutuelle de Solidarité

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N/A	Not Applicable
NE	Not Evaluated
NGO	Non-Governmental Organization
NGO	Non-Governmental Organisation
NISR	National Institution of Statistics of Rwanda
NT	Near Threatened
NTS	Non-Technical Summary
OBPE	*l'Office burundais de protection de l'environnement* (Burundian Environmental Protection Office)
PA	Protected Area
PAP	Project Affected People
PCG	Pentecostal Church of God
PDD	Paix et Développement durable
PES	Present Ecological State
Pre-ESIA	Preliminary Environmental and Social Impact Assessment
PS	Performance Standard
RAP	Resettlement Action Plan
RDB	Rwanda Development Board
RDBI	Rwandan Dragonfly Biotic Index
REG	Rwanda Energy Group
REGIDESO	*Régie de distribution d'eau*
REL	Ruzizi III Energy Limited
REMA	Rwanda Environment Management Authority
RLMUA	Rwanda Land Management and Use Authority
RMA	Rwanda Meteorology Agency
SAIAB	South African Institute for Aquatic Biodiversity
SAR	Synthetic Aperture Radar
SASS5	South African Scoring System version 5
SCC	Species of Conservation Concern
SEA	Sexual Exploitation and Abuse
SEP	Stakeholder Engagement Plan
SINELAC	*Société Internationale d'Électricité des Pays des Grands Lacs*
SoW	Scope of Work
SPI	Specific Pollution Index (Diatoms)
SRTM	Shuttle Radar Topography Mission
STD	Sexually Transmitted Diseases
SYDERU	Synergie des expatriés de Ruduha
TDI	Trophic Diatom Index
TMS	Timed-Meander Search
UNEP	United Nation Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNPO	Unrepresented Nations and Peoples Organisation
VEC	Valued Environmental Component
VECEA	Vegetation and Climate change in East Africa
VU	Vulnerable
WB	World Bank
WDPA	World Database on Protected Areas
WHO	World Health Organization

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Units

Unit	Full text
%	Percent
gCO_2e/kWh	Grams of equivalent carbon dioxide per kilowatt hour
GWh	Gigawatt hour
ha	Hectare
km	Kilometre
km^2	Square kilometre
kWh	Kilowatt hour
m	Metre
m^3/s	Cubic metres per second
Mm^3	Million cublic metres
MW	Megawatt
s	Second
t/km^2	Tonnes per square kilometre
W/m^2	Watts per square metre

PUBLIC DISCLOSURE AUTHORIZED

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1 Introduction

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Contents

1.1 Purpose of this Document 1-1

1.2 Objectives and Rationale of the Project 1-1

1.3 Project Location and Overview 1-1

1.4 The Project Proponent 1-2

1.5 ESIA Team 1-4

1.6 Facilities & Activities Included in the ESIA Scope . 1-4

1.7 ESIA Report Structure 1-5

PUBLIC DISCLOSURE AUTHORIZED

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1.1 Purpose of this Document

This document is the International Environmental and Social Impact Assessment (ESIA) for the 206 MW Ruzizi III Regional Hydroelectric Power Project, including a 7-km-long 220 kV Transmission Line. The purpose of this ESIA is to demonstrate the Project's alignment with the Environmental and Social (E&S) policies of the International Financial Institutions (IFIs) that are considering supporting the Project, comprising AFD, AfDB, BII, EIB, KfW and the World Bank. Earlier versions of this report were provided to environmental authorities in Rwanda and DRC and the environmental permits obtained on 14 April 2023 and 26 June 2026 respectively.

1.2 Objectives and Rationale of the Project

The Project will generate clean and renewable power, reducing the region's reliance on expensive thermal generation. It will also reduce the local communities' dependence on wood fuel and charcoal which represents a major threat to the countries' forests and biodiversity. Availability of the renewable power will support efforts to extend electrification to the region.

It is currently projected that the Project will benefit a population of 30 million people, 54% of whom are living under the poverty line and averaging a 24% electricity access rate. Once commissioned, Ruzizi-III will almost double Burundi's current capacity, increase Rwanda's installed capacity by nearly 30% and provide much needed baseload power in Eastern Democratic Republic of the Congo (DRC), a region that is otherwise isolated from DRC's interconnected grid.

The Project will be constructed and owned as a public-private partnership (PPP) among the Republic of Burundi, DRC, and the Republic of Rwanda (together as the Contracting States) and the Project Proponent. It is an Independent Power Project (IPP) based on a Build, Own, Operate, Transfer (BOOT) structure and underpinned by a 25-year concession agreement and Power Purchase Agreements (PPAs).

1.3 Project Location and Overview

The Project is situated on the Ruzizi River which flows from Lake Kivu to Lake Tanganyika. At the Project location the river represents the border between Rwanda and DRC and the administrative limit between the Rusizi District of the Western Province of Rwanda and the Walungu Territory of the South Kivu Province of DRC. The Ruzizi-III dam is situated 16 km downstream from the existing 29.8 MW Ruzizi-I and 12 km downstream from the existing 36 MW Ruzizi-II hydroelectric schemes, which started operation in 1959 and 1989 respectively. The Project location is shown on the map provided in Figure 1-1.

The main Project components comprise a rockfill embankment dam with a height of 51 m and a small reservoir occupying 46 ha (16 ha in Rwanda and 30 ha in DRC). These components occupy areas in Rwanda and DRC. Project components situated in Rwanda comprise the dam's spillway and bottom outlet, a 3.8 km long headrace tunnel, an above ground powerhouse, dam access road, permanent operators' village and temporary facilities for the construction phase, including a temporary accommodation camp for workers. Project components situated in DRC comprise a 220 kV substation, a 7-km-long 220 kV Transmission Line, a dam access road, 30 kV Power Supply Line and temporary facilities for the construction phase including a temporary accommodation camp for workers.

No Project components are situated in Burundi. However, the Ruzizi River flows into Burundi 10 km downstream from the Project powerhouse and one of the objectives of the ESIA is to access the types of impacts and significance that alteration to flow regimes and sediment transport may impacts receptors in Burundi.

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The Project has completed a Feasibility Study, and the detailed design and construction will be managed by an Engineering, Procurement and Construction (EPC) Contractor in the next stage of the Project. Construction duration is estimated to be between 48 and 56 months, requiring an estimated workforce of 500-1,000 workers. On completion of the Project construction, the operation of the scheme will be handed over to an operating company that will be created or nominated at a later stage. The Project will operate in a coordinated manner with the Ruzizi-I and -II hydroelectric schemes upstream which operate with periods of peak and off peak flows. The Project's peak flows (150 m^3/s) are identical to the peak flows from Ruzizi-I and -II.

1.4 The Project Proponent

The Project Proponent is Ruzizi III Energy Limited (REL), a special purpose vehicle that has been established and registered in Rwanda to develop the Project. REL will be a public-private partnership during construction and operation of the Project. The Company will be registered as a Community Enterprise at the level of the Economic Community of the Great Lakes Countries (ECGLC) in parallel with financing for the project construction. The Company will function in accordance with various consents issued by the Contracting States and at the ECGLC level as required for construction and operations.

The shareholders of REL during the initial development period are Industrial Promotion Services (IPS) and SN Power AS (SNP).

- IPS is the infrastructure and industrial development arm of Aga Khan Fund for Economic Development (AKFED). Within East Africa, IPS has operations in Kenya, Uganda, Tanzania, Burundi, Mozambique and DRC and employs over 10,000 people. Outside the East and Central Africa region, IPS operates in Cote d'Ivoire, Burkina Faso, Mali, Senegal, Tajikistan, Afghanistan, Kyrgyzstan and Pakistan.
- AKFED is an international development agency dedicated to promoting entrepreneurship and building economically sound enterprises in parts of the developing world that lack sufficient foreign direct investment. It also makes bold but calculated investments in situations that are fragile and complex. It is part of the Aga Khan Development Network.

SN Power is owned by Scatec ASA a leading renewable power producer, delivering affordable and clean energy worldwide. As a long- term player, Scatec develops, builds, owns and operates solar, wind and hydro power plants and storage solutions. Scatec has more than 3.5 GW in operation and under construction on four continents and more than 500 employees. Scatec is headquartered in Oslo, Norway and listed on the Oslo Stock Exchange under the ticker symbol 'SCATC'.

After financial close, the shareholders of REL will be Ruzizi III HPCL (comprising SNP and IPS) and the Contracting States (comprising Burundi, DRC, and Rwanda), with the private and public parties holding 70% and 30% of the company's share capital respectively. The ECGLC Organisation for *Energie des Pays des Grands Lacs* (EGL) acts as the agent for the three Contracting States and the power purchasers from each Contracting State (Offtakers) for the Project. EGL is a specialised ECGLC body responsible for energy cooperation among the Contracting States.

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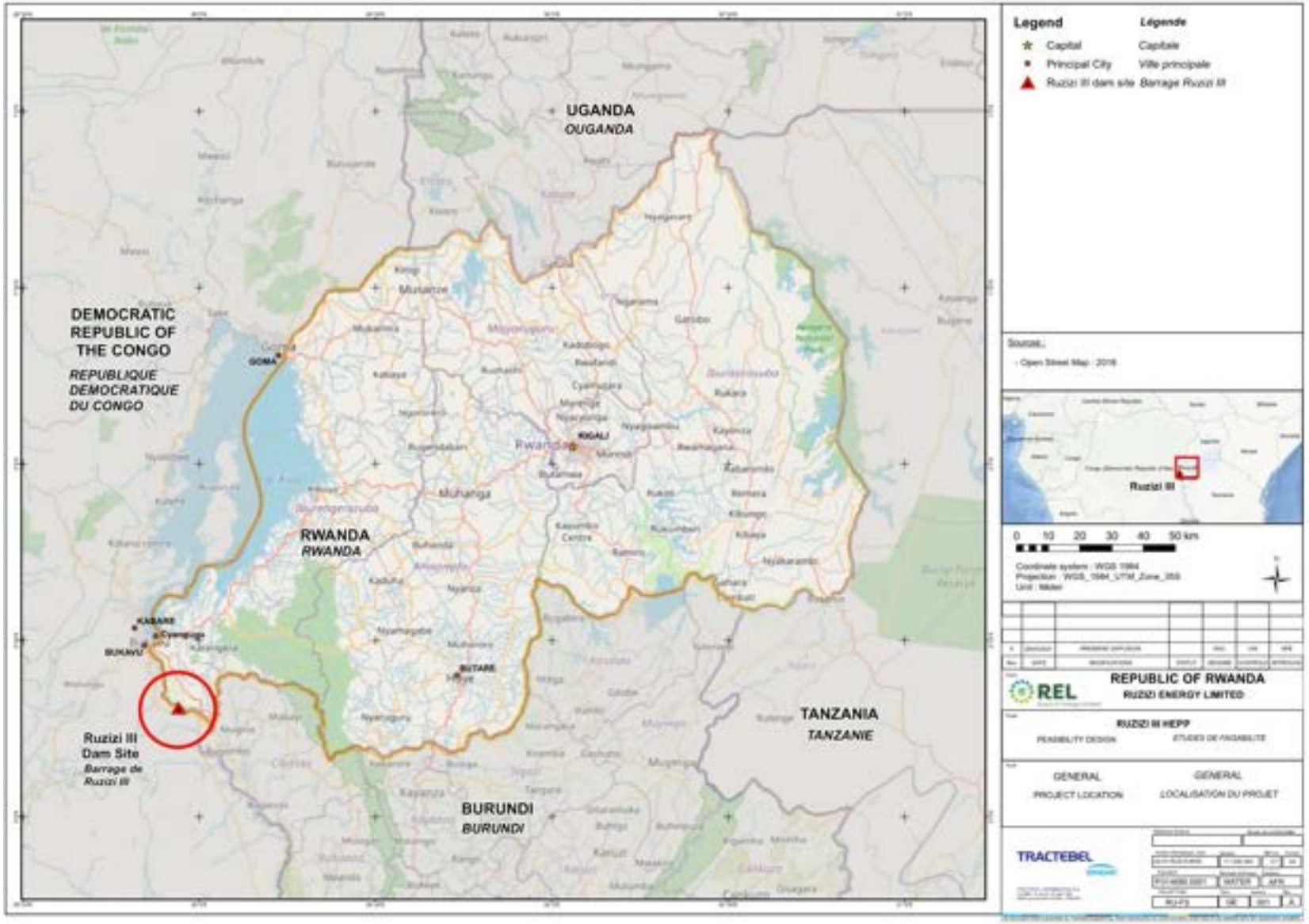


Figure 1-1 Project Situation

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1.5 ESIA Team

The ESIA has been prepared by SLR Consulting, an international environmental consulting company. SLR's international ESIA team have a long track record of preparing ESIA for international hydropower projects that meet the requirements of International Financing Institution (IFI) environmental and social policies. The team members have extensive Africa experience and experience in Rwanda and DRC. The Ruzizi-III ESIA has been prepared by environmental and social specialist and experts from SLR France, South Africa, Ireland and UK with support for the field surveys from international and regional biodiversity experts and regional social experts. The list of ESIA team members is provided in Annex A. The level of effort in the preparation of the ESIA is 45 person-months.

1.6 Facilities & Activities Included in the ESIA Scope

The Project facilities and activities that are included in the scope of the ESIA comprise the following:

- Construction and operation of the power production facilities comprising the dam, headrace tunnel, power waterways, powerhouse, 7-km-long 220 kV transmission line, access roads, and operators' village.
- Facilities required for construction including worksite and construction camp and worker accommodation camp.
- Reservoir impoundment.
- Impacts from operation of the facilities, including impacts from the creation of a 5.5-km-long bypassed reach of the Ruzizi River and downstream impacts from hydrological changes to the Ruzizi River caused by the Project.

Project facilities and activities that are not included in the scope of this ESIA comprise quarries and borrow areas developed for the construction phase and Associated Facilities.

- Quarries and borrow areas are not included in the scope of the ESIA because the sitting will be defined at a later stage. Chapter 4 - project description provides the locations of potential sites for quarries and borrow areas that have been identified by REL. However, it will be the EPC Contract that selects site locations, and they may correspond to sites identified by REL or alternative sites. Vol. IV - ESMP includes the process for REL's review and approval of the sites proposed by the EPC Contractor so that there is avoidance or minimisation of environmental and social impacts. REL will engage an ESIA consultant to conduct the environmental and social impacts for the establishment and exploitation of the quarries and borrow areas and any necessary access roads. The ESIA and RAP will meet international standards and demonstrate alignment with lenders' E&S policies.
- Associated facilities are not included in the scope of this ESIA. The ESIAs and RAPs for the Kamanyola substation and transmission lines that transport electricity produced by the Project to Rwanda, DRC and Burundi are prepared by the developers of these projects. However, the projects to develop associated facilities are also receiving support from IFIs (AfDB, KfW, EIB) and as a consequence the ESIAs and RAPs shall also be prepared in in alignment with lenders' E&S policies.

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1.7 ESIA Report Structure

The ESIA report structure below is an adaption of the structure recommended by the IHA[1].

Volume I - ESIA Summary

Volume II – Environmental and Social Impact Assessment – Main Report

1. **Introduction** – includes objectives of the project, project overview, description of the project proponent, ESIA team and report structure.
2. **Legal and Administrative Framework** – includes ESIA regulations and requirements, regulations on environment, health and safety, social issues, national institutional framework and applicable international standards.
3. **ESIA Process and Methodology** – describes the ESIA process and dates, scoping, data collection for baseline surveys, direct and indirect area of influence and impact assessment methodology.
4. **Project Description** – describes the location and regional setting, overview and layout, project components, construction activities and operations.
5. **Analysis of Alternatives** – describes the needs and objectives, identification of alternative options to the project, comparison of environmental and social impacts of the options, alternative site layout and design and comparison of the environmental and social impacts of the alternatives
6. **Public Participation and Engagement** – describes stakeholder groups, consultations undertaken, findings of the consultations, grievance redress mechanism and ongoing consultations.
7. **Environmental Baseline Situation** – describes the physical and biological baseline situation.
8. **Social baseline Situation -** describes the social baseline situation.
9. **Critical Habitat Assessment** – assesses if and how the project area could qualify as critical habitat as per the World Bank ESS6 criteria and IFC Guidance Note 6 (GN6) thresholds for species criteria.
10. **Environmental Flow Assessment** – assesses the Project impacts on downstream river ecosystems and people in order to determine the environmental flow commitment.
11. **Impact Assessment and Mitigation** – assessment of climate change vulnerability, greenhouse gas emissions, air quality/odours, noise/vibration, geology and soils, hydrology, water quality, wastes, aquatic/terrestrial habitats and biodiversity, physical and economic displacement, community health and safety, cultural heritage, landscape and visual amenity, positive impacts and benefits.
12. **Cumulative Impact Assessment** – assesses incremental impacts from temporal and special overlap of Project impacts with other projects and external factors.
13. **References**

Volume III - Environmental and Social Impact Assessment – Annexes

Volume IV - Environmental and Social Management Plan (ESMP)

Volume V - Resettlement Action Plan (RAP)

Volume VI - Resettlement Policy Framework (RPF) for Quarries and Borrow Areas

Volume VII – Gender-Based Violence and Harassment (GBVH) Action Plan

Stakeholder Engagement Plan (SEP)[2]

Local Area Development Plan (LADP)[2]

Environmental and Social Commitments Plan (ESCP)[2]

[1] How-To Guide - Hydropower Environmental and Social Assessment and Management (IHA, 2021)

[2] Prepared by REL

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

2 Legal and Administrative Framework

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Contents

2.1 National Environmental Policies 2-1

2.1.1 Burundi's Environmental Policy 2-1
2.1.2 DRC's Environmental Policy 2-2
2.1.3 Rwanda's Environmental Policy 2-2

2.2 Institutional Frameworks 2-4

2.2.1 Burundi's Institutional Framework 2-4
2.2.2 DRC's Institutional Framework 2-5
2.2.3 Rwanda's Institutional Framework 2-6

2.3 National Legal Frameworks for Environmental Management 2-7

2.3.1 Burundi's Environment Legislation 2-7
2.3.2 DRC's Environmental Legislation 2-10
2.3.3 Rwanda's Environment Legislation 2-13
2.3.4 Comparative Analysis of Environmental Legislation and National ESIA Procedures 2-16

2.4 Legislation on Expropriation in the Public Interest . 2-17

2.4.1 DRC's Legislation on Expropriations 2-17
2.4.2 Rwanda's Legislation on Expropriations 2-21
2.4.3 Burundi's Legislation on Expropriation 2-24
2.4.4 Comparison with International Standards 2-24

2.5 Legislation on Indigenous People 2-26

2.5.1 Burundi's Legislation on Indigenous People 2-26
2.5.2 DRC's Legislation on Indigenous People 2-26
2.5.3 Rwanda's Legislation on Indigenous People 2-26

2.6 International Legal Framework 2-26

2.6.1 International Environmental Commitments of the Three States 2-26
2.6.2 Regional Environmental Commitments 2-27
2.6.3 Lenders' Environmental and Social Standards 2-29

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Tables

Table 2-1 Comparative Analysis of ESIA Frameworks in Great Lake States 2-16
Table 2-2 Summary of Steps for Public Expropriation in DRC 2-20
Table 2-3 Summary of Steps for Public Expropriation in Rwanda 2-22
Table 2-4 Summary of Steps for Public Expropriation in Burundi 2-25
Table 2-5 Main International Environmental Conventions Signed by the Three States 2-27
Table 2-6 Rationale for Triggering Lenders' Standards and Operational Safeguards 2-33
Table 2-7 Gap Analysis Between the National Legal Frameworks and Lenders Policies regarding land Acquisition and Involuntary Resettlement 2-37

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

2.1 National Environmental Policies

2.1.1 Burundi's Environmental Policy

The new Constitution of Burundi promulgated in 2018 reiterates the provisions of Article 35 of the previous Constitution (2005) declaring that "The State shall ensure the sound management and rational exploitation of the country's natural resources, while protecting the environment and conserving these resources for future generations."

The first texts on national environmental strategy – the National Strategy on the Environment in Burundi (NSEB) and the Environmental Action Plan (EAP) – were drawn up in a difficult period for the country (1997) and are already outmoded. Similarly, the first national strategy on biological diversity came out of the Rio Conference with the following national vision: "All sections of the population are properly informed about the values of biological diversity and the risks it incurs and are involved and committed to its conservation and sustainable use for the well-being of present and future generations".

In 2006, the Ministry for the Environment adopted a sectoral policy and an action plan (2006–2010) with the following objectives:

- The promotion of coordinated environmental management.
- Rational management of land, water, forests and air.
- The preservation of ecological balances and the conservation of biodiversity.

This last objective was promoted in the (new) 2013–2020 National Biodiversity Strategy and Action Plan, with support from the GEF and the UNEP, with:

- As national priorities:
  - Engaging and involving all stakeholders, including decision-makers, in the conservation and sustainable use of biodiversity.
  - Developing and using effective knowledge, tools and techniques to halt pressures on biodiversity.
  - Creating ecosystem reserves representative of national biodiversity.
  - Maximizing the benefits derived from biodiversity and ecosystem services.
  - Establishing a framework for participatory planning, knowledge management and capacity building.
- And as strategic focuses:
  - Addressing the underlying causes of biodiversity loss through the involvement and commitment of all stakeholders at all levels.
  - Reducing direct pressures on biodiversity and biological resources.
  - Improving the status of biological diversity by safeguarding ecosystems, species and genetic diversity.
  - Capitalizing on the benefits derived from biodiversity and ecosystem services.
  - Strengthening a framework for participatory planning, knowledge management and capacity building.

The following strategic documents have been published:

- National Strategy and Action Plan for Environmental Education and Awareness in 2009.
- National Strategy and Action Plan to Combat Soil Degradation from 2011.
- National Water Strategy 2011–2020, finalized in 2012.

In 2021, the government of Burundi updated its law on Environment (law no. 1/09/25 of May 2021). The new environment law integrates the international commitments and policies that Burundi has ratified. These include, for example, the United Nations Framework Convention on Climate Change, the Kyoto Protocol and the Paris Agreement on Climate Change. Moreover,

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this new law recognizes the role of civil society organizations involved in the field of environment and climate change.

2.1.2 DRC's Environmental Policy

Texts pertaining to environmental strategies mainly appear to be the:

- National Environmental Action Plan (EAP) from 1997.
- National Strategy and Action Plan for Biological Diversity, written in 1999 and approved in 2001.

The EAP establishes an initial inventory of the state of the environment in the DRC which, among the main threats and damage to the environment, points to the physical degradation of land. The sources of environmental degradation are mainly demographic pressure, erosion, poor farming practices, industrial pollution, deforestation, illegal logging, intensive poaching and uncontrolled mining in certain protected areas. The EAP stresses the urgent need to develop a legal framework for environmental protection and procedures for environmental impact assessments.

The EAP needs to be updated to integrate the new multilateral environmental agreements that have been adopted since it was first drawn up and ratified by the DRC (Basel Convention and Protocol, Rotterdam Convention, RAMSAR Convention, Kyoto Protocol to the United Nations Framework Convention on Climate Change, Cartagena Protocol on Biosafety), as well as broad guidelines to account for the impacts of infrastructure works and transport activities on the environment.

The National Strategy and Action Plan for Biological Diversity is a reference document for the sustainable management of the DRC's biological resources. As such, it defines various strategies to put an end to human activities that have a negative impact on natural ecosystems, namely the harvesting of wood fuels, agricultural slash-and-burn practices, lumber and timber exploitation, the harvesting of non-timber forest products, bush fires, and logging.

The focus of DRC's environmental policy is biodiversity protection.

2.1.3 Rwanda's Environmental Policy

Rwanda's first environmental policy was published in 2003, the same year as the Constitution which, in its Article 49, clearly enshrined environmental protection and conservation, a provision maintained in the revised Constitution of 2015. Rwanda's Ministry of Environment (MoE) published its latest National Policy Document on Environment and Climate Change in June 2019. The guiding principles are:

- Inclusiveness of women and youth in environmental management and decision-making.
- Economic value.
- An ecosystem approach.
- Environmental and social risk assessment.
- A precautionary principle.
- A principle of sustainability of the environment and equal opportunities across generations.
- Mitigation and adaptation to climate change.
- "Polluter pays" principle.
- Extended producer responsibility.
- Information dissemination and community awareness-raising in the conservation and protection of the environment.
- A principle of cooperation between public institutions, international partners, associations and private operators for the protection of the environment.

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- Endeavours to promote the circular economy and industrial symbiosis.

The stated objectives and adapted strategies of this policy are:

1) The green economy:

- Promote a green economy that is resource efficient, low-carbon and climate resilient.
- Promote the circular economy to advance sustainable consumption and production patterns.
- Promote green technologies and procurement.
- Promote green urbanization and green rural settlement.
- Promote green mobility.

2) Enhancing functional natural ecosystems and managing biosafety:

- Conserve, preserve, and restore ecosystems and enhance their ecological functioning.
- Promote sustainable management of wetlands.
- Ensure biosafety and precautious adoption and use of biotechnology.

3) Strengthening meteorological and early warning services:

- Develop and maintain environment, climate services and climate change information systems and promote their use by all sectors of Rwandan society.
- Promote generation and access to accurate and adequate meteorological weather and climate information for better planning in all sectors of the economy.

4) Promoting climate change adaptation, mitigation and response:

- Strengthen adaptation mechanisms in planning and implementation.
- Strengthen mitigation mechanisms in planning and implementation.

5) Improving environmental well-being for Rwandans:

- Improve the health and quality of life for every citizen and promote sustainable socio-economic development.
- Prevent pollution and promote integrated pollution control and waste management.
- Strengthen capacity in the management of nuclear and radioactive substances.

6) Strengthening environment and climate change governance:

- Ensure that sectoral policies define and adopt sector-specific environment and climate change quality standards for their respective core activities.
- Establish a statutory national coordination framework for the management of critical ecosystems.
- Promote inclusivity for participation in environmental management and climate change intervention decision-making.
- Enhance environment, weather and climate information use and climate change awareness and education among Rwandans.
- Strengthen existing institutional roles and coordination mechanisms.

7) Promoting green foreign and domestic direct investment and other capital inflows:

- Strengthen the capacity of national environment and climate change finance mechanisms for greater efficiency, effectiveness and impact.
- Strengthen climate proofing capital inflow in national economic planning.

These strategies are set out in detail along with an implementation plan. Rwanda's recent environmental policy is therefore comprehensive and ambitious, drawing on the approaches developed by industrialized nations, most notably by integrating environmental and climate requirements into projects and investments in all sectors of the economy.

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2.2 Institutional Frameworks

2.2.1 Burundi's Institutional Framework

Decree no. 100/037 of 19 April 2018 revising Decree no. 100/29 of 18 September 2015 on the Structure, Functioning and Missions of the Government of the Republic of Burundi, assigns the environment sector to the Ministry of Environment, Agriculture and Livestock (MEAE); from 2002 until then, it had been part of the Ministry for Water, Environment, Land Use and Urban Planning (MEEATU). The environmental role of the MEAE defined by the decree is to:

- Design, plan, coordinate and implement national policy on the environment, water, land, agriculture and livestock.
- Design and implement the national environmental policy by ensuring the protection and conservation of natural resources.
- Design and implement the national policy on sanitation and industrial pollution control in collaboration with the other services concerned.
- Ensure the protection and conservation of natural resources and develop environmental standards to serve as a code of conduct for environmental management.
- Develop and popularize a national environmental education program.
- Introduce climate change adaptation policies in collaboration with the other technical services concerned.
- Develop and enforce environmental protection and management regulations.
- Contribute to the implementation of international conventions and programs on the management and protection of the environment and natural resources.
- Oversee regular updates of the Environment Code.

Within the MEAE, the Burundian Office for Environmental Protection (OBPE) is more specifically in charge of the environmental assessment and management of projects. The prerogatives of the OBPE are defined in Decree no. 100/240 of 2 October 2014 on the establishment, role, organization, and operation of the OBPE. In particular, the decree's Article 6 sets out the OBPE's role, which includes:

- Ensuring compliance with the Water Code, the Forestry Code, the Environmental Code and other texts relating to environmental protection.
- Setting up and overseeing mechanisms for the international trade and exchange of fauna and flora species.
- Enforcing environmental standards and putting forward all measures to safeguard and protect nature.
- Monitoring and evaluation of development programs to ensure compliance with environmental standards when planning and implementing development projects that may have a negative impact on the environment.
- Ensuring implementation of the obligations arising from international conventions and agreements on the environment to which Burundi is a party.
- Undertaking and encouraging research and support measures for the maintenance of biological diversity.
- Setting up mechanisms for mitigation and adaptation to climate change.

The OBPE has a Board of Directors and General Management divided into two technical departments: the Forestry Department and the Environment and Climate Change Department (DECC), whose roles include:

- Coordinating the response to climate change.
- Analysing Environmental Impact Studies (ESIA).
- Monitoring the protection of green spaces and safeguard zones.

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- Monitoring the implementation of the policy, the national strategy and the Action Plan on Climate Change by the different stakeholders on a daily basis.

It is therefore clearly the OBPE's responsibility to assess the ESIA/ESMP of projects such as Ruzizi-III.

2.2.2 DRC's Institutional Framework

At national level, the environment sector is overseen by the Ministry of the Environment and Sustainable Development (MEDD), whose attributions are defined by Order no. 17/025 of 10 July 2017. These attributions include:

- Implementation of national policies for the sustainable management of the environment and the preservation of biodiversity and ecosystems.
- Drawing up plans for the implementation of these policies, their monitoring and evaluation.
- Sustainable management of forests, water resources, wildlife and the environment.
- Human settlements management.
- Evaluation and follow-up of environmental and social studies of any project likely to harm the environment.
- Regulation of all activities likely to harm the environment, biodiversity and ecosystems and the health of the environment.
- Drafting and implementation of environmental sanitation standards.
- Protecting plant and animal life.
- Promotion and coordination of all activities relating to the sustainable management of the environment, forest, wildlife and aquatic resources, and nature conservation.
- Environmental monitoring and audits of public institutions and private companies as well as non-governmental organizations active in the environmental and nature conservation sectors.
- Ecosystem identification and management.
- Environmental services management.
- Creating protected areas other than strict nature reserves and proposals for the creation of the latter.
- Development, extension, and management of environmental education programs.

The MEDD's missions are applied at the provincial level by the Provincial Ministries of Environment and Sustainable Development and by the Provincial Coordination Units for the Environment and Sustainable Development (CPEDD). At provincial capital level, there are also Urban Coordination Units for the Environment and Sustainable Development (CUEDD).

The Executive Order of 2 July 1998 on the territorial and administrative organization of the DRC defines the decentralized administrative entities with legal status (provinces, towns, territories, and communes) and assigns them, inter alia, the following environmental competences:

- Vector control and, in particular, insect control in all its forms.
- Protection of classified sites and monuments in local entities.
- Raising public awareness of environmental health issues, licensing and control of unhealthy, inadequate and dangerous Class III establishments.
- Drainage and cleaning of sewers and sewage collection systems.
- Cleaning, collection and disposal of household waste and rubbish.

However, the low financial and technical capacity of these collectivities often holds back their environmental and social management performance, particularly when it comes to overseeing the implementation of projects within their territory.

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Within the MEED, the Congolese Environment Agency (ACE), created by Decree no. 14/03 of 18 November 2014, is responsible for the environmental and social assessment of projects likely to impact the environment, thus replacing the Congo Environmental Assessment Group (GEEC) created in 2006.

Under the terms of this Decree, the ACE's mission is to:

- Evaluate and approve all environmental and social studies, and monitoring their implementation.
- Ensure that environmental protection is considered when implementing any development or infrastructure project or any industrial, commercial, agricultural, forestry, mining, telecommunications or other activity likely to have an impact on the environment.

The ACE's role in any project is to ensure strict compliance with the applicable laws, decrees and ministerial directives on environmental protection and improvement throughout the project's implementation. In this respect, the ACE is responsible for assessing and approving Environmental and Social Impact Assessment (ESIA) reports, Environmental and Social Impact Diagnostics (ESID), Environmental and Social Management Plans (ESMP) and Environmental and Social Compliance Plans (ESCP). The ACE also monitors projects underway (analysing field reports, inspections, and environmental audits).

According to the legal texts, the ACE has the required human resources skilled in the field of Environmental Impact Assessments and Studies. However, given the vastness of the territory, it lacks the necessary material and financial capacities to fully fulfil its role.

2.2.3 Rwanda's Institutional Framework

Established by Prime Ministerial Order no. 131/03 of 23/12/2017, the Ministry of Environment (MoE) recently replaced the Ministry of Natural Resources (MINIRENA), which had previously taken over from the Ministry of Environment and Land, created in March 2009.

The Order defines the MoE's main responsibilities as follows:

- Develop and publish national policies, strategies and programs on environment and climate change to:
  - Develop strategies to promote partnership and strengthen the private sector's capacity to invest in environment and climate change activities that foster sustainable economic development.
  - Develop laws and regulations designed to protect the environment and conserve natural ecosystems.
  - Develop the environmental and climate competences of institutions and human resources.
- Monitor and evaluate the implementation and integration of environment and climate change policies, strategies and programs in all sectors of activity, and especially the productive sectors.
- Supervise and evaluate the institutions under its authority by providing guidance documents for the delivery of programs to be implemented by those institutions and local governments; and,
- Mobilize the resources needed for development, environmental protection, and conservation and for climate change adaptation and mitigation.

The MoE has two technical directorates:

- The Environment and Climate Change Directorate.
- The Directorate of Land, Water and Forests.

The MoE also comprises certain entities that report directly to the General Secretariat, including:

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- The Rwanda Environment Management Authority (REMA), in charge of implementing the State's environmental policy. It coordinates and supervises all environmental management and sustainable development aspects throughout the country. Although placed under the supervision of the Ministry for the Environment, it enjoys administrative and financial autonomy. The REMA was also previously charged with reviewing impact assessments, but this responsibility was transferred to the Rwanda Development Board (RDB, see below) in 2008. However, the REMA remains responsible for the environmental and social monitoring and evaluation of development projects and for monitoring compliance with safeguard measures during project operations.
- The Rwanda Water and Forestry Authority (RWFA).
- The Rwanda Land Management and Use Authority (RLMUA).
- The Rwanda Meteorology Agency (RMA).
- The Rwanda Green Fund (FONERWA).

The Rwanda Development Board (RDB) is the national agency for the promotion of investments in the country. It is a "one-stop-shop" for all the administrative formalities required for investments. The RDB therefore includes an "Environmental Compliance and Cleaner Production Unit" responsible for examining environmental and social impact studies before issuing certificates approving the impact studies required before project implementation.

Decentralized environmental management is governed by Law no. 04/2001 of 13 January 2001 on the Organization and Functioning of Districts and Cities which defines their responsibilities, in particular in terms of land-use planning and environmental protection and management.

Environment Law 48/2018 of 13 August 2018 provides for District or City Environmental Protection Committees, who oversee environmental management and assist with the implementation of environmental protection policies and programs at the local level. Their organization, functioning and allocation are subject to a Prime Ministerial Order.

However, the central Government remains responsible for policy formulation and environmental planning, making laws and regulations as required and providing monitoring and evaluation services. Local Government will be responsible for policy implementation, enforcement of environment laws and regulations, and ensures the day-to-day safeguarding of the environment under its jurisdiction.

2.3 National Legal Frameworks for Environmental Management

2.3.1 Burundi's Environment Legislation

2.3.1.1 Basic Texts on Environment and Impact Assessment

Burundi's Environmental law no. 1/09/25 of May 2021 lays down the fundamental rules for managing the environment and protecting it against all forms of degradation, to safeguard and enhance rational use of natural resources, combat the various forms of pollution and undesirable impacts, and improve human living conditions, while respecting ecosystem balance (Article 1).

When developments, works or installations are likely to harm the environment, the Code requires the proponent or contractor to draw up and submit to the environmental authorities an impact study assessing the direct or indirect impact of the project on the ecological balance, the environment and the population's quality of life, and the impact on protection of the general environment (Article 31 and 32). When the impact study is given the green light by the Ministry, the public will be consulted on the nature of the project to gather their comments or possible recommendations that must be considered in the final report (Article 40). Hydropower and rural

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road projects are likely to harm the environment and are thus concerned by this requirement (Article 74).

The other provisions in the Act (Titles III and IV) concern the protection and development of natural resources such as soil, subsoil, water and forests, and the control of pollution and undesirable impacts. According to these provisions, protecting soil against erosion is a national and individual ecological duty, and the measures to be taken to achieve this goal may be declared to be in the public interest and imposed on any person using or occupying land (Art. 69).

The impact study procedure is described in chapter 3 of the environmental law

For project investments, the proponent or contractor is required to send a screening document, using the format stipulated by the Ministry for the Environment. This document will describe the project and its potential effects on the environment, as well as the terms and conditions for its implementation, including the necessary measures applied to prevent, mitigate, correct, or offset the potential effects on the environment (article 37) Based on this document, the Ministry decides, within a maximum period of one month, whether or not to carry out an Environmental Impact Assessment (Article 38)

The environmental impact study is carried out before the project gets underway and is the responsibility of the proponent or person/entity in charge of the project (Art. 41). The main components of the Environmental impact study listed are:

- A non-technical summary that allows the public to analyse the environmental and social impact study and the environmental and social impacts of the project and its alternatives.
- An introduction which contains a presentation of the applicant, the title and category of the project, the supervising ministry, and the authorization(s) to be obtained in order to carry out the project.
- The legal and institutional framework and its relevance to the project.
- The project components: location, layout, size/scope/area, capacity, pre-construction, construction, operation and rehabilitation activities, schedule, staffing requirements, facilities and services, operation and maintenance activities, required off-site investments and life span, project budget, and an indication of the main reasons for its selection, taking into account environmental and social impacts.
- An analysis of the initial state of the project's area of influence and its physical, biological, socio-economic and human environment, including natural resources, socio-economic and socio-cultural aspects likely to be affected by the project or its alternatives.
- An analysis of the evolution of the environment of the project's area of influence, based on the analysis referred to in point 5, in the absence of the project or its alternatives, and in the presence of other projects already authorized but not yet implemented.
- A description of the main positive and negative impacts that the project and its alternatives are likely to have on the environment and an explanation of the methods of identification and description of these impacts.
- A comparison of the evolution of the environment of the site, in accordance with point 6, and the environmental and social impacts of the project and its alternatives, in accordance with point 7
- A description of the measures to avoid, reduce and eliminate the harmful impacts and those foreseen to optimize the favourable impacts on the environment and the social life.
- The environmental and social management plan which describes the measures to prevent, reduce and/or compensate for the environmental impacts of the project, including the institutional arrangements, their costs, the timetable for their implementation, the mechanisms for monitoring the project and its environment, as well as the compensation plan for the people and communities affected by the project, if any.

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- Approved terms of reference.
- A summary of public participation, including the list of stakeholders consulted (administrative, local residents, non-governmental organizations, other stakeholders, and concerned groups), the methods used to inform and consult stakeholders (meetings, communications, observations, and surveys), and the results of public participation.
- A description of the data gaps in the analyses according to points 5° and 6°, and the description according to point 7°.

A presentation of the information using tables, photos, figures, and maps with clear legends, inclusion in the annex of an explanatory list of terms and abbreviations, recitation of any useful source of information in the area. The start of work will be subject to an environmental compliance certificate or statement issued by the Ministry for the Environment after approval of the EIA report (Article 44).

The authorities and the public may express their opinion on the EIA report, which is subsequently submitted (in three copies) to the Ministry of Environment for review and approval ((article 48)The review is carried out within a period not exceeding three months from the date of closure of the mandatory disclosure procedures (Once the EIA report has been approved, it becomes a legal act and requires the proponent or contractor to comply with and carry out the measures it sets out (Article 43).

2.3.1.2 Other Texts on Water and the Natural Environment

Law no. 1/02 of 26 March 2012 on the Water Code in Burundi defines the principles of water management and use, which include:

- The user-pays principle: this principle recognizes water as an economic good. Water thus has a cost, which must be borne by the user.
- The principle of sustainability: since water is recognized as a finite resource, appropriate measures must be taken at all levels to ensure efficient management of resources and infrastructure and to reduce the burden on water services. Therefore, in rural areas, the water tariff must at least cover the costs of operating and maintaining infrastructures.
- The principle of accountability: this principle aims to prevent waste and activities related to water resources. In the event of environmental damage, it also aims to introduce mechanisms to redress the damage either by compensating the victims or by remedial measures in kind. In a river basin, the different uses of water are therefore taken together, and each use takes into account its effects on the others. Accountability implies several duties for users and public authorities with regard to water resources, including application of the "polluter-pays" principle.

Under the principles of accountability and "user pays", natural or legal persons using water for productive or income-generating purposes are subject to the payment of a license fee, the rate of which is set in the regulations (Article 35). However, the payment of this fee does not preclude the civil or criminal liability of the fee-payer when their activity causes damage or constitutes an offence (Art. 36).

Furthermore, every holder of a right to use water is bound by the following obligations (Art. 92):

- To use water in a rational and economical way, avoiding all waste.
- To observe strictly the conditions laid down for applying the right to use water.
- To respect the rights of other legitimate water users.
- To submit to regular water metering (or monitoring) and the conditions under which this takes place.
- To pay the license fees that are due.

The Water Code provides, inter alia, for a 150-metre-wide protection zone along the shores of Lake Tanganyika, a 25-metre-wide zone on each of the banks of the rivers tributary to the Lake,

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and a 5-metre-wide zone along rivers that are not tributary to Lake Tanganyika (Art.5, paragraph 3). The delimitation of these protection zones is the responsibility of the Ministry for Water and is performed in respect of any duly acquired rights (Art.11). When implementing the project, investments in these zones must be avoided, except for waterworks.

Law no. 1/10 of 30 May 2011 on the creation and management of protected areas stipulates that protected areas must be considered in the overall development plan and their management must go hand-in-hand with the development of the riparian human environment. It also indicates that the participatory management of protected areas must commit to improving the living environment of local communities (Art.29). The project will therefore contribute to the fulfilment of this requirement, most notably with the actions designed to benefit residents in the protected areas of Rusizi, Rumonge and Kigwena.

Law no. 1/07 July 2016 on the Forestry Code lays down special rules on the administration, management, exploitation, surveillance, and policing of forests. It regulates wildfires, defines prevention measures, and establishes protection forests or forest reserves to combat soil degradation and protect plant and animal species threatened with extinction.

2.3.2 DRC's Environmental Legislation

2.3.2.1 Basic Texts on Environment and Impact Assessment

The first text to formally integrate environmental considerations was actually the Constitution of 18 February 2006 which, in its Articles 53, 54 and 55 respectively, stipulates that:

- Everyone has the right to a healthy environment conducive to their overall development and a duty to defend it.
- The State sees to the protection of the environment and the health of the population.
- The conditions for the construction of industrial plants, and of facilities for storage, handling, incineration and disposal of toxic, polluting or radioactive waste produced by industrial units or workshops within the national territory are laid down by the law.
- Any pollution or destruction resulting from economic activity shall give rise to compensation and/or to reparation.
- The transportation, importation, storage, spilling or disposal in inland waters or maritime spaces under national jurisdiction, or the release into the airspace of toxic, polluting, or radioactive waste or of any other dangerous product, of foreign origin or otherwise, is a crime punishable by law.

The main environmental text in force in the DRC is Law no. 11/009 of 9 July 2011 modified and completed by the "ordonnance-law" no. 23/007 of 3 March 2023 on the fundamental principles of environmental protection. The law has been This framework law defines the principles and tools for environmental management to be applied in the DRC. It stipulates that:

- Any policy, plan or program initiated up by the State, a province, decentralized territorial entity or public institution, the implementation of which is likely to have a significant impact on the environment, shall be subject to a prior environmental assessment (Article 19).
- Any development or infrastructure project or any industrial, commercial, agricultural, forestry, mining, telecommunications, or other activity likely to have an impact on the environment is subject to a prior environmental and social impact study, together with a management plan, duly approved by a public institution (Arts. 21–22).
- The Minister for the Environment will audit any work, project or activity presenting a potential risk for the environment and population. This audit will lead to the prescription of appropriate environmental protection measures (Art. 23).
- Any project or activity likely to have an impact on the environment is subject to a prior public inquiry, including a public information and consultation campaign (Art. 24).

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- Any person who carries out or contributes to a project or activity without an impact study, where one was required, will be subject to a fine and the court addressed may order the destruction of any unlawfully constructed work (Art. 72).

The Law also made provision to establish a National Council for the Environment and Sustainable Development (CNDD, Art. 17) under the authority of the Prime Minister. This Council provides advice on the definition and implementation of national environmental policy, and on the preparation of sectoral environmental plans and programs that may have an impact on the environment.

This framework law is not self-executing, so for it to become fully operational it will require the publication of a series of implementing decrees setting out, as priority, the (new) formal and detailed procedures for the implementation of impact assessments and environmental audits. A further series of texts will be needed to define precise standards for air and water quality and for the management of the various categories of waste and other toxic or environmentally harmful substances.

The principle of environmental assessment was already the subject of Ministerial Order no. 043/CAB/MIN/ECN-EF/2006 of 8 December 2006 on the obligation to conduct environmental and social assessments for projects in the DRC. However, ESIA procedures are described in the implementing texts of the Framework Law, namely:

- Decree n° 13/015 of May 29, 2013 regulating classified installations, and more significantly.
- Decree no. 14/019 of 2 August 2014 defining how the procedural mechanisms for environmental protection are applied.

The latter lists the types of projects and activities subject to an ESIA, including hydropower dam projects and power line installations. It also describes the procedures and contents of ESIAs, strategic environmental studies and environmental audits.

According to Order 14/019 (Title III, Chapter 2), an ESIA report must contain the following elements:

- A non-technical summary written in English, French and the relevant local language.
- Project background and justification.
- The project's institutional, legal and judicial framework.
- A detailed description of the project, including plans, maps, images and figures useful for its understanding.
- A detailed baseline inventory of the site, its natural, socio-economic and human environment, including the elements and natural resources likely to be affected and the use that would be made of them.
- A comparative analysis of alternatives, justification of selected technologies and the procedures to be adopted by the contractor, in light of concerns to protect the environment.
- Identification, analysis and evaluation of predictable direct, indirect and cumulative impacts of the project and its options on the environment.
- The ESMP describing the impacts, mitigation or enhancement measures, monitoring and evaluation responsibilities and their estimated cost during and after project implementation, follow-up indicators, timelines, capacity building procedures, and the results of public consultations.
- A conclusion that can be drawn from the study and a commitment from the contractor to respect environmental and social requirements.
- Annexes including maps, figures, documentation concerning the public consultation, administrative documents, analysis results, the curriculum vitae of experts, any further information on the study, and the terms of reference for the study.

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The ESIA process for a project described in Order 14/019 (Title III, Chapters 3 & 4) is as follows:

- The proponent submits a request to the ACE to conduct an ESIA, in accordance with the guidelines in the Operations and Procedures Manual from the ACE.
- Authorizations to proceed with a project subject to an environmental and social impact study is subject to an Environmental Certificate issued by the ACE.
- The ACE reviews the request and decides whether the project should undergo an ESIA and informs the proponent accordingly.
- After submission of the report, the ACE establishes a panel of experts, selected according to the project's specifics, to review the report. This Panel includes four representatives of the competent public institution, one representative per Ministry concerned by the project, one representative of the National Fund for the Promotion of Social Services (FNPSS) and three resource persons with the relevant expertise.
- The ACE has three months from the date of submission of the report to notify the proponent, either:
  - of the admissibility of the report, in which case it issues the Environmental Certificate,
  - or of the observations to be incorporated to make the study admissible, subject to amendment,
  - or its rejection, in which case the proponent must redo its study.
- The proponent has 30 days from the date of notification of the observations to incorporate them into its report and submit it again for review. After that period, the report shall be deemed rejected.
- If the proponent does not hear anything from the ACE within the timeframe indicated in Article 27 above, the study shall be deemed admissible and the certificate acquired.
- Costs related to the review of environmental and social impact studies shall be borne by the proponent and payable at the time of submission of the study report.
- After issuance of the Environmental Certificate and prior to starting work, the proponent prepares its Environmental and Social Management Plan (ESMP), which it submits to the ACE for evaluation.
- When it receives this plan, the ACE requests the opinion of the National Fund for the Promotion of Social Services on the project's social management aspects.
- The ACE has 60 days from receipt of the ESMP to review and approve it. After this period, the ESMP is deemed to be approved.
- The Environmental Certificate issued is valid for the entire duration of the project.
- In the event of amendments made to the initial project that was subject to the environmental and social impact study approved by the ACE, an update is required and subject to the same conditions.
- When the ESMP is implemented, along with any work carried out by subcontractors under supervision of the proponent's Environmental Officer, the prescribed measures to prevent, reduce and eventually offset the harmful consequences on the environment must be applied throughout the project.
- Implementation of the plan is monitored to track changes in the state of the environment and the effectiveness of the mitigation measures and other recommended measures.
- In the event of non-compliance with the obligations, the ACE shall suspend work and ask the proponent to comply within a certain period, which will be defined according to the scale of the negative impacts.
- If the proponent does not react within the given timeframe, the environmental certificate shall be duly withdrawn.
- If the measures initially planned in the environmental and social management plan prove inadequate for any reason, the proponent is required to take appropriate measures to

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adapt them. These measures shall comply with any new directives and environmental standards applicable in this area.

The environmental and social impact study is the responsibility of the proponent, who shall recruit a national consultancy firm approved by the Ministry for the Environment, or an international consultancy to conduct the study. Where there is equal merit, priority is given to national firms. Any international consultancy firm recruited must be partnered with a national consultancy. A decree by the Minister for the Environment lays down the conditions for approving consultancy firms.

As far as we know, the ACE's Operations and Procedures Manual is not yet available.

2.3.2.2 Other Texts on Water and the Natural Environment

Law no. 15/026 of 31 December 2015 on water (the Water Code) aims at the fair and sustainable management of water resources (both ground and surface water). It defines its nature, the regimes for its development, protection and use as an economic resource, and inter-State cooperation for cross-border lakes and rivers. As concerns these projects, Article 40 of the law stipulates: "Riparian land along a river or lake is subject, on each bank, to a public utility servitude over a width of 100 meters from the banks, known as an 'easement of unrestricted access', to allow the circulation of dredging and maintenance equipment and for the water authorities to install signage and measuring and surveying equipment."

Law 011-2002 of 29 August 2002 on the Forestry Code prohibits land clearing over a distance of 50 meters on either side of a watercourse. The Code also stipulates that any forest clearing is subject to a permit and payment of a tax. Forest clearing work must be offset by the planting of an equivalent number of trees over the same surface area as the initial forest cover; this will be carried out by the operator behind the forest clearing work or at their expense (Art. 52). For an agricultural activity, a deforestation permit is only required beyond an area of 2 hectares (Art. 53). It should be noted that, with regard to firewood production, the DRC Forest Code and Land Law provide for the following legal options: (i) public plantations, (ii) private plantations, (iii) reforestation of agricultural plots, (iv) exploitation of firewood with a permit to cut wood and proceed with carbonization, and (v) community forests.

Inter-ministerial Order n° 0021 of 29, October 1993 implementing regulations on Easements include:

- The banks of the courses up to at least 10 metres from the line formed by the highest level reached by the waters in their normal flood period.
- The rights-of-way of high voltage power lines for a distance of 25 metres on each side (50 m on both sides).

2.3.3 Rwanda's Environment Legislation

2.3.3.1 Basic Texts on Environment and Impact Assessment

The 2003 Constitution, revised in 2015, specifies that every individual has the right to a clean and healthy environment and the duty to protect, safeguard and promote the environment. It also stipulates the prohibition of international agreements to store hazardous waste in the country.

The recent Environment law no. 48/2018 of 13 August 2018 defines the procedures for the protection, conservation, and promotion of the environment (air, water, soil, living species) and lays down the rules for environmental assessment. The law is based on the principles of precaution, environmental sustainability, the polluter pays principle, dissemination of information, and incentives for environmental conservation and cooperation.

The Act states that rivers, streams, creeks, groundwater, springs, ponds, marshes, and lakes are part of the State public domain. It prohibits the construction of an agricultural or livestock

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facility within 10 meters of the banks of a watercourse and within 50 meters of the banks of a lake (Art. 42, 5°). This law recalls the principle of environmental impact assessment but does not define any new procedures or standards. The numerous implementing texts that will make it fully operational are currently being drafted.

Prior to the Environmental Law of 2018, the reference text for environmental protection was the Organic Law no. 04/2005 of 8 April 2005 on the protection, preservation, and promotion of the environment in Rwanda. This law introduced the principle of a two-level impact study (partial and full) and appointed the REMA as the national authority in charge of the environment. Following the promulgation of this law, a general procedural guide for impact studies was published (REMA, 2006), along with a guide to environmental auditing (REMA, 2009) and a series of sector-specific guides, including a guide on impact studies for hydropower development projects (REMA, 2008).

The lists of projects requiring a full or partial environmental impact assessment are regularly updated. The latest version is set out in Ministerial Order No. 001/2019 of 15 April 2019 establishing the list of projects subject to an environmental impact study, and the instructions, conditions, and the procedures for conducting the said impact study, which is a revision of Ministerial Order No. 001/2018 of 25 April 2018 on the list of works, activities and projects subject to environmental impact assessment.

Among the projects subject to full impact assessment are the construction of buildings of more than 1,000 m^2, construction and repair of international, national and district roads and repair of large bridges, construction of hydropower dams and power lines, and construction of artificial lakes and water storage dams. However, projects for micro-hydro power plants, small power lines and off-grid power lines are subject to a partial impact assessment.

The Environmental and Social Impact Assessment (ESIA) procedure, as defined in Ministerial Order No. 001/2019 of 15 April 2019, is as follows:

- The Project Proponent submits a short project description and a proposed Terms of Reference (ToR) online via the Rwanda Development Board (RDB) website.
- The RDB (i) reviews the project description, (ii) visits the site, and (iii) reviews the proposed ToR for approval. All of these scoping activities are completed within a timeframe of 7 + 2 + 15 = 24 days.
- Once the ToR have been approved, the Proponent will recruit a Consultant certified by the Ministry for the Environment to conduct the ESIA.
- The Consultant carries out the ESIA in accordance with the ToR. The Consultant is required to involve the Proponent in all stages of the ESIA process. It also has the duty to assess the Proponent and its responsibilities and obligations in implementing the results of the environmental impact assessment. The ESIA takes into account the views of all relevant stakeholders.
- Upon completion of the ESIA, the Consultant submits the report to the Proponent for approval. The Consultant then submits the report online to the RDB.
- The RDB reviews the ESIA report within 20 days to ensure compliance with the ToR and relevant guidelines. As appropriate, the RDB approves the report or requests additional information.
- Where public consultation is required, the period for examining the report may be extended by a further 15 working days from the date that the consultation is notified.
- Stakeholders can comment on the ESIA report and express their views on the impacts of the proposed project.
- The RDB covers all costs of the public consultation process.
- As part of the public consultation, the RDB shall inform the public of:
  - The day, time and place of the public consultation by means of a notice published twice in a local newspaper or four radio announcements, or by displaying posters at the project site.
  - The Proponent's contact information, including name and address.

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- The RDB shares its decision (acceptance and environmental certificate, or rejection of the project) in writing with the ESIA Consultant, who then has 24 hours after receipt to submit a copy of the decision to the Proponent.
- If the Proponent contests the RDB's decision, it may appeal to the Minister for the Environment.
- The required content of the ESIA is defined in Article 68 of the Organic Law of 2005 and in the General Guide to Environmental Impact Studies (REMA, 2006). The report must at least include the following chapters:
- Executive summary of the ESIA report.
- Objectives of the project, including ideas, intentions and specific goals.
- Description of the proposed project and its alternatives.
- Discussion of the proposal and its relationship to relevant (sectoral and regional) policies, laws and programs.
- Description of the initial state of the environment.
- Impact analysis. In this section, the spatial and temporal scope of the impacts and the characteristics of the various impacts (positive or negative, direct or indirect, their intensity, extent and significance) must be described for the project and for all alternatives considered.
- Evaluation and comparison of the alternatives and selection of the one best suited to the environment.
- Impact Management Plan and Environmental Monitoring and Surveillance Plan (ESMP).
- Financial evaluation of the recommended measures.
- Annexes containing tables, diagrams, maps, supplementary documents, and anything else relevant.

It is recalled that while the RDB is tasked with reviewing and approving the ESIA, the REMA is responsible for environmental monitoring and inspections conducted on behalf of the State.

2.3.3.2 Other Texts on Water and the Natural Environment

Enacted on the same day as the Environment Act, Law No. 49/2018 of 13 August 2018 on the use and management of water resources in Rwanda sets out as guiding principles the prevention of pollution – at source as a priority –, the precautionary principle, integrated water resources management (IWRM), participation, the user-pays principle and the principle of subsidiarity. The law also provides for a National Water Advisory Committee, River Basin Committees and assigns responsibilities to decentralized administrative entities to contribute to the development of rivers and lakes, the protection of water bodies and the drafting of river basin management plans. It sets up buffer zones for the protection of surface and ground water resources. It also provides for a Technical Commission on Dams to advise on the construction and use of dams and stipulates that any person who has built a dam or who is entrusted with dam management is responsible for ensuring the safety of the dam.

Ministerial Order No. 007/16.01 of 15 July 2010 determining the length of land along the banks of lakes and rivers to be transferred to the public domain states that land located within 50 meters of the banks of a lake is State property. Land located within 10 meters of a large river and 5 meters of a small river is also State property. The distances are calculated from the most distant line reached by the water during reported floods. This land is considered to be a protected area and not available for private construction. Only activities designed to protect the water bodies are permitted.

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2.3.4 Comparative Analysis of Environmental Legislation and National ESIA Procedures

The table below provides a comparative summary of environmental legislation and ESIA procedures in the three countries.

Table 2-1 Comparative Analysis of ESIA Frameworks in Great Lake States

Ministry currently responsible for the environment	Burundi	DRC	Rwanda
	Ministry of Environment, Agriculture and Livestock (MEAE) since 2018	Ministry of the Environment and Sustainable Development (MEDD) since 2017	Ministry of Environment (MoE) since 2017
Reference legislation (most recent texts)	Law no. 01/09 May 2021 on the Environment Code. This new law defines the framework for the environmental impact study procedures. .	Law no. 11/009 of 9 July 2011 on the fundamental principles of environmental protection modified and completed by the ordonnance-law no. 23/007 of 3 March 2023. Ministerial Order no. 043/CAB/MIN/ECN-EF/2006 of 8 December 2006 on the provisions concerning the obligation to conduct environmental and social assessments. Decree no. 14/019 of 2 August 2014 defining how the procedural mechanisms for environmental protection are applied	Environment Law no. 48/2018 of 13 August 2018 Organic Law no. 04/2005 of 8 April 2005 on the protection, preservation, and promotion of the environment Ministerial Order no. 001/2019 of 15 April 2019 establishing the list of projects subject to an environmental impact study, instructions, conditions, and the procedures for conducting the said impact study
Administrative body responsible for examining and approving ESIAs	Burundian Environmental Protection Office (OBPE)	Congolese Environment Agency (ACE)	Rwanda Development Board (RDB)
Handling ESIA files	By post	By post	Online via the RDB website
Administrative body responsible for follow-up	OPBE	ACE	Rwanda Environment Management Authority (REMA)
List of projects and activities subject to an ESIA	Yes	Yes	Yes (regularly updated for full or partial ESIAs)
Different levels of impact study?	No	No	Yes (full or partial ESIA)
Methodological guides	No, but content of ESIA defined by the legal texts	No, but content of ESIA defined by the legal texts	Yes (general and sector-based)
Prior approval of the ToR by the administrative body in charge	Yes	No, but the administrative body decides whether or not the impact assessment is necessary	Yes
Public consultation	Yes	Yes	Yes
Accreditation of experts responsible for ESIAs	No	Yes	Yes
Document approving the ESIA	Environmental compliance certificate	Environmental certificate	ESIA certificate of approval

All three countries thus have basic environmental legislation establishing the principle of an environmental impact assessment as a prerequisite for the authorization of projects or activities potentially harmful to the environment. The three countries all have ministries in charge of the environment, sometimes with exclusive responsibility as is the case in the DRC and Rwanda.

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They also have administrative entities dedicated to examining and approving the impact studies. However, from an operational viewpoint, the environment appears to be more effectively taken into account in the project cycle in Rwanda, which has fully integrated environmental assessment into the formalities required for national and international investments through the RDB (a one-stop shop) and has an exclusively online procedure for submitting files and correspondence. Rwanda also separates responsibility for examining and approving ESIAs from that for the environmental monitoring of projects once implemented. This progress has largely been enabled by more than 20 years of political stability and the desire to promote investment in a context of sustainable development.

To meet the requirements of international Technical and Financial Partners such as the European Investment Bank, the World Bank, the International Finance Corporation, the African Development Bank, and others, national ESIAs of the three countries need additional information that is not required by national regulations and procedures, such as:

- Greenhouse gas (GHG) emissions.
- Gender and social inclusion.
- Health of local residents and workers.
- Stakeholder engagement and communication plans.
- Complaint management and grievance procedure.
- In some cases, human trafficking.
- Supply chain management.
- Worker's influx.

In addition, there are specific procedures for land acquisition and the involuntary resettlement of populations.

It has been confirmed that in all three countries, a project such as Ruzizi III is subject to impact assessment (a full ESIA in Rwanda).

2.4 Legislation on Expropriation in the Public Interest

2.4.1 DRC's Legislation on Expropriations

The Constitution of 18 February 2006 stipulates that '*the State guarantees the right to individual or collective property, acquired in conformity to the law or to custom*', and that '*one may only be deprived of his property for reasons of public utility and in return for a just and prior indemnity conceded under the conditions established by the law*.'

Law no. 73-081 of 20 July 1973 (Land Law), amended and completed by Law no 80-008 of 18 July 1980, states that soil is the exclusive, inalienable and imprescriptible property of the State. The State's domain includes a public domain and a private domain (Art. 54). Land in the private domain may be the subject of a concession, defined as a contract whereby the State grants a community, a natural person, or a legal entity of private or public law the right to enjoy a piece of land under the terms and conditions provided for by this law and its implementing measures (Art. 57 and 61). The different kinds of concessions recognised by the law are:

- A perpetual concession, where the State grants a natural person of Congolese nationality the right to indefinitely enjoy a plot of land as long as the conditions provided for by the law are met; or,
- An ordinary concession (most common), granted to a natural or legal person of private or public law in one of the following forms:
  - Emphyteutic lease: full use of an uncultivated plot of land belonging to the State with responsibility to develop and maintain the land and to pay the State a fee in kind or in money, for a maximum period of 25 years renewable.

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- Surface area contract: the right to enjoy the land and to dispose of the buildings, wood, trees and other plants thereon, for a maximum period of 25 years renewable.
- Usufruct contract: the right to enjoy the land, like the State itself, but with responsibility to keep it in good condition, for a maximum period of 25 years, renewable.
- Contract of use: recognized right of a person to enjoy a plot of land with his/her family, either by living on it or by creating warehouses for him/herself for a maximum period of 5 years renewable.
- Rental contract: enjoyment of land for a specific price that the lessor undertakes to pay to the State for a maximum period of 3 years, generally preparatory to another type of concession.

According to Article 18 of Law 11/022 of 24 December 2011, each local community is recognized as having customary land rights exercised collectively or individually on the land. State lands can indeed be inhabited and used by local communities – individually or collectively – in accordance with local customs and practices. Land where customary rights are exercised may be subject to expropriation in the public interest: in this case, the identification of entitled persons will have to take into account the traditional system of land allocation and management.

There are four different types of land titles in DRC:

- The Certificate of Registration (most common) formalises the right to enjoy land conceded by the State. The private ownership of buildings on a concession is always considered separately from that of the land and is only legally established by the registration of the buildings on the Certificate of Registration establishing the concession ('ownership by incorporation'). Without this registration, the ownership of the buildings is not legally recognized.
- The 'Titre de propriété foncière' (Land Title) for land acquired in accordance with the rules before the publication of the Land Law, provided that it has been sufficiently developed.
- The 'Titre d'occupation 2-18roviso ire' Provisional Occupation Title, preparatory to the concession of rural land exceeding 10 ha intended for agricultural or livestock farming purposes.
- The 'Livret de logeur' or equivalent title in a city: a perpetual concession on a piece of land in a district divided into plots and registered in the land register under the private domain of the State, exclusively for national citizens.

Immovable property, perpetual concessions, emphyteutic concessions, surface area concessions and the rights of enjoyment of local communities to State lands are all eligible for public expropriation.

The procedure of expropriation is outlined in Law 73-021 of 20th July 1973 and in Law 77-001 of 22nd February 1977 of expropriation for public utility.

According to articles 4-7 of Law 77-001 of 22nd February 1977, the procedure of expropriation starts with a decision pronouncing the public utility of the project and ordering the expropriation.

In the case of expropriation of collective or individual rights of use exercised by local populations on state-owned land, the expropriator shall base his compensation proposals on a survey prescribed and carried out in accordance with the provisions of articles 193 to 203 of law no. 73-021 of 20 July 1973. Expertise and survey can be made prior to the opening of the expropriation procedure.

Articles 193 to 203 of the Land Code describe, in the case of an application for a concession, the data that must be collected during the appraisal of the property to be expropriated, including the collective and individual rights of enjoyment exercised by the local populations on State lands. The enquiry prior to the concession (a public enquiry) includes:

- On-site verification of the delimitation of the requested land boundary;
- A census of the persons present on the land or who carry out any type of activity thereon;

PUBLIC DISCLOSURE AUTHORIZED

- A description of the site and an inventory of what exists on it in terms of woods, forests, watercourses and traffic routes;
- A hearing of anyone making oral complaints or observations; and,
- A record and study of all written information.

The enquiry is carried out by the Zone Commissary of by a functionary or agent charged with this task. The enquiry is opened by posting of a notice in the locality where the land is located. A copy of the application specifying the land concerned shall be annexed to the posted notice. The investigation is closed by a report indicating all the information gathered and the conclusions of the agent who was in charge. Any document useful to support the report shall be attached to it.

Within one month, the author of the enquiry sends two copies of his/her report to the competent administrative authority. The applicant may obtain a copy of the letter of transmission of the file. The various levels of administration involved in the expropriation may request a review of the enquiry. When the enquiry file is deemed satisfactory, it is sent to the Public Prosecutor who has one month to approve the enquiry report or to communicate his/her observations. The administration must respond to all of the Public Prosecutor's observations. If this one-month period is exceeded the report is automatically accepted.

Once that the public prosecutor has validated the enquiry report, the decision of expropriation is made by ministerial order (ordinary expropriation) or presidential decree (expropriation by area) and published in the Official Gazette. The decision of expropriation will set a date for eviction. Expropriated people will be notified by registered letter either delivered by post with acknowledgement of receipt or hand-delivered with a dated and signed receipt. When the expropriation concerns collective rights of enjoyment, the population is notified by a communication made to the representative of the community by the Zone Commissioner or his/her delegate. If a person cannot be reached, the administration notifies the Public Prosecutor who issues an instruction to continue the investigation. In case of failure, the Public Prosecutor asks the Court of First Instance to appoint an administrator of the property to be expropriated, who will represent the person to be expropriated in the expropriation procedure and the legal establishment of the compensation.

Following receipt of the letter, the person to be expropriated has in principle one month to communicate his/her observations and claims to the ministry in charge of land matters. During this period, which may be extended by the competent authority, the expropriator and the expropriated person may reach an agreement on the amount of compensation. If an agreement has not been reached, the authority sends the person to be expropriated a compensation proposal, based on an expert report drawn up and signed by two land surveyors from the Land Registry, and possibly a specialist on the type of property to be expropriated (for example, an agronomist for agricultural property). If the expropriated person does not accept the compensation, the expropriator will resort to the court's judgment. Within 15 days following the summons, the court hears the parties. Within 8 days from the hearing, three experts are appointed to submit a report within an established deadline. This period may not exceed 60 days or exceptionally 90 days. Within 8 days from the submission of the experts' report, the court summons the parties to a hearing. No later than one month after this hearing, the court decides on the amount of compensation and deadline for eviction.

The compensation due to the expropriated person must be based on the value of the property at the date of the court's judgment. It must be paid before the registration of the transfer and at the latest 4 months from the date of the judgement establishing the compensation. Once this period has elapsed, the party to be expropriated can take legal action for the expropriator to cancel the expropriation.

Table 2-2 summarises the steps included in the public expropriation process in DRC, alongside the institution responsible for each of them.

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Table 2-2 Summary of Steps for Public Expropriation in DRC

#	Activity	Description	Responsibility	Time
1	Public enquiry	A public enquiry will be opened by displaying posters and closed by a conclusions report. The public enquiry will identify the rights enjoyed by local populations on the land, describe the environment and enumerate the people using the land through a census.	Ministerial officer	Once land to be acquired has been demarcated
2	Transmission of the conclusion report to the competent administrative authority	Within one month, the author of the enquiry sends two copies of the report to the competent administrative authority.	Competent administrative authority	Within one month from opening the enquiry
3	Transmission of the enquiry to the public prosecutor for approval	When the enquiry file is deemed satisfactory, it is sent to the Public Prosecutor who needs to approve it or communicate his/her observations. The administration must respond to the Public Prosecutor's observations.	Competent administrative authority	The public prosecutor has to approve the enquiry within 1 month from reception
4	Declaration of Public Utility	The decision declaring the public interest of the works and ordering the expropriation is made by ministerial order or presidential decree and published in the Official Gazette.	Ministry of Land Affairs	Once the public prosecutor has approved the enquiry report
5	Notification of expropriated people	This decision, setting an eviction date, is notified to the expropriated people by registered letter delivered by post with acknowledgement of receipt or hand-delivered with a dated and signed receipt	Ministry of Land Affairs	Once the declaration of public utility is published
6	Negotiation of compensations	Once informed, the expropriated people have one month to communicate their claims and observations to the Ministry of Land Affairs. During this period, which may be extended by the competent authority, the expropriator and the expropriated person should reach an agreement on the amount of compensation and indemnity.	Ministry of Land Affairs	Within 1 month from the notification of expropriation
7	Agreement or disagreement with compensation	If satisfied, the expropriated person signs the compensation report.	Expropriated person	As soon as a compensation is agreed upon
		If dissatisfied, a compensation amount is proposed based on an expert report prepared and signed by two land surveyors from the Land Registry and a specialist on the type of property to be expropriated, as required	If an agreement is not reached after the evaluation, the expropriated person can resort to justice	If an expropriation case goes to court, three experts are appointed to submit a report within 60 days from the first hearing. Within a month after the delivery of the report, the court decides on the amount of compensation.
9	Payment of compensation	The compensation will be based on the value of the property at the date of the judgement ruling on the regularity of the procedure.	Expropriating authority	Compensation must be paid 4 months from the date of the judgement establishing compensation
10	Eviction of the acquired land	The evacuation date is set in the declaration of public utility.	Affected person	By the evacuation date set in the declaration of public utility

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2.4.2 Rwanda's Legislation on Expropriations

The 2003 Constitution, revised in 2015, establishes the right to individual or collective private property. Private property is guaranteed by the State and is inviolable except when it interferes with the public interest. Land in Rwanda is divided into public land (public and private domains of the State, public institutions, and local communities) and the private domain. According to Law No. 43/2013 of 16 June 2013, there are two types of private ownership:

- Full ownership (perpetual possession).
- Emphyteutic lease (land granted for 20, 49 or 99 years), which is the predominant form of ownership.

According to Organic Law No. 08/2005 of 14/07/2005, the state has the right to own and use land for public interest and to expropriate, if necessary, through procedures established by national law and ensuring adequate compensation. Law No. 32/2015 of 11 June 2015 established that Projects wishing to expropriate for the public interest must provide at their own cost a list of the land and people to be expropriated and make provision for the amount of compensation from their own budget.

To begin the procedure, the Project developer must do an application for expropriation in the public interest. The following documentation must be included in this application (Art. 10):

- The nature of the project.
- The justification of the Project's relevance for being in the general interest.
- The master plan of the land on which the project will be carried out (demarcations, maps, nature of assets, list of holders of rights registered on the land titles).
- A document indicating that the project has no detrimental effects on the environment.
- A document confirming the availability of funds for fair compensation.
- An explanatory note detailing that such land or place suits the project.
- Minutes of the consultative meeting indicating that the concerned population has been made aware of the Project and its importance.
- A study indicating the consequences of expropriation on PAP's living conditions.

The competent committee in charge of monitoring projects of expropriation in the public interest considers the relevance of the project within a period not exceeding 30 days after receiving the request for expropriation (Art. 11).

The expropriated persons shall receive a fair and just compensation covering not only the price of the land but also compensation for the activities carried out on expropriated plots such as crops, plantations or buildings, or other activities aimed at improving the productivity of the land. However, no activity undertaken after the official publication of the expropriation decision shall be subject to compensation (Art. 17). The amount of compensation shall be set according to prevailing market prices estimated by the Institute of Real Property Values in Rwanda. The unit prices of land and property thus established are published annually in the Official Gazette (Art. 22). The District or City of Kigali administration or the relevant Ministry must inform the persons to be expropriated of the expected start date of the measurement of the land and inventory of property incorporated thereon. This information must be conveyed via posters at the Unit's office at the project location, or by messages on the radio or in the press (media with a large audience or readership). If necessary, other means of communication may be used (Art. 24).

Anyone claiming expropriation rights must provide proof of their property rights (Art. 26).

Compensation for disruption (5 % of the basic compensation) shall be granted to those expropriated (Art. 27).

If the person to be expropriated is satisfied with the amount of compensation, he/she shall sign or fingerprint the compensation report (Art. 32). If the person to be expropriated is not satisfied, s/he has the right to contest the amount based on the work of a valuer recognized by the

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Institute of Real Property Valuers in Rwanda, at his/her own expense and within a maximum of 10 days (Art. 33). In the absence of an arrangement, the dispute will be dealt with in court, but the compensation initially planned will be paid before the court's decision to avoid delay of the expropriation (Art. 34). The amount of compensation must be paid within 120 days of approval by the District Council. After receiving fair compensation, the expropriated person must move out within a period not exceeding 120 days. The person to be expropriated is not allowed to plant crops that require more than 120 days of growth before they can be harvested (Art. 36). The compensation shall be made in Rwandan currency or in any other form agreed upon (in kind) between the expropriating party and the expropriated person but must be paid before the resettlement (Art. 35). Monetary compensation shall be deposited into the account of the person to be expropriated opened with a recognized locally based bank or financial institution of his/her choice (Art. 38). Compensation in kind shall be paid in line with the agreed upon method (Art. 39).

Table 2-3 summarises the steps included in the public expropriation process, alongside the institution responsible for each of them.

Table 2-3 Summary of Steps for Public Expropriation in Rwanda

#	Activity	Description	Responsibility	Time
1	Application for expropriation in the public interest	The application for expropriation shall be prepared according to article 10 of Law No. 32/2015 of 11 June 2015	Project developer	Once affected people have been enumerated and the required land has been demarcated and surveyed
2	Approval of the application	A competent committee in charge of monitoring expropriation for public interest projects will consider the relevance of the project within 30 days from reception of the application.	Land Commissions and Land Committees (District, Sector and Cell level), which are in charge of monitoring public expropriations.	No later than 30 days after reception of the application
3	Publication of the official decision of expropriation	Once the application is approved, the decision of expropriation will be published. No activity undertaken after the official publication of the expropriation decision shall be subject to compensation.	District Council	Once the application has been approved
4	Land measurement and asset inventory	The District or City of Kigali administration or the relevant Ministry must inform the persons to be expropriated of the expected start date of the measurement of the land and inventory of property incorporated thereon (radio, press and posters). At this stage, the validity of land tenure rights will be assessed. If needed, required land documents can be updated or produced at this stage.	District Land Office	Once the official decision has been published

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#	Activity	Description	Responsibility	Time
5	Establishment of compensation payments	The amount of compensation shall be set according to prevailing market prices estimated by the Institute of Real Property Values in Rwanda. The unit prices of land and property thus established are published annually in the Official Gazette	Project developer, according to the expert judgment of registered real property valuers from the Council for Regulation of the Real Property Valuation	Once the official decision has been published
6	Agreement or disagreement with compensation	If satisfied, the expropriated person signs the compensation report. All compensation reports are sent to the district council for validation.	Affected person	Once the affected person agrees with the compensation
		If dissatisfied, the expropriated person can demand an evaluation of their property	If an agreement is not reached after the second evaluation, the expropriated person can still resort to justice	The expropriated person has 10 days from the proposal of compensation to request an evaluation
7	Payment of the agreed compensations	The amount of compensation must be paid within 120 days after approval by the District Council. All compensations must be paid before the affected people are resettled	Project developer	Within 120 days from the District Council's approval
8	Evacuation of the acquired land	After receiving fair compensation, the expropriated person must move out within a period not exceeding 120 days. The person to be expropriated is not allowed to plant crops that require more than 120 days of growth before they can be harvested.	Affected person	Within 120 days from the payment of compensation

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2.4.3 Burundi's Legislation on Expropriation

Land use is governed by the Law 1/13 of August 9, 2011 (Land Code), which replaced Law 1/008 of September 1, 1986. The main objective of the revision of the Land Code was to formalise unwritten rights and reconcile the legitimacy of local actors' land tenure practices with the legality of legislative and regulatory texts. This law recognises three categories of land ownership (Article 2):

- Land under the public domain of the State or other public entities.
- Land belonging to the private domain of the State or other public entities.
- Land belonging to private individuals or legal entities – as Article 313 establishes, these titles are granted by the Communal Land Service.

Expropriation is enshrined in Article 36 of the Constitution (June 7, 2018), which lays down the principle that "*Every person has the right to property. No one may be deprived of his property except for reasons of public utility, in the cases and in the manner established by the law and in return for fair and prior compensation or in execution of a judicial decision having the force of res judicata*". Paragraph 5 of the Land Code sets out the expropriation procedure.

The first step of expropriation is outlined in Article 417 of the Land Code. This article that the Project developer requiring a land concession will have to file an application for expropriation in the public interest, justifying the Project's land requirements. The validation of the expropriation file will lead to a provisional declaration of public utility, published by ministerial decree. After this step, an enquiry report will be produced for the validation of the National Land Commission. Once the enquiry report is accepted, a decree of order of expropriation is published by:

- The Ministry of rural lands for areas of rural lands which do not exceed 25 hectares.
- The Ministry of urban planning for urban areas which do not exceed 1 hectare.
- The President of the Republic for a rural land exceeding 25 hectares or an urban area exceeding 1 hectare.

The Decree of Order of Expropriation needs to be posted for the comments and observations of interested parties at the communal administration for a month. All comments are compiled in a report sent to the competent authority. During this phase, the expropriated people will be proposed a compensation offer, following which:

- If the expropriated person accepts, a deed of sale by mutual agreement is prepared.
- If the person disagrees, she will be able to resort to justice according to article 428.

Compensation rates for land, crops and buildings are set by Ministerial Order No. 720/CAB/304/2008. This ordinance establishes the modalities for calculating compensation, based on formulas adapted and applied to annual and biennial food crops, perennial crops (banana, coffee, tea, etc.) and buildings. Article 1 of this order specifies that the payment of compensation is in all cases prior to any action for the expropriated person. According to Article 14, the rates should be updated every 3 to 5 years to reflect socio-economic changes. Table 2-4 summarises the steps included in the public expropriation process, alongside the institution responsible for each of them.

2.4.4 Comparison with International Standards

The texts governing land tenure and expropriation procedures in the public interest are relatively old in the DRC (pre-1980), and more recent in Rwanda and Burundi (post-2010). Rwanda has a much smaller surface area than DRC and has been able to finalize the formalisation of its land cadaster making the expropriation procedure easier to implement, particularly for linking plots with plot owners. Table 2-7, at the end of this section, sets out the differences between DRC and Rwandan legislation and lenders' requirements. In almost all aspects, the lender' requirements are more protective of Project Affected Persons than the laws and procedures of DRC, Burundi and Rwanda and the lenders' policies therefore remain benchmarks for the implementation of the RAP.

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Table 2-4 Summary of Steps for Public Expropriation in Burundi

#	Activity	Description	Responsibility	Time
1	Application for expropriation in the public interest	A file describing the Project and justifying the land needs for which expropriation will be necessary is compiled by the Project developer and sent to the competent ministry.	Project developer	Before receiving a declaration of expropriation
2	Provisional declaration of public utility	The validation of the expropriation file will lead to a provisional declaration of public utility, published by ministerial decree	Competent ministry	Once the application for expropriation in the public interest has been approved
3	Enquiry Report	An enquiry report is prepared by a ministerial officer for validation by the National Land Commission	Ministry of Land Affairs	Once the declaration of public utility is published
4	Decree of order of expropriation	Compensation is set according to the unit prices of land and property published annually in the official gazette. The order of expropriation will be sent to the communal administration concerned for the public enquiry stage. The decree of order of expropriation sets the deadline for the occupants' expropriation.	> Ministry of rural lands for rural areas over 25 ha. > Ministry of urban planning for urban areas over 1 ha. > President of the Republic for rural lands over 25 ha or urban areas over 1 ha.	Once the enquiry report is validated by the National Land Commission
5	Public enquiry	Article 420 establishes that the Decree of Order of Expropriation needs to be posted for the comments and observations of interested parties at the communal administration for a month. The results of the enquiry are compiled in a report sent to the competent authority.	Communal administration	For a month, from the transmission of the decree of order of expropriation to the communal administration
6	Agreement or disagreement with compensation	If satisfied, the expropriated person signs the compensation report.	Affected person and Project expropriator	As soon as an agreement on compensation is reached
		If dissatisfied, the expropriated person can bring legal action before the competent court. The court will appoint three experts e and set a time limit for filing the report.	Competent court	The amount of compensation is established by the court within a month from the delivery of the report.
7	Payment of the agreed compensations	The compensation will be based on the value of the asset at the time of evaluation.	Expropriator	Compensations will be paid 4 months after the legal or amicable judgment at latest.
8	Eviction from the acquired land	The eviction limit will be set in the order of expropriation	Affected person	By the date set in the order of expropriation

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2.5 Legislation on Indigenous People

2.5.1 Burundi's Legislation on Indigenous People

Burundi does not have specific laws which recognise indigenous people.

2.5.2 DRC's Legislation on Indigenous People

In DRC, Law No. 22/030 was established in July 2022 to promote and protect the rights of indigenous Pygmy peoples. The law recognizes Pygmy communities as hunter-gatherer groups with distinct cultural identities and lifestyles and seeks to incorporate international standards into national law. It covers various aspects, including civil and political rights, economic and social rights, environmental protection, land rights, and participation in decision-making processes. Additionally, the law mandates the creation of development plans, policies for indigenous women and children, and a special fund for the protection and promotion of Pygmy rights.

2.5.3 Rwanda's Legislation on Indigenous People

Since the genocide, Rwanda has adopted a policy of national reconciliation which prohibits ethnic identification. Laws against ethnic divisionism were passed in 2001 (Law n°47/2001 of 18 December 2001 on the Prevention, Suppression and Punishment of the Crime of Discrimination and Sectarism) and are enshrined in the 2003 Constitutions. Consequently, Rwanda does not legally recognise the existence of indigenous people.

2.6 International Legal Framework

2.6.1 International Environmental Commitments of the Three States

With the development of international relations, it seemed crucial to introduce the concept of ESIA to international instruments. This was achieved in 1972 through the Stockholm Declaration, then in the Rio Convention and its action plan (Agenda 21) and has been included in the guidelines of the United Nations Environment Program as well as instruments of a more 'philosophical' nature, such as the World Charter for Nature.

While this ESIA focuses on a number of acts chosen for their particular importance, it should be borne in mind that almost all conventions and other acts in the field of environmental protection include one or more provisions on impact assessment.

Moreover, in the context of the Ruzizi III dam construction project, Burundi, Rwanda and DRC have joined in this global obligation as described in certain acts of conventions listed in the table below.

Table 2-3 below presents the main commitments made by the three States in terms of environmental protection. The three countries appear to present equivalent profiles with regard to their environmental commitments even if the dates of membership differ depending on the country's recent history.

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Table 2-5 Main International Environmental Conventions Signed by the Three States

International commitment	Burundi	DRC	Rwanda
Ramsar Convention on Wetlands (2 February 1971)	Joined (2002)	Joined (1996)	Joined (2005)
Convention on Biological Diversity (the 'Rio Summit') (5 June 1992)	Ratified (1997)	Ratified (1994)	Ratified (1996)
Basel Convention on the control of transboundary movements of hazardous wastes and their disposal (22 May 1989)	Joined (1997)	Joined (1994)	Joined (2004)
The Kyoto Protocol on climate change (1998)	Joined (2001)	Joined (2005)	Joined (2004)
United Nations Convention to Combat Desertification (October 1994)	Ratified (1997)	Ratified (1997)	Ratified (1998)
United Nations Framework Convention on Climate Change (1992)	Ratified (1997)	Ratified (1994)	Ratified (1998)
The Vienna Convention and the Montreal Protocol for the Protection of the Ozone Layer (1985)	Joined (1997)	Joined (1994)	Joined (2001)
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1971)	Joined (1988)	Joined (1975)	Joined (1980)
Cartagena Protocol on Biosafety (29 January 2000)	Joined (2008)	Joined (2005)	Ratified (2004)
Stockholm Convention on Persistent Organic Pollutants (22 May 2001)	Ratified (2005)	Joined (2005)	Joined (2002)
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	Joined (2004)	Ratified (2005)	Joined (2004)
Source: website of each convention			

2.6.2 Regional Environmental Commitments

2.6.2.1 The Convention on the Sustainable Management of Lake Tanganyika (2003)

The objective of this Convention is to ensure the protection and conservation of the biological diversity and the sustainable use of the natural resources of Lake Tanganyika and of its basin by the Contracting States on the basis of integrated management and cooperation (Art. 2). It is based on a number of principles, namely: precaution, the polluter pays, preventive action and participation (Art. 5).

By signing the Convention, each of the four riparian States, Burundi, DRC, Zambia and Tanzania, undertake to:

- Ensure that activities within their jurisdiction or control do not cause transboundary adverse impacts, particularly related to fishing activities, through preventive measures (Arts. 6 and 7);
- Prevent, control and reduce liquid and solid pollution from, amongst others, factories, and the handling, transportation, use and disposal of toxic or hazardous materials in the lake basin. Each State must, to the extent possible, construct and maintain installations to reduce the risk of pollution of the lake and of its environment (Art. 8);
- Prevent all causes of excessive sedimentation in the lake, such as deforestation, land degradation and the destruction of wetlands (Art. 9);
- Conserve ecosystems, species of fauna and flora and genetic resources as well as their habitats that form part of the lake basin, particularly those that are endemic, rare, fragile, depleted or threatened; and prevent the introduction of, control and eradicate exotic species that threaten ecosystems, habitats or species and the genetic resources that form part of the lake basin (Art. 10).

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If a Contracting State (or States) envisage(s) activities that could give rise to adverse impacts, it (they) must notify the Secretariat of the Lake Tanganyika Authority as soon as possible and carry out an environmental impact assessment which must necessarily involve the public (Arts. 14, 15 and 17).

With regards to the Ruzizi III HEPP, it is noteworthy that the first version of the ESIA prepared in 2012 by SOFRECO was prepared under the auspices of regional organisations, including EGL, and included transboundary impacts. This ESIA, prepared in 2024 by REL in coordination with EGL, is an update of the 2012 ESIA. In addition, transboundary aspects are included in the project Implementation Agreement: Article 4.3 (i): "*The Company shall update the Resettlement Action Plan and the Environmental and Social Impact Assessment, with respect to the Site, in accordance with the Environmental and Social Standards. No later than six (6) months after the Effective Date, the Company shall submit the updated Resettlement Action Plan and the Environmental and Social Impact Assessment to the Contracting States for their approval*".

2.6.2.2 Joint Management of the Water Resources of the River Ruzizi (ABAKIR)

With a view to implementing international cooperation for the sustainable and equitable management of the basin's water resources and for the better socio-economic integration of the countries of the subregion, the three ECGLC countries decided to sign an international convention establishing an International Basin Authority under the acronym of ABAKIR (Autorité de Bassin du Lac Kivu et de la rivière Ruzizi), in English, the Lake Kivu and Ruzizi River Basin Authority, located in Rubavu in the ECGLC's buildings.

ABAKIR was created in July 2011, but its transitional structure only became operational in January 2013. On 4 October 2014, ABAKIR's Council of Ministers endorsed the international convention on the integrated water resource management of the basin of Lake Kivu. The participants also officially adopted and signed the statutes of ABAKIR.

The main objective of ABAKIR as set out in its presentation is to implement a cooperation policy for the sustainable development and stabilization of the Great Lakes Region, through the integrated management of the water resources of the basin of Lake Kivu and of the River Ruzizi in all dimensions (energy, agriculture, fishing activity, lake transportation, tourism, biodiversity, etc.).

ABAKIR's main roles are to:

- Establish an overview of the current situation of the water resources and environment of the basin, with an inventory of sources of pollution of Lake Kivu and of the River Ruzizi (industries, agriculture, intensive livestock farming, mines), and carry out a baseline environmental assessment of the catchment area.
- Monitor the state of the resources, their uses and consequences, taking into account risks such as floods, droughts, fluctuations in the lake's level, the release of gases at the lake's surface, erosion, volcanic and seismic activity, pollution, etc., with a view to proposing adapted measures.
- Develop and maintain a network on the quality and quantity of the water resources.
- Draw up development plans to manage and protect the resources based on information collected from various existing sources or structures and on that exchanged between the Member States.
- Establish common rules for the regulation of the resources, ensure their application, and assess the impact of non-compliance in order to establish remedial measures.
- Examine any user complaints and help the States to resolve conflicts in this area.

ABAKIR is very supportive of the project to build the Ruzizi III hydroelectric power plant and wants to contribute to its success, in particular:

- Through the reasoned promotion of reforestation in the upper part of the Ruzizi sub-basin to limit soil erosion and the resultant sedimentation in reservoir dams reducing the potential for peak electricity production.

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- By promoting resilient agricultural practices including erosion control.
- By organizing the collection of floating solid waste (soft and hard plastics, etc.).
- By monitoring and maintaining the physico-chemical and biological quality of the waters of the Kivu–Ruzizi system.
- By maintaining the stable annual flow of the River Ruzizi.
- By implementing a database that is available to all and which allows the water quality and the environment of the Kivu-Ruzizi system to be monitored.

ABAKIR also wants to invest in the basin's protection against erosion and soil degradation through reforestation and a sustainable land management policy. Cultivation practices that are resilient to climate change have been adopted (soil fertility management, anti-erosion, etc.). Renewable energies should be promoted on the scale of the basin. Environmentally-friendly solid and liquid waste management should be ensured in the urban areas of Lake Kivu and the Ruzizi [Kubaburanzi, 2015].

2.6.3 Lenders' Environmental and Social Standards

The Lenders that are considering providing financial assistance for the Project comprise:

- African Development Bank (AfDB).
- European Investment Bank (EIB).
- German Development Bank (KfW) – which aligns with World Bank Environmental and Social Standards (ESS).
- French Agency for Development (AFD) – which aligns with World Bank ESS.
- World Bank.

The potential Lenders' environmental and social policies are listed in the following paragraphs. The rational for triggering the standards and operational safeguards is presented in Table 2-6 and a gap analysis of Lenders' requirements compared to national requirements is provided in Table 2-7.

2.6.3.1 African Development Bank

The AfDB's environmental and social requirements are set out in an Integrated Safeguards System comprising a policy statement and operational safeguards (2013). The Operational Safeguards (OS) are as follows:

- OS1 – Environmental and social assessment
- OS2 – Involuntary resettlement: land acquisition, population displacement and compensation
- OS3 – Biodiversity, renewable resources and ecosystem services
- OS4 – Pollution prevention and control, hazardous materials and resource efficiency
- OS5 – Labour conditions, health and safety.

2.6.3.2 European Investment Bank

The EIB's environmental and social requirements are set out in the EIB's Environmental, Climate and Social Guidelines on Hydropower Development (2019) and in the Environmental and Social Sustainability Framework which is included in the EIB Group Environmental and Social Policy (2022). The policy includes the following 11 Environmental and Social Standards ("E&S Standards" or "the standards"):

- Standard 1: Environmental and social impacts and risks
- Standard 2: Stakeholder engagement
- Standard 3: Resource efficiency and pollution prevention
- Standard 4: Biodiversity and ecosystems

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- Standard 5: Climate change
- Standard 6: Involuntary resettlement
- Standard 7: Vulnerable groups, Indigenous Peoples and Gender
- Standard 8: Labour rights
- Standard 9: Health, safety and security
- Standard 10: Cultural heritage
- Standard 11: Intermediated finance

The EIB's Environmental, Climate and Social Guidelines on Hydropower Development set out the EIB's objectives for investments in hydropower projects, establishing sector-specific standards and criteria, which promoters should meet. They also summarise best practice recommendations for integrating social, biodiversity, natural resource management and climate considerations into hydropower projects. The topics included in the guidelines include management of the following: (i) strategic and basin-wide issues, (ii) environmental issues and impacts, (iii) social issues and impacts, (iv) climate resilience and GHG emissions, (v) reservoir and dam safety issues, and (vi) monitoring requirements.

2.6.3.3 IFC Performance Standards

The IFC Performance Standards (PS) where relevant:

- PS1 – Social and Environmental Assessment and Management System
- PS2 – Labor and Working Conditions
- PS3 – Pollution Prevention and Abatement
- PS4 – Community Health, Safety and Security
- PS5 – Land Acquisition and Involuntary Resettlement
- PS6 – Biodiversity Conservation and Sustainable Natural Resources Management
- PS7 – Indigenous Peoples
- PS8 – Cultural Heritage

2.6.3.4 World Bank

A Environmental and Social Framework

The World Bank's environmental and social requirements are set out in the World Bank Environmental and Social Framework (2018). The framework includes the following 10 Environmental and Social Standards (ESS):

- ESS1: Assessment and management of environmental and social risks and impacts
- ESS2: Labor and working conditions
- ESS3: Resource efficiency and pollution prevention and management
- ESS4: Community health and safety
- ESS5: Land Acquisition, restrictions on land use and involuntary resettlement
- ESS6: Biodiversity conservation and sustainable management of living natural resources
- ESS7: Indigenous Peoples/sub-saharan African historically underserved traditional local communities
- ESS8: Cultural Heritage
- ESS9: Financial intermediaries
- ESS10: Stakeholder engagement and information disclosure

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B Environmental, Health and Safety Guidelines

The World Bank Group's Environmental, Health and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). They cover the following categories:

- Environmental
  - Air Emissions and Air Quality
  - Energy Conservation
  - Wastewater and Water Quality
  - Water Conservation
  - Hazardous Materials Management
  - Waste Management
  - Noise
  - Contaminated Land
- Occupational Health and Safety
  - Facility Design and Operation
  - Communication and Training
  - Physical Hazards
  - Chemical Hazards
  - Biological Hazards
  - Radiological Hazards
  - Personal Protective Equipment (PPE)
  - Special Hazardous Materials
  - Disease Prevention
  - Emergency Preparedness and Response
- Construction and decommissioning
  - Environment
  - Occupational Health and Safety
  - Community Health and Safety ESS7
- General Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution
- General Environmental, Health and Safety Guidelines for Construction Material Extraction

C World Bank Good Practice Notes

The principles in the following Good Practice Notes are applied to the Project:

- Addressing Sexual Exploitation and Abuse and Sexual Harassment in Investment Projects Financing Involving Major Civil Works (2020)
- Addressing Gender-based Violence in Investment Project Financing Involving Major Civil Works (2018).
- Gender (2019)
- Road Safety (2019)
- Assessing and Managing the Risks and Impacts of the Use of Security Personnel (2018).
- Managing the Risks of Adverse Impacts on Communities from Temporary Project-induced Labour Influx (2016).

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D World Bank OP/BP 7.50 Project on International Waterways

The Bank recognizes that the cooperation and goodwill of riparians is essential for the efficient use and protection of the waterway. Therefore, it attaches great importance to riparians' making appropriate agreements or arrangements for these purposes for the entire waterway or any part thereof. The Bank ensures that the international aspects of a project on an international waterway are dealt with at the earliest possible opportunity. If such a project is proposed, the Bank requires the beneficiary state, if it has not already done so, formally to notify the other riparians of the proposed project and its Project/Program Details. The Bank ascertains whether the riparians have entered into agreements or arrangements or have established any institutional framework for the international waterway concerned.

The Project is a developed as a Private-Public Partnership (PPP), the shareholders of REL act as the private component and the *Energie des Grands Lacs* (EGL) acts as the public component. EGL is a specialised body of the Economic Community of the Great lakes Countries (ECGLC)[1] and is the agent for the three Contracting States (Burundi, DRC and Rwanda), which are also the riparian states affected by the Project's impacts on the Ruzizi River. It can therefore be considered that the Ruzizi River riparian states have been informed of the Project. The Lake Tanganyika Riparian States comprise Burundi, DRC, Tanzania and Zambia. The states of Tanzania and Zambia are not included in the PPP and have been informed of the Project by EGL (see 2.6.2.1).

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[1] Members comprise Burundi, DRC, Rwanda and Tanzania

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Table 2-6 Rationale for Triggering Lenders' Standards and Operational Safeguards

Topic	Lenders' E&S Standard / Operational Safeguard	Triggered		Scoping Rationale
		Yes	No	
Environmental and Social Assessment	• World Bank. ESS1 – Assessment and Management of Environmental and Social Risks and Impacts • IFC. PS1 – Assessment and Management of Environmental and Social Risks and Impacts • AfDB. OS1 - Environmental and Social Assessment • EIB: ESS1 – Assessment and Management of Environmental and Social Risks and Impacts, ESS4 – EIB Climate-Related Standards, and ESS7 – Rights and Interests of Vulnerable Groups	■	☐	The Project is a Category A project, with transboundary impacts, cumulative impacts, physical and economic resettlement. Full ESIA is required with environmental and social baseline surveys, ESMP, RAP, CIA, EFlow Assessment, CHA, climate resilience and GHG assessment.
Labor and Working Conditions	• World Bank. ESS2 – Labour and Working Conditions • IFC. PS2 – Labour and Working Conditions • AfDB. O25 Labour Conditions, health and Safety • EIB: ESS8 – Labour Standards	■	☐	Project construction will require 500-1,000 workers, with workers from the region (Burundi, DRC and Rwanda) and workers from other regions or countries. Many of the workers will be unskilled labourers. Construction works will represent high-risk activities for workers' health and safety and a robust system for management of labour and working conditions will be required. The impact assessment scope includes identification of the types of health and safety hazards and potential labour issues. The ESMP scope includes developing measures for managing labour and working conditions.
Resource Efficiency and Pollution Prevention and Management	• World Bank. ESS3 – Resource Efficiency and Pollution Prevention and Management • IFC. PS3 – Resource Efficiency and Pollution Prevention • AfDB. OS4 Pollution Prevention and Control, Hazardous • EIB: ESS2 – Pollution Prevention and Abatement	■	☐	Project construction activities will require handling and storage of hazardous substances such as fuel for vehicles and power generation, lubricating and hydraulic fluids, chemicals and transformer oils. Hazardous waste will be generated, domestic wastewater and sewage generated by 500-1,000 workers and will need to be managed. During operation, there will be fewer staff and less hazardous substances to manage. The impact assessment scope includes identification of the types of pollution risks during construction and operation, and the ESMP scope includes developing measures for pollution prevention management by the Contractor and Operator during construction and operation respectively.

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Topic	Lenders' E&S Standard / Operational Safeguard	Triggered		Scoping Rationale
		Yes	No	
Community Health and Safety	• World Bank. ESS4 – Community Health and Safety • IFC. PS4 – Community Health and Safety and Security • AfDB. OS1 - Environmental and Social Assessment • EIB: ESS9 – Occupational and Public Health, Safety and Security	■	☐	Community health and safety hazards include the consequences of accidental events such as dam failure and operational hazards such as peak and off peak flows in the river, exposure to EMF, traffic hazards and exposure to communicable diseases and waterborne diseases. The impact assessment scope includes identification of the types of health and safety risk during construction and operation, and the ESMP scope includes developing prevention and protection measures by the Contractor and Operator during construction and operation respectively, including the preparation of an Emergency Response Plan.
Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement	• World Bank. ESS5 – Land Acquisition, Restrictions on Land Use and Involuntary Resettlement • IFC. PS5 – Land Acquisition and Involuntary Resettlement AfDB. OS1 - Environmental and Social Assessment • AfDB. OS2 - Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation • EIB: ESS6 – Involuntary Resettlement, and ESS7 – Rights and Interests of Vulnerable Groups	■	☐	The project will require land acquisition in Rwanda and DRC resulting in physical and economic displacement. The ESIA will include social surveys, land valuation, development of an entitlement matrix for compensation and preparation of a RAP. Effected communities will be engaged to agree on compensation. 50 household (485 people) are affected by physical resettlement and 2,249 households (17,943 people) affected by economic displacement.
Biodiversity Conservation and Sustainable Management of Living Natural Resources	• World Bank. ESS6 – Biodiversity Conservation and Sustainable Management of Living • IFC. PS6 – Biodiversity Conservation and Sustainable Management of Living • AfDB. OS3 - Biodiversity, Renewable Resources and Ecosystem Services • EIB: ESS3 – EIB Standard on Biodiversity and Standards	■	☐	Much of the terrestrial habitat affected by the Project is modified habitat and is used primarily for agriculture. There are small discrete areas of natural habitat and degraded natural habitat in areas where slopes are too steep for agriculture, along riverbanks and on islands in the river channel. A baseline survey is included in the scope to characterise and map the terrestrial habitat. The aquatic habitat has been affected by the hydropeaking operation of the Ruzizi-I and -II hydropower schemes upstream from Ruzizi-III and which started operation in 1959 and 1989 respectively. However, although the fish present in the river includes several endangered and migratory species. Consequently, the scope of the ESIA includes a Critical Habitat Assessment, and the ESMP includes a framework for a Biodiversity Action Plan. The Critical Habitat Assessment qualifies the Ruzizi River in the Project area as Modified Habitat

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Topic	Lenders' E&S Standard / Operational Safeguard	Triggered		Scoping Rationale
		Yes	No	
Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	• World Bank. ESS7 – Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities • IFC. PS7 – Indigenous Peoples • AfDB. OS1 - Environmental and Social Assessment • EIB: ESS7 – Rights and Interests of Vulnerable Groups	■	☐	In 2023, an anthropological study conducted for the Project concluded that the 'Twa' social group, known as 'Batwa' in DRC and 'Historically Marginalised People (HMP)' in Rwanda, qualifies as Indigenous according to SP 7, WB ESS 7, AfDB OS 1 and EIB ESS 7. As per the standards, the following criteria are met: • **Self-identification as members of a distinct indigenous social and cultural group and recognition of this identity by others** – The communities recognise themselves and are identified as belonging to a social group separate to mainstream society. In Rwanda, identification with ethnic labels is outlawed. However, the community identifies itself and is identified as Historically Marginalised People (HMP), a term coined by the Rwandan administration. • **Collective attachment to geographically distinct habitats, ancestral territories, or areas of seasonal use or occupation, as well as to the natural resources in these areas** – The Batwas and HMP have lost attachment to their ancestral forests after decades of forced displacements. However, attachment to clay quarries and areas for wild plant and honey harvesting remains important. • **Customary cultural, economic, social, or political institutions that are distinct or separate from those of the mainstream society or culture –** The Batwas and HMP both engage in collecting and selling wild products, such as honey, medicinal plants, and straw. HMP specializes in pottery production, while this tradition has been lost in DRC. Both communities live together and do not integrate with mainstream society, maintaining a sense of unity. They face discrimination and derogatory labelling and are identified as living in extreme poverty. They have unique dances and songs, some of which are forgotten, and maintain distinct practices related to birth and death. • **A distinct language or dialect, often different from the official language or languages of the country or region in which they reside** – Although it is reported that the communities have specific words and intonation, the communities are not characterised by a specific language. It is possible that traditional languages got lost due to the communities' displacement and integration into mainstream society. Although the Lenders' standards on indigenous people are triggered, the requirements for Free and Prior Informed Consent (FPIC) are not met for the following reasons: • **The Project will not affect and / or relocate indigenous people from lands and natural resources subject to traditional ownership or under customary use** – The Batwas and HMP have been dispossessed of all collective, historical and customary property with forced displacements from ancestral forests. Consequently, both communities do not have any traditional rights over the lands which they use and / or inhabit in the Project area. • **The Project will not have a significant impact on cultural heritage that is essential to the communities' identity and / or to the cultural, ceremonial or spiritual aspects of the lives of indigenous people** – Most of the communities' cultural heritage has been lost due to their forced displacement from ancestral forests. The Project will not impact the communities' remaining cultural heritage, which is limited to a small number of dances and performances. The Project will develop an Historically Marginalized People Development Plan (HMPDP), which will assess and mitigate adverse impacts on the Batwas in DRC and HMP in Rwanda, as well as develop a timebound plan to ensure informed participation and consultation of indigenous people and create positive opportunities for the sustainable development of the communities.

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Topic	Lenders' E&S Standard / Operational Safeguard	Triggered		Scoping Rationale
		Yes	No	
Cultural Heritage	• World Bank. ESS8 – Cultural Heritage • IFC. PS8 – Cultural Heritage • AfDB. OS1 - Environmental and Social Assessment • EIB: ESS5 – Cultural Heritage	■	☐	The scope of the ESIA has included verification of this understanding through interviews with local communities the presence of tangible and intangible cultural heritage in the project area. There is 1 church and 7 graves affected by the Project in DRC, and several intangible cultural heritage sites, comprising 4 baptism sites and 3 prayer sites.
Stakeholder Engagement	• World Bank. ESS10 – Stakeholder Engagement and Information Disclosure • IFC. PS1 – Assessment and Management of Environmental and Social Risks and Impacts • AfDB. OS1 - Environmental and Social Assessment • EIB: ESS10 – Stakeholder Engagement	■	☐	With 485 people affected by physical resettlement and 17,943 people affected by economic displacement, stakeholder engagement needs to be undertaken.

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Table 2-7 Gap Analysis Between the National Legal Frameworks and Lenders Policies regarding land Acquisition and Involuntary Resettlement

Topics	Provision in Congolese legislation	Provision in Rwandan legislation	World Bank ES5, EIB ESS6 and AfDB OS 2 requirements
Avoidance and minimisation of displacement	No legal requirement to avoid or minimize physical and economic displacement	No legal requirement to avoid or minimize physical and economic displacement	The first objective of these policies is to avoid involuntary resettlement or, when unavoidable, minimize involuntary resettlement
Eligibility	Agricultural Law 11/02 of 24/12/2011 recognizes the customary land rights of each local community exercised collectively or individually on the land; these communities are therefore compensable. Expropriation Law no. 77-001 of 22/02/1977 stipulates that individual and collective rights of enjoyment may be subject to compensation. It states that expropriated landlords must notify tenants. If an identified rightful claimant cannot be reached at the time of expropriation, they will be represented, and their interests defended by an administrator of expropriable property appointed by the Regional Court. The Congolese texts do not mention the case of irregular (untitled and non-customary) occupants.	Law no. 32/2015 on expropriation specifies that persons claiming expropriation rights have to provide proof of their ownership rights. The first land registration campaign in Rwanda was finalized in June 2012, allowing for the legal allocation of all private-status land to title holders or customary occupants. The status of customary occupant is thus formalized by a certificate of registration (most frequently an emphyteutic lease). Rwandan legislation on expropriation does not provide for compensation for untitled occupants, especially since all private plots were in principle allocated in 2012. Law no. 32/2015 specifies that persons claiming expropriation rights have to provide proof of their ownership rights. Rwandan legislation on expropriation does not provide for compensation for untitled occupants, especially since all private plots were in principle allocated in 2012. Law no. 32/2015 specifies that persons claiming expropriation rights have to provide proof of their ownership rights.	Affected persons are those affected by physical displacement (relocation, loss of residential land or loss of shelter), or economic displacement (loss of land, assets or access to assets, leading to loss of income sources or other means of livelihood). Affected persons may be classified as persons: > Who have formal legal rights to land or assets; > Who do not have formal legal rights to land or assets, but have a claim to land or assets that is recognized or recognizable under national law; or > Who have no recognizable legal right or claim to the land or assets they occupy or use. People under the third category are eligible for compensation for loss of assets (but not land) and are entitled to resettlement and livelihood restoration assistance, as the other categories. Tenants are eligible to resettlement and livelihood restoration assistance.
Cut-off date	According to Land Law no. 73-081 of 20/07/1973 and Expropriation Law no. 77-001 of 22/02/1977, the cut-off date is the date on which the public enquiry is launched; this date must be clearly notified at the expropriation site.	According to Law no. 32/2015 on expropriation, it is the start date of the land measurement and property inventory, which is notified via posters at the office of the Project Site Unit, or by messages on the radio or in the press (media with a large audience or readership). If necessary, any other means of communication may be used (Art. 24). This law also specifies that no activity undertaken after the official publication of the expropriation decision shall be subject to compensation (Article 17).	For both ESS n°5 and OS n°2, a cut-off date shall be established for eligibility prior to the assets inventory. Information about the cut-off date should be disseminate throughout the project area of influence in a culturally appropriate and accessible manner, before taking any action on clearing land or restricting local community access to land.
Valuation of compensation	The 2006 Constitution stipulates that expropriation compensation must be fair. Land Law no. 73-081 of 20/07/1973 and Expropriation Law no. 77-001 of 22/02/1977 specify that the compensation due to an expropriated person must be based on the value of the property on the date of the judgement ruling on the legality of the process. Expropriation Law no. 77-001 of 22/02/1977 also specifies that compensation is estimated by surveyors working alongside specialists in the activities carried out in the field (agronomists for agricultural activities, for example). It may be assumed that the amounts of	Law no. 32/2015 of 11 June 2015 on expropriation for reasons of public interest stipulates that expropriated people must receive fair and equitable compensation covering not only the price of the land but also the activities carried out on the expropriated plots such as crops, plantations or buildings, or other activities aimed at improving the productivity of the land. This law specifies that the amount of compensation will be set according to prevailing market prices estimated by the Institute of Real Property Values in Rwanda. The unit prices of land and property thus	PAPs should be compensated at full replacement cost in real terms. The replacement cost is a method of valuation yielding compensation sufficient to replace assets, plus necessary transaction costs associated with asset replacement. Transaction costs include labour cost, administrative charges or registration or title fees, and any similar costs imposed on affected persons. The valuation method used for determining replacement cost should be transparent and documented. Whenever feasible, all PAPs should be offered an informed choice of either compensation in kind (land-

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Topics	Provision in Congolese legislation	Provision in Rwandan legislation	World Bank ES5, EIB ESS6 and AfDB OS 2 requirements
	compensation correspond to the nature of the property lost and take into account the investments made and the expected returns. Agricultural Law no. 11/022 provides that "The State, the province and the decentralized territorial entity shall set up information systems on the markets and prices of agricultural products" (Art. 64), but these systems do not appear to be in force at present. However, resettlement studies show that relevant scales are developed on a case-by-case basis.	established are published annually in the Official Gazette (Art. 22). It should be added that the law also provides for compensation for disruption to cover moving expenses. This compensation amounts to 5 % of the amount of property compensation (Art. 28).	for-land; house-for-house; shop-for-shop) or monetary compensation at full replacement cost. Where the PAPs' livelihood is land-based or the land is collectively owned, land-for-land compensation should be favoured. If this option is not available, sufficient justification needs to be provided as to why this option is not feasible, including justification that livelihoods are not affected by not replacing land.
Timing of the Payment of Compensations	The 2006 Constitution stipulates that expropriation compensation must be paid before dispossession. The date of dispossession shall be notified in the declaration of public utility. Compensation must be paid before the transfer of property, i.e. before the new certificate of registration is drawn up in the name of the State and before annulment of the expropriated person's certificate, and no later than four months (120 days) after the date of the judgement setting the amount of compensation (Expropriation Law no. 77-001 of 22 February 1977).	According to Law no. 32/2015 of 11 June 2015 on expropriation, fair compensation for the expropriated party must be paid before their move. The amount of compensation must be paid within 120 days of approval by the District Council. After receiving fair compensation, the expropriated person shall move out within a period not exceeding 120 days (Art. 35 and 36).	Land plots and related assets should be acquired for the Project only after full payment of compensations and, where applicable, after the displaced people have been resettled and moving allowances have been provided to the displaced persons in addition to compensation.
Resettlement assistance and Livelihood restoration	Apart from compensation for the land and property affected, DRC's legislation does not provide for any special assistance to displaced persons, regardless of their status.	Support for displaced persons is limited to the payment of compensation for disruption, as provided for by Law no. 32/2015 on expropriation.	Resettlement assistance shall be provided to the affected persons. Requirement to provide assistance to the affected people improve or at least restore their livelihoods and standards of living compared to pre-displacements levels. Transitional assistance should also be provided during the time needed to restore the livelihoods.
Vulnerable people	In DRC, legislation on expropriation does not make special provision for vulnerable groups or disadvantaged individuals or families.	Rwanda's legislation on expropriation does not make special provision for vulnerable groups or disadvantaged individuals or families.	Vulnerable people must be identified and those who warrant specific assistance must be identified and supported throughout the resettlement compensation process.
Gender	DRC's legislation does not include any gender-related provisions in its expropriation procedures.	Rwandan legislation does not include any gender-related provision in its expropriation procedures.	The Lenders' policies require the promoter to ensure that compensation is paid without discrimination on the basis of gender, ethnic group, religion, or disability. When compensation takes the form of new housing, it is recommended that the title deeds be issued in the name of the head of household and his wife, and not in the name of the former alone.

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Topics	Provision in Congolese legislation	Provision in Rwandan legislation	World Bank ES5, EIB ESS6 and AfDB OS 2 requirements
Consultation with affected persons	The public enquiry procedure defined by Land Law no. 73-081 of 20/07/1973 and reiterated in Expropriation Law no. 77-001 of 22/02/1977 prescribes poster advertising in the place concerned and a census of the occupants and persons carrying out an activity on the land to be expropriated, along with a hearing of anyone who makes complaints or observations orally.	Law no. 32/2015 on expropriation states that (Art. 11 and 16): the committee responsible for monitoring expropriation projects shall review the appropriateness of the project within a period not exceeding 30 days of receipt of the request and shall hold a consultative meeting with the population who live where the land is situated to discuss the appropriateness of the expropriation project. The decision to expropriate in the public interest shall be announced on at least one radio station with a wide audience and in a newspaper with a wide readership for the attention of the parties concerned. If necessary, other means of communication may be used. The list of registered rights holders for land titles and property incorporated on the land shall be posted in a place accessible to the public in the district, sector, and the unit where the land is located, within a period not exceeding 15 days of the date of approval of expropriation in the public interest.	Resettlement activities shall be planned and implemented with appropriate disclosure of information, meaningful consultation, and the informed participation of those affected.
Grievances management	Expropriation Law no. 77-001 of 22 February 1977 provides for action in the civil court (the 'legal phase' of the procedure) in the event of a disagreement between the expropriating party and the expropriated person(s) on the amount of compensation. The court first verifies the legality of the proceedings and then automatically appoints three experts agreed on by the parties and sets the deadline for their report (maximum 60 days, or 90 days in exceptional cases). Within eight days of the experts' report being filed, the court summons the parties to a hearing, which the experts also attend. Within one month of this hearing, the court rules on the amount of compensation and ancillary costs and, if the expropriated person so requests, the deadline for dispossession.	Law no. 32/2015 of 11 June 2015 on expropriation stipulates that whoever contests the value attributed, shall, at their own expense, hire an appraiser or firm of appraisers approved by the Institute of Real Property Values in Rwanda to provide a counter-assessment. The counter-assessment report must be provided within 10 days of its request. If the disagreement remains after the expropriating party's examination of this report, the expropriated person may take the case to the competent court within a period of 15 days of signature of the report, indicating the areas of disagreement (Articles 33 and 34).	According to the Lenders' policies, the Project shall establish a grievance mechanism to address specific concerns about compensation, relocation or livelihood restoration measures raised by displaced persons (or others) in a timely fashion. The grievance mechanism will be proportionate to the potential risks and impacts of the project and will be accessible and inclusive. Handling of grievances will be done in a culturally appropriate manner and be discreet, objective, sensitive and responsive to the needs and concerns of the project-affected parties. The mechanism will also allow for anonymous complaints to be raised and addressed
Monitoring and evaluation	DRC's legislation on expropriation does not provide for monitoring and evaluation procedures.	Rwandan expropriation legislation does not provide for monitoring and evaluation procedures but the REMA, which is responsible for monitoring impact assessments, is supposed to control social impacts.	As per the Lenders' requirements, The Project shall establish procedures to monitor and evaluate the implementation of the Resettlement Action Plan. The extent of monitoring activities will be proportionate to the project's risks and impacts. These policies require the promoter to provide the resources, staff and procedures necessary to develop a monitoring and evaluation system for the resettlement process.

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3 ESIA Process & Methodology

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Contents

3.1 ESIA Process and Dates 3-1

3.2 Baseline Surveys 3-1

3.2.1 Biodiversity Surveys 3-1
3.2.2 Hydrology and Geomorphology 3-2
3.2.3 Social Surveys and Studies 3-3

3.3 Area of Influence, Study Area & Approach for Assessment 3-4

3.4 Impact Assessment Methodology 3-9

3.4.1 Identification of Impacts 3-9
3.4.2 Magnitude 3-9
3.4.3 Sensitivity 3-10
3.4.4 Assessment of Impact Significance 3-11
3.4.5 Residual Impacts 3-12

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Tables

Table 3-1 Dates of Key ESIA Activities for the Present Report 3-1
Table 3-2 Area of Influence and Approach for Assessment 3-7
Table 3-3 Definitions of Types of Impacts 3-9
Table 3-4 General Criteria for Determining Magnitude 3-10
Table 3-5 General Criteria for Determining Sensitivity 3-10
Table 3-6 Ranking of Mitigation Measures 3-11

List of Figures

Figure 3-1 Area of Influence / Study Area Map (1/2) 3-5
Figure 3-2 Area of Influence / Study Area Map (2/2) 3-6
Figure 3-3 Significance Ranking Matrix 3-11

PUBLIC DISCLOSURE AUTHORIZED

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3.1 ESIA Process and Dates

The Project's ESIA process started in 2012, when the Project was being developed by EGL. The environmental consulting company SOFRECO was engaged by EGL to prepare an ESIA and a RAP based on the 2010 Feasibility Study prepared by Fichtner, and this was financed by the EIB. Environmental and Social baseline surveys were conducted by SOFRECO in 2012 and some stakeholder consultations undertaken.

In 2019, after a period of remaining dormant, the Project was relaunched via a PPP with REL as the private partner. The engineering company TRACTEBEL conducted further Feasibility Studies and REL engaged SOFRECO to update the 2012 ESIA to assess the impacts of the TRACTEBEL's design, which included designs for the original dam site and an alternative dam site situated 500 m upstream from the original.

SOFRECO updated the 2012 ESIA and RAP in 2021 in order to assess the TRACTEBEL design for the original and alternative dam location design. However, the 2021 ESIA (SOFRECO, 2021a) did not include a comprehensive social baseline update because of COVID travel restrictions. Two additional fish surveys were undertaken and biodiversity baseline data was briefly studied.

In Q4 2021 REL engaged SLR to develop the Pre-ESIA prepared by SOFRECO into a full bankable ESIA. The key activities in the ESIA process for the present report are as follows:

Table 3-1 Dates of Key ESIA Activities for the Present Report

Dates	Key activities
December 2O21	• Review of the SOFRECO 2021 Pre-ESIA / Gap Analysis and scoping • Reconnaissance mission
January 2O22	• Environmental and social baseline surveys
February-April 2022	• Draft ESIA, RAP, CIA, EFlow Assessment and ESMP preparation
May 2022	• Presentation of the ESIA and RAP findings to local communities • Issue of the draft ESIA, RAP, CIA, EFlow and ESMP to potential lenders
June 2023	• Issue of the revised draft ESIA, RAP, CIA, EFlow and ESMP to potential lenders
June 2024	• Issue of the draft final ESIA, RAP, CIA, EFlow and ESMP to potential lenders

3.2 Baseline Surveys

Baseline environmental and social survey data collected by SOFRECO in 2012 is considered outdated and is not presented in this report. SLR mobilised environmental and social survey teams to the Project area in January and February 2022, to complement the 2021 Preliminary ESIA (SOFRECO, 2021a) as described in the following paragraphs.

3.2.1 Biodiversity Surveys

3.2.1.1 Terrestrial Biodiversity

SLR conducted a terrestrial biodiversity survey from 19-24 January 2022. The terrestrial biodiversity team was composed of one international bird and vegetation expert and one national bird expert. The team covered the project area upstream of the Burundi border, including areas where infrastructure will be built. It targeted the different natural habitats identified on satellite imagery prior to the survey and while in the field. Informal interviews were undertaken with the local communities, in order to identify the potential presence of some species (particularly mammals), based on illustrations. In addition, a second targeted survey for flora and avifauna was undertaken from 13-17 May 2024 involving one international

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bird and vegetation expert and one national bird expert. The focus of this survey was to (i) locate any flora Species of Conservation Concern and (ii) identify any avifauna species that are considered at high-risk from the proposed development.

3.2.1.2 Aquatic Biodiversity

SLR conducted an aquatic biodiversity survey from 19-24 January 2022 and a short follow-up low flow survey on 27 February 2022. The aquatic biodiversity team was composed of one international f aquatic ecologist and one national macroinvertebrate expert. The team covered the whole project area, including areas where infrastructure will be built, and areas outside the project footprint, in the wider watershed. Twenty-two survey sites were sampled, along three river courses: Ruzizi, Rubyiro and Ruhwa. Fish sampling was undertaken using electrofishing at 15 sites. Depending on the environmental conditions, four fishing techniques were used: (i) short nets; (ii) experimental gill nets (iii) electro fishing and (iv) crab/fish trap. Informal ad hoc interviews were undertaken with local fishers to identify the potential presence of some fish species based on illustrations.

The February 2022 survey involved electrofishing at two sites in the Ruzizi River (Sites R09a and R12) focussed on confirming the presence of *Chiloglanis* spp. only, and one site (Site R12), was sampled for macroinvertebrates.

The baseline surveys included the Ruzizi tributaries of Rubyiro and Ruhwa. However, it did not include the tributaries further downstream of Bugarama in Burundi, including the Muhira, Kaburantwa, Nyakagunda and Nyamagana, largely due to border access and security concerns. Additional fish survey data for the Lower and Middle Ruzizi (collected between 2015 and 2022) was obtained from national fish experts at Centre of Research in Biodiversity, Ecology, Evolution and Conservation (CRBEC) and the Research Centre in Natural Sciences and Environment (CRSNE) in Burundi. Although not yet published, key findings have been integrated into the report where appropriate.

3.2.2 Hydrology and Geomorphology

The principal sources of hydrology and geomorphology baseline information presented in the ESIA are the Project's technical studies prepared by Tractebel and comprising the following:

- Hydrology and Sediment Review (2020)
- River Channel Hydraulics (2020)
- Upstream Site Feasibility Study (2021)
- Natural Hazards Assessment (2021)
- Final Project Design Report (2022)
- Sediment Management Study (2022)

These studies were informed in part by previous technical studies undertaken for the Project by Fichtner in 2010 and Studio Pietrangeli in 2013.

Additional assessment of sediment has been provided by SLR's sediment specialist using expert judgment and interpretation of satellite imagery in conjunction with review of the Tractebel technical studies.

The hydrology expert conducted a site visit from 19-24 January 2022 to make a visual appraisal. While in Rwanda, the expert also met with ABAKIR and the Rwanda Water Board to collect secondary data on hydrology and sediments, in particular the *Baseline study for the basin of Lake Kivu and the Ruzizi River* (SHER Consult, 2020).

Additional primary data collection of water levels was undertaken during the period 8 February 2023 to 12 March 2023 to support appraisal of the hydrological conditions in Burundi.

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3.2.3 Social Surveys and Studies

3.2.3.1 Qualitative Social Survey

The qualitative social survey carried out in January 2022 was designed to achieve the following objectives:

- Map and document the settlements and communities who will be the receptors of impacts during construction and operation, namely, (i) the closest settlements to the project footprints, (ii) the communities using the land and natural resources downstream of the future dam, down to the confluence with the Ruhwa River, and (iii) the communities benefitting from ecosystem services affected by the Project.
- Document the socio-political organisation of communities which may be the receptors of various impacts, including decision-making systems, social hierarchies and conflict resolutions mechanisms.
- Document formal and informal patterns of land tenure and land usage.
- Assess and document the impact of the loss of and loss of access to land and assets affected by the land acquisition.
- Assess and document the presence of any material and immaterial cultural heritage elements.
- Identify vulnerable groups according to local understandings and perceptions of vulnerability.
- Assess the overall public health situation in the study area, documenting the most common diseases, closest health centres, and drinking water and sanitation facilities.
- Assessing and documenting current use of provisional or cultural ecosystem services by the communities living close the river.
- Assessing gender dynamics across the study area and identifying additional Project-related impacts on women, both due to land acquisition and worker in-flow during construction.

Socio-economic qualitative data was collected through several activities which consisted of on-site observations, focus groups, formal interviews and informal discussions. A more detailed description is provided in Section 8 – Social Baseline Situation.

3.2.3.2 Quantitative Social Survey

The quantitative socio-economic survey was carried out from 28 January to 9 February 2022 and consisted of a socio-economic questionnaire. The objective was to collect socio-economic information on the physically and economically displaced households in DRC and Rwanda. The information collected as part of the quantitative survey was related to:

- The demographic profile of the surveyed population, including nationality, ethnicity (in the case of DRC only), language, education, religion, age and gender.
- Current livelihood strategies, types of income generating activities, levels of cash circulating in the economy and existing financial management and risk sharing institutions.
- Land owning and renting trends.
- Access to and use of natural resources.

Six hundred and one (601) households were randomly selected for the survey. This represents a sample of 27% of the affected households. A total of 2,249 households will be affected by the project of which 50 are affected by physical displacement and 2,199 affected only be economic displacement. The survey interviewed all households potentially impacted by physical displacement.

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3.2.3.3 Inventory of Assets

The Project Developer undertook an inventory of affected assets in Rwanda and DRC starting on 28 September 2021 and 1 October 2021 respectively. The inventory is provided in the RAP (see Vol. V).

3.2.3.4 Historically Marginalized People Studies

An assessment of the situation of the Historically Marginalized People (HMP) in Rwanda impacted by the Project was undertaken by REL. An interview was conducted with the only historically marginalized family impacted by the project in Rwanda. The interview took place on 9 February 2022 in the Ryagashyitsi village, Murya Cell, Nzahaha Sector. with the participation of the Social Economic Development Officer of the Cell.

An assessment based on interviews conducted in DRC by REL was conducted. 9 heads of Batwa households in Bujenjere and 8 heads of Batwa households in Ruduha (both in Nyangezi cluster) were interviewed. Focus groups discussions were undertaken on 7 and 12 October 2022 in Kamanyola, Ruduha, and Bujenjere Nyangezi. The interviews gathered additional information on the socio-economic life of the HMP.

A specialist study was undertaken by Anthropolinks in 2023 to investigate the socioeconomic and cultural characteristics of the two communities. Three indigenous people experts conducted (i) a data desk documentation review, (ii) a 7-day fieldtrip to the Project area (in DRC and Rwanda), and (iii) interviews with two local HMP experts and local leaders. During the fieldwork, the experts visited Batwa's communities including individuals and households. Data was collected through intensive Interviews and focus group discussions, conducted in Swahili in DRC and in Kinyarwanda in Rwanda. Interviews were conducted with local authority and civil society to collect their view on the subject and to cross-check information. A total of 17 interviews were conducted (7 in DRC and 8 in Rwanda). In addition, the expert's team interviewed HMP leaders and NGOs focusing on protecting the rights of the HMP.

3.3 Area of Influence, Study Area & Approach for Assessment

The table below summarises the area of influence and approach for the assessment of impacts. More detailed information is provided in Section 11 – Impact Assessment and Mitigation.

The maps showing the Area of Influence and Study Area are provided in Figure 3-1 and Figure 3-2.

Overall, the area of influence defined for the assessment is precautionary and covers the area occupied by the Project facilities and the Ruzizi River between Ruzizi-II dam and the outflow of the Ruzizi River into Lake Tanganyika. However, it is noteworthy that the ESIA assesses that the alteration to river hydrology downstream from the Project powerhouse is not significant, and although the Ruzizi Delta and Rusizi National Park and Ramsar site are within the AoI they are not predicted to be subject to significant impacts.

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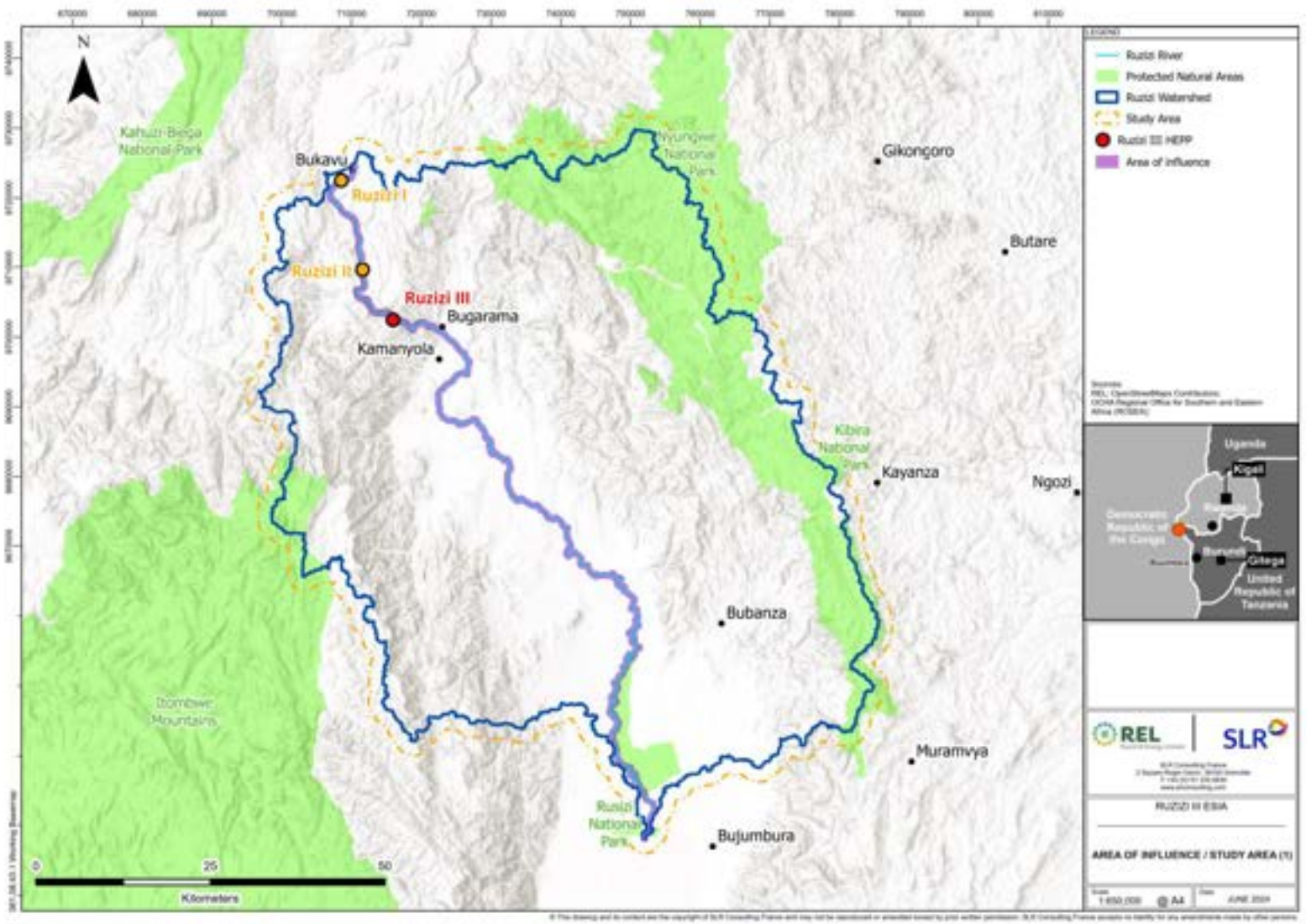


Figure 3-1 Area of Influence / Study Area Map (1/2)

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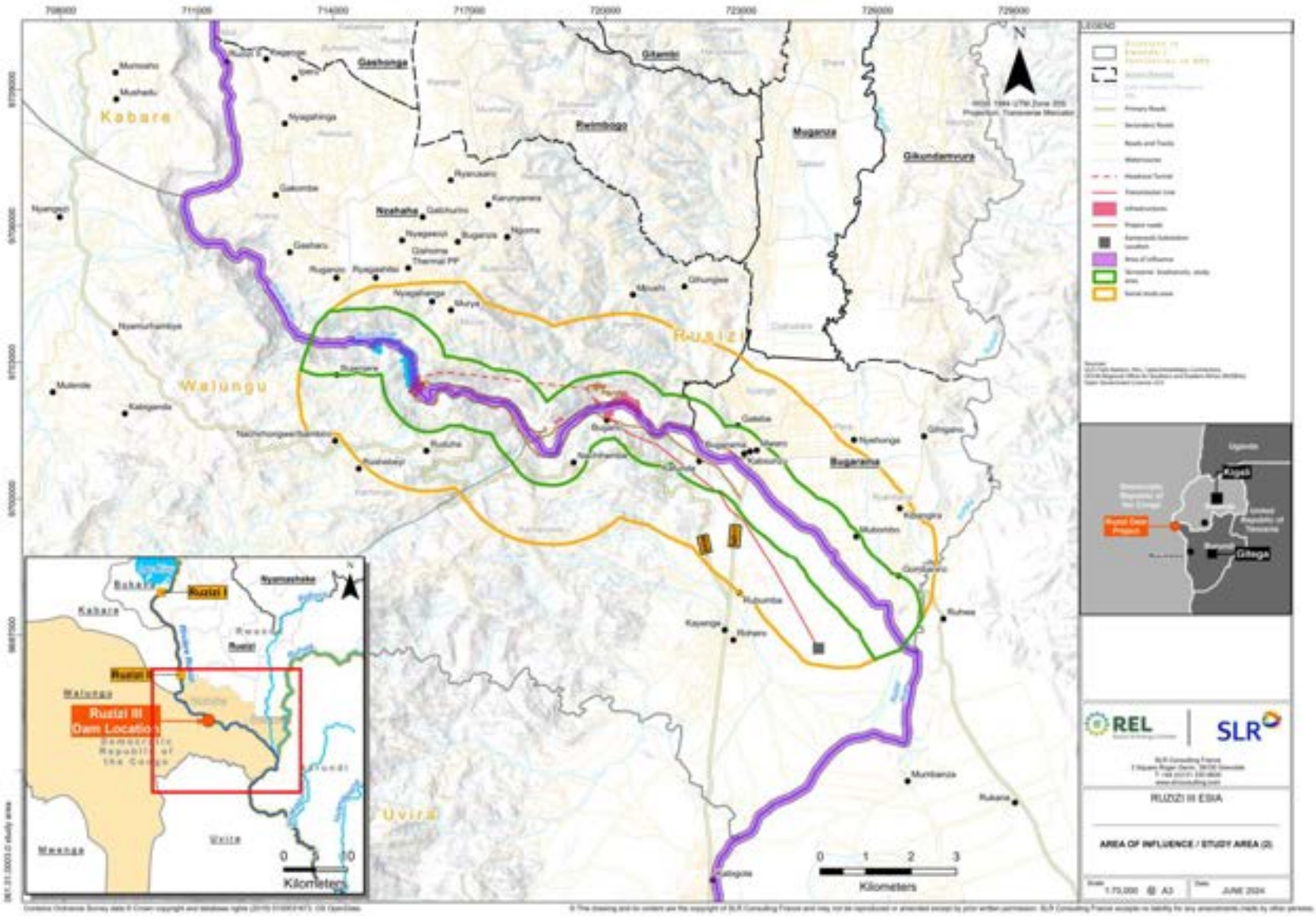


Figure 3-2 Area of Influence / Study Area Map (2/2)

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Table 3-2 Area of Influence and Approach for Assessment

Impact Topic	Area of Influence	Approach for Assessment
Climate change vulnerability	Ruzizi river inflow into Project reservoir	Quantitative, climate resilience study in alignment with IHA guide.
Greenhouse gas emissions	National and international	Quantitative, emissions construction and reservoir emissions calculated using method aligned with IHA guide. Emission reductions compared to continued use of current energy mix calculated.
Air quality, dust and odour	Immediate vicinity of worksites during construction	Semi quantitative, location of impact producing activities in relation to sensitive receptors identified and characterised, impact assessed using expert judgment.
Noise and vibration	Immediate vicinity of worksites during construction	Semi quantitative, location of impact producing activities in relation to sensitive receptors identified and characterised, impact assessed using expert judgment.
Soils, groundwater	Footprint of worksites during construction	Semi quantitative, location of impact producing activities in relation to sensitive receptors identified and characterised, impact assessed using expert judgment.
Surface water	Project reservoir and Ruzizi River downstream during operation	Quantitative, changes in water quality from biodegradation of flooded biomass calculated
Hydrology	Dewatered reach between project dam and powerhouse	Quantitative, baseline conditions (operation of Ruzizi-I and -II) and future conditions with the Ruzizi-III project determined using 1D & 2D hydraulic modelling.
	Hydropeaking reach between Project powerhouse and border with Burundi	Quantitative, baseline conditions (operation of Ruzizi-I and -II) and future conditions with the Ruzizi-III project determined using 1D hydraulic modelling.
	Border with Burundi to Lake Tanganyika	Quantitative, baseline conditions (operation of Ruzizi-I and -II) and future conditions with the Ruzizi-III project determined using broad-scale 1D hydraulic modelling.
Geomorphology and sediment	Ruzizi River from Lake Kivu outfall to Ruzizi Delta at inflow to Lake Tanganyika	Semi -quantitative, baseline conditions assessed, impact assessed using expert judgment.
Wastes		Expert judgement for identification of impact producing activities, focus on recommendations for management measures.
Aquatic habitat and biodiversity	Ruzizi River from Ruzizi-II HPP to Ruzizi Delta at inflow to northern end of Lake Tanganyika (to cater for potential downstream impacts on fish migration). The AoI includes: • 12.5 km upstream from Ruzizi III to Ruzizi II HPP including 3 km inundation zone • 6 km dewatered reach • 130 km downstream reach to Ruzizi National Park & Ramsar site (fish migration & flow modification)	Semi-quantitative, baseline survey conducted in Middle Ruzizi with Rwanda. Changes to hydrology assessed using modelling tools to determine extent of potential downstream impacts. Medium resolution Environmental Flow Assessment conducted informed by the IFC good practice handbook – and using expert judgment and used to assess downstream impacts. Critical Habitat Assessment conducted based on ESS criteria and IFC GN6 thresholds.

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Impact Topic	Area of Influence	Approach for Assessment
Terrestrial habitat and biodiversity	Footprint of Project components and buffer zones	Baseline survey conducted, and habitats affected quantified by overlaying proposed project infrastructure. Critical Habitat Assessment conducted based on ESS criteria and IFC GN6 thresholds. Note: Physical land-take infrastructure polygons provided by REL cater for potential degradation edge effects as these polygons represent the outer boundary for infrastructure placement. It is noted that impacts of noise and air quality on fauna/flora are likely to be minimal given the degree of habitat modification and scarcity of fauna. The transmission line AOI of 30 m was considered for habitat loss. The risk of bird collision and electrocution was based on species occurring within the landscape and not only within the 30 m corridor.
Social and economic impacts	Villages where residents are affected by physical and economic displacement, population influx, impacts from Project traffic	Quantitative, baseline survey conducted and impacts on individual households determined. RAP prepared.
Labour and working conditions	Worksites	Expert judgement for identification of impact producing activities, focus on recommendations for management measures.
Community health and safety	Immediate vicinity of footprint of Project components	Expert judgement for identification of impact producing activities, focus on recommendations for management measures.
Ecosystem services	Immediate vicinity of footprint of Project components	Qualitative, ecosystem services identified through interviews with people in the project area, assessment of impacts made using expert judgement.
Indigenous People	Villages where residents are affected by physical and economic displacement, population influx, impacts from Project traffic	Qualitative and quantitative social baseline surveys identified Batwas (DRC) and historically marginalised people (Rwanda) in the Project area of influence and amongst Project Affected People. The Project has conducted an anthropological study to further assess the integration of Batwa people and historically marginalised people in respectively in DRC and Rwandan society.
Landscape and visual amenity	Immediate vicinity of footprint of Project components	Qualitative, sensitivity of landscape and magnate of impacts assessed using expert judgement.
Positive impacts and benefits	Regional	Qualitative assessment based on expert judgement
Cumulative impacts	Ruzizi River watershed	The methodology follows the approach and steps set out in the Good Practice Handbook on Cumulative Impact Assessment and Management for the Private Sector in Emerging Markets (IFC, 2013).

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3.4 Impact Assessment Methodology

The assessment of impacts has been carried out following the methodology and approach described in the "How to Guide" for Hydropower Environmental and Social Assessment and Management, published by the International Hydropower Association (IHA, 2021). The publication is intended to contribute to increasing knowledge and understanding of the practical measures that can be undertaken to meet good international industry practice, in conformance with the internationally recognised Hydropower Sustainability Tools[1].

3.4.1 Identification of Impacts

The assessment of impacts involves four main stages, namely (i) identification and prediction, (ii) determination of significance, (iii) identification of mitigation measures, and (iv) evaluation of residual impact. Impacts may be direct or indirect, adverse (negative) or positive, induced or cumulative (see table below). The impact assessment systematically considers whether each project feature or activity will have an impact on each aspect of the baseline.

Table 3-3 Definitions of Types of Impacts

Type of Impact	Definition
Negative	An impact that is considered to be an adverse change from the baseline or introduces a new undesirable factor.
Positive	An impact that is considered to be an improvement on the baseline conditions or introduces a positive change.
Direct impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (e.g. the loss of vegetation and habitat as a result of site clearing, or between an effluent discharge and receiving water quality).
Indirect impact	Impacts that result from other activities that occur as a consequence of the project.
Induced impact	Induced impacts are a type of indirect impact, and result from activities that occur in response to the changes brought by a new development (e.g. increased forest loss due to in-migration using improved access from the construction of the project access road). They may also be referred to as secondary impacts.
Cumulative Impact	The combined effects of the project and other existing or planned future developments or natural processes on the same resources and/or receptors; these effects are additive or interactive in nature.

3.4.2 Magnitude

The assessment of magnitude will be undertaken in two steps. Firstly, the key issues associated with the Project have been categorised as beneficial or adverse. Secondly, the magnitude of potential impacts has been categorised as major, moderate, minor or negligible based on parameters such as:

- Duration of the impact - ranging from beyond decommissioning to temporary with no detectable impact.
- Spatial extent of the impact – for instance, within the site, boundary to regional, national, and international.
- Reversibility - ranging from permanent requiring significant intervention to return to baseline to no change.
- Likelihood – ranging from occurring regularly under typical conditions to unlikely to occur.

[1] An independent and accredited IHA assessor assessed the Project in 2022 using the IHA sustainability tool and no gaps were identified.

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- Compliance with legal standards and established professional criteria - ranging from substantially exceeds national standards and limits / international guidance to meets or exceeds minimum standards or international guidance.

Table 3-4 below outlines generic criteria for determining magnitude. The matrix and definitions of magnitude associated with different receptors (i.e. water, air, biodiversity, etc.) are provided within each subsection of Section 11.

Table 3-4 General Criteria for Determining Magnitude

Magnitude (Beneficial or Adverse)	Description
Major	Fundamental change to the specific conditions assessed resulting in long term or permanent change, typically widespread in nature, and requiring significant intervention to return to baseline; exceeds national standards and limits.
Moderate	Detectable change to the specific conditions assessed resulting in non-fundamental temporary or permanent change.
Minor	Detectable but minor change to the specific condition assessed.
Negligible	No perceptible change to the specific condition assessed.

Topic-specific criteria are provided in Section 11 – Assessment of Impacts and Mitigations

3.4.3 Sensitivity

Sensitivity is generally site specific and criteria have been developed from baseline information gathered. The sensitivity of a receptor will be determined based on review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the surrounding area. Generic criteria for determining sensitivity of receptors are outlined in Table 3-5. Each detailed assessment defines sensitivity in relation to the relevant discipline.

Table 3-5 General Criteria for Determining Sensitivity

Sensitivity	Description
High	Vulnerable receptor (human or ecological) with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
Medium	Vulnerable receptor (human or ecological) with limited capacity to absorb proposed changes or limited opportunities for mitigation.
Low	Vulnerable receptor (human or ecological) with some capacity to absorb proposed changes or moderate opportunities for mitigation.
Negligible	Vulnerable receptor (human or ecological) with good capacity to absorb proposed changes or and good opportunities for mitigation.

Topic-specific criteria are provided in Section 11 – Assessment of Impacts and Mitigations

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3.4.4 Assessment of Impact Significance

Assessing the significance of each identified potential impact is central to the assessment. Impacts that are concluded to be Not Significant (NS) do not require any management. Impacts that are Significant (S) must be avoided, minimised, mitigated or compensated, so that the residual impact is Not Significant. In assessing significance, a precautionary approach is applied and measures to manage an impact are planned, even if the impact is not certain. The significance of each impact is determined by categorising the Magnitude of the impact and the Sensitivity of the receptor, as shown in the matrix below.

		Sensitivity			
		Negligible	**Low**	**Medium**	**High**
Magnitude	**Negligible**	**Negligible** Not Significant	**Negligible** Not Significant	**Negligible** Not Significant	**Negligible** Not Significant
	Minor	**Negligible** Not Significant	**Minor** Not Significant	**Minor** Not Significant	**Moderate** Significant
	Moderate	**Negligible** Not Significant	**Minor** Not Significant	**Moderate** Significant	**Major** Significant
	Major	**Minor** Not Significant	**Moderate** Significant	**Major** Significant	**Major** Significant

Figure 3-3 Significance Ranking Matrix

Negligible and Minor impacts are **Not Significant**, and Moderate and Major impacts are **Significant**.

If a particular potential impact of the project is rated as significant using the above methodology, the next step is to determine which mitigation measures can be taken to avoid, minimise and mitigate the impact, and if necessary, compensate for it in accordance with the mitigation hierarchy. The aim is to first entirely avoid, then to minimise, then restore, or finally to compensate for the impact, so that any remaining adverse residual impact is not significant. Table 3-6describes the mitigation hierarchy and presents environmental and social examples.

Table 3-6 Ranking of Mitigation Measures

Avoidance at source Develop the project such that the characteristic causing an impact is eliminated at the design stage (elimination of waste materials flow, for example).
Reducing at source Modify the design of the project or of operational procedures in order to reduce the impact. For example, measures used to process effluent and waste materials fall into this category.
Reducing at receptor level If an impact cannot be reduced on site, measures can be implemented off site (e.g. noise barriers to reduce noise impact at a nearby residence or fencing to prevent animals straying onto the site).
Repairing or correcting Some impacts imply damage to a resource that is unavoidable (e.g. loss of agricultural land and forestry due to creating access, work camps or materials storage areas). Repair mainly involves restoration and re-establishment type measures.
Compensation in kind When other mitigation methods are either not possible or are not entirely efficient, compensation can be adapted, to a certain extent, to losses (e.g. planting to replace damaged vegetation, financial compensation for damaged crops or providing community facilities for loss of fisheries access, recreation and amenity space).

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3.4.5 Residual Impacts

Residual impacts are defined as those impacts that remain following the implementation of these measures. The impact assessment process should seek to iteratively consider the likely effectiveness of the measures in reducing the magnitude of the impact, and identify additional or alternative measures, so that the residual impact is not significant.

Once all feasible mitigation measures have been defined, a final reassessment of impacts is undertaken to determine the magnitude and significance of residual impacts. Where impacts with major significance remain after all mitigation measures have been applied, compensation may need to be identified and applied. For example, this would include compensation for loss of natural habitat 'where feasible' to achieve no net loss.

The residual impact significance takes into account the country context when assessing the effectiveness and robustness of the mitigation measures. This is done in a qualitative manner on a case-by-case basis.

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4 Project Description

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Contents

4.1 Generalities 4-1

4.1.1 Overview 4-1
4.1.2 Project History 4-2
4.1.3 Project Activities and Planning 4-2
4.1.4 Project Location, Access and Setting 4-4

4.2 Permanent Project Components 4-8

4.2.1 Overview and Layout 4-8
4.2.2 Reservoir 4-10
4.2.3 Rockfill Embankment Dam 4-12
4.2.4 Spillway 4-14
4.2.5 Bottom Outlet 4-15
4.2.6 Ecological Flow Release – Minihydro 4-17
4.2.7 Power Waterway 4-17
4.2.8 Roads and Bridges 4-18
4.2.9 Operators' Village 4-22
4.2.10 Transmission Lines and Switchyard 4-22

4.3 Components for Construction Only 4-24

4.3.1 Overview and Layout 4-24
4.3.2 Temporary Worker Accommodation Camp 4-24
4.3.3 Quarries and Borrow Areas 4-24
4.3.4 Spoil Disposal Areas 4-28
4.3.5 Construction Access Roads 4-28
4.3.6 Diversion Tunnels 4-28
4.3.7 Cofferdam 4-28

4.4 Construction Activities and Reservoir Filling 4-30

4.4.1 Construction Contracts 4-30
4.4.2 Construction Schedule 4-30
4.4.3 River Diversion Works 4-30
4.4.4 Power Supply, Water Supply and Wastewater 4-31
4.4.5 Materials Origins and Wastes 4-32
4.4.6 Traffic 4-35
4.4.7 Reservoir Clearing and Filling 4-36
4.4.8 Construction Methods for the Transmission Line 4-36
4.4.9 Manpower Requirements 4-37

PUBLIC DISCLOSURE AUTHORIZED

4.5 Operation and Maintenance 4-37

4.5.1 General 4-37
4.5.2 Annual Energy Generation 4-38
4.5.3 Powerhouse Daily Operations 4-38
4.5.4 Variations of Reservoir Water Level and Downstream Flow 4-40
4.5.5 Sediment Management 4-40
4.5.6 Transmission Line Maintenance 4-41
4.5.7 Maintenance of Hydromechanical Equipment 4-41

4.6 Associated Facilities 4-42

4.6.1 Kamanyola 220 kV Substation 4-42
4.6.2 Kamanyola - Buhandahanda 220 kV Transmission Line 4-42
4.6.3 Kamanyola - Bujumbura 220 kV Transmission Line 4-43
4.6.4 Kamanyola - Kibuye 220 kV Transmission Line 4-43
4.6.5 Other 220 kV Transmission Lines 4-43

4.7 Decommissioning 4-45

4.7.1 Hydroelectric Power Production Facilities 4-45
4.7.2 Transmission Line 4-45

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Tables

Table 4-1 Key Reservoir Characteristics....4-10
Table 4-2 Key Dam Characteristics....4-12
Table 4-3 Key Characteristics of the Power Waterway Components....4-18
Table 4-4 Roads and Bridges....4-18
Table 4-5 Estimated Quantities of Extracted Materials....4-24
Table 4-6 Potential Sites for Quarries in DRC, Rwanda and Burundi....4-25
Table 4-7 Estimated Quantities of Construction Materials....4-32
Table 4-8 Key Characteristics of the Power Waterway Components....4-38

List of Figures

Figure 4-1 Provisional Project Implementation Schedule....4-3
Figure 4-2 Project Location....4-6
Figure 4-3 Project Layout....4-9
Figure 4-4 Reservoir Surface Area and Capacity Curves....4-10
Figure 4-5 Reservoir Layout....4-11
Figure 4-6 Dam Design Drawings: Longitudinal Section....4-12
Figure 4-7 Dam Design Drawings: Cross Section 1-1....4-13
Figure 4-8 Dam Design Drawings: Cross Sections 2-2 and 3-3....4-13
Figure 4-9 Spillway and Dam layout Drawing....4-14
Figure 4-10 Spillway Design Drawing....4-15
Figure 4-11 Deviation Tunnel Layout (showing Bottom Outlet, Water Intake and Spillway)....4-16
Figure 4-12 Bottom Outlet Cross Section....4-16
Figure 4-13 Minihydro Cross Section....4-17
Figure 4-14 Layout and Profile of the headrace Tunnel....4-19
Figure 4-15 Surge Shaft and Penstock Layout....4-20
Figure 4-16 Surge Shaft and Penstock Profile....4-21
Figure 4-17 Project Structures Layout....4-23
Figure 4-18 Location of Potential Quarry sites in DRC, Rwanda and Burundi....4-27
Figure 4-19 Diversion Tunnels Profiles....4-29
Figure 4-20 Daily Energy Demand Distribution Considered in the Ruzizi-III Power Purchase Agreement4-38
Figure 4-21 Optimised Turbined Flows for Ruzizi-I, -II and -III....4-40
Figure 4-22 Associated Facilities Layout....4-44

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4.1 Generalities

4.1.1 Overview

The Project comprises the construction and operation of a 206 MW HEPP on the Ruzizi River, downstream from the existing Ruzizi-I and -II hydroelectric schemes. The project includes a 7-km-long 220 kV transmission line. The river represents the border between Rwanda and DRC and project facilities and infrastructure will be installed on both the Rwanda and DRC riverbanks. A rockfill embankment dam, 51 m in height, will be constructed creating a small reservoir occupying 46 ha (30 ha in DRC and 16 ha in Rwanda) and inundating areas of agricultural land in both Rwanda and DRC. However, no dwellings or structures are impacted by the dam construction and reservoir impoundment.

Project components to be situated on the left bank (Rwanda) are as follows:

- Spillway.
- Bottom outlet.
- Two river diversion tunnels (used during construction, one of which is reused as the bottom outlet tunnel during operation).
- Power waterway components: water intake, 3.8 km headrace tunnel, penstock and an aboveground powerhouse.
- Permanent accommodation facilities.
- Access roads comprising completion of the existing road between Bugarama and existing bridge upstream of the powerhouse site, new road from the bridge to the dam site following the left bank of river.
- Temporary infrastructure for construction purposes including a borrow area, river diversion, worker accommodation facilities.

Project components to be situated on the right bank (DRC) are as follows:

- 220 kV switchyard (on the opposite side of the river to the powerhouse).
- 220 kV transmission line (7 km in length) from the 220 kV switchyard to the Kamanyola substation[1].
- 30 kV power line from the 220 kV switchyard to the dam site, following the dam access road in DRC.
- Permanent access roads and bridges comprising a dam access road following the right bank of the river from the outskirts of Kamanyola, and completion of the existing bridge upstream from the powerhouse site. The construction workers' accommodation camp adjacent to the 220 kV switchyard in DRC will continue to be used during operation as REL's DRC offices.
- Temporary infrastructure for construction purposes, including a bridge at the dam site, and storage areas near the river between the dam site and the 220 kV switchyard.

The Project has completed a Feasibility Study, and the detailed design and construction will be managed by an EPC Contractor in the next stage of the Project. Construction duration is estimated at 56 months, requiring an estimated workforce of 500-1,000 workers during the period of peak activities. On completion of the Project construction, the operation of the scheme will be handed over to an operating company that will be created or nominated at a later stage.

The Project will operate in a coordinated manner with the Ruzizi-I and -II hydroelectric schemes upstream which operate with periods of peak and off peak flows. The Project's peak flows (150 m^3/s) are identical to the peak flows from Ruzizi-I and -II.

[1] The Kamanyola substation is not part of the Project, it will be developed by *Energie des Grands Lacs* (EGL)

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The Project's 220 kV Transmission Line will transport electrical power generated by the Project to the Kamanyola 220 kV substation, developed by EGL and which will be operated by SINELAC.

The Kamanyola substation will act as the dispatching centre and SINELAC will coordinate the equal sharing of the electrical power with Burundi, DRC and Rwanda. Five Transmission Lines will be connected to the Kamanyola substation; the Project's 220 kV Transmission Line, and four other 220 kV Transmission Lines; one for Rwanda, one for Burundi and two for DRC. The Kamanyola substation and the 5 transmission lines are considered to be "Associated Facilities" and are not included in the scope of this ESIA (see Chapter 1 Introduction - Section 1.6).

It should be noted that the Project does not include installation of power lines and supply of electricity to nearby villages. Nevertheless, the Project implement a Local Area Development Plan (LADP) as part of a benefit sharing strategy.

4.1.2 Project History

The Project history is summarised as follows:

- EGL carried out initial studies in 2007 and in the 2010s.
- A Feasibility Study (FS) and Front-End-Engineering Study (FEED) were prepared by Fichtner engineering company in 2010-11.
- After remaining dormant, the Project was re-launched via a Public-Private Partnership (PPP) with the company REL as the private partner in 2019.
- TRACTEBEL engineering company conducted further Feasibility Studies in 2020-22 for an alternative project design with the dam site moved to an alternative location to avoid an area exposed to landslide and to increase the reservoir volume and power production capacity.

Past ESIA studies conducted are as follows:

- An ESIA and a Resettlement Action Plan (RAP) based on Fichtner's technical studies and financed by the European Investment Bank (EIB) were prepared in 2012 by SOFRECO.
- SOFRECO updated the 2012 ESIA and RAP in 2021 for the original design and alternative dam location design. However, the 2021 ESIA (SOFRECO, 2021a) did not include a comprehensive social baseline update because of COVID travel restrictions and although two additional fish surveys were undertaken, the biodiversity baseline data from 2012 was not updated.

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4.1.3 Project Activities and Planning

The Project will be implemented on an Engineering Procurement and Construction (EPC) basis. A competitive tendering process will be undertaken to select the EPC Contractor. The EPC Contractor will then undertake the Project detailed design using information from the Feasibility Study and the outcomes of this ESIA. The EPC Contractor may also appoint sub-contractors for the provision of various items of the Project and different aspects of the construction works such as site clearing and civil construction. Following award of the EPC contract and the detailed design stage, it is anticipated that it will take around 56months to complete the construction works.

REL has engaged Tractebel as Owner's Engineer, to assist in the EPC contractor appointment process, to advise REL on design features and monitor and report on the Project construction and commissioning.

The provisional Project schedule is provided in the Gantt Chart below. Site preparation works will start Q4 2025, and reservoir filling is anticipated in Q4 2029. Power production is planned to commence in Q2 2030.

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ID	Task Name	Start	Finish	Duration
1	Engineering	17/10/2025	25/12/2026	62.2w
2	Preparation Works	17/10/2025	16/06/2027	86.8w
3	Civil Works	15/09/2026	07/06/2030	194.8w
4	Powerhouse works	15/09/2026	26/10/2029	162.8w
5	Electromechanical Works	15/09/2026	09/05/2030	190.6w
6	Transmission Line	05/07/2027	30/06/2028	52w
7	Testing and Commissioning	02/11/2028	27/06/2030	86.2w

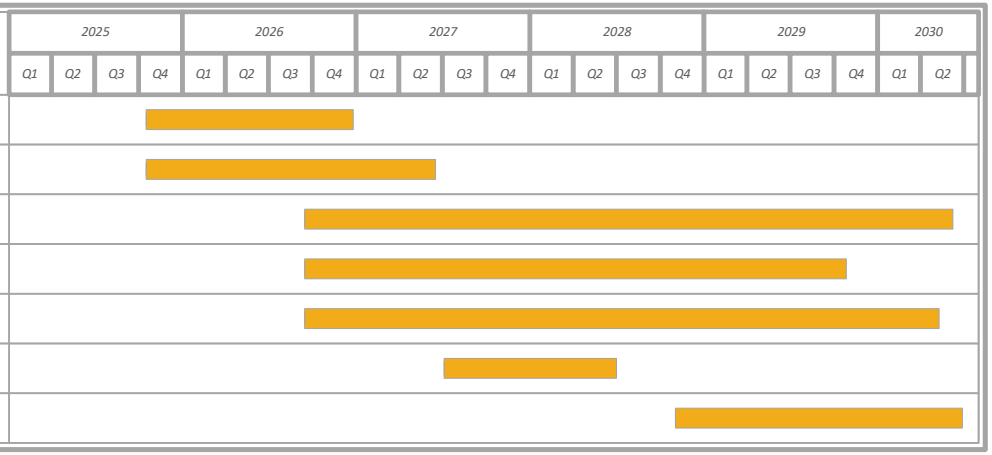


Figure 4-1 Provisional Project Implementation Schedule

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4.1.4 Project Location, Access and Setting

4.1.4.1 Project Location

The Project site is located on the border between DRC and Rwanda. It is located on the Ruzizi River, between Lake Kivu and Lake Tanganyika (see Figure 4-2).

- Project components situated in Rwanda are located in the Rusizi district of the Western Province. The dam and reservoir are located in the Nzahaha Sector, and the powerhouse is in the Bugarama Sector.
- Project components situated in DRC are located in the Walungu territory of the South Kivu Province. The dam and reservoir components are located in the Karhongo groupement (administrative seat at Nyangezi) and the 220 kV transmission line, 220 kV switchyard and dam access road are located in the Kamanyola groupement (administrative seat at Kamanyola).

4.1.4.2 Access

The Project site can be accessed from Kigali (Rwanda) by travelling to Kamembe by air (30-minute flight) or road (6-hour drive). Then by road to Bugarama (1-hour). The powerhouse site can be accessed by road from Bugarama (15 minutes). At the current time the dam access road has not been constructed and is undertaken on foot (2-hour walk) from a partially completed road bridge near the powerhouse. Alternatively, the dam and reservoir can be accessed on foot from the village of Murya, Rwanda (situated on the reservoir rim), a 90-minute walk down a steep path.

The Project components in the vicinity of Kamanyola DRC can be accessed by road from Bukavu, the capital South Kivu Province (3 to 4-hour drive) along the RN5 road, which is unpaved and in poor condition. Alternatively, they can be accessed from Rwanda by crossing the border at Bugarama.

4.1.4.3 Environmental and Social Setting

A Upstream Setting

The Project's dam site is situated 31 km downstream from the Lake Kivu outflow. The lake is situated at an altitude of 1,462 m asl and occupies an area of 2,412 km^2. The DRC cities of Goma and Bukavu are situated on the shores of the lake, each have more than one million inhabitants with high levels of poverty and lack of collective sanitation infrastructure and little solid waste collection. Consequently, there is bacteriological and chemical contamination of the lake due to inadequately treated, poorly treated or untreated domestic and industrial wastewater.

The Ruzizi-I and -II hydropower schemes are situated upstream from the Project's dam site, situated 3 km and 19 km from the Lake Kivu outflow respectively and Ruzizi-III is situated 12 km downstream from Ruzizi-II (and 16 km downstream from Ruzizi-I). Ruzizi-I and -II started operation in 1959 and 1989 respectively and both operate with hydropeaking with peak flows of 150 m^3/s, as will the Project. The hydropeaking has resulted in significant degrading of the aquatic biodiversity of the river.

The Ruzizi River valley upstream from Ruzizi-II is characterised by a dense and extensive urban development on the right bank and significant quantities of domestic solid waste accumulates in the Ruzizi-I and -II reservoirs, carried by runoff from the urban areas. The floating solid waste that accumulates in the reservoir is removed from the reservoir by the Operator of the Ruzizi-II hydropower scheme and the waste is transported to a municipal disposal site and some is burnt within the Ruzizi-II grounds. However, some floating waste (plastic bottles, plastic bags, etc) is not trapped by the reservoir and is carried downstream by the Ruzizi River waters.

There has been extensive deforestation of the banks resulting in slope instability and soil erosion. Consequently, the storage capacity of the Ruzizi-I and -II reservoirs have been significantly

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reduced because of accumulation of sediments. The KfW is funding a programme to rehabilitate the Ruzizi-I and -II hydropower schemes which includes reservoir dredging to remove the accumulated sediment and improve the live storage capacity of the Ruzizi -I and -II reservoirs. If sufficient sediment is removed it should enable sediment flushing for these reservoirs to be performed in the future.

If the Ruzizi-I and -II reservoir dredging is ineffective, it can be expected that the available storage volume in Ruzizi-I and -II will further decrease in the coming years because of continued accumulation of sediment. The reduced storage volume will result in shorter time intervals with peak flows and longer intervals with off peak flow from Ruzizi-I and -II (i.e. tending towards a run-of-river mode of operation). However, because of overall quantity of water released downstream during the Ruzizi-III reservoir filling time interval will be unchanged, no consequences on the Project power production capacity are expected.

Downstream from the Ruzizi-I the valley becomes a steep-sided gorge with land use dominated by agriculture. There are only small areas of natural habitat on craggy slopes that that are too steep to be cultivated and along the edge of the river. Between Ruzizi-II and -III dam sites there are a total of 22 areas (on both sides of the river) where slopes are subject to landslides which contribute to the sediment load in the Ruzizi River.

A description of the studies to identify and assess the slope instability and landslide hazards is provided in Chapter 7 - Environmental Baseline, Section 7.2.3. Information on the soil, slope stability and erosion control is provided in Vol. IV – ESMP, section 3.8.

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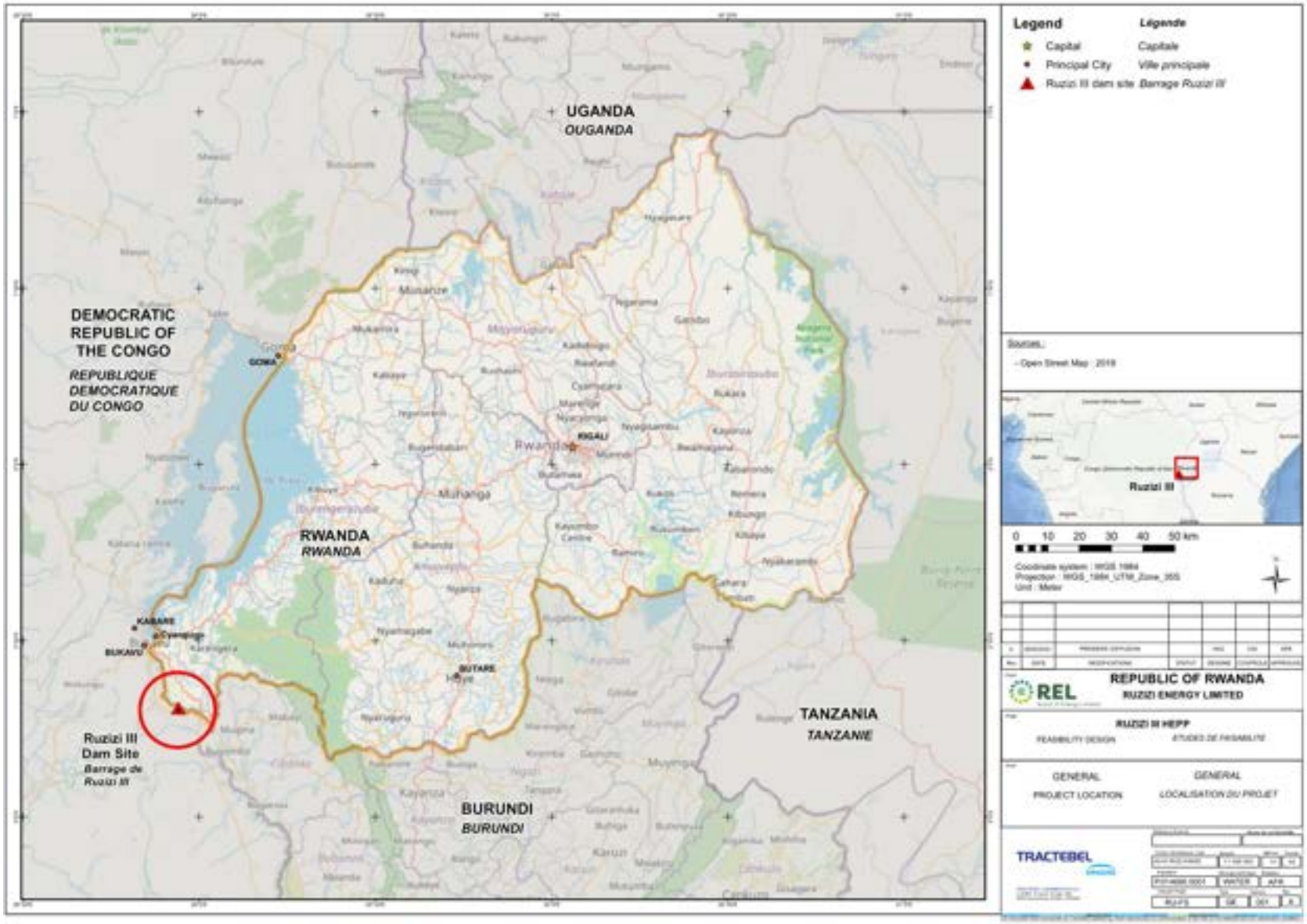


Figure 4-2 Project Location

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B **Dam and Reservoir Area Setting**

The dam and reservoir are situated in a deep, steep sided valley. The river is at an elevation of c.1,000 m asl and the reservoir rim at an altitude of c. 1,500 m. At the current time there are no roads to the site of the proposed dam and reservoir and access is undertaken on foot from the reservoir rim or following the river from the partially completed road bridge upstream from Bugarama. There are no dwellings or structures in the valley in or near the footprint of the proposed dam and reservoir. The major types of land cover in the valley are agricultural land, areas comprising a mosaic of agricultural land/modified natural habitat, steep rocky outcrops and riverine habitat at the edge of the riverbanks. All land that can be cultivated is being cultivated – even very steep land – and the only land that is not cultivated is that which is too steep and rocky.

C **Powerhouse Area Setting**

The site for the powerhouse is situated 5.5 km downstream from the dam where the valley sides are less steep and the valley bottom wider. The powerhouse site can be accessed by road on the left bank following the river from Bugarama, Rwanda. The predominant land use in the powerhouse area is agriculture, and there are almost no areas of natural vegetation.

D **220 kV Switchyard and 220 kV Transmission Line Area Setting**

The site of the 220 kV switchyard in DRC is situated close to a village and land around the village is predominantly agricultural land. The 220 kV Transmission Line that transports electricity from the Project switchyard to Kamanyola substation crosses land that is also predominantly used for agriculture with almost no area of natural vegetation. The line crosses the Bugarama-Kamanyola road.

E **Downstream Setting**

The Ruzizi River downstream from the Project flow to Bugarama, Rwanda and then crosses the Ruzizi plain and flows into Lake Tanganyika some 131 km further downstream. Land use in the plain is predominantly cattle grazing and agriculture and there are several large irrigation projects planned – which divert water from the Ruzizi's tributaries. The Ruzizi delta area at the outflow into Lake Tanganyika is a RAMSAR site.

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4.2 Permanent Project Components

4.2.1 Overview and Layout

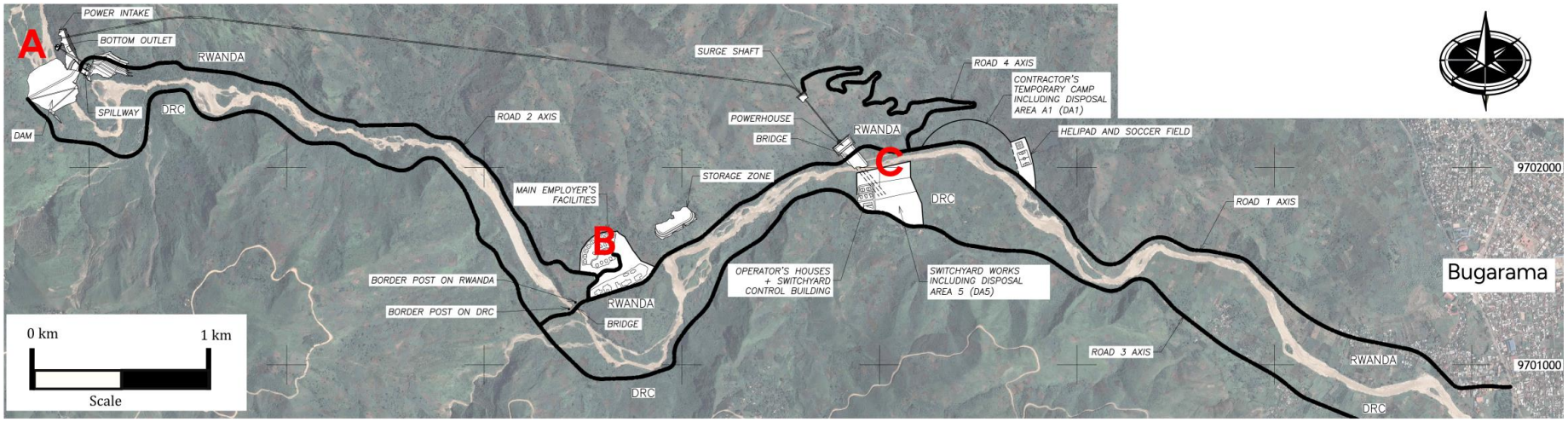
The Project components described in the following subsections comprise:

- Reservoir
- Rockfill embankment dam
- Spillway
- Bottom Outlet
- Ecological flow release – minihydro power plant
- Power waterway (including water intake, headrace tunnel, surge shaft, penstock and powerhouse)
- Roads
- Permanent camps

The layout is illustrated in the drawing below.

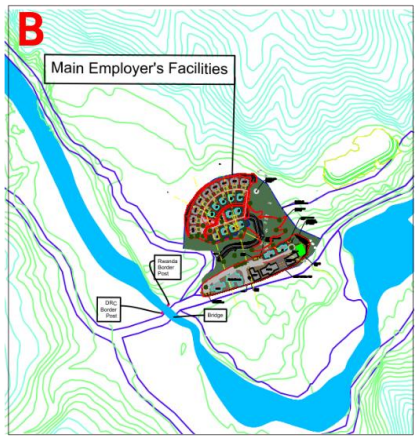
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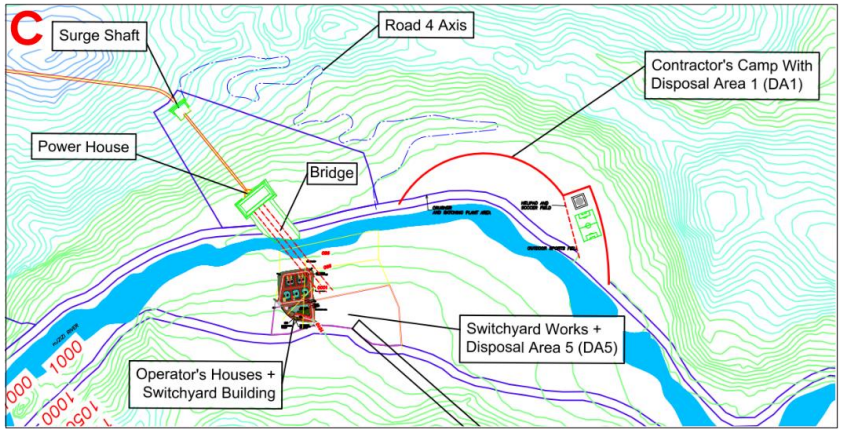




Dam-Reservoir, power intake and spillway



Employer's Facilities



Powerhouse and switchyard

Figure 4-3 Project Layout

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4.2.2 Reservoir

The dam (described in section 4.2.3) will create a relatively small reservoir extending upstream from the dam structure and inundating areas in Rwanda and DRC as shown the figure below. The land cover in the inundated area is predominantly agricultural land with some small areas of natural habitat. No dwellings or structures are expected to be flooded.

The key characteristics of the reservoir are presented in the table below.

Table 4-1 Key Reservoir Characteristics

Data	Unit	Value
Full supply level (FSL)	m asl	1,145.0
Maximum water level	m asl	1,149.4
Minimum operating level	m asl	1,133
Total storage at FSL	Mm^3	7.7
Active storage at FSL	Mm^3	5.1
Dead volume	Mm^3	1.0
Reservoir area at FSL	ha	46
Reservoir area at minimum operating level	ha	20
Reservoir area at maximum operating level	ha	53
Length of reservoir	km	2.3 km

The reservoir surface area and capacity curves are presented in the figure below. The maximum water level is defined as the water level in the reservoir when a 10,000-year return period (the design flood) occurs in the Ruzizi River.

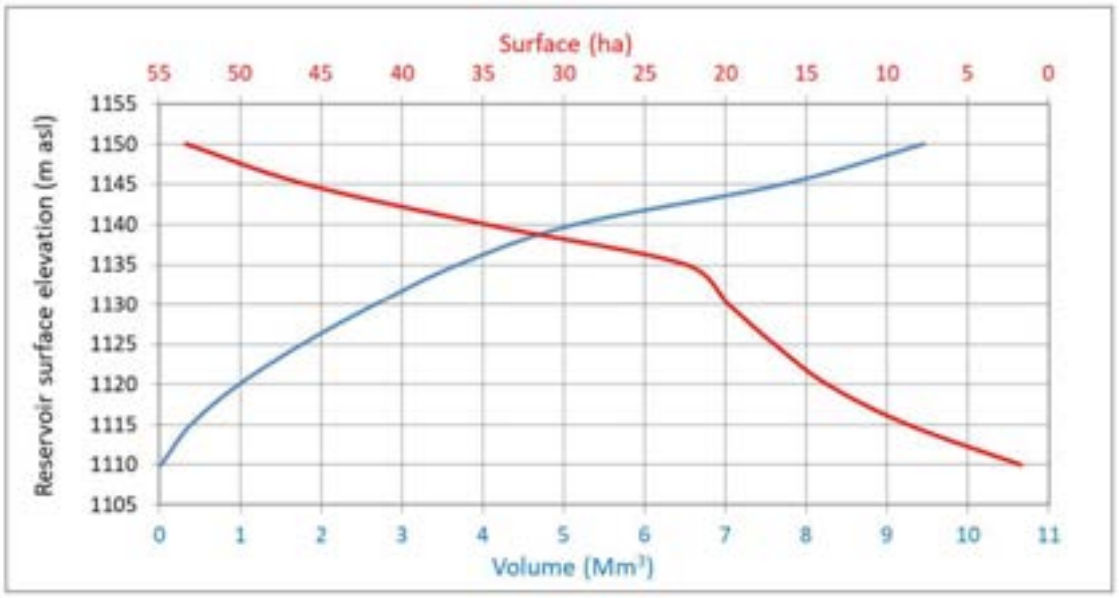


Figure 4-4 Reservoir Surface Area and Capacity Curves

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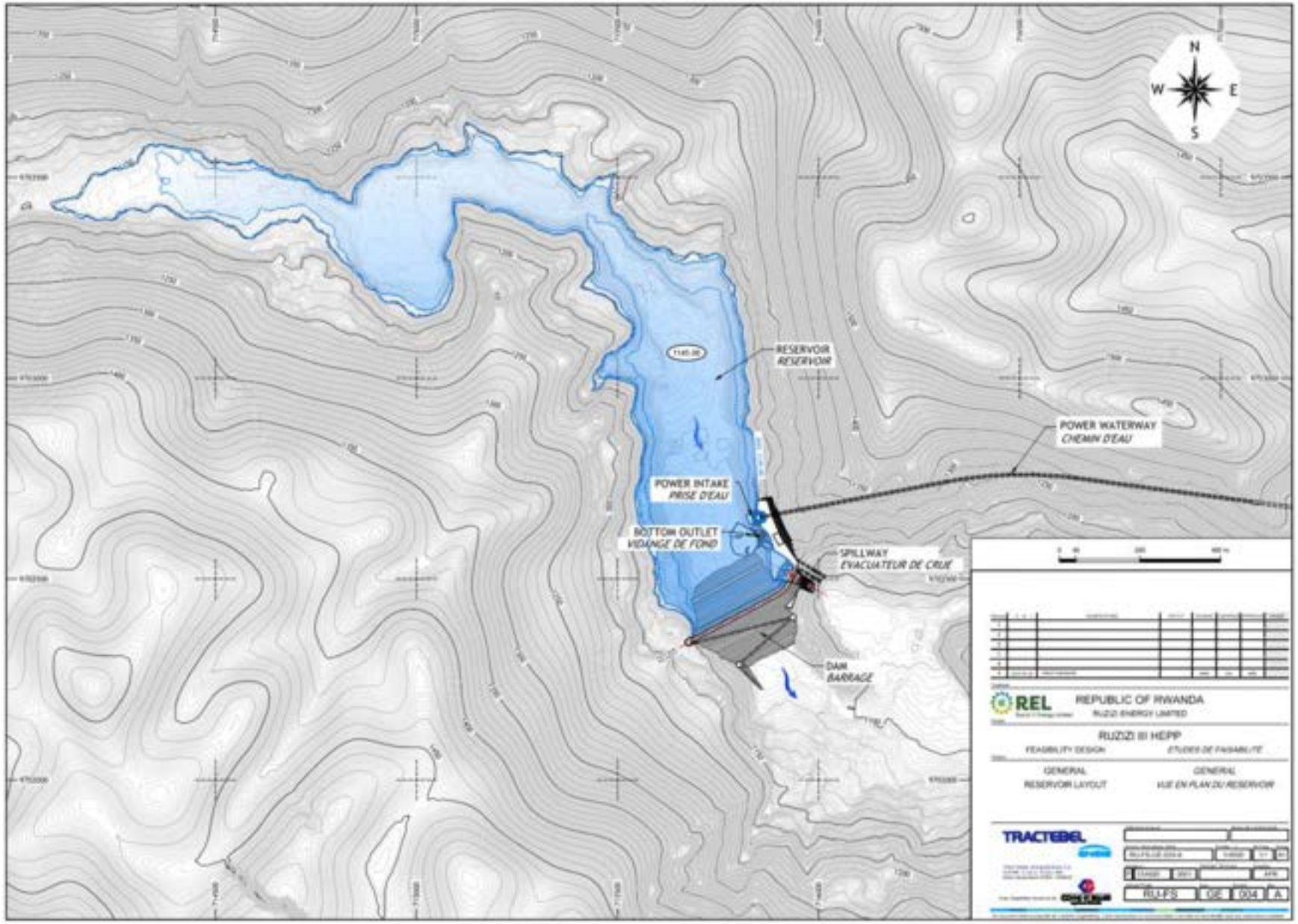


Figure 4-5 Reservoir Layout

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4.2.3 Rockfill Embankment Dam

The Project plans for a central core rockfill dam. This type of dam is considered to be the most appropriate type of dam structure because of the geological conditions, the high seismic activity in the area and the availability of construction materials. The key characteristics are presented in the table below.

Table 4-2 Key Dam Characteristics

Data	Unit	Value
Design flood (10,000-year return period flood)	m^3/s	985
Check flood (100,000-year return period flood / Probable Maximum Flood (PMF))	m^3/s	1,420
Dam type	-	Rockfill
Crest elevation	m asl	1,150.5
Dam height at axis	m	51.5
Crest length	m	287.6

The upstream embankment of the dam will integrate the upstream cofferdam (used for protecting the works during construction – see Section 4.3.7). The upstream slope, above the cofferdam, will be protected against erosion with rip rap, and the downstream slope will be protected with coarse rockfill.

Lateritic material extracted from the excavations of the other Project components (river diversion tunnels, headrace tunnel and spillway) will be used for the rockfill. Relatively mild embankment slopes are foreseen so that material of moderate performance can be used and to reduce the amount of material disposed of at spoil disposal sites.

Foundation treatment will be used to control water seepage. This will comprise grouting below the abutments and construction of a 50-m-deep plastic/concrete cut-off wall in the riverbed below the dam structure.

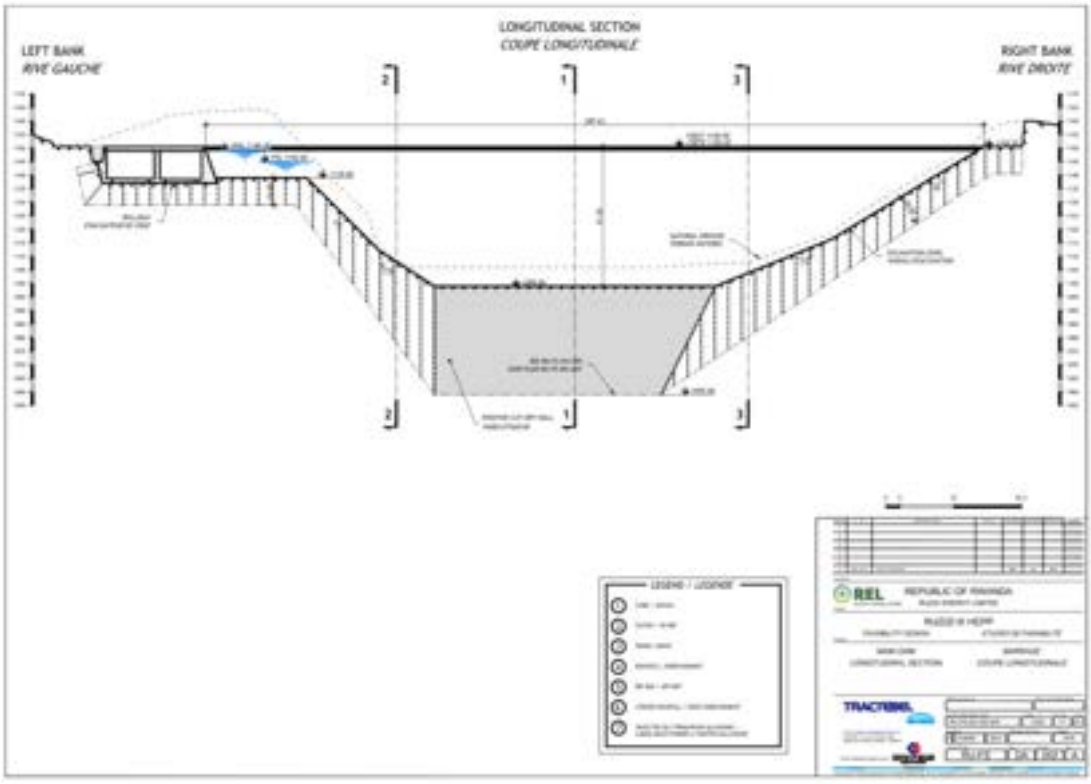


Figure 4-6 Dam Design Drawings: Longitudinal Section

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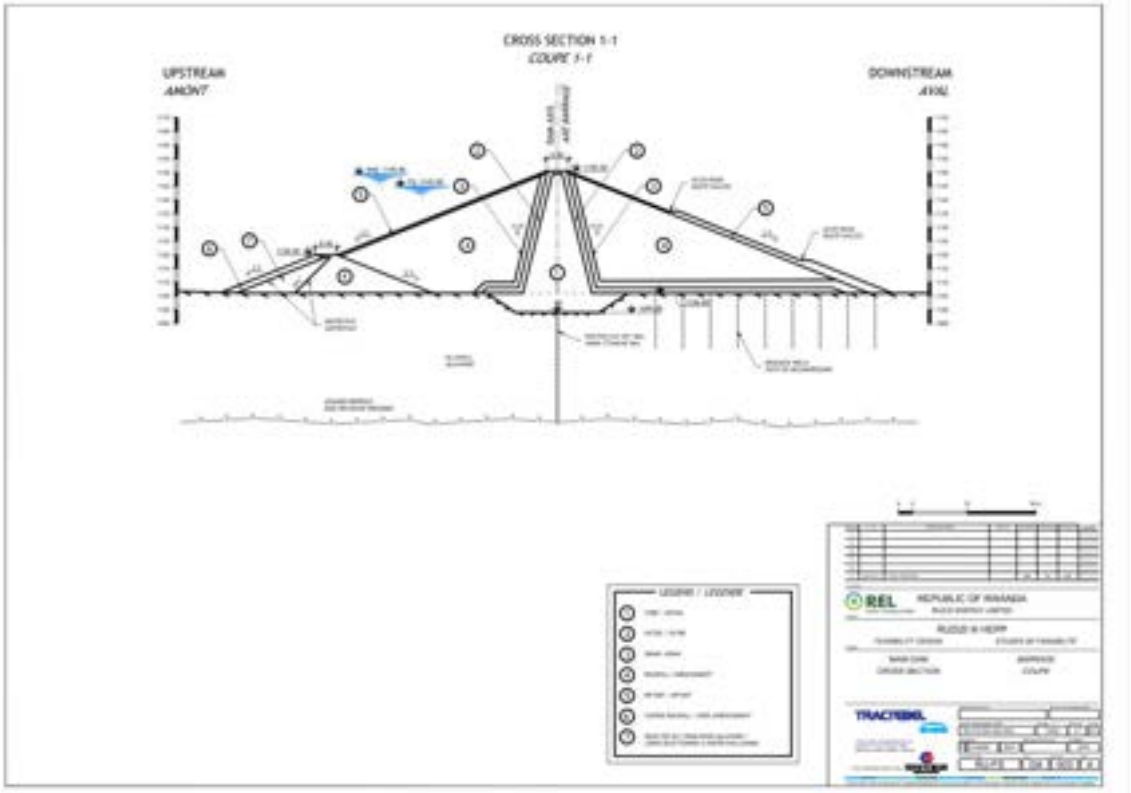


Figure 4-7 Dam Design Drawings: Cross Section 1-1

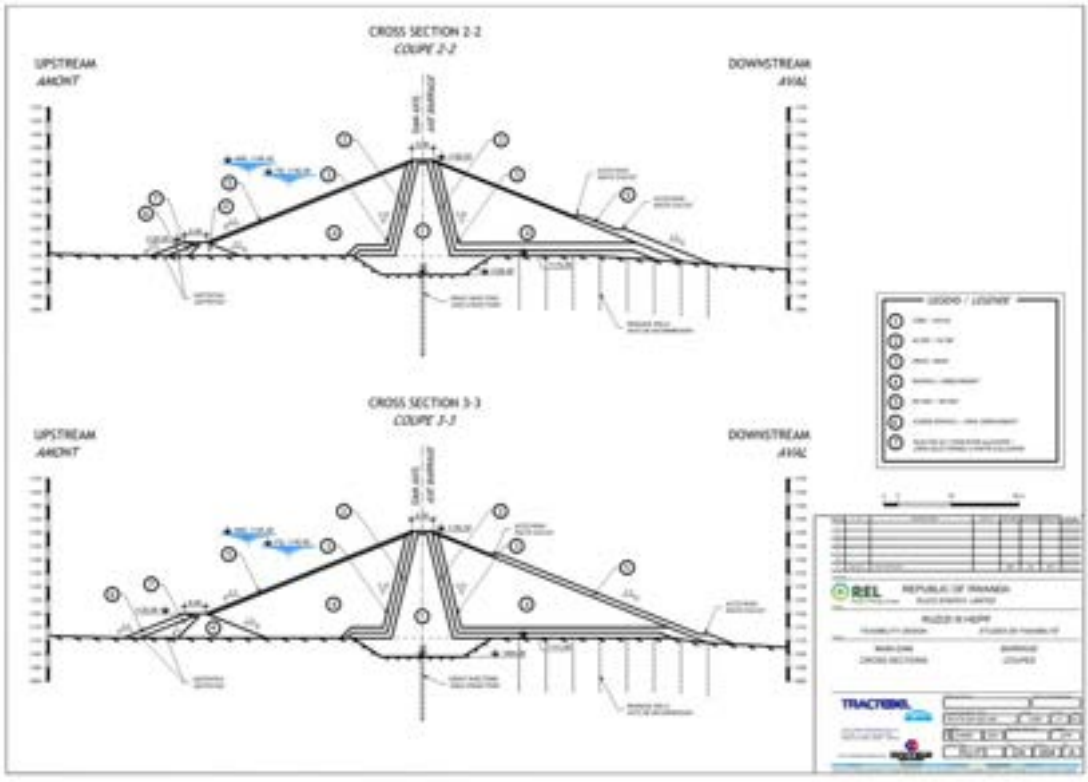


Figure 4-8 Dam Design Drawings: Cross Sections 2-2 and 3-3

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4.2.4 Spillway

The spillway is a safety feature of the dam. When the flow of the Ruzizi River is greater than the turbining capacity of the powerhouse, the excess flow is diverted safely to the reach of the Ruzizi River immediately downstream from the dam via the spillway. This prevents uncontrolled overtopping of the dam structure which can damage the dam.

A labyrinth weir type spillway will be a located on the Rwandan abutment of the dam. A labyrinth weir spillway comprises a weir wall constructed in a zigzag manner in order to increase the effective length of the weir crest with respect to the channel width. The increase in effective length raises the discharge capacity of the weir. The spillway comprises three main subcomponents, the approach channel, the labyrinth weir and the chute channel.

The spillway is designed for the Project's Design Flood (985 m^3/s, 10,000-year return period) and checked for the PMF (1,420 m^3/s, 100,000-year return period).

The spillway layout and position on dam are illustrate in the drawings provided in Figure 4-10.

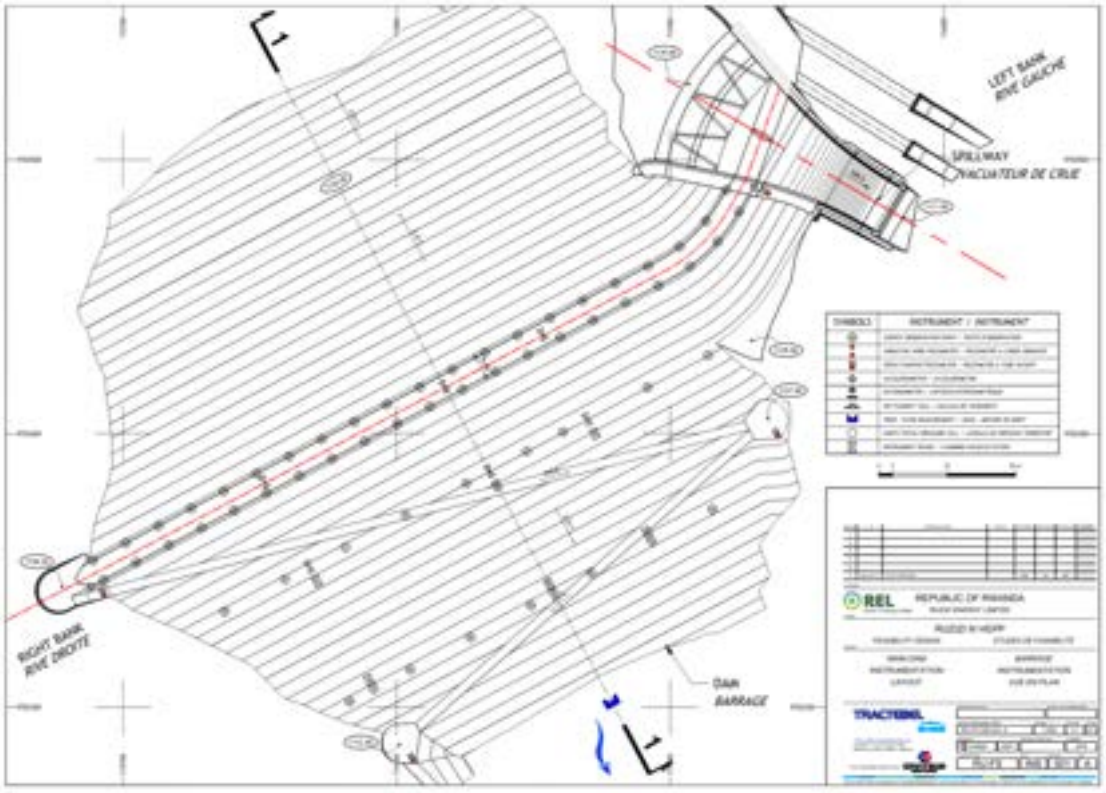


Figure 4-9 Spillway and Dam layout Drawing

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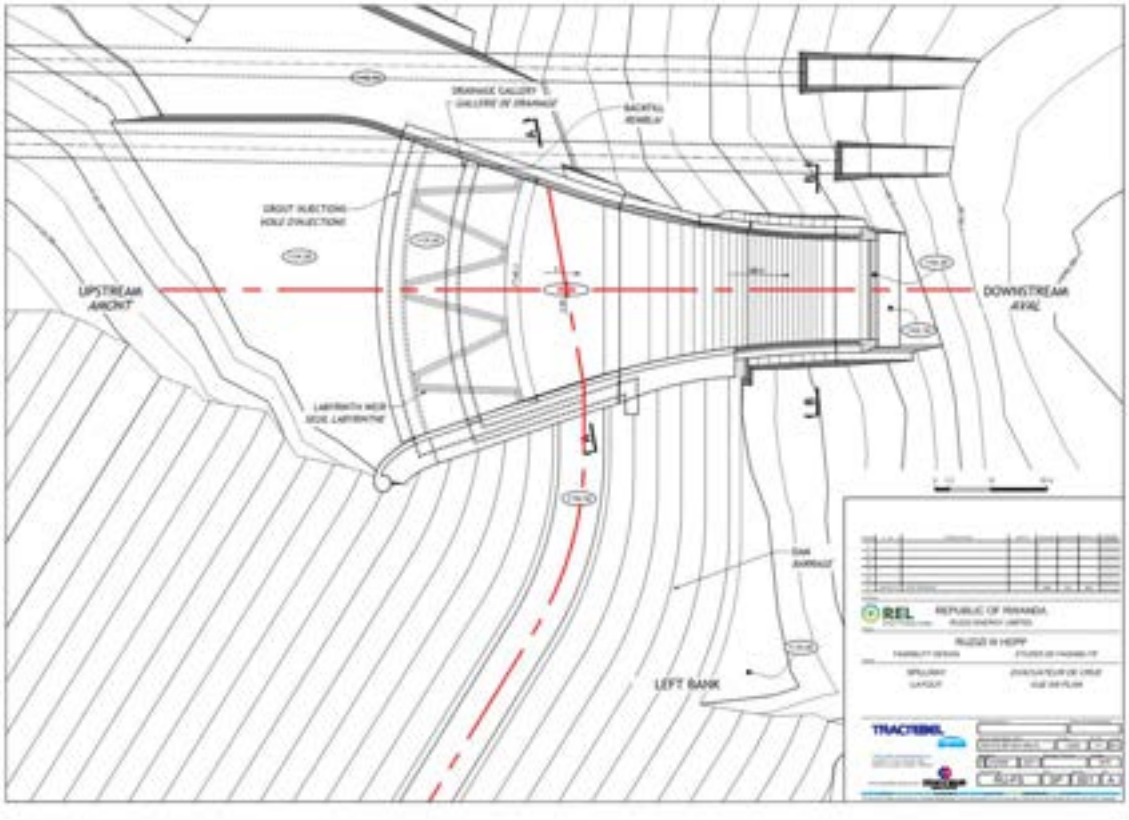


Figure 4-10 Spillway Design Drawing

4.2.5 Bottom Outlet

The bottom outlet is a safety feature of the dam. It allows the reservoir water level to be drown down if the need arises, such as for maintenance or inspection of the dam structure. It is comprised of a radial gate (service gate) and a guard gate and is operated from a tower above the gates. The gates are opened using a hydraulic jack and close by gravity.

The bottom outlet and control tower are situated at the upstream portal of the left bank diversion tunnel. A bridge links the tower to the left bank of the river. Downstream from the bottom outlet, released water is conveyed as free surface flow in one of the diversion tunnels (from construction) that is reused. The tunnel is 180 m in length and has diameter of 4.8 m and discharges the water into the Ruzizi River downstream from the dam via a short chute.

The capacity of the bottom outlet is 200 m^3/s at FSL and 160 m^3/s at minimum operating level. The reservoir water level can be lowered from FSL to the minimum operating level in less than an hour and can be lowered to below the power intake within 3 hours.

The position of the bottom outlet in relation to the dam, spillway and power intake is illustrated in the drawing provided in Figure 4-11. The cross-sectional drawing is provided in Figure 4-12.

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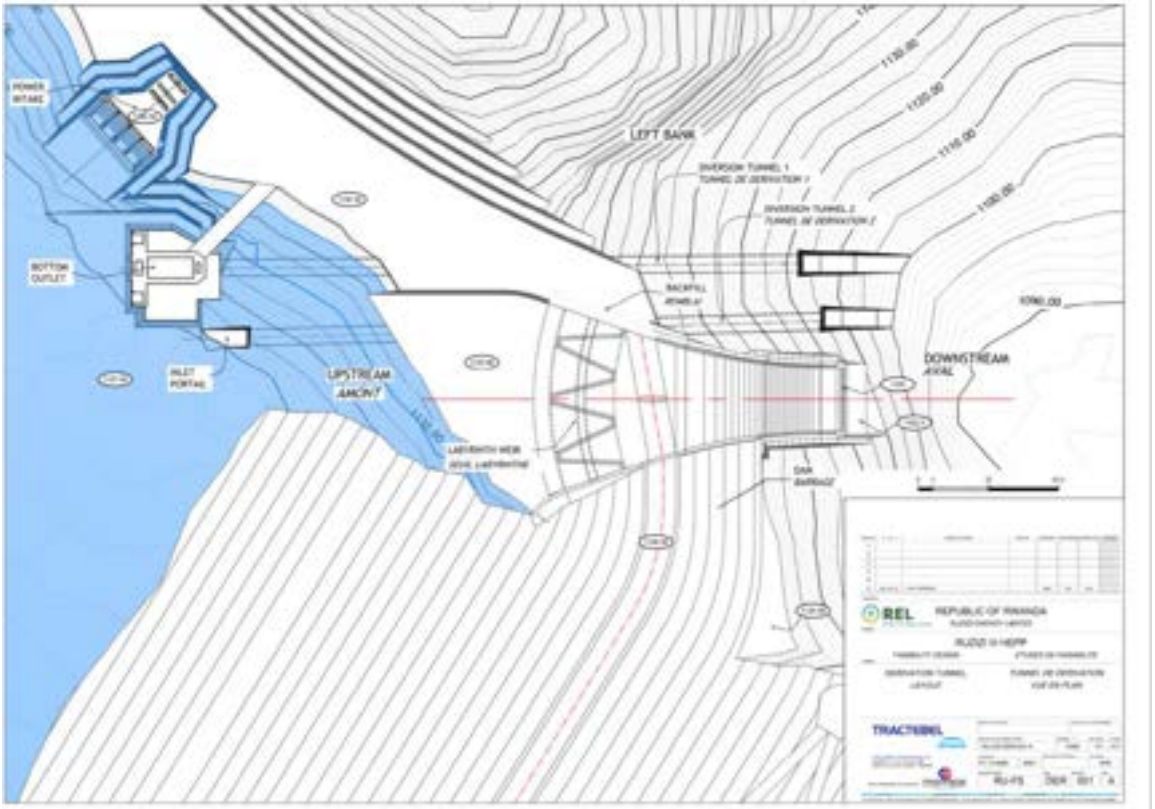


Figure 4-11 Deviation Tunnel Layout (showing Bottom Outlet, Water Intake and Spillway)

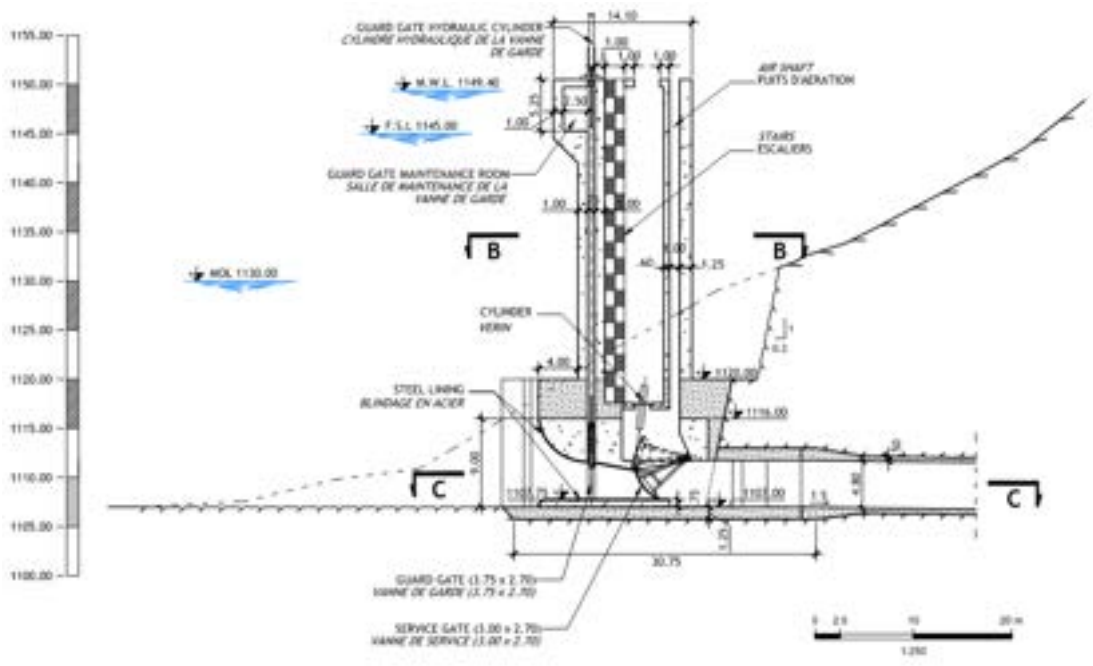


Figure 4-12 Bottom Outlet Cross Section

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4.2.6 Ecological Flow Release – Minihydro

The ecological flow has been set by the Feasibility Study (Tracebel, 2021) at 11 m^3/s (10% of average annual flow of the Ruzizi River). The ecological flow is turbined by a minihydro power generation group (2.9 MW capacity) situated in the Bottom Outlet tower before being discharged into the Ruzizi River via the bottom outlet tunnel. Group consists of a horizontal axis Francis turbine. The cross-sectional drawing is provided in the figure below.

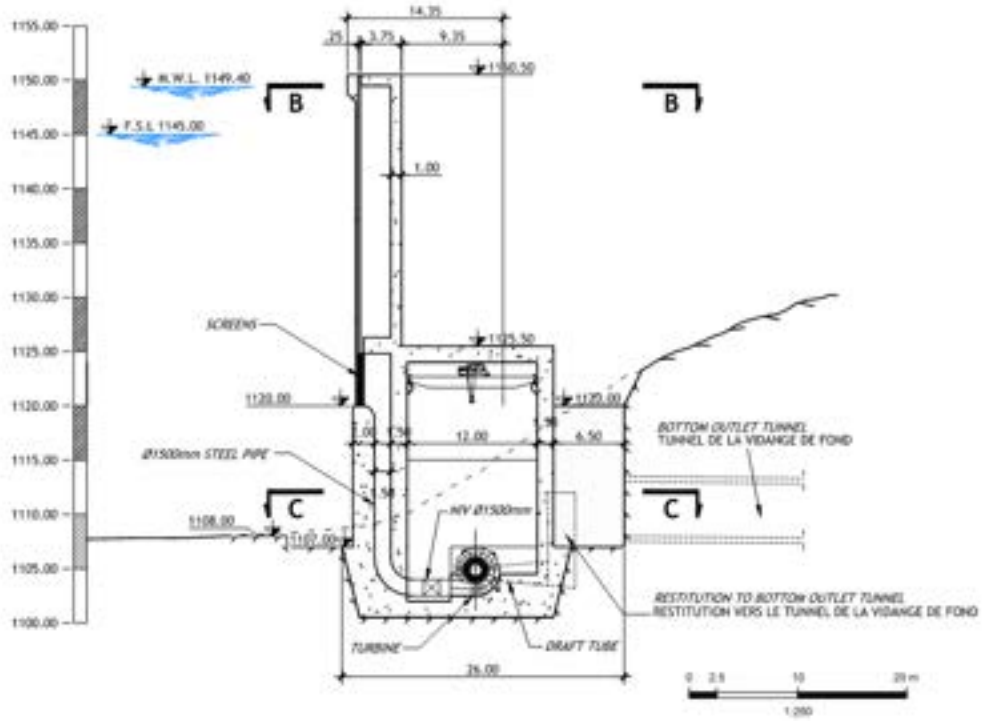


Figure 4-13 Minihydro Cross Section

4.2.7 Power Waterway

The components of the power waterway comprise the following:

- Water intake: The intake is located on the Rwanda side of the reservoir near the dam. The location of the water intake is illustrated in Figure 4-11. The intake comprises 2 main sluices each divided into 2 narrower sluices.
- Concrete-lined headrace tunnel: The tunnel conveys the water from the water intake to the penstock. The Layout and profile are provided in Figure 4-14.
- Surge shaft. The purpose of the surge shaft is to absorb transient surges in flow conditions in the waterway associated with powerhouse operation. The surge shaft is situated at the end of the headrace tunnel and comprises a vertical shaft from the tunnel to the ground surface. The layout and profile are provided in Figure 4-14 and Figure 4-15.
- Steel-lined tunnel and penstock. The steel-lined tunnel and penstock is situated downstream of the surge shaft. The layout and profile are provided in Figure 4-14 and Figure 4-15.
- Aboveground powerhouse: The powerhouse is situated in the left bank of the Ruzizi River at a location 5.5 km downstream from the dam, and where there is a relatively large bank and set back from the steep slopes above. The exact location, footprint and building dimensions of the powerhouse will be determined by the EPC Contractor.

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- Tailrace channel: A short but wide tailrace will convey discharges from the powerhouse to the Ruzizi River.

The general layout of the power waterway components is provided in Figure 4-3 and key characteristics are provided in the table below.

Table 4-3 Key Characteristics of the Power Waterway Components

Data	Unit	Value
Water intake		
Platform elevation	m asl	1,1150.5
Number of gates	-	2
Gate type	-	Fixed roller gate
Headrace tunnel		
Diameter	m	6.7
Length	m	3,820
Max. flow velocity (at 150 m^3/s)	m/s	4.03
Penstock		
Diameter	m	5.4
Length	m	In the range of 314-360 m*
Powerhouse		
Turbine type	Francis	
Installed capacity of turbines	MW	3 x 50 = 150*
Net head	m	153.5
Net power capacity at transformers	MW	204*
Annual average generation	GWh	1,157
Powerhouse dimensions	m	**
Tailrace		
Length	m	**
Width	m	54
* The total power production capacity of the Project (206 MW) is calculated using the formula: Power = Flow rate x net head x efficiency x gravity and including power produced by the minihydro unit (2.9 MW) turbining the ecological flow (11 m^3/s), with power produced varying with reservoir water depth. ** Powerhouse dimensions and footprint to be determined by the EPC contractor		

4.2.8 Roads and Bridges

The Project includes the construction of the roads and bridges presented in the table below. The layout is provided in Figure 4-3. The design of the roads will be undertaken by the EPC Contractor in the next stage of the project. The total width of roads will be 6 m (lane and shoulder widths combined).

Table 4-4 Roads and Bridges

Code	Description	Length (km)
Rwanda		
1	Completion of the existing road from Bugarama	5.4
2	New dam access road from the incompleted bridge	3.2
4	New serpentine road from powerhouse to surge shaft (joins existing road to be improved)	2.9
DRC		
3	New dam access road Kamanyola	9.6
	Completion of the existing incompleted bridge	-

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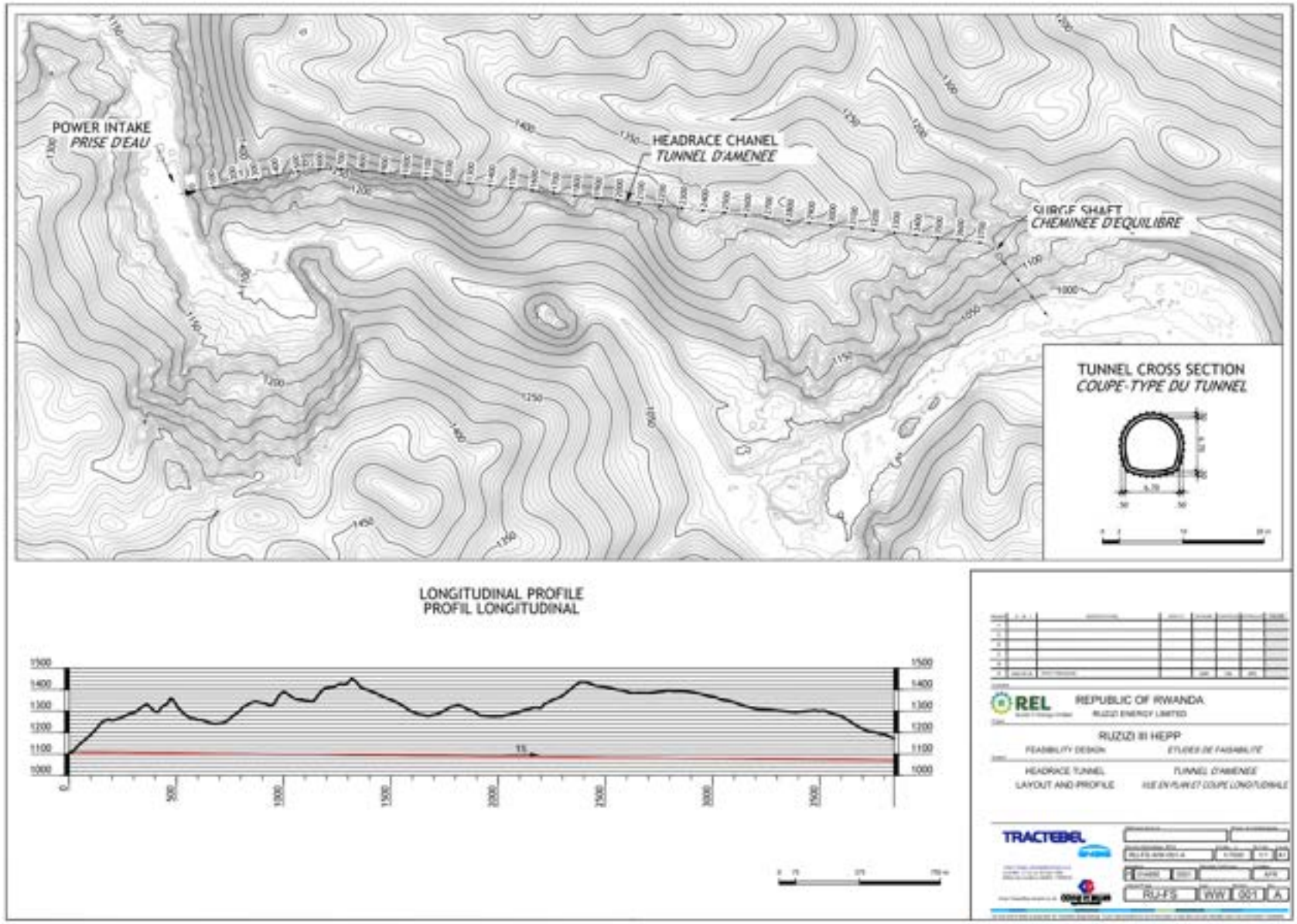


Figure 4-14 Layout and Profile of the headrace Tunnel

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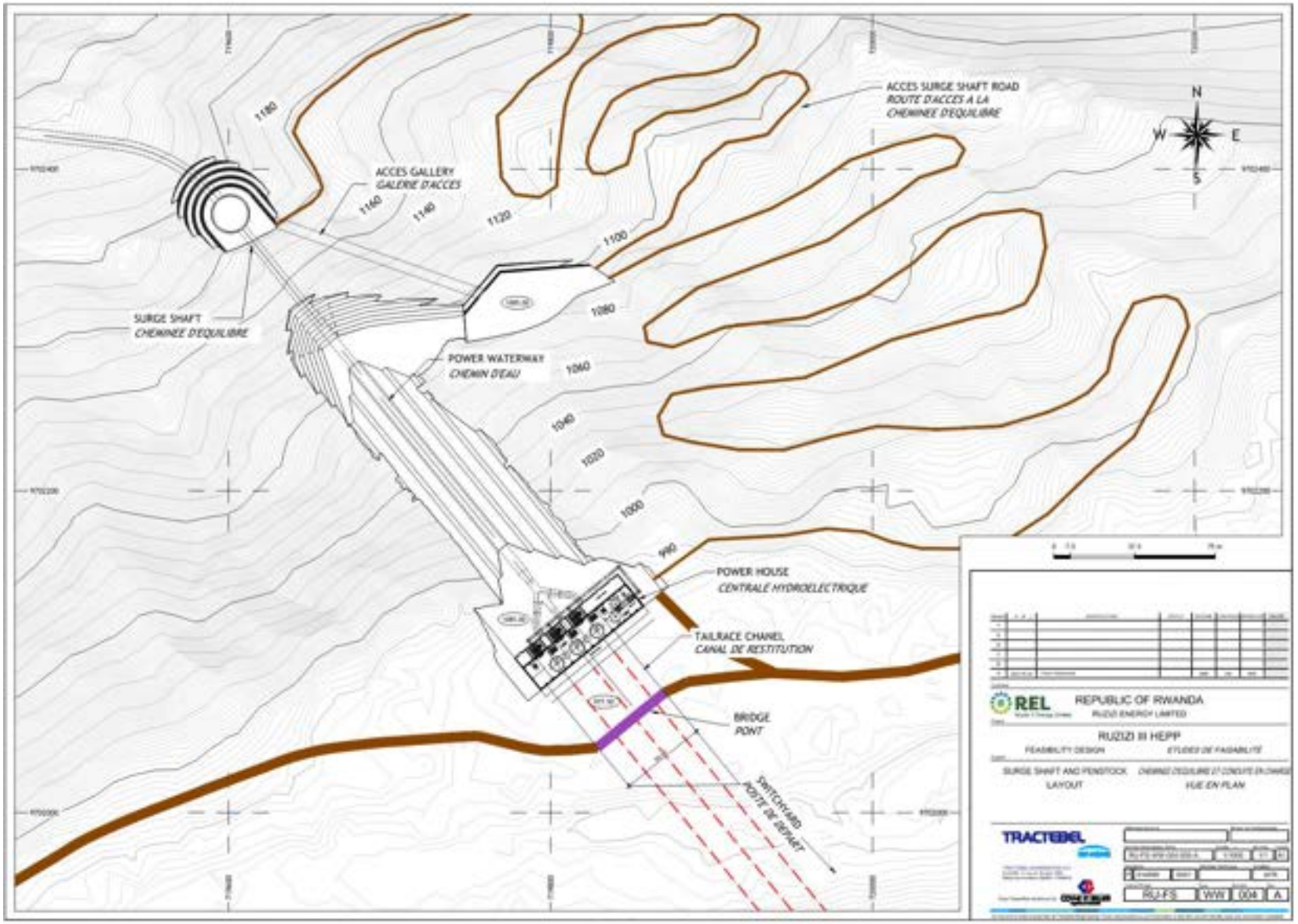


Figure 4-15 Surge Shaft and Penstock Layout

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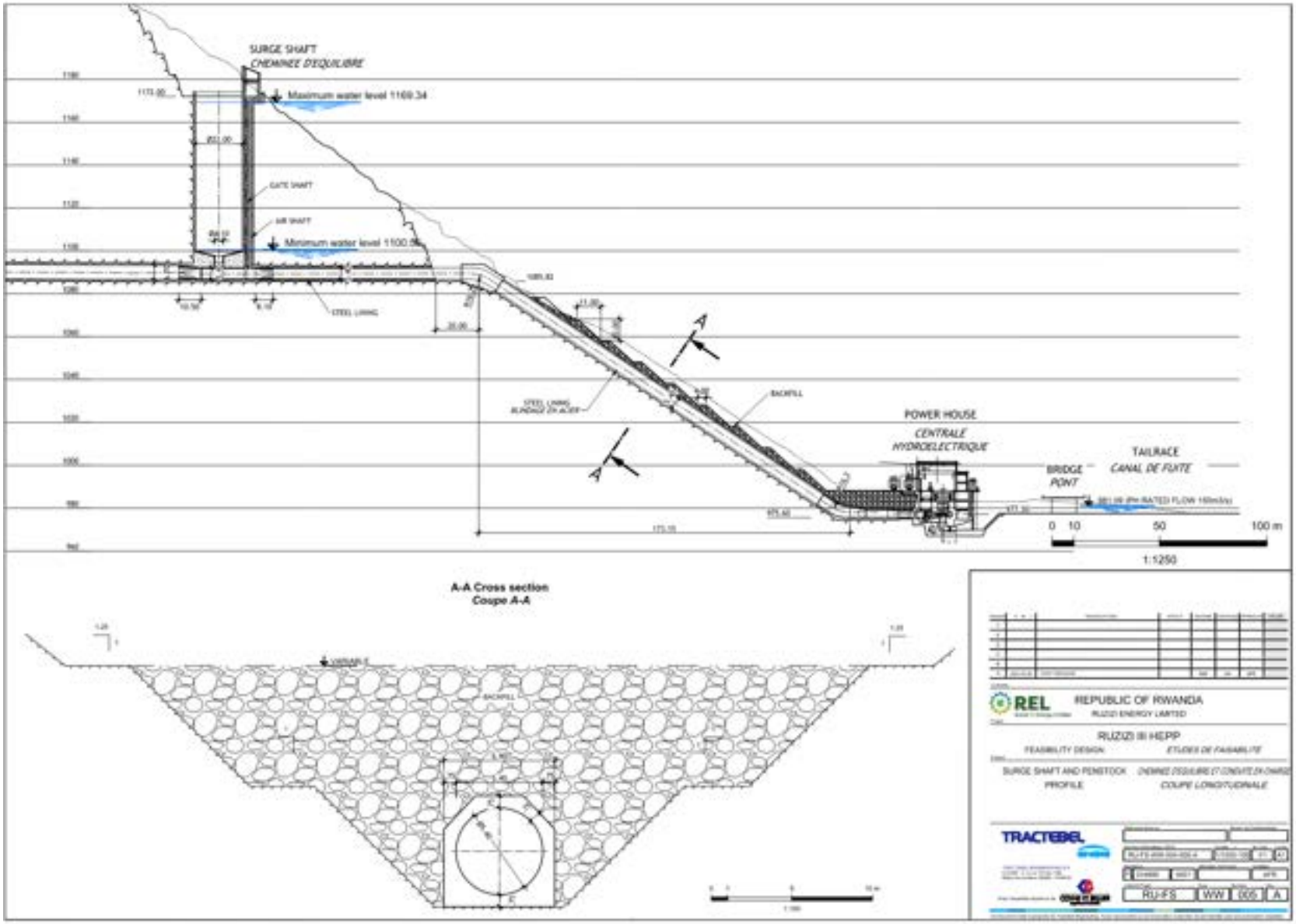


Figure 4-16 Surge Shaft and Penstock Profile

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4.2.9 Operators' Village

The operators' village, a permanent accommodation camp, will be constructed near the powerhouse (see

Figure 4-3). During the construction phase, the camp will accommodate expatriate staff and REL's supervisors. Once construction is completed, the camp will accommodate operator staff. The camp on the Rwanda side will have accommodation capacity of 86 bedrooms as the camp on the DRC side will have 12 bedrooms. The camp will be equipped with adequate sanitary systems and a supply of clean water in sufficient quantity. Dispositions for waste managements will be foreseen. Part of the infrastructures of the camp may be used after the construction phase for medical treatment and/or educational purposes for local populations.

4.2.10 Transmission Lines and Switchyard

4.2.10.1 220 kV Switchyard

The Project's transmission switchyard (also called the evacuation switchyard) is a 220 kV switchyard situated downstream of the powerhouse on the DRC side of the river. It is an outdoor, air insulted, double busbar substation with coupling and a so-called associated phase arrangement. The switchyard is connected to the powerhouse step-up transformers via three 220 kV single circuit lines approximately 400 m long (see Figure 4-3).

4.2.10.2 30 kV Overhead Power Supply Transmission Line

The facilities located in the reservoir area, including the dam site and intake control tower, will be supplied with electrical power from the Project's transmission switchyard. A 30 kV overhead line on concrete poles follows the dam access road on the DRC side of the river.

4.2.10.3 220 kV Overhead Transmission Line

Electrical power generated by the Project is transported from the transmission switchyard to the Kamanyola substation via a 220 kV overhead line that is 7 km in length. The line will have 18 double circuit galvanized steel lattice towers installed. Depending on the geotechnical conditions, the towers will be placed on either reinforced concrete slab foundation or concrete blocks anchored to the rock. The transmission line alignment is shown in the figure below. The width of the transmission line wayleave will be 30 m as per the Ministerial Order N° 0032/CAB/MIN/AFF.FONC/ASM/2023 dated 18 February 2023 which specifically authorises, for reasons of public utility, a wayleave width of 30 m for the Project.

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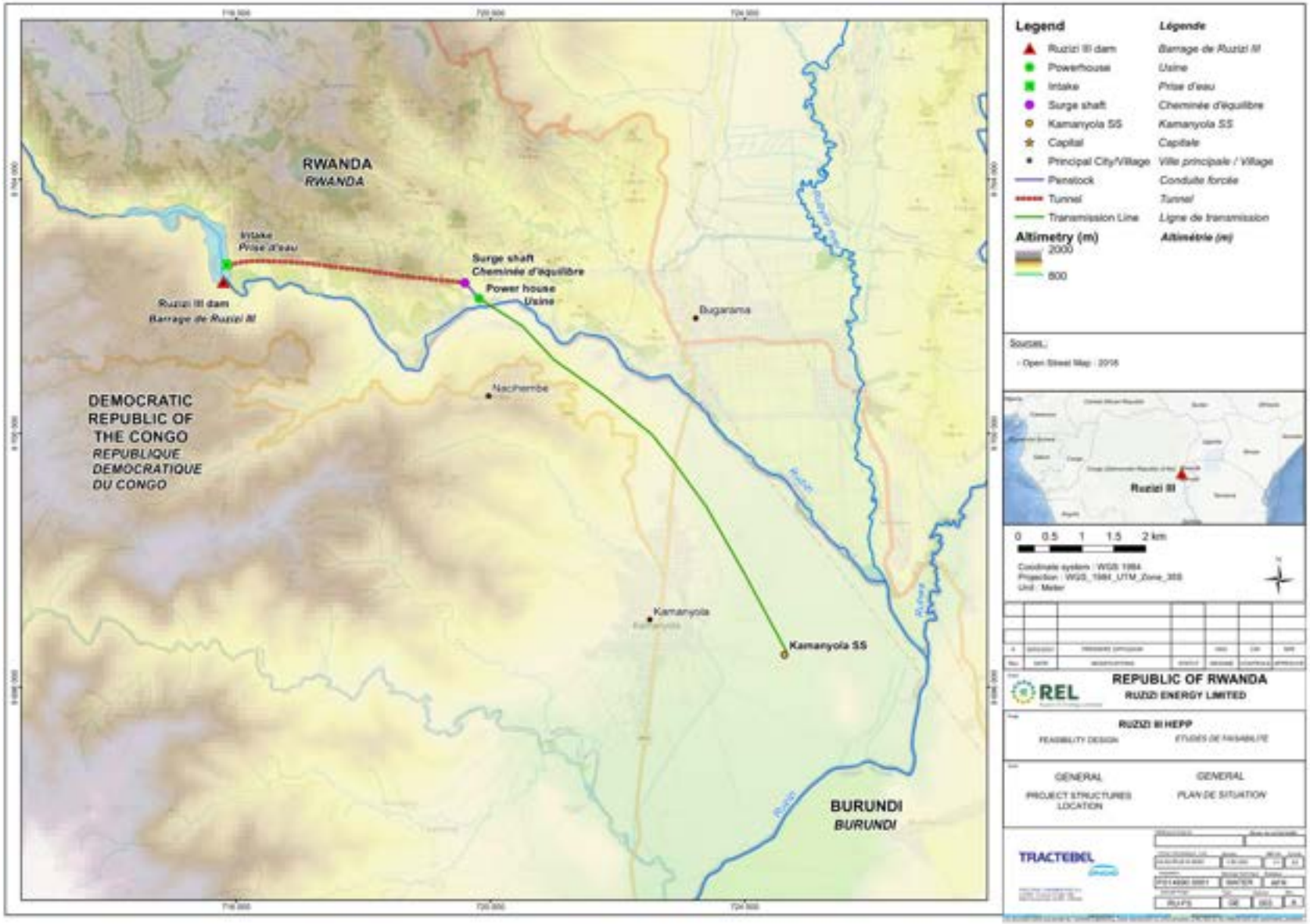


Figure 4-17 Project Structures Layout

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4.3 Components for Construction Only

4.3.1 Overview and Layout

The facilities and infrastructure used for construction purposes only are described in the following subsections and comprise:

- Temporary accommodation camp for construction workers.
- Quarries and borrow areas.
- Spoil disposal areas.
- Access roads.
- River diversion works (tunnels and coffer dam).

The layout of facilities and infrastructure are shown in Figure 4-3.

4.3.2 Temporary Worker Accommodation Camp

An estimated 500-1,000 workers (skilled and unskilled) will be required for Project construction during the peak construction period. A temporary accommodation camp for workers will be installed on the left bank (Rwanda) between the dam site and powerhouse site (see Figure 4-3). The design of the camp (including definition of capacity) will be undertaken by the EPC Contractor.

The camp buildings will be provided by the Contractor on dedicated areas. Other necessary buildings will also be provided by the Contractor. The camps will be equipped with the necessary sanitary and water supply installations.

The Contractor will implement a water treatment plant for wastewater and ensure waste is managed in alignment with DRC and Rwanda regulatory requirements and in alignment with the World Bank ESS 3 – Resource Efficiency and Pollution Prevention and Management. Vol. IV – ESMP includes the framework Waste Management Plan and a framework Pollution Prevention and Control Plan, and these plans will be developed into detailed plans by the EPC Contractor prior to the start of construction.

The camp will be designed and operated in alignment with (i) ILO 1961 Workers' Housing Recommendations (R115) and IFC and EBRD 2009 Workers' Accommodation Processes and Standards.

The temporary camps will be dismantled at the end of the Works.

4.3.3 Quarries and Borrow Areas

Based on the project reference design, preliminary estimates of quantities needed for extracted materials is presented in Table 4-5 below.

Table 4-5 Estimated Quantities of Extracted Materials

Category of Material	Estimated Quantities	Use
Clayey Material	177,164 m^3	Central Core for Dam body
River Sand (Fine Aggregates)	50,550 m^3	Dam filter material and Concrete Works
Coarse Aggregates	101,101 m^3	Concrete Works and Base Material for Road Works
Rock fill & Ripraps	776,364 m^3	Dam slopes protection works + powerhouse works
Subbase Material (Murrum)	31,818.00 m^3	Road Construction

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The potential quarry sites which have been identified by REL in Rwanda, DRC and Burundi are listed in Table 4-6 together with an indication of the quantity of material available from each site. However, the EPC contractor will be responsible for selecting the choice of materials and sites for the quarries taking into account material quality and haulage distance economics. Consequently, the selected sites may correspond to sites identified by REL or alternative sites.

Because the sitting of the quarries and borrow areas will be defined at a later stage, they are not included in the scope of the ESIA. However, Vol. IV - ESMP includes the process for REL's review and approval of the sites proposed by the EPC Contractor so that there is avoidance or minimisation of environmental and social impacts. REL will engage an ESIA consultant to conduct the environmental and social impacts for the establishment and exploitation of the quarries and borrow areas and any necessary access roads. The ESIA and RAP will meet international standards and demonstrate alignment with lenders' E&S policies.

Table 4-6 Potential Sites for Quarries in DRC, Rwanda and Burundi

Country	Site	Type of material	Quantity available
DRC	Bwegera	River Sand	Large quantities of sand replenished during rainy season
	Kirindangumi	River Sand	
	Ruvubu/ Nyabulindima River	Site 1 fine to coarse gravel; Site 2 river Sand, coarse grained gravelly sand	Large quantities of sand replenished during rainy season Estimated 180 m^3/day
	Nyarubare	Basalt Aggregates	Not specified in study
	Mt. Rubona	Sandstone Aggregates	Not specified in study
Rwanda	Ntangara River	River Sand, Medium to coarse grained Sand with mica flakes	Not specified in study
	Kirimbi River	River Sand, Fine to medium with visible organic matter and mica	Sand available perennially Estimated 180 m^3/day
	Kirimbi Delta	River Sand, Fine to medium grained with micas	Not specified in study
	Kigoya River	River Sand, Dark Brown Silty Sand	Not specified in study
	Karundura River	Whitish Grey, medium to coarse grained sand	About 180m^3/day
	Gihungwe	Mafic, fine grained columnal basalt	About 1.6 Million m^3 of aggregate reserve
	Quartzite APD	Light grey, slightly foliated, Quartzite Schist (suitable for riprap and retaining wall masonry works)	About 500,000 m^3 of exploitable material
	Tunnel Spoils	Quartzite Schist (may be suitable for riprap, retaining masonry works, road base material)	Not specified in study
	Gishoma Peat Power Plant	Lateritic Clayey Soil for Dam Core	About 300,000 m^3 of suitable material
	Nyagahanda	Lateritic Clayey Soil	About 50,000 m^3 of suitable material
	Mashyuza	Murrum material	To be defined by the EPC Contractor
	Mashesha	Murrum material	To be defined by the EPC Contractor
	Gombaniro	Murrum material	To be defined by the EPC Contractor
	Kibangira	Murrum material	To be defined by the EPC Contractor
	Gatebe	Murrum material	To be defined by the EPC Contractor
Burundi	Rukana II	Lateritic Clayey Soil	About 300,000 m^3 of suitable material
	Rukana I	Basalt rock	About 700,000 m^3 of suitable material
	Nyakagunda	Fine to medium sand with occasional cobbles	Estimated 50 m^3/day during wet season, 14 m^3/day during dry season

Source: Construction Material study by REL, August 2022

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The Construction Materials Study prepared by REL concluded the following:

- Abundant and suitable impervious material for the dam core structure is available at the Gishoma Peat borrow area (Rwanda) and its surrounding areas. A key consideration is the need to create a new road which traverses through steep terrain and area prone to landslides. The Rukana II (Burundi) Borrow areas are also potential candidate sites for EPC contractor consideration.
- For River Sand requirements, the Ruvubu/Nyabulindima Rivers on the DRC side provide materials seemingly free of mica when compared to sources on the Rwanda side. Mica poses a challenge to the quality and durability of concrete. The nearest site in Burundi offers small quantities. Challenges to consider regarding the DRC sources is related to poor road conditions, unpredictable insecurity situation within DRC territory as well as complications related to cross border issues.
- Potential basalt quarry sites in both DRC and Rwanda have material with acceptable suitability for construction. Test results for aggregates showed the Ruganzu quarry to be the best in terms of quality however this site has been excluded due to the presence of cultural heritage. While the quality of material from the APD site is not considered suitable for general construction, the material may be suitable for rockfill and riprap material. Burundi's Rukana I Basalt site is also a likely suitable candidate.
- For road subbase (murrum) material, several existing borrow areas have been identified and material samples tested in the laboratory have suitable properties/characteristics.

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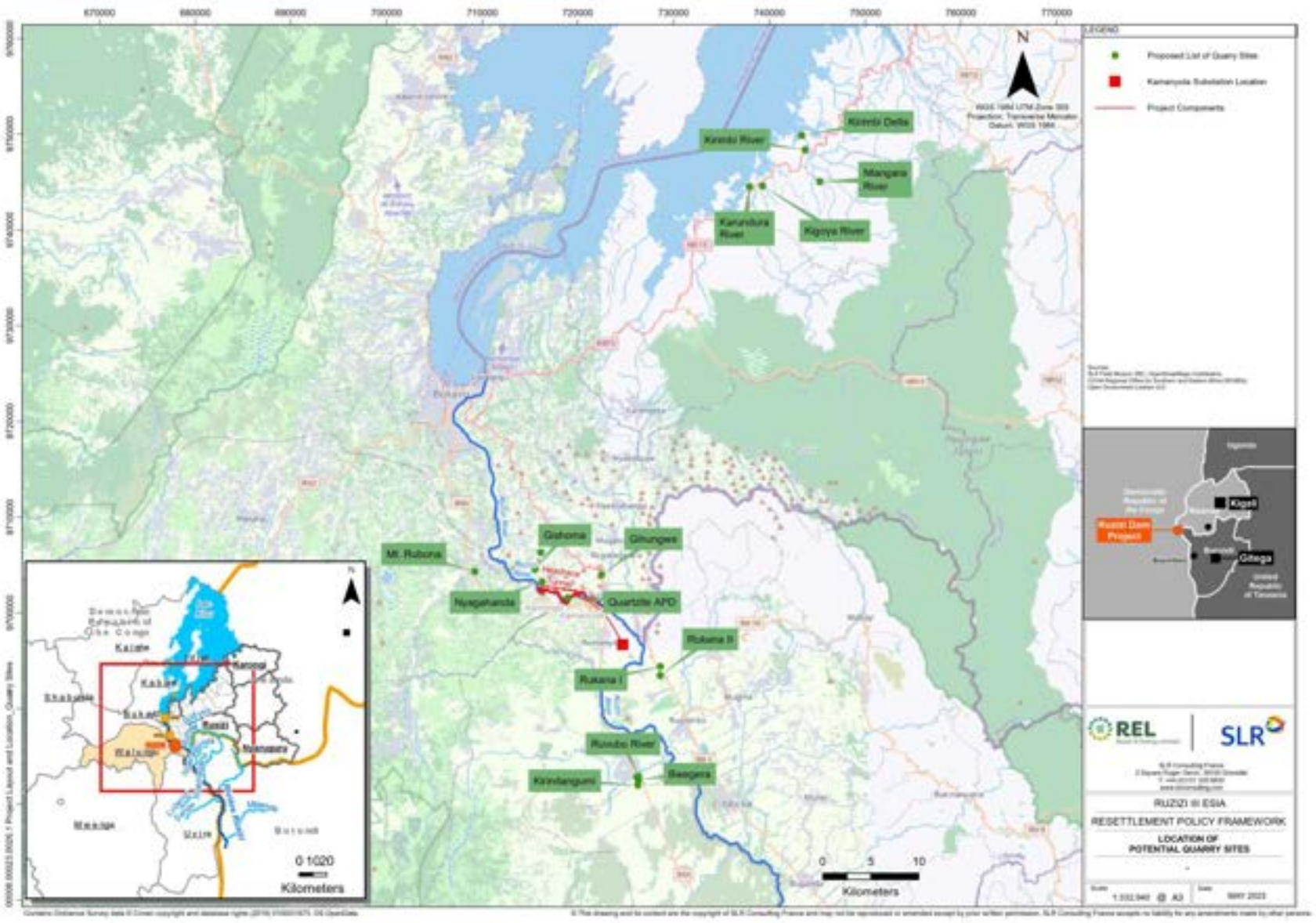


Figure 4-18 Location of Potential Quarry sites in DRC, Rwanda and Burundi

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4.3.4 Spoil Disposal Areas

Information regarding volume, use, disposition of spoils is unknown at the time of writing and will be determined by the EPC Contractor. Spoil disposal areas will be identified by the EPC Contractor at a later stage. The Feasibility Study has identified a potential spoil area shown in Figure 4-3.

.

4.3.5 Construction Access Roads

The permanent roads and roads which will be used only during construction are described in Section 4.2.8.

4.3.6 Diversion Tunnels

The Project plans for two concrete-lined diversion tunnels with a capacity to divert the peak discharge of the construction flood (452 m^3/s). The construction flood corresponds to the combined flows of the maximum turbined discharge from Ruzizi-III (154 m^3/s), Ruzizi-I spillway operating with one gate open (57 m^3/s) and a peak discharge from a 20-year return period flood on the catchment between Ruzizi-I and -III (241 m^3/s). The two tunnels will have their inlet inverts at an elevation of 1,107 m asl, a slope of 1% and a length of approximately 180 m. They will both have a diameter of 4.8 m. The sections are characterized by vertical walls on the lower half of the height and an arched roof. The tunnel profiles are provided in Figure 4-19.

4.3.7 Cofferdam

The role of the cofferdam is to protect the site from floods and divert the river flow into the diversion tunnels. The cofferdam will be made of alluvial material recovered from the river, and its crest will reach the 1,120 m asl level, fine sorted materials will ensure its sealing, and the upstream recharge will be protected by large-diameter riprap.

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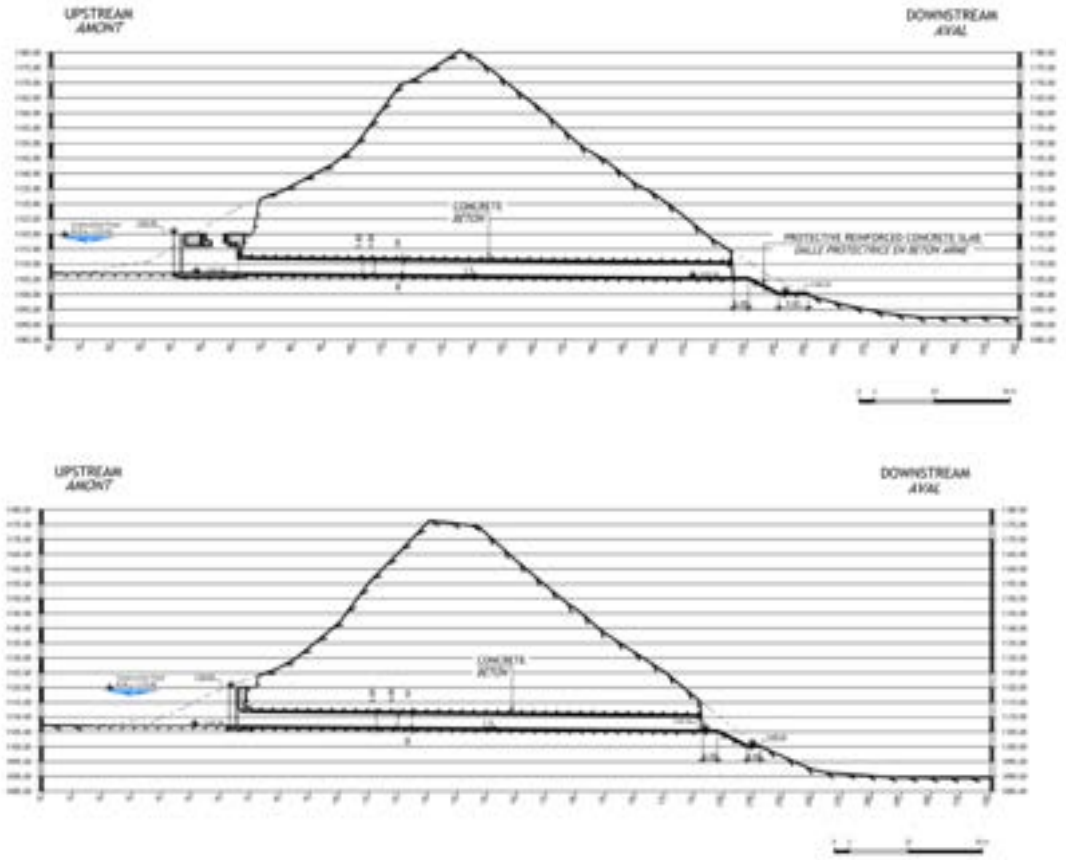


Figure 4-19 Diversion Tunnels Profiles

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4.4 Construction Activities and Reservoir Filling

4.4.1 Construction Contracts

The construction works will be executed by an EPC Contractor. An EPC Contract is a prominent form of contracting agreement in the construction industry. The EPC Contractor carries out the detailed engineering design of the Project, procures all the equipment and materials necessary, and through various subcontracts then constructs the Project to deliver a functioning facility to REL.

4.4.2 Construction Schedule

The construction schedule for the Project is estimated by the Feasibility Study (Tractebel, 2022a) to be approximately 56 months.

- At the start of the Contract, the Contractor shall mobilize the personnel and equipment on the site to start the first activities. At the same time, various studies of the civil engineering, the hydro-electro-mechanical equipment, and transmission lines shall start.
- The preparatory works concern mainly the access infrastructures to the project site and the camp on the Rwanda side as well as construction facilities.
- Once the state of roads allows to access the main construction fronts (dam site, tunnel adits, surge shaft, etc) the excavation activities will start.
- On the reservoir area the surface excavations for the spillway from top to bottom will be performed followed by the excavation of the intake tower and deviation tunnels intakes.
- At the same time preparation of underground excavations is set up in three different fronts (upstream, intermediate adit and downstream).
- The excavation of deviation tunnels will be performed followed by the concreting of inner lining.
- Once the intakes of the deviation tunnel are ready the river is diverted, and the cofferdam construction starts. Following the cofferdam, the excavation and foundation treatment of the dam can start.
- The concrete works of the powerhouse are separated in two stages. The schedule presents the works necessary to provide the erection bay operational as soon as possible to allow starting the handling of heavy components of equipment.

4.4.3 River Diversion Works

The construction of the dam requires the dewatering of the site where it will be located. The dewatering is carried out by means of an upstream cofferdam to protect the construction area from flooding. It will divert the river during construction by means of two tunnels (approximately 180 m long).

4.4.3.1 Stage 1

Two concrete-lined tunnels will be excavated through the rock spur that is the left bank abutment of the dam (Rwanda side), while the river flows in its natural bed. The tunnels will be designed for a capacity of 452 m^3/s (the diversion flood). One of the tunnels will be re-used later as a bottom outlet tunnel. The tunnels are horseshoe-shaped in cross-section, rest on a base plate at elevation 1,107 m asl, are 180 m long, have a 1% inclination and an internal diameter of 4.8 m. Underground excavation work for the tunnels, it will be done with the drill and blast technique.

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4.4.3.2 Stage 2

Once the two diversion tunnels are completed, the river will be dammed with a cofferdam and will be diverted through the tunnels. The cofferdam embankment will be made of alluvial material. Specifically selected fine material from the river alluvium will make the imperviousness of the embankment. The upstream slope will be protected with selected coarse rockfill. The crest of the cofferdam will be set at elevation 1,120 m asl.

No downstream cofferdam will be required to protect the dam construction works because the diverted flows re-join the Ruzizi downstream of a natural fall, some 16 m below the dam site elevation.

4.4.3.3 Stage 3

Once the dam, spillway, intake tower and first stage concrete of the bottom outlet tower are completed, the diversion tunnel that will be re-equipped as bottom outlet will be closed with stoplogs. Once it is closed, its hydraulic steel structures will be installed and the second stage concrete will be cast, for completion of the structure. Once the gates are installed and the structure completed, the upstream stoplog will be removed. During the installation of the bottom outlet equipment, the Ruzizi flows will be derived though the second diversion tunnel which is designed so that it can convey the maximum flow rate of Ruzizi I powerhouse, i.e. 154 m^3/s, so that it remains possible to access to the stoplog of the bottom outlet tunnel. Once the bottom outlet is completed, this second diversion tunnel will be completed to install the minihydro.

4.4.4 Power Supply, Water Supply and Wastewater

4.4.4.1 Power Supply

The main worksites will be supplied with electricity through generator plants installed by the EPC Contractor for the construction period. A network of distribution lines will link the generator to the workplaces.

4.4.4.2 Water Supply

The water requirements will be determined by the EPC Contractor during the detailed design. It can be anticipated that water will be required for industrial uses (e.g. washing & screening of aggregates, concrete batching, field compaction, dust suppression, wet-drilling) and domestic uses (e.g. drinking, food preparation and other canteen operations, laundry, bathrooms and other sanitary facilities located within the Project temporary facilities such as accommodation camps and offices.

The source of water will be defined by the EPC Contractor in the detailed design phase. However, it can be expected the water will be abstracted from the Ruzizi River, and if necessary treated to applicable standards and distributed to construction facilities through buried pipelines. It is unlikely that river water will be used as potable water and may need to be transport to the worker camps.

4.4.4.3 Wastewater

Wastewater treatment will be defined by the EPC Contractor during the detailed design. However, it can be anticipated that domestic wastewater is likely to be treated by modular unit type wastewater treatment plants, which include preliminary treatment (physical screening), secondary treatment (biological and chemical), and tertiary treatment (e.g. chlorination disinfection and sand filter).

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The quality of treated effluents will be monitored on a regular basis and will comply with the national standards for sanitary wastewater discharges to surface waters and the discharge standards set out in the World Bank EHS Guidelines before discharge into the Ruzizi River.

Treated wastewater will be stored in an impounding tank and may be used for industrial process or dust suppression where it is available. Wastewater from offices, warehouse and workshops will be directed to septic tanks. Sewage trucks will regularly maintain these septic tanks and transport the effluents to the wastewater treatment plants. Oily effluents collected in oil separators will be collected and transported to a specialized facility in Rwanda for treatment and disposal.

4.4.5 Materials Origins and Wastes

4.4.5.1 Rockfill Embankment Material

The material will be sourced from excavation works and from a borrow area, as described in Section 4.3.3.

4.4.5.2 Quantities of Material

Table 4-7 Estimated Quantities of Construction Materials

Item	Type	Quantity	Unit
Upstream cofferdam			
Clay core	Earth and Rock	14,701	m^3
Filter/Drain/Transition	Earth and Rock	29,403	m^3
Rockfill	Earth and Rock	30,235	m^3
Rip rap	Earth and Rock	3,920	m^3
Dam			
Excavation - Open air - Soil	Earth and Rock	13,554	m^3
Clay core	Earth and Rock	162,463	m^3
Filter/Drain/Transition	Earth and Rock	64,019	m^3
Rockfill	Earth and Rock	635,620	m^3
Rip rap	Earth and Rock	90,206	m^3
LB platform			
Excavation - Open air - Soil	Earth and Rock	6,520	m^3
Excavation - Open air - Rock	Earth and Rock	58,680	m^3
Shotcrete - Open air	Concrete	94	m^3
Spillway			
Open air spillway - Inlet, weir, chute, energy dissipation			
Excavation - Open air - Soil	Earth and Rock	10,800	m^3
Excavation - Open air - Rock	Earth and Rock	97,200	m^3
Concrete - Open air - structural	Earth and Rock	8,581	m^3
Reinforcement steel	Steel	520	Tonnes
Bottom Outlet			
Inlet			
Excavation - Open air - Rock	Earth and Rock	7,139	m^3
Concrete - Open air - structural	Concrete	3,073	m^3

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Item	Type	Quantity	Unit
Reinforcement steel	Steel	292	Tonnes
Shotcrete - Open air (incl. wire mesh)	Concrete	41	m^3
Tunnel			
Excavation - Tunnel - Rock I-III	Earth and Rock	4,756	m^3
Concrete - Underground - Structural (incl. formwork)	Concrete	1,499	m^3
Reinforcement steel	Steel	229	Tonnes
Shotcrete - Underground	Concrete	236	m^3
Energy dissipation			
Excavation - Open air - Rock	Earth and Rock	954	m^3
Concrete - Open air - structural	Concrete	434	m^3
Reinforcement steel	Steel	33	Tonnes
Shotcrete - Open air	Concrete	9	m^3
Diversion Tunnel			
Portals			
Excavation - Open air - Rock	Earth and Rock	8,739	m^3
Concrete - Open air - structural	Concrete	600	m^3
Reinforcement steel	Steel	36	Tonnes
Shotcrete - Open air	Concrete	43	m^3
Tunnel			
Excavation - Tunnel - Rock I-III	Earth and Rock	4,756	m^3
Concrete - Underground - Structural	Concrete	1,499	m^3
Reinforcement steel	Steel	229	Tonnes
Shotcrete - Underground	Concrete	236	m^3
Power waterways			
Power intake			
Excavation - Open air - Rock	Earth and Rock	7,258	m^3
Concrete - Open air - structural	Concrete	6,500	m^3
Reinforcement steel	Steel	389	Tonnes
Shotcrete - Open air	Concrete	34	m^3
Headrace tunnel			
Excavation - Tunnel - Rock I-III	Earth and Rock	138,750	m^3
Excavation - Tunnel - Rock IV-V	Earth and Rock	46,250	m^3
Concrete - Underground - Structural	Concrete	40,300	m^3
Reinforcement steel	Steel	1,900	Tonnes
Shotcrete - Underground	Concrete	3,920	m^3
Surge tank			
Excavation - Open air - Soil	Earth and Rock	19,825	m^3
Excavation - Open air - Rock	Earth and Rock	19,825	m^3
Excavation - Shaft - Rock	Earth and Rock	34,265	m^3
Concrete - Underground - Structural	Concrete	8,265	m^3
Reinforcement steel	Steel	248	Tonnes

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Item	Type	Quantity	Unit
Shotcrete - Open air	Concrete	145	m^3
Shotcrete - Underground	Concrete	1,011	m^3
Steel-lined tunnel and penstock			
Excavation - Open air - Soil	Earth and Rock	127,400	m^3
Excavation - Open air - Rock	Earth and Rock	54,600	m^3
Excavation - Tunnel - Rock I-III	Earth and Rock	3,848	m^3
Random fill	Earth and Rock	81,478	m^3
Concrete - Open air - structural	Concrete	5,149	m^3
Concrete - Underground - Structural	Concrete	1,558	m^3
Reinforcement steel	Steel	268	Tonnes
Shotcrete - Open air	Concrete	225	m^3
Shotcrete - Underground	Concrete	148	m^3
Access tunnel			
Excavation - Open air - Soil	Earth and Rock	10,000	m^3
Excavation - Open air - Rock	Earth and Rock	11,600	m^3
Excavation - Tunnel - Rock I-III	Earth and Rock	9,925	m^3
Excavation - Tunnel - Rock IV-V	Earth and Rock	1,080	m^3
Concrete - Underground - Structural	Concrete	3,270	m^3
Concrete - Underground - Backfill	Concrete	165	m^3
Reinforcement steel	Steel	100	Tonnes
Shotcrete - Underground	Concrete	275	m^3
Powerhouse			
Excavation - Open air - Soil	Earth and Rock	81,131	m^3
Excavation - Open air - Rock	Earth and Rock	50,387	m^3
Random fill	Earth and Rock	27,510	m^3
Rockfill	Earth and Rock	13,255	m^3
Rip rap	Earth and Rock	3,128	m^3
Concrete - Open air - backfill	Concrete	300	m^3
Concrete - Open air - structural	Concrete	17,000	m^3
Reinforcement steel	Steel	1,530	Tonnes
Steel - structural	Steel	110	Tonnes
Switchyard			
Random fill	Earth and Rock	48,500	m^3
Concrete - Open air - backfill	Concrete	2,400	m^3
Concrete - Open air - structural	Concrete	2,000	m^3
Reinforcement steel	Steel	100	Tonnes
Roads			
Earthworks	Earth and Rock	75,790	m^3
Excavation - Open air - Soil	Earth and Rock	45,898	m^3
Excavation - Open air - Rock	Earth and Rock	81,693	m^3
Fill	Earth and Rock	185,921	m^3

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Item	Type	Quantity	Unit
Subbase	Earth and Rock	31,818	m^3
Roadbase	Earth and Rock	31,565	m^3
Concrete - Lateral drainage channels	Concrete	5,010	m^3
Concrete - Drainage channels on slopes	Concrete	1,953	m^3
Gabions	Earth and Rock	39,024	m^3
Minihydro Civil Works			
Excavation - Open air - Rock	Earth and Rock	1,072	m^3
Concrete - Open air - backfill	Concrete	195	m^3
Concrete - Open air - structural (incl. formwork)	Concrete	2,955	m^3
Reinforcement steel	Steel	191	Tonnes

Source: TRACTEBEL, 2022a

4.4.5.3 Spoil

Civil works will be designed by the EPC Contractor in the next stage of the Project to optimise the reuse of excavated material for the dam construction. At the current stage in the Project the quantities of spoil and identification of spoil disposal sites has not been carried out. Nevertheless, it can be anticipated that not all excavated material may be used for backfilling purposes, and that there will be a need for some spoil disposal.

4.4.5.4 Wastes

The typical waste generated by hydropower schemes such as Ruzizi-III include the following:

- **Non-hazardous waste**: Waste from the camps and canteens, paper, cardboard, plastics, wood and vegetation, inert wastes from construction and demolition (concrete, scrap iron, bricks, etc). The amount of domestic waste to be generated from the workers' camp can be estimated at 0.5 kg/per person/day, or about 500 kg/day for 1,000 workers.
- **Hazardous waste:** Engine oils and used hydraulic fluids, residues of paint, solvents and resins, fluids from transformers, medical wastes, sludge from septic tanks, and various concrete additives. Quantities of hazardous waste are variable and project specific. The EPC Contractor bidding documents require the Contractor to prepare a waste management plan, which will require preparation of a detailed inventory of wastes, estimation of quantities and identification of management solutions in alignment with Rwanda and DRC regulations and Good International Practice.

4.4.6 Traffic

A detailed construction traffic study will be conducted by the EPC contractor in the next phase of the Project. However, for the purpose of this ESIA a preliminary estimate of the order of magnitude of truck movements has been made. The Feasibility Bill of Quantities estimates that a total of 2.5 million m^3 of earth and rock will need to be moved and 110,542 m^3 of concrete will be needed.

The Feasibility Study indicates that the duration of the civil works is 1,168 days. Therefore, assuming that a typical tuck has a capacity of ~60 m^3, there will be in the order of 36 return-trip truck journeys per day on average, and during periods of peak activity there may be up to c. 50-60 return trips per day. It is not possible at this stage to determine the number of trucks on each stretch of road, but the overall figures indicate that during peak activity periods there may one truck passing along an access road every 5 to 10 minutes during daylight hours.

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4.4.7 Reservoir Clearing and Filling

Clearing of the reservoir footprint (46 ha) may be needed prior to reservoir filling. However, it expected that clearing of trees and vegetation will not be carried out. The vast majority of the land cover in the footprint is agricultural land. However, there are some trees and scrub, which will probably not need to be clearedas the environmental gain in terms of reservoir water quality will be negligible, and the management of the removed vegetation will incur additional costs.

With an annual average flow of 109.9 m^3/s, the Ruzizi River would theoretically fill the Ruzizi-III reservoir in less than 24 hours. However, for dam structure stability reasons it would be better to fill the reservoir more slowly and part of the river flow will have to continue flowing downstream for ecological and socioeconomic reasons during reservoir filling. Therefore, the Feasibility Study assumes 12 days for reservoir filling.

4.4.8 Construction Methods for the Transmission Line

4.4.8.1 Site Preparation, Establishment and Reinstatement

Works would commence with site clearance and ground preparation of working areas, creation of access tracks and associated laydown areas. This would typically involve the removal and appropriate storage of topsoil (for later reinstatement). Some working areas may require the use of crushed stone potentially overlain on a reinforcing geotextile membrane if the ground conditions are soft.

4.4.8.2 Access Tracks

Where possible, existing roads and access tracks would be used for the works. However, some access tracks will need to be established by the Construction Contractor. Access tracks would be approximately 4.5 m wide although could be wider in places depending upon topography and access requirements.

4.4.8.3 Tree and Vegetation Removal

The removal (or height reduction) of trees and ground vegetation would be required ahead of soil stripping or any excavation and foundation works. Tree removal and vegetation clearance would be kept to a minimum within the 30 m wide wayleave. It is noteworthy that the land cover of the vast majority of the transmission line wayleave is agricultural land and there are very few trees or almost no natural vegetation.

4.4.8.4 Temporary Construction Compounds

Because of the relatively short length of the transmission line (7 km) it is probably unlikely that temporary construction compounds will be required at intervals along the transmission line.

4.4.8.5 Installation of the Transmission Line Towers and Conductor Lines

Following construction of the working areas and the clearance of the wayleave, the construction of the transmission lines would begin with the construction of the foundations for the towers. In flat or moderately hilly areas, the foundations would generally comprise either standard pad and chimney, concrete block designs or be piled depending on ground conditions. Pre-mixed concrete would be delivered to site along with steelwork for the foundation frames and bases. The foundation would comprise reinforcing steelwork cylinders encased in concrete, with 'stubs' projecting through the concrete above ground to which the tower legs would be attached. The modular lattice towers would be erected in sections, with a mobile crane.

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The conductor lines would be delivered to site on drums using HGVs as would the tensioning and pulling machines. The preparation of the working corridor is undertaken in advance of the conductor stringing. This may require the use of scaffolding in some instances to protect members of the public and assets from transmission line construction works. Items that may require protection include roads, tracks, buildings, and lower voltage transmission lines. The works may also require the crossing over or diversion of lower voltage local distribution lines. This would typically be undertaken in advance of the Project's construction works and in a manner that ensured continuity of local energy supplies to local communities. Some tree and vegetation removal would also be required to enable the stringing works to take place, particularly in wooded areas.

The conductor lines are installed in sections between approximately 10 towers at a time. The pilot wires are run at ground level (and over any temporary scaffolding protecting obstacles and roads) along the full length of the section, between the 'pulling site' and the 'tensioning site' where the new conductor is positioned. If necessary, a corridor of up to 5m wide would be cleared of trees and vegetation. However, such clearance would be avoided where possible by passing the pilot wire around areas of tree and vegetation. The pilot wires are then lifted and fed through running wheels on the cross arms of all the towers in the middle of the section, and then fed around a special machine at the final tower or pulling site in the run of towers being strung. In order to keep the conductor lines off the ground and avoid any damage to property, the tensioning site has a similar machine that stops the conductor line running freely when the pulling machine 'pulls' the pilot wire. When the pilot wire is tensioned, it pulls through the conductor line avoiding contact with the ground through the towers before connecting to the final tower in the run. The required tension and height above ground are made and the process begins again for the next section of towers.

4.4.9 Manpower Requirements

The construction will require between 500 and 1,000 workers at the site (Tracebel, 2021) and the duration of the construction is expected to be in the order of 56 months. It can be expected that about 80% to 90% of the workforce will work at the dam site and the access roads. The other 10% to 20% will be mobilized for the construction of the transmission line. The operation of the scheme will require only a small number of staff, probably in the order of 50 people.

4.5 Operation and Maintenance

4.5.1 General

The Project is situated downstream from the existing Ruzizi-I and -II hydropower schemes, both of which operate with hydropeaking. Consequently, once the Project is implemented the Ruzizi cascade will need to operate in a coordinated manner, and Ruzizi-III and will operate with periods of peak and off peak flows. The timing of the release of peak and off peak flows from the Project is driven by the demand for electricity and the Power Purchase Agreement (see Figure 4-20). The daily energy demand considered in the Project's Power Purchase Agreement is provided in the figure below and it shows that the peak and off peak energy demand periods are as follows:

- Off peak energy demand during the night (22:00 to 04:00).
- Ramp up in energy demand in the early morning (04:00 to 06:00).
- Period of peak demand during the morning (06:00 to 08:00).
- Lowering of energy demand during the day (08:00 to 16:00).
- Second ramp up of energy demand and period of peak demand in evening (16:00 to 20:00).

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- Lowering of energy demand to off peak levels in the late evening (20:00 to 22:00).

The electrical power generated by the Project is transported to the Kamanyola 220 kV substation, developed by EGL and which will be operated by SINELAC. The Kamanyola substation will act as the dispatching centre and will coordinate the transport of electrical power to Burundi, DRC and Rwanda.

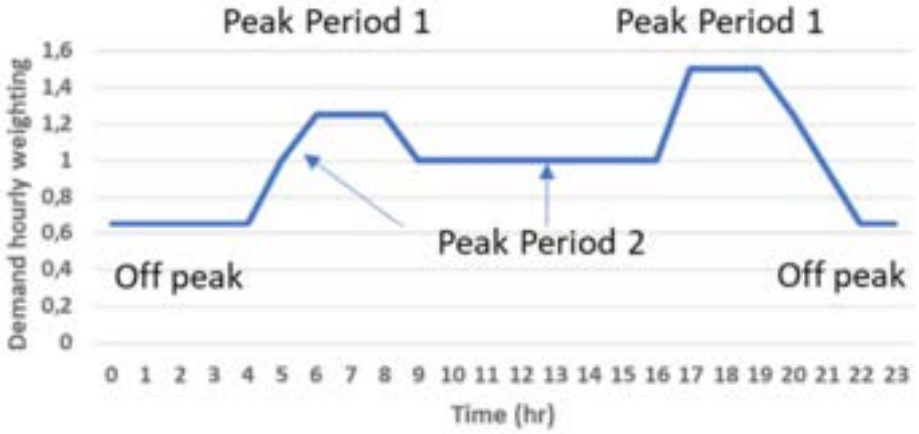


Figure 4-20 Daily Energy Demand Distribution Considered in the Ruzizi-III Power Purchase Agreement

4.5.2 Annual Energy Generation

The Project's feasibility Study (Tractebel, 2022a) has estimated energy production for the Ruzizi-III powerplant and the Ruzizi cascade as a whole using the software programme MIKE HYDRO Basin. Energy production has been estimated using simulations for 2 operating schemes and the results are presented in the table below for two cases: (i) relative distribution of flows, where operators aim to maintain the relative distribution of flows in order to meet the requirements of the power purchase agreement, and (ii) peak hour placement of flows, where operators aim to release the maximum installed capacity flows during the peak hours and to replenish the reservoir storage during off-peak hours.

Table 4-8 Key Characteristics of the Power Waterway Components

Operating Scheme	Mean Annual Energy (GWh)		Firm Energy (GWh)*	
	Project	Cascade	Project	Cascade
Relative distribution of flows	1,197	1,544	989	1,269
Peak hour placement of flows	1,153	1,496	945	1,226
* Non-exceedance probability of 5% Source: Tractebel, 2021				

4.5.3 Powerhouse Daily Operations

The Project's feasibility Study (Tractebel, 2022a) has assessed how Ruzizi-I, -II and -III reservoir and powerhouse operations can be optimised once the Project is implemented. The findings of the assessment are summarised as follows:

- Ruzizi-I: It is optimal to release peak flows during the morning and afternoon period of peak energy demand, and to replenish reservoir storage during periods of off peak energy demand.
- Ruzizi-II: Operation is constrained by the lack of available storage volume (because of sedimentation) and the 3-hour lag for the flows from Ruzizi-I to reach Ruzizi-II. Consequently, it will be frequent that releases during peak energy demand periods are below the maximum installed capacity.

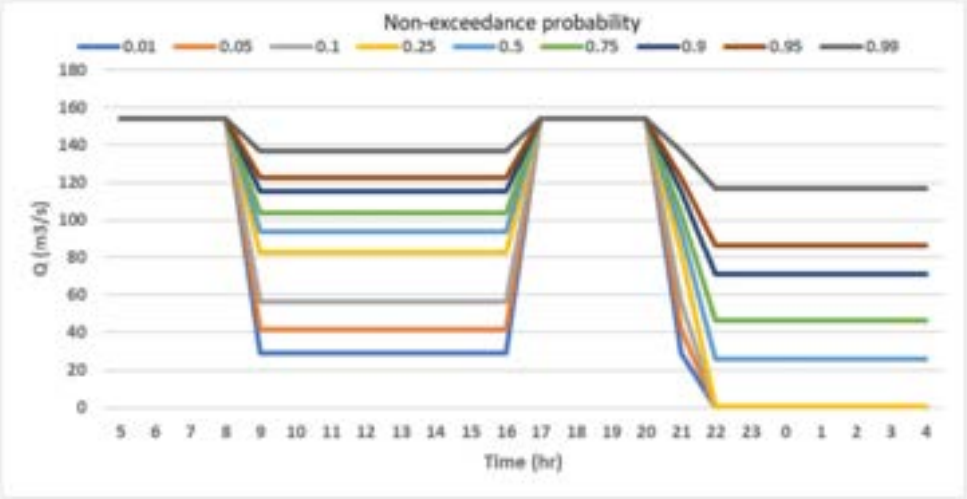
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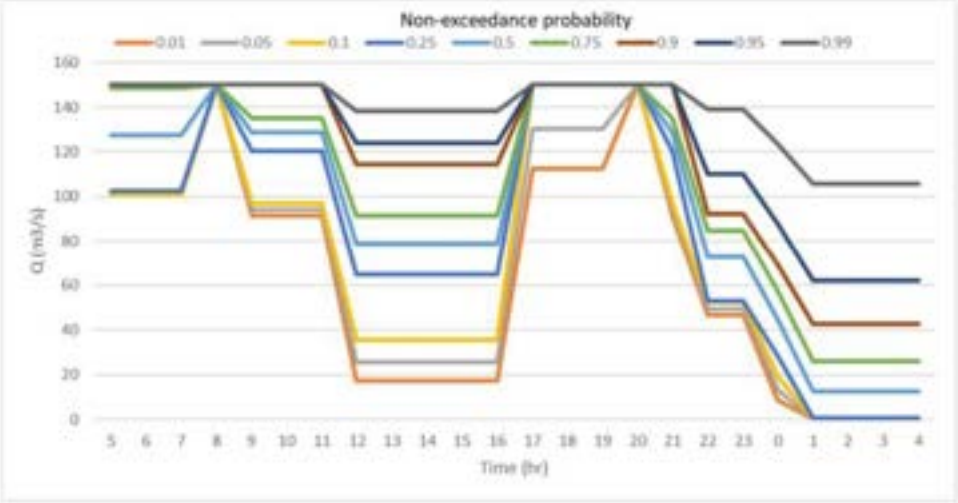
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- Ruzizi-III: The operation will be as for Ruzizi-I, i.e. to release peak flows during the morning and afternoon period of peak energy demand, and to replenish reservoir storage during periods of off peak energy demand.

The variations in turbined flows over 24-hours for the Ruzizi cascade hydropower schemes for different inflow conditions are presented graphically in Figure 4-21.

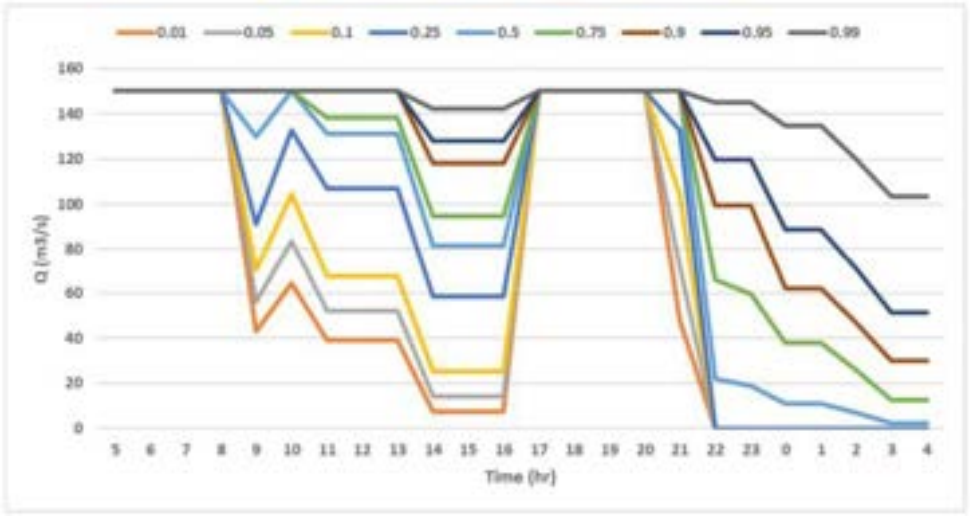


Ruzizi-I



Ruzizi-II

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Ruzizi-III

Explanatory Note: Non-Exceedance Probability (NEP) is the likelihood that a specified flow rate is not exceeded. The NEP of 0.01 corresponds to a low river flow and the NEP of 0.99 corresponds to high river flow

Figure 4-21 Optimised Turbined Flows for Ruzizi-I, -II and -III

4.5.4 Variations of Reservoir Water Level and Downstream Flow

The hydropeaking mode of operation has implications in terms of variation of reservoir water level, and variation of river flow and river water levels downstream of the powerhouse.

Reservoir water levels will fluctuate, to varying degrees, between the FSL and the minimum operating level during the course of 24 hours. Consequently, the maximum change in water level will be 12 m, which will occur during periods of low seasonal river flow, when off peak flow is at the lowest. During periods of high seasonal river flow, there will be smaller changes in reservoir water levels.

The lowering of the reservoir water level by 12 m will reduce the reservoir surface area from 46 ha to 20 ha, effectively temporarily reducing the size of the reservoir by 40%.

Hydropeaking will also result in hourly variations in river flow rates in the reach downstream from the Project powerhouse. During normal river flow conditions, the highest flow rate will be the maximum turbining capacity of the powerhouse (150 m^3/s), and the lowest flow rate will be ecological flow (11 m^3/s) plus the off peak flow.

To summarise, the river flow rate immediately downstream from the powerhouse can change from 150 m^3/s to 11 m^3/s during a 24-hour period. The magnitude of variations in river flow rate decreased with distance from the powerhouse as discussed in Chapter 10 – Eflow Assessment.

4.5.5 Sediment Management

A sediment management plan will be prepared during the EPC design activities and will consider both structural and non-structural measures to manage sediment. For comparison, it is noteworthy that the Ruzizi-II reservoir capacity has been reduced to 40% of the initial capacity after 24 years of operation (1989-2013). The framework sediment management plan that will be developed into a detailed plan early during project preparation by the EPC Contractor is provided in Vol. IV – ESMP.

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4.5.6 Transmission Line Maintenance

The Project has not at this stage prepared a transmission line maintenance programme. However, it can be anticipated that the 220 kV transmission line would be operated remotely and would require very little maintenance. The lines would be subject to annual inspections from the ground and the inspection would identify any visible faults or signs of wear or safety risks, including the presence of any physical structures or tree regrowth in the wayleave infringing on safety clearance and require attention. Inspections would also confirm when refurbishment is required.

Small 4-wheel drive vehicles could be used to carry out routine maintenance works. Trucks would probably only be used to bring new materials and equipment to site and remove old equipment if major repairs were required. Maintenance of the wayleave corridor would be undertaking using manual cutting to minimise the intrusion into the vegetated corridor.

Refurbishment of the transmission line may be required throughout the life of the Project and this could involve:

- The replacement of conductors and earth wire.
- The replacement of insulators and steelwork that holds the conductors and insulators in place.
- Painting or replacing the tower steelwork.
- Replacement of tower furniture (anti-climbing devices, colour identification plates, danger of death notices, number plates).

4.5.7 Maintenance of Hydromechanical Equipment

The Project will prepare an Operation and Maintenance (O&M) Plan, including the Instrumentation Plan and the Emergency Preparedness Plan, in alignment with the requirements of the World Bank ESS4 Community Health and Safety. The preliminary plan will be available for the Lenders' review at the appraisal stage and the final plan will be available not less than six months before starting the initial reservoir filling.

The plan will set out details of the organizational structure, staffing, technical expertise and training required; equipment and facilities needed to operate and maintain the dam; O&M procedures; and arrangements for funding O&M, including long-term maintenance and safety inspections. The O&M plan will reflect changes in the dam's structure or in the nature of the impounded material that may be expected over a period of years.

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4.6 Associated Facilities

The AFD, EIB, KfW, EIB and World Bank recognise Associated Facilities.

The World Bank definition of "Associated Facilities" that is included in the Environmental and Social Framework, 2018 is as follows: *"….facilities or activities that are not funded as part of the project and, in the judgment of the Bank, are: (a) directly and significantly related to the project; and (b) carried out, or planned to be carried out, contemporaneously with the project; and (c) necessary for the project to be viable and would not have been constructed, expanded or conducted if the project did not exist"*. This definition is also adopted by the AFD and KfW.

The EIB definition considers the following as Associated Facilities: (i) assets and facilities directly owned or managed by the promoter that relate to the project activities to be financed, (ii) supporting activities, assets and facilities owned or under the control of parties contracted for the operation of the promoters business or for the completion of the project (such as contractors); (iii) associated facilities or businesses that are not funded by the EIB as part of the project and may be separate legal entities yet whose viability and existence depend exclusively on the project or whose goods and services are essential for the successful operation of the project.

In the frame of the Ruzizi III HEPP, facilities considered as "Associated Facilities" are described in the following paragraphs and presented in Figure 4-22. These facilities are required as part of regional inter-connection projects and are developed with financial assistance from EIB, KfW and AfDB, who have similar E&S requirements to the World Bank. The Associated Facilities will need to comply with the same Environmental, Social, Health and Safety requirements as the Ruzizi-III Project.

The lenders potentially supporting the Ruzizi III Project will review the projects to develop the Associated Facilities, and clear by appraisal related instruments to ensure compliance. The associated facilities are at different stages of planning and implementation. The lenders would need the following: (i) progress report for Kamanyola - Bujumbura 220 kV Transmission Line construction works; and (ii) timeline to update/complete and clear feasibility Studies, ESIAs and RAPs for other Associated Facilities. The World Bank will need the EIAs and Terms of Refence for updated studies for the transmission line projects to be re-disclosed locally.

Undertaking of E&S due diligences for the associated facilities are included in Ruzizi III HEPP ESCP.

4.6.1 Kamanyola 220 kV Substation

The Kamanyola 220 kV substation is situated in DRC. It is developed, financed, constructed, owned, ensured, operated and maintained by the Contracting States with financial support from KfW. The Ruzizi-III 7-km-long 220 kV transmission line will connect to the Kamanyola substation. The substation will include the dispatching centre and a coordination centre for the operation of Ruzizi-I, -II, -III (and -IV when operational). The substation will be operated by SINELAC. A Feasibility Study, ESIA and RAP in alignment with international standards has been prepared with funds from the KfW. However, it is planned that these studies be updated to reflect recent developments in the Ruzizi III Project. With regard to the ESIA for the substation, an updated version of the ESIA/RAP Terms of Reference has been approved by lenders and the ESIA/RAP is expected to be available Q3 2025.

4.6.2 Kamanyola - Buhandahanda 220 kV Transmission Line

The Kamanyola-Buhandahanda transmission line is situated in DRC and is developed by EGL with financial support from the EIB and KfW. Pre-Feasibility studies for the 68.5 km line have been completed. However, the studies will need to be updated to take into account (i) changes made to the Ruzizi-III project since the feasibility studies were undertaken, (ii) the Ruzizi-IV

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project, and (iii) conception of the regional electricity market which is being developed. The Terms of Refence for the updated ESIA/RAP have been approved by KfW and the ESIA/RAP is expected to be available Q3 2024.

4.6.3 Kamanyola - Bujumbura 220 kV Transmission Line

The project is developed by REGIDESO and comprises a 77 km line of which 2.4 km are situated in DRC and 74.6 km in Burundi. The project has been developed with financial support from AfDB and KfW. Feasibility studies, ESIA and RAP have been prepared and project affected people have been compensated. The start of construction works is programmed for Q2 2022 and completion scheduled for Q4 2024.

4.6.4 Kamanyola - Kibuye 220 kV Transmission Line

The proposed line is 82 km long, mostly in Rwanda, but with a short section in DRC. The project is developed by Rwanda Energy Group (REG) with financial support from the EIB. A pre-feasibility study and ESIA were prepared in 2014. However, the feasibility study and ESIA will be updated and a RAP prepared.

4.6.5 Other 220 kV Transmission Lines

Other transmission lines in DRC that are planned in a longer term, comprise (i) the line from Bahandahanda to Goma West which will allow an interconnection of the Kamanyola-Bahandahanda line to connect to the existing line connecting to Rwanda, and (ii) the line from Kamanyola to Kiliba and Uvira. The routing of these lines is shown in Figure 4-22.

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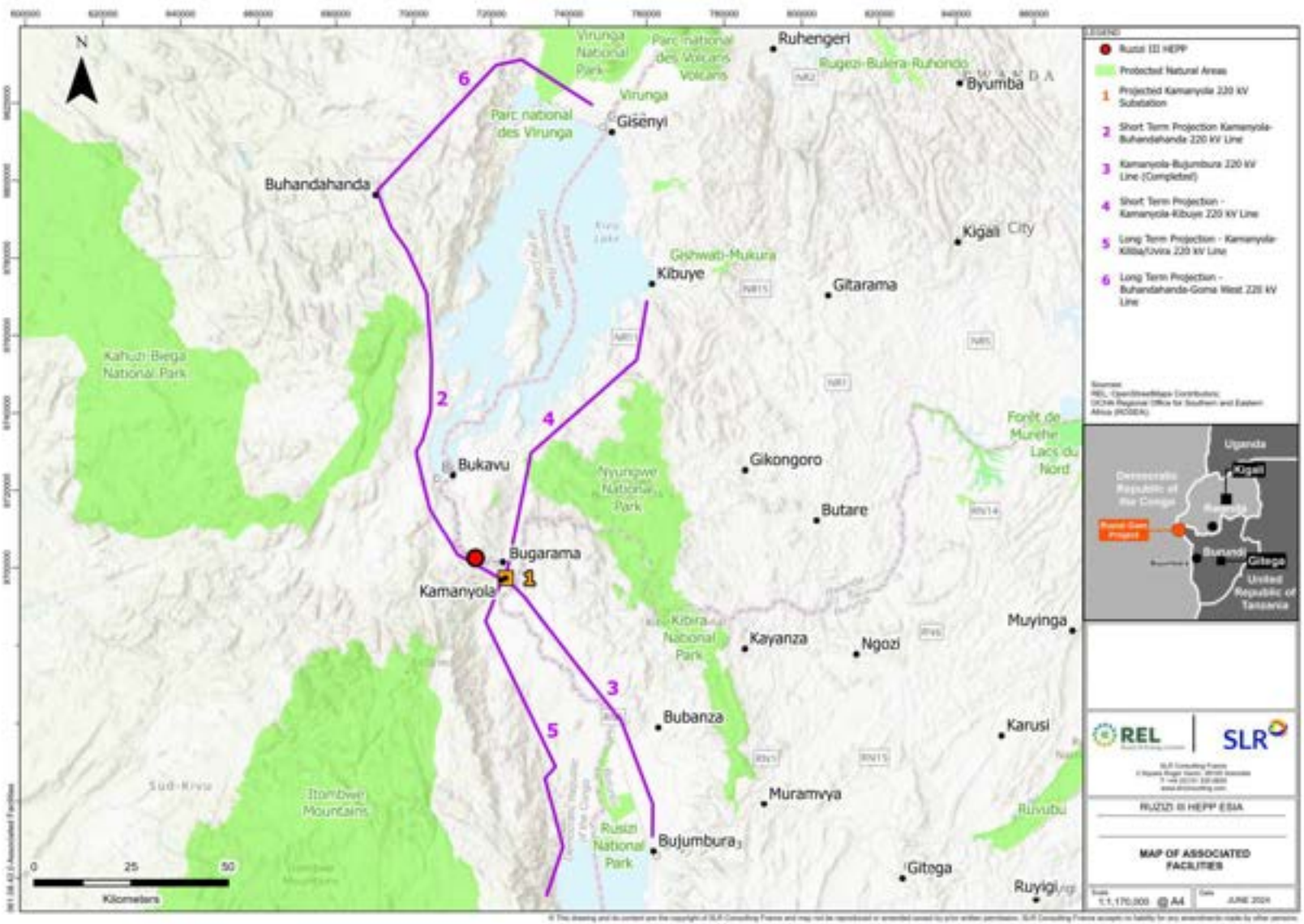


Figure 4-22 Associated Facilities Layout

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4.7 Decommissioning

The general objective of the decommissioning process is to carry out the definitive dismantling, partial or total, of the facilities. This objective consists particularly in returning the site in accordance with the regulatory framework constituted by conventions and local, regional, national and international legislation with due observance of REL and lenders' E&S policies and under the best possible economic conditions. The overall aim is to leave Project land and any equipment and infrastructure that remains in a condition that allows it to be transferred with minimal residual liabilities or risk to public safety and the environment. For example, land would be returned to the communities.

The decommissioning of the facilities is expected to be similar to that planned for other existing hydropower facilities in the region. However, the final decision regarding the decommissioning may not be possible prior to performing a specific decommissioning ESIA. At the time of writing a decommissioning ESIA is not a regulatory requirement in Rwanda and DRC, but the environmental laws and regulations will evolve in the coming years.

4.7.1 Hydroelectric Power Production Facilities

The Project has a minimum economical life expectancy of approximately 50 years. The actual length of service is however difficult to estimate. The decommissioning of the HEPP facilities could involve removal of the dam and the powerhouse and returning the Ruzizi River to its original situation, but this is unlikely. Depending upon the length of service, the Ruzizi III reservoir may have established a new valuable ecosystem also beneficial to local communities. In this instance, removal of the civil works could create a considerable negative effect. In general, decommissioning of a hydropower project requires as much planning as the construction of the Project in the first place. Considerable consultation would be required. It could be assumed that prior to decommissioning the Ruzizi III HEPP, the other dams on the Ruzizi River would also be decommissioned and would provide valuable lessons for planning for decommissioning of the Project.

4.7.2 Transmission Line

The Ruzizi III transmission line would be made up of a variety of materials, from concrete and steel for the foundations, steelwork for the tower and aluminium/steel for the conductors. All these materials have an expected lifespan, which varies depending on how the transmission line is used and where it is located. The transmission line has a minimum design life expectancy of approximately 50 years. After construction, the components of the Project would become an integral part of the regional transmission network. As such the lifespan of the transmission line may be longer than the anticipated 50 years, depending on their condition, refurbishment and the future transmission network requirements. If the transmission line is no longer required as part of the network of electricity transmission, it may be removed. Upon removal, much of the material would be suitable for recycling. Similar access would be required as outlined for construction.

Fittings, such as dampers and spacers, would be removed from the conductors. The conductors would be cut into manageable lengths or would be winched onto drums in a reverse process to that described for construction. The fittings would be removed from the towers and lowered to the ground. The tower may be dismantled by crane, with sections cut and lowered to the ground for further dismantling and removal from site. Depending on the space available, it may be possible to cut the tower legs and then pull the tower to the ground using a tractor. The tower can then be cut into sections on the ground. Unless there is a compelling need for removal of all the foundations, to avoid ground disturbance steel work may be removed to ground level with subsurface elements left in situ.

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The lifespan of equipment within the Project switchyard would be approximately 40 years. If its useful life has expired, it would be removed and replaced as the switchyard would form an important part of the regional transmission network. Much of the material removed from the switchyard would be suitable for recycling. Similar methods of installation and equipment would be required as for construction.

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5 Analysis of Alternatives

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Contents

5.1 Project Needs and Objectives 5-1

5.2 Alternative Power Production Technologies 5-1

5.2.1 General 5-1
5.2.2 HFO - Diesel 5-3
5.2.3 Methane 5-3
5.2.4 Peat 5-3
5.2.5 Other Technologies 5-4

5.3 Alternative Site Layout, Design and Mode of Operation 5-4

5.3.1 Dam Type 5-4
5.3.2 Project Layout and Design 5-4
5.3.3 Mode of Operation 5-6
5.3.4 Hydropower Generation 5-7
5.3.5 Sitting of Facilities 5-8

5.4 Do-Nothing Alternative 5-9

5.5 Comparative Assessment of Alternatives 5-9

5.5.1 General Comparative Assessment 5-9
5.5.2 Comparison of Project GHG Emissions with Alternative Technologies 5-12

5.6 Selection of the Preferred Alternative 5-13

PUBLIC DISCLOSURE AUTHORIZED

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List of Tables

Table 4-1 Access to Electricity in the Region 5-1
Table 4-2 Key Characteristics of the 2010 and 2021 Designs 5-5
Table 4-3 – Estimated Annual GHG Emissions from Alternative Technologies 5-12

List of Figures

Figure 4-1 Installed Power Generation Capacity (2019-2025) for Rwanda 5-2
Figure 4-2 Installed Power Generation Capacity (2026-2040) for Rwanda 5-2
Figure 4-3 Indicative Qualitative Comparison of Alternatives 5-10
Figure 4-4 Comparison of the Project GHG Emissions with Alternative Technologies 5-12

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5.1 Project Needs and Objectives

Lack of electricity is a key constraint hampering economic development and livelihood improvement in Burundi, DRC and Rwanda. Current electricity demand by far exceeds supply. Many households rely on biomass for their cooking and heating needs, leading to deforestation and soil erosion. There is consequently a need for improved access to electricity as demonstrated by the figures provided in the table below.

Table 5-1 Access to Electricity in the Region

Country	Access to Electricity (%) in 2016	
	Urban	Rural
DRC (North/South Kivu provinces)	5%	
Burundi	49.7%	1.7%
Rwanda	80%	17.8%

Source for DRC: IRD. 2015. Atlas of the North Tanganyika countries, p146
Source for Burundi and Rwanda: https://www.se4all-africa.org/seforall-in-africa/country-data/burundi/

The lack of access to reliable power supply services hampers countries' growth potential, contributes to the poverty and isolation of rural population, and affects provision of other key services, such as water supply, health, and education. It is also a major constraint for commercial and industrial development. The deficit in power supply is rapidly increasing, despite governments efforts. The investments in new power generation plans, transmission/distribution lines and substations as well as the rehabilitation of existing facilities are greatly needed.

5.2 Alternative Power Production Technologies

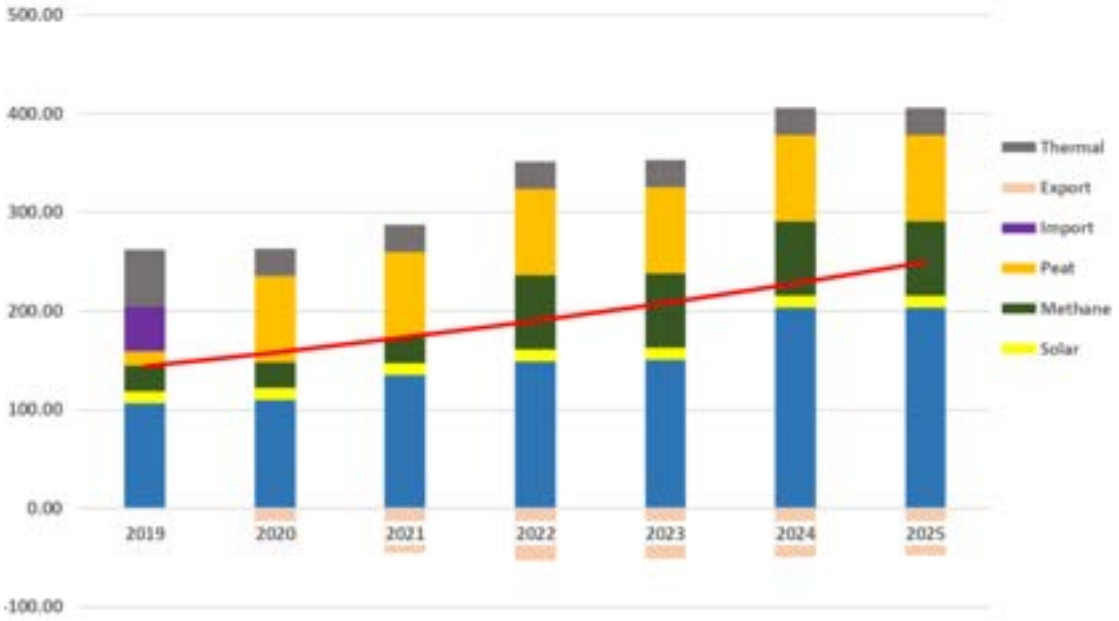
5.2.1 General

Power generation in Rwanda uses thermal power plants (fuelled with Heavy Fuel Oil (HFO), diesel, methane gas from Lake Kivu, peat, and biomass) and solar power. In DRC and Burundi power is provided mostly from hydropower schemes and from electricity imported from neighbouring countries including Rwanda.

The power strategy in Rwanda is to increase power generation capacity to meet increasing demand using a mix of technologies and making the best use of available resources. Figure 5-1 and Figure 5-2 overleaf illustrate the strategy for the horizon 2040, which comprises increasing hydropower and methane capacity over the next 18 years, but no new projects to generate power from peat, solar, diesel are anticipated. The introduction of natural gas and development of pump storage hydropower schemes are anticipated from 2030.

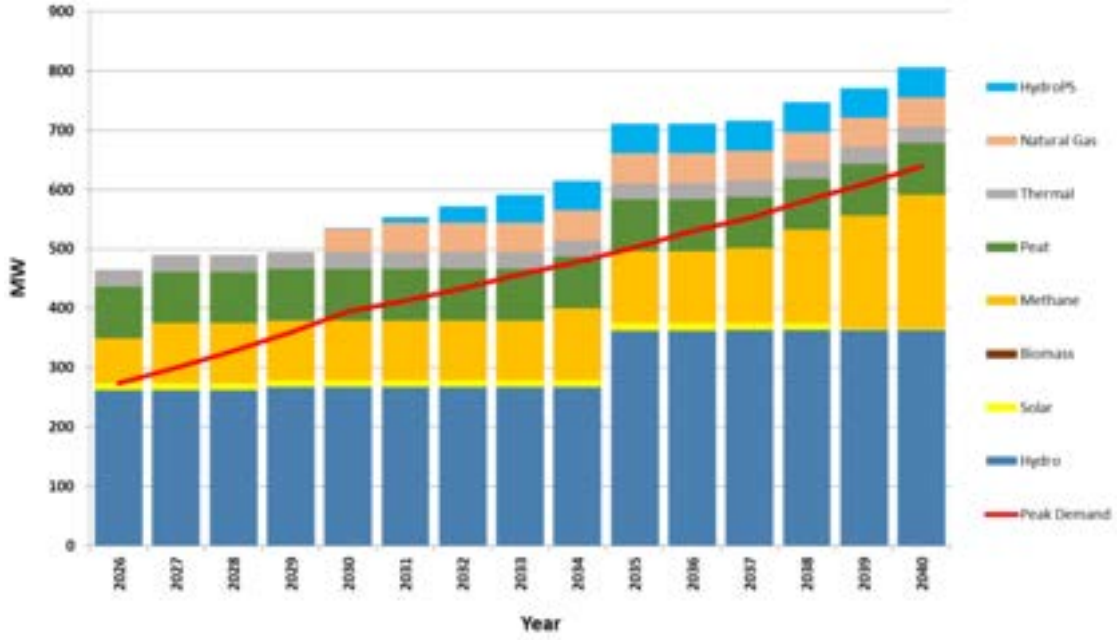
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Source; REG, 2019

Figure 5-1 Installed Power Generation Capacity (2019-2025) for Rwanda



Source; REG, 2019

Figure 5-2 Installed Power Generation Capacity (2026-2040) for Rwanda

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5.2.2 HFO - Diesel

HFO and diesel-fuelled thermal power plants use technically mature technology. In 2019, 27% of power in Rwanda was produced with diesel and HFO power plants (REG, 2019).

However, producing electricity with HFO and diesel is an expensive option and currently in Rwanda the HFO and diesel-fuelled power plant are used during periods of peak demand, which result in high electricity tariffs. In addition, the use of HFO and diesel is not in alignment with the Paris Agreement, the 7th Sustainability Goal set by the United Nations and targets for the contribution if renewable energy to the nation electricity production set by Burundi, DRC and Rwanda. As a result of the above, Rwanda does not anticipate investing in additional HFO-diesel power plants and is seeking alternatives.

An HFO/diesel-fuelled power plant with the same power production capacity as the Project would require a project footprint in the order of 200 ha or more on flat terrain with good existing road access, thus requiring land acquisition probably resulting in physical and economic displacement. The plant would probably need to be constructed near Bugarama in order to link in with the transmission line interconnection projects so that power can be shared with Burundi and DRC.

The key environmental issues would be related to GHGs, air quality pollutants, wastewater, hazardous waste and noise. The operation would require important quantities of water. The storage of HFO and/or diesel would represent a technological risk.

5.2.3 Methane

Significant quantities of methane gas are dissolved in the waters at the bottom of Lake Kivu. In 2019, 12% of Rwanda's power production was produced using this methane and the power strategy is for additional power plant to be developed. The methane power production facilities comprise floating offshore facilities to extract the methane gas from the Lake Kivu's waters, submerged floating pipeline to convey the gas to onshore gas-fired power generation facilities.

A single methane gas fuelled power plant with the same power production capacity as the Project would be a major undertaking, and it may be more realistic to develop several smaller projects. Each plant would require a project footprint in the order of 100-200 ha on flat terrain with good existing road access, thus requiring land acquisition resulting in physical and economic displacement. The plant would probably need to be constructed near Kamembe in order to be close to Lake Kivu and additional transmission lines would need to be developed to link in with the transmission line interconnection projects so that power can be shared with Burundi and DRC, thus increasing project cost and incurring additional environmental and social impacts.

The key environmental issues would be related to GHGs, air quality pollutants, wastewater, hazardous waste and noise. The transport and storage of methane would represent a technological risk.

5.2.4 Peat

Large areas of peatland are present in southern part of Rwanda. The peat is harvested during the dry season and dried and then combusted for power generation. In 2019, 7% of Rwanda's power production was produced from peat. However, Rwanda's power strategy does not include developing more peat-fuelled power plants.

A single peat fuelled power plant with the same power production capacity as the Project may not be feasible because of the need for availability of nearby peat resources and it may be more realistic to develop several smaller projects, and these would be situated at suitable locations near to the peat resources to minimise transport costs. Environmental impacts of

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peat projects include soil damage and erosion, hydrologic impacts, sediment transport and erosion, impacts on water quality, and impacts from disposal of waste ash. Large areas of land would need to be required incurring social impacts. Additional transmission lines would need to be developed to link in with the transmission line interconnection projects so that power can be shared with Burundi and DRC, thus increasing project cost and incurring additional environmental and social impacts.

5.2.5 Other Technologies

Other technologies which are part of the current power generation mix comprise solar energy and biomass, which represent 5% and <1% of the installed power capacity in Rwanda in 2019.

The power generation strategy does not include developing further of wind or geothermal power (see Figure 5-2) because of the lack of wind and geothermal resources. Neither is it planned to develop solar power further because of the following reasons (Rwanda Energy Group, 2019):

- The national power system is still small and annual addition of the generating capacity required to expand the system is still very small. This reduces the ability of the electricity sector to benefit from economies of scale through construction of new large generating units. High specific investments in the construction of small power plants (such as solar power plants) will inevitably lead to high electricity generation costs.
- At present, due to the large share of domestic sector in total electricity demand, the daily peak load occurs in the evening. These hours have the greatest impact on the reliability of electricity generation and on the needs of generating capacity expansion in the system. Solar generation is not available during evening hours, when generating capacity is most required.

A hybrid pump-storage development combining solar with hydropower would allow solar produced energy to be stored and dispatched to the power system using the hydro capacity. This is a future opportunity for the Ruzizi III Project that can be developed when the Contracting States require additional energy sources to meet their demands. At present, the demands are low enough that the hydro can supply alone without the support of energy from solar. However, solar cannot supply alone the energy demand without constructing additional energy storage (e.g., hydro, pumped storage hydro, or battery).

5.3 Alternative Site Layout, Design and Mode of Operation

5.3.1 Dam Type

Alternative dam types are not considered technically feasible because the adopted dam type, a rockfill embankment dam, is considered the best choice when considering the geological conditions and seismic activity of the project location. Rockfill structures are the most robust solutions in areas of seismic activity such as at the project location.

5.3.2 Project Layout and Design

5.3.2.1 Hydropower Component

Project layout and design has evolved over time. The Fichtner 2010 Feasibility Study proposed a dam site, powerhouse and reservoir footprints different from those in the current 2021 design. The dam for the 2010 design was positioned further downstream, but for the 2021

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design it was moved upstream because of landslide risks and in order to increasing the hydraulic head by 45 m. The powerhouse for the 2010 design was positioned 950 m upstream from that of the 2021. The 2021 design moved the powerhouse downstream for geotechnical reasons and create more head, increasing power capacity.

Table 5-2 Key Characteristics of the 2010 and 2021 Designs

Characteristic	Unit	2010 Design	Adopted 2021 Design (the Project)
Dam			
Maximum height	m	39	51.5
Length	m	120	287.6
Reservoir			
Full supply operating level	m asl	1,107	1,145
Minimum operating level	m asl	1,101	1,133
Total Volume	Mm^3	1.68	7.7
Active Volume	Mm^3	0.84	5.1
Reservoir surface area	ha	18	46
Reservoir length	km	0.5	2.3
Headrace			
Length	m	2,840	3,820
Diameter	m	6.7	6.7
Rock excavation volume	m^3	140,000	188,310
Powerhouse			
Design flow	m^3/s	150	150*
Installed capacity	MW	147	204*

* The total power production capacity of the Project (206 MW) is calculated using the formula: Power = Flow rate x net head x efficiency x gravity and including power produced by the mini-hydro unit (2.9 MW) turbining the ecological flow (11 m^3/s), with power produced varying with reservoir water depth.

5.3.2.2 Transmission Line

The selected 7-km-long transmission line takes the shortest distance between the Project's switchyard and the Kamanyola 220 kV substation. The route avoids houses and so no physical displacement is required. Most of the route crosses modified habitat used for agriculture, but there is short 180 m section that crosses an area of hillslope grassland/savannah (natural habitat).

Alternative routes that avoid the hilly slopes and cross flat areas of land would be longer than the selected route and would incur additional construction costs and more households would be affected by economic displacement. This would have no economic or social benefit. However, it would avoid the 180 m of hillslope grassland (natural habitat). However, the environmental gain is expected to be negligible because the transmission line has negligible impact on the grassland habitat – there would be no need for vegetation removal.

Alternative routes that increase the length of the line crossing the hillslope grassland would make no reduction in scale of impacts on economic displacement but would incur higher construction costs as the transmission line would be longer and in length in areas difficult to access would be increased. The impacts on natural habitat would be increased because longer temporary access tracks would be required. Therefore, this alternative has no environmental or social gain.

5.3.2.3 Avoidance and Minimisation of Involuntary Resettlement

To minimize involuntary resettlement impacts, two design changes were implemented. In DRC, the right-of-way for the transmission line was reduced from 50 m to 30 m, which avoided the resettlement of 2 houses and reduced the area to be acquired from 34.5 ha to 21.06 ha. In Rwanda, the width of the access road was reduced, avoiding impacts on about 20 houses and 83 land plots in the outskirts of Bugarama.

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The location of quarry sites will be selected when the EPC contract is mobilised. After ensuring quality and quantity of materials in the proposed sites, the EPC contractor will have to submit a list of preferred sites to REL. Based on this list, REL will make a selection with the objective of avoiding and minimising displacement impacts as much as possible.

5.3.2.4 Avoidance of Cultural Heritage Sites

The social baseline survey included identification of tangible and intangible cultural heritage elements potentially affected by the Project. The location of the cultural heritage elements in relation to Project infrastructure and the risk of impacts is assessed in Chapter 11 – Impacts Assessment and Mitigation (section 11.17). The assessment concludes that no significant impacts on the tangible and intangible cultural heritage sites are expected during construction and operation. Consequently, the Project has not explored alternatives to further distance infrastructure from cultural heritage elements.

5.3.3 Mode of Operation

A basic consideration for the selection of the mode of operation of the Project was that the operating mode of the river would not change from the existing situation. The existing Ruzizi-I and -II hydropower schemes operate with a daily peaking mode, where flow is released through the day to match the energy demands from the power system. Ruzizi-III will follow this pattern, although shifting the timing of the peak flow using the storage capacity of the Ruzizi-III reservoir. The Project's peak capacity of 150 m^3/s was specifically selected so that the Project does not cause an alteration to the existing conditions, where Ruzizi-I releases up to 150 m^3/s daily as needed for demand. Ruzizi-II has very little storage so releases the peak flows from Ruzizi-I as it arrives in Ruzizi-II reservoir.

Some consideration was given to a larger installed capacity for Ruzizi-III to improve the economics, but this would increase the daily peaking. This option was rejected on environmental grounds.

5.3.3.1 Run-of-River

The alterative mode of operation would be for the Ruzizi-III scheme to operate as a run-of-river and to turbine the discharges from Ruzizi-II without storing water. This option would avoid creating the reservoir, but in order to be economically feasible the headrace tunnel creating a bypassed reach of Ruzizi River would still be required. This configuration would have approximately 30% less power production capacity (because the hydraulic head would be reduced by approximately 30%) and only a small environmental and social gain compared to the adopted design. Functioning with this mode of operation the Project is probable not economically viable.

5.3.3.2 Regulating Dam-Reservoir

The dam-reservoir could be used to regulate the flow of the Ruzizi River by acting as a buffer reservoir absorbing the peak flows discharged from Ruzizi-II (or Ruzizi-IV once built) and discharging a flow that is similar to that of the natural conditions of the river. This would avoid the negative impacts on hydrology from alternating peak and off peak flows, but will have reduced power production capacity, and would not be able to meet the requirements of peak power demand. Functioning with this mode of operation the Project is probable not economically viable.

5.3.3.3 Peaking Mode

The 2021 Feasibility Study design, which this ESIA assesses, has peak flows of 150 m^3/s. This discharge aligns with the peak flows discharged from the upstream Ruzizi-I and -II hydropower

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scheme that have been in operation for over 50 years. The 2010 Feasibility Study prepared by Fichtner when EGL was developing the Project also planned for peak flows of 150 m^3/s.

The purpose of the Project is to increase regional power production capacity to meet an ever-increasing power demand, including periods of peak demand. The Project's peak flow rate enables the Project to achieve its full hydropower potential without causing a significant incremental increase to downstream hydrological conditions over and above those caused by the operation of Ruzizi-I and -II.

One alternative to the proposed peak flows would be to design the Project with a capacity to discharge peak flows >150 m^3/s. This would incur additional construction costs but enable peak power production to be higher, but for a shorter period. However, this would expose the downstream river flow conditions to a higher degree of alteration compared to the proposed Project and current conditions. The degree of alteration would be proportional to increase in peak flow capacity. The gain in terms of peak power production capacity would be offset by the reduced duration of peak power and environmental impacts. This configuration has therefore not been considered by the Project.

Another alternative would be to design the Project with peak discharge flows <150 m^3/s. This would result in lower peak power production and reduce the degree of alteration to river flow conditions caused by the existing Ruzizi-I and -II hydropower schemes that have been in operation for over 50 years. However, there would probably not be a significant rapid environmental gain from adopting the lower peak discharge. In the long-term, the river may recover to a certain extent from the impacts caused over the last 50 years by the operation of Ruzizi-I and -II. However, unless Ruzizi-III were to operate as a regulation reservoir, any recovery would be negligible-minor. This configuration has therefore not been considered by the Project.

5.3.4 Hydropower Generation

The Project Agreements with the Contracting States specify that REL is to construct a hydropower generation system comprising 3 generating units.

As part of the Project's power system studies, the impact of an alternative 4 generating units on the transmission grid system (static and dynamic stability analysis of the power flow) was assessed. The 4-unit option would increase the cost of the power station but would not provide any significant improvement in the operating mode for the plant. The 4 units would each be smaller than the 3-unit plant. In some cases this is required because of the variability of flow rate and limits in storage. However, in the case of Ruzizi-III, the 3 units are adequate because of the amount of storage available and the characteristics of the flow available from upstream. The grid system is able to absorb either 3 or 4 units without difficulty.

A 2-unit plant was not studied although this would likely be less expensive. The larger units would have a smaller flow rate range that the 2-unit plant. This would constrain the plant somewhat and require more use of the daily storage capacity (possibly with more on-off peak cycles). The larger units would also be more difficult to dispatch to the Contracting States if the connection to Rwanda were ever interrupted (the systems in both Burundi and DRC are very small for larger units).

With respect to the type of generating units. Francis generating units have been selected as this is the most suitable units for this range of flow rate and generating head. Francis units will also be the least expensive in this range. Pelton units would be well outside their normal operating range and would require a large powerhouse while having lower efficiency. Similarly, the generating head is too high for Kaplan or Propeller units.

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5.3.5 Sitting of Facilities

5.3.5.1 Generalities

There are no realistic alternatives to the proposed siting of the facilities other than adopting an alternative layout within the current proposed footprint. This is because facilities need to be sited on flat land that is not exposed to flood risks and landsides, and there are limited areas that meet these criteria.

5.3.5.2 Operator's Village

The location finally selected was determined to ensure that the area is above the 100-year return period flood level in the area while being close to the powerhouse. The Employer's camp location was selected to allow easy access to the dam site in emergency situations. A separate camp is located adjacent to the switchyard in DRC that will house employees working in the switchyard. This site was selected because of its proximity to the yard.

5.3.5.3 Switchyard

The site for the switchyard location in DRC across the river from the powerhouse. The location allows for an efficient arrangement of the transmission lines from the powerhouse to the yard and then on to the Kamanyola substation. The site was selected because it is above the flood level and not used for other high value purposes. This location also allows for the minimum length of the transmission line to Kamanyola.

5.3.5.4 Contractor's Camps and Work Areas

It is planned for Contractor's camps and work areas to be located adjacent to the main works area at the powerhouse because of the availability of sufficient flat land in this area. The lands farther upstream towards the dam site are very steep and unsuited for the large industrial installations needed. A somewhat higher flood risk is accepted for these facilities because of the short period of risk exposure and the consequences of flooding.

5.3.5.5 Roads

Road layouts were selected based on the available topography and for minimization of the total earthmoving requirements. Alignments were tested to reduce the depth of cuts and fills while achieving acceptable geometric design parameters.

5.3.5.6 220 kV Transmission Line Route

The Project's 7-km-long 220 kV transmission line route was originally selected by EGL and included in REL's Project Agreements. The route is located in DRC and connects the Project's switchyard to the Kamanyola substation.

The transmission line route and the siting of the Kamanyola substation (see below) had been selected by EGL with the intention of avoiding technical constraints and minimising social impacts. The route and substation are located on modified habitat and consequently direct environmental impacts have been avoided.

The Project re-examined the transmission line route and made some small adjustments to avoid interference with houses where the line crosses the Kamanyola-Bugarama road. Given that the two end points are fixed there were few degrees of freedom available for route refinement.

The Project's route selection criteria were (i) minimize cost by keeping the line as short as possible, (ii) avoid zones with risk of flooding, (iii) position pylons on land with suitable ground

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conditions (i.e. avoid ancient alluvial zones), (iv) and avoid residential areas. Other adjustments to the line route would result in increased social impacts.

Avoidance/minimisation of impacts on birds was not a criterion used by EGL for the route selection, or by the Project for refinement of the route. This was because it had been assessed that the line would not have significant impact on birds. In addition, it would be unlikely that alternative routing would reduce any such impacts. However, alternative routes would incur additional cost and additional social impacts because the longer length would cause increase economic displacement.

5.3.5.7 Kamanyola Substation

The Kamanyola substation is an Associated Facility located in DRC and developed, financed, constructed, owned, ensured, operated and maintained by the Contracting States with financial support from KfW (see Chapter 4 – Project Description). The Kamanyola substation is not included in the scope of this ESIA, however, it is mentioned in this Analysis of Alternatives chapter because it is the termination point of the Project's 220 kV transmission line route. The location of the substation has been defined as part of the ongoing development work by the Contracting States with the objective to establish regional power inter-connection. In addition to the being the termination point of the Project's 220 kV line, there will be 3 transmission lines transporting electricity from the substation to the Contracting States. Consequently, the selection of the substation site has required consideration of the technical, environmental and social criteria for the other transmission lines.

5.3.5.8 Quarries and Borrow Areas

Quarries and borrow areas are not included in the scope of the ESIA because the sitting will be defined at a later stage. Chapter 4 - project description provides the locations of potential sites for quarries and borrow areas that have been identified by REL. However, it will be the EPC Contract that selects site locations, and they may correspond to sites identified by REL or alternative sites. Vol. IV - ESMP includes the process for REL's review and approval of the sites proposed by the EPC Contractor so that there is avoidance or minimisation of environmental and social impacts.

5.4 Do-Nothing Alternative

With the do-nothing scenario, the Project is not implemented, and the project's negative impacts can be avoided, but benefits and positive impacts will not be realised. There would be a gap in the power production strategy and a lack of access to reliable power supply services which hampers economic growth and contributes to poverty and isolation of rural population would continue.

5.5 Comparative Assessment of Alternatives

5.5.1 General Comparative Assessment

A qualitative comparison of the magnitude of impacts on the various receptors for each alternative is presented in the matrix overleaf and discussed in the following paragraphs.

The assessment is qualitative and based on expert judgement. This is because the magnitude of many of the impacts of alternative technologies are dependent on the site location and project footprint, and this information is not available.

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Alternative	GHG emissions	Air Quality and Odour	Noise and vibration	Geology and soils	Hydrology	Water quality	Geomorphology and sediment	Aquatic habitats and biodiversity	Terrestrial habitats and biodiversity	Social and economic impacts	Community health and safety	Cultural heritage	Landscape and visual amenity	Positive impacts and benefits
Alternative Technology HFO Diesel	●	●	●	•	•	•	–	–	•	●	•	•	●	□
Alternative Technology Methane	•	•	●	•	•	•	–	–	•	●	•	•	●	□
Alternative Technology Peat	●	●	●	•	•	•	•	–	•	●	•	•	●	□
Alternative Technology Solar	•	•	•	•	•	•	–	–	•	●	•	•	●	□
Alternative Technology Biomass	•	•	●	•	•	•	–	–	•	●	•	•	●	□
Alternative Layout and Design	•	•	•	●	●	•	●	●	•	•	●	•	•	■
Alternative Operation Run-of-River	•	•	•	●	•	•	●	•	•	•	•	•	•	■
Alternative Operation Regulation	•	•	•	•	•	•	●	•	•	•	•	•	•	■
Adopted Project Design	•	•	•	●	●	•	●	●	•	•	●	•	•	■
No Project	●	●	–	–	–	–	–	–	–	–	–	–	–	–

Explanatory note

The sizes of the circles in each column illustrate the relative magnitude of impacts from each alternative for the specific receptor/topic. The larger the circle the greater the relative magnitude of the impact.

It should be noted that the size of the circles should not be used to compare magnitude of impacts on the different receptors for a given alternative.

Magnitude of positive impacts and benefits are illustrated using squares, the larger the square the greater to positive impact/benefit.

Figure 5-3 Indicative Qualitative Comparison of Alternatives

Discussion

- **GHG emissions**: The alternative generating the highest emissions is the "no project" alternative, as households in the region without electricity will continue to use firewood and charcoal for household cooking and heating. HFO, diesel and peat - and to a lesser extent methane - have relatively high GHG emissions compared to the hydropower alternatives. The alternative hydropower designs all have the same GHG emission orders of magnitude. Solar power has the lowest GHG emissions.
- **Air Quality and Odour**: The relative impacts of the alternatives follow the same rationale as for GHG emissions above.
- **Noise and vibration**: The thermal power plants will probably generate levels of noise that are similar or slightly higher than for the hydropower alternatives. However, the thermal power plants will probably be located closer to communities because of siting constraints than the hydropower plant's powerhouse. The solar power plant will generate the least noise.

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- **Geology and soils**: The hydropower alternatives include tunnelling and major earthworks for construction of the spillway, bottom outlet and access roads. Earthworks for the alternative technologies will probably be required for site preparation and levelling, but on a smaller scale to that of the works for the hydropower alternatives.
- **Hydrology**: The alternative technologies are not expected to have noticeable impacts on hydrology. Whereas the hydropower alternatives (except the regulation dam alternative) will have an operating mode that alters river flow conditions.
- **Water quality**: Hydropower alternatives are not expected to have a significant impact on water quality because the reservoir is small, and the residence time of stored water is less than 24 hours. No industrial effluents are discharged. However, the thermal power plants will generate industrial waste water that will be discharged into watercourses altering water quality.
- **Geomorphology and sediment**: With the exception of peat-fuelled power plants, the alternative technologies are not expected to have noticeable impacts on geomorphology and sediment as impacts on hydrology are not expected. Whereas the hydropower alternatives will trap sediment and cause downstream alteration to sediment loads causing changes to geomorphology. The stripping of peat wetland for peat-fuelled power plant can result in increased soil erosion and sediment loads in watercourses.
- **Aquatic habitats and biodiversity**: Hydropower alternatives are expected to have a significant impact on aquatic habitats and biodiversity because of the alteration to hydrology, sediment and geomorphology. Thermal power plants are expected to discharge industrial wastewaters to surface waters, however, if wastewater is treated to comply with national and IFC wastewater discharge criteria the impact should not be significant.
- **Terrestrial habitats and biodiversity**: All alternatives are expected to have similar orders of magnitude of impacts on terrestrial habitat and biodiversity as much of the project footprints will be predominantly agricultural or modified habitat.
- **Social and economic impacts**: The thermal power plants and the solar power projects are expected to have a greater degree of impact on social and economic environment than that of the hydropower alternatives. This is because the hydropower dam-reservoir project footprint is small compared to the footprint for thermal power plants.
- **Community health and safety**: The hydropower projects probably represent a higher risk to community health and safety because of the dam rupture risk. Which although highly unlikely would affect a much larger number of people than an accident at a thermal power plant. In addition, the variations in river flows from hydropeaking represent a risk of drowning. The thermal powerplant represent a risk because of the storage of large quantities of hazardous substances representing a risk of fire and/or explosion, but these risks can be controlled through including protection and prevention measures in the design.
- **Cultural heritage**: Impacts on cultural heritage are not anticipated for all alternatives.
- **Landscape and visual amenity**. The impact from the thermal power plant and solar power plant are expected to have a higher impact significance than that of the hydropower alternatives. This is because the thermal and solar power projects will be far more visible as they will probably be sited in more populous areas, whereas the hydropower facilities will be located in a deep sided valley which will only be visible to a small number of people.
- **Positive impacts and benefits**: The hydropower project is expected to result in more positive impacts and benefits that the thermal and solar projects, because more unskilled workers will be employed during the construction phase, and there will be more opportunities for economic development such as fisheries.

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5.5.2 Comparison of Project GHG Emissions with Alternative Technologies

Cumulative GHG emissions over a period of 30 years for the project and power plants fuelled with diesel, methane and peat producing the same amount of energy as the Project are compared.

Emissions have been estimated using emission factors published by the IPCC. The method comprises estimating the fuel consumption of diesel, methane and peat based on energy requirements and the power production energy efficiency of the different fuels. The calculation is presented in Table 5-3 and the emissions are presented in Figure 5-4.

Table 5-3 – Estimated Annual GHG Emissions from Alternative Technologies

Parameter used in the calculation	Diesel	Methane	Peat	Units
Input				
Plant power capacity	206	206	206	MW
Annual electricity production	1.2×10^9	1.2×10^9	1.2×10^9	kWh/year
Calculated Fuel Requirements				
Conversion factor	3.6×10^6	3.6×10^6	3.6×10^6	J/kWh
Conversion efficiency *	0.35	0.4	0.33	None
Conversion factor	1.0×10^{12}	1.0×10^{12}	1.0×10^{12}	TJ
Fuel requirement	12,312	10,773	13,058	TJ/year
Calculation of GHG emissions				
Emission factor CO2	74,100	56,100	106,000	kg/TJ
Emission factor CH4	10	5	0.4	kg/TJ
Emission factor N2O	0.6	0.1	0.4	kg/TJ
CO2e emissions	0.92	0.61	1.4	MtCO2e/year

* Modern state-of-the-art thermal power plants may have slightly higher efficiencies than those indicated. However, efficiencies used in the calculations are representative values for a wide range of equipment types. Consequently, the estimated emissions indicate orders of magnitude and are indicative of the relative performance of the different technologies in terms of emissions with or without the use of state-of-the-art equipment.

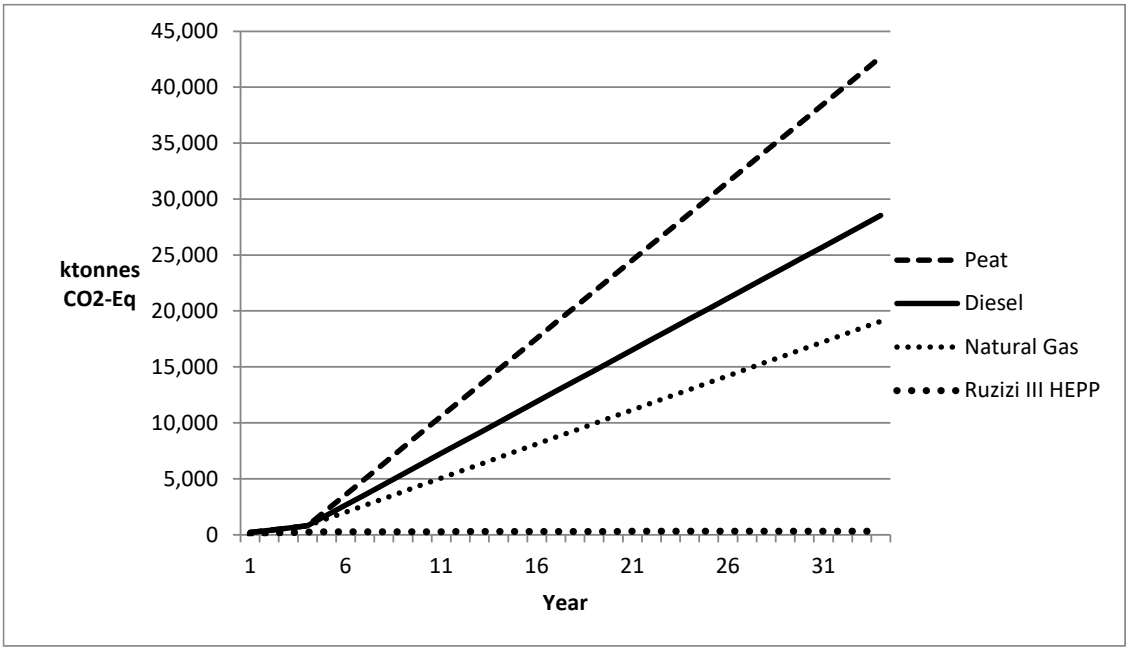


Figure 5-4 Comparison of the Project GHG Emissions with Alternative Technologies

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5.6 Selection of the Preferred Alternative

The preferred option is the 206 MW HEPP with hydropeaking mode of operation and the rationale for the selection is that this is the alternative that aligns best with Rwanda's power strategy, is the cheapest technology that is able to produce the forecast peak power demand, results in reduced GHG emissions compared to the thermal power alternatives and offers the best compromise in terms of environmental impacts for energy produced.

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6 Public Participation and Engagement

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Contents

6.1 Introduction 6-1

6.2 Stakeholder Identification 6-1

6.3 Engagement Activities Undertaken to Date 6-3

6.3.1 Stakeholder Engagement Activities Performed in 2020 6-3
6.3.2 Stakeholder Engagement Activities Performed in 2021-2023 6-4

6.4 Future Consultation Programme 6-19

6.4.1 Summary of Stakeholder Engagement Plan 6-19
6.4.2 RAP Engagement Programme 6-21
6.4.3 Specific Measures for Vulnerable Groups 6-23
6.4.4 Specific Gender-related Measures 6-25

6.5 Disclosure of the ESIA Documentation 6-25

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List of Tables

Table 6-1 Categories of Stakeholders Affected by or Interested In the Project 6-1
Table 6-2 Summary of Stakeholder Engagement Activities Performed in 2020 6-4
Table 6-3 Stakeholder Engagement Activities Performed between 2021 and 2023 6-5
Table 6-4 - People Interviewed in DRC and Rwanda for the Qualitative Social Survey in 2022 6-13
Table 6-5 Distribution of Households Surveyed During the Quantitative Households' Survey (2022) 6-15
Table 6-6 Engagement conducted with Historically Marginalised People in DRC and Rwanda 6-16
Table 6-7 Engagement with Institutional Stakeholders 6-17
Table 6-8 List of FGDs with Communities 6-18
Table 6-9 Summary of Future Stakeholder Engagement 6-19
Table 6-10 Stakeholder Engagement Actions during the RAP Implementation (TBC) 6-23
Table 6-11 Specific Engagement Measures to Support Vulnerable PAPs 6-24
Table 6-12 Specific Engagement Measures to Support Female PAPs 6-25

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6.1 Introduction

This section provides an identification of project stakeholders, a summary of the stakeholder engagement activities and the stakeholders' expectations and concerns. This section is to be read in conjunction with the Stakeholder Engagement Plan and the Resettlement Action Plan.

6.2 Stakeholder Identification

The Project's stakeholders have been identified as part of the SEP (issued as a stand-alone document). The table below provides the Project stakeholders and their concerns or roles.

Table 6-1 Categories of Stakeholders Affected by or Interested In the Project

Stakeholder	Concern / Role
Project-Affected Stakeholders	
Physically and economically displaced households in the Groupement of Kamanyola and Karhongo	Impacted by loss of housing, land and / or assets
All people living in the settlements within 2 km from the river but not directly affected by Project activities	Potentially reduced access to natural resources and ecosystem services
PAPs considered vulnerable because of their difficulties accessing information on land acquisition: • Illiterate people • People without access to information technologies • People with mental and physical disabilities	May encounter issues (i) accessing or understanding information regarding land acquisition, resettlement and compensations and (ii) negotiating a fair compensation or expressing grievances to the Project.
PAPs considered vulnerable because of their difficulties accessing and maintaining control over land and livelihood sources: • Women-headed households • Disabled-headed households • Elder-headed households • Historically marginalised households • Landless households	May encounter issues (i) finding alternative or additional land resources, (ii) negotiating fair compensation and (iii) restoring their means of livelihood.
Resettlement Committees of Bugarama, Nzahaha, Ibambiro, Manda, Kafunda and Nachirongwe	In charge of facilitating and mediating relations between the Project and PAPs, for all that pertains to economic and physical displacement due to land acquisition
Women's and Youth Associations in the villages affected by land acquisition.	Will be engaged by the Project to ensure that these two groups are appropriately consulted and to promote their participation and fair inclusion in livelihood restoration activities.
Internal Stakeholders	
REL RAP Officer	In charge of coordinating and managing relations between the Project and PAPs, for all that pertains to economic and physical displacement due to land acquisition
REL Grievances Officer	In charge of receiving, logging and solving all Project-related grievances
REL Livelihood Restoration Officer	In charge of coordinating and managing relations between the Project and people receiving Livelihood Restoration Measures after economic displacement
External Stakeholders	
Energie des Grands Lacs (EGL)	In charge of paying all compensations
Local Authorities in DRC, including: • Heads of Karhongo and Kamanyola Groupements • Heads of Ngweshe and Ishamba Sous-Groupements	Interest in the social consequences of economic and physical displacement and responsibility acting as representatives to express the populations' fears and wishes

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Stakeholder	Concern / Role
Local Authorities in Rwanda, including: • Heads of Nzahaha and Bugarama Sectors • Executive Secretaries of Nyenji, Murya, Nyange, Ryankana and Pera Cells	Interest in the social consequences of economic and physical displacement and responsibility acting as representatives to express the populations' fears and wishes
Institute of Real Property Values (Rwanda)	In charge of setting the prices of land and property and publishing them annually in the Official Gazette
Rusizi District Administration (Rwanda)	In charge of informing expropriated people of the start date of the measurement of the land and inventory of property via posters or messages on the radio / press
District Council (Rwanda)	Approval of amount of compensation according to national law
Public Authorities in DRC, including: • Heads of Karhongo and Kamanyola Groupements • Heads of Ngweshe and Ishamba Sous-Groupements • Provincial Government of South Kivu • MINISTRY OF Environment and Sustainable Development • Ministry of Public Works and Land Affairs • Ministry of Energy and Hydraulic Resources • Ministry of Agriculture • Congolese Agency of Environment • National Society of Electricity • Administration of Walungu Territory	Interest in the overall development of the region and of the hydropower industry Interest in the Project's positive and negative impacts on the economy and society
Public Authorities in Rwanda, including: • Heads of Nzahaha and Bugarama Sectors • Executive Secretaries of Nyenji, Murya, Nyange, Ryankana and Pera Cells • Administration of the Western Province • Ministry of Finance and Economic Planning • Ministry of Infrastructure • Ministry of Foreign Affairs and International Cooperation • Ministry of Public Service and Labour • Ministry of the Environment • Rwanda Green Fund • Rwanda Development Board • Rwanda Water and Forest Authority • Rwanda Water Resources Board • Rwanda Environment Management Authority • Rwanda Meteorology Agency • Rwanda Land Management and Use Authority • Rwanda Energy Group • Private Sector Federation of Rwanda	Interest in the overall development of the region and of the hydropower industry Interest in the Project's positive and negative impacts on the economy and society
Public Authorities in Burundi, including: • Ministry of Environment, Agriculture and Livestock • Commune of Rugombo • Ministry for Water, Environment, Land Use and Urban Planning • Ministry of Infrastructure, Equipment and Social Housing • Ministry of the Interior, Community Development and Public Security • Ministries of Finances, Budget and Economic Planning • Burundian Office of Revenues	Interest in the overall development of the region and of the hydropower industry Interest in the Project's positive and negative impacts on the economy and society

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Stakeholder	Concern / Role
NGOs active in the villages within and surrounding the Project's footprints, in particular: • Caritas (Rwanda) • Profam (Rwanda) • ARCT Rumuka (Rwanda) • One Acre Fund (Rwanda) • Benevolencia (Rwanda) • Mukopaka Shambalet (Rwanda) • World Vision (Rwanda) • Care International (Rwanda) • Compassion Internationale (Rwanda) • GIZ (DRC) • Foundation Chokola (DRC) • FUMU (DRC) • ASDECEM (DRC) • Femme Leve-Toi (DRC) • Swaf (DRC) • IADEL (DRC) • DRISHA (DRC) • ACEDP (DRC) • Rhukole Kuguma (DRC)	In charge of: Supporting PAPs and facilitating communication with them throughout the RAP implementation process. Supporting with the implementation of livelihood restoration measures.
Health centres and hospitals within 5 km from the Project footprint	Potential changes in the health profile of the area (waterborne diseases and sexually transmitted diseases)
Communication technologies, in particular: • Radio Mandeleo (DRC) • Radio Communautaire de Kamanyola (DRC) • Radio Communautaire Flash FM de Kamanyola (DRC) • Radio Rusizi (Rwanda) • Radio Rwanda (Rwanda) • Television Rwanda (Rwanda) • Media in Cibitoki Province, Rugombo (Burundi)	Supporting in effectively disseminating information about progress on the RAP process.

6.3 Engagement Activities Undertaken to Date

6.3.1 Stakeholder Engagement Activities Performed in 2020

The Project's ESIA process started in 2012, when the Project was being developed by EGL. The environmental consulting company SOFRECO was engaged by EGL to prepare an ESIA and a RAP based on the 2010 Feasibility Study prepared by Fichtner. Environmental and Social baseline surveys were conducted by SOFRECO in 2012 and some stakeholder consultations undertaken.

In 2019, after a period of remaining dormant, the Project was relaunched via a PPP with REL as the private partner. The engineering company TRACTEBEL conducted further Feasibility Studies and REL engaged SOFRECO to update the 2012 preliminary ESIA, and some further stakeholder consultations were undertaken. In Q4 2021 REL engaged SLR to develop the ESIA prepared by SOFRECO into a full bankable ESIA.

The 2021 preliminary ESIA prepared by SOFRECO included a series of stakeholder engagement activities, summarised in Table 6-2 below[1].

[1] This information has been extracted from the 2021 preliminary ESIA (SOFRECO , 2021)

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Table 6-2 Summary of Stakeholder Engagement Activities Performed in 2020

Date	Type of activities	Main issues and concerns raised
17 January 2020	Workshop for administrative stakeholders in Bukavu, DRC	Raised questions regarding: • The conclusion of geological studies and risk of erosion. • The public expropriation procedure. • The development opportunities and benefits offered to the affected population. • Modalities of compensation and actualisation of the 2010 studies • Modalities of energy sharing agreement. • Means of information between the Project and PAPs.
5 February 2020	Workshop for administrative stakeholders in Kamembe, Rwanda	
January – February 2020	Public consultation with population potentially affected by the Project footprint in Bugarama, Nzahaha, Ruduha (Rwanda), Kafunda, Bugano and Kamanyola (DRC).	Both Rwandan and Congolese people raised concerns regarding: • Noise and vibration disturbances and damage to property during construction. • Difficulty finding / affording land after expropriation. • Impossibility of building on pipe passages. • Scarcity of water resources for crop irrigation as a caused by the Project. • Positive benefits (electricity) not received by the affected village. In DRC only, the following concerns were raised: • Fear of local and government authorities embezzling fund to the detriment of expropriated people's compensation. • Land conflicts following compensation, underestimating the amount of compensation for loss of land. • Lack of compensation as occurred when Ruzizi II HEPP was developed.
28 August 2020	Public consultations in Bugarama and Nzahaha (Rwanda)	
12 October 2020	Public consultation in Kamanyola and Kashenyi (DRC)	

6.3.2 Stakeholder Engagement Activities Performed in 2021-2023

In January/February 2022 SLR conducted stakeholder engagement activities with PAPs in the frame of the current ESIA and RAP preparation. In 2022-2023, REL also conducted several stakeholder engagement activities in Burundi, Rwanda and DRC.

All of the stakeholder engagement activities performed by the Project from 2021 to 2023 are summarised in Table 6-3 below.

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Table 6-3 Stakeholder Engagement Activities Performed between 2021 and 2023

Date	Type of activities	Topics discussed	Main issues and concerns raised	Response provided
2021 ESIA (SOFRECO)				
14 August 2021	Consultation with Nzahaha Sector Population and Local authorities on project progress and impacts	Project progress Project Impact	General discussion on the progress of the Project and expected impacts	ESIA documentation to be publicly disclosed
17 August 2021	Consultation with Bugarama Sector Population and Local authorities on project progress and impacts	Project progress Project Impact	General discussion on the progress of the Project and expected impacts	ESIA documentation to be publicly disclosed
24 August 2021	Meeting in Bukavu involving Governor, army, policy, immigration and technical services, alongside local authorities	Compensation Community development Livelihood restoration	Raised concerns regarding: The fairness of compensation procedures in both countries. Project's support to households that haven't received compensation for previous property acquisition since 2010. Extent of community development activities which will be offered by the Project. Type and extent of livelihood restoration activities.	ESIA documentation – including RAP (including livelihood restoration) to be publicly disclosed. Local Area Development Plan (LADP) prepared and publicly disclosed
	Meeting with PAPs in Nyagahanga to start the property valuation process	Property valuation Compensation	Raised concerns regarding: Certain crops being left out of the valuation process, as was the case with the previous valuation. Damage of property during construction. Damage of property before the payment of compensations. Non-payment of compensations to people without a land title. Inequality in compensation fees, which have previously been much higher in DRC than in Rwanda.	ESIA documentation – including RAP (including livelihood restoration) to be publicly disclosed.
26 August 2021	Meeting in Rusizi involving Governor, Ruzizi District, army, police, immigration and technical services and local authorities	Project benefits	Concern that PAPs may not benefit from the Project.	Local Area Development Plan (LADP) prepared and publicly disclosed

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Date	Type of activities	Topics discussed	Main issues and concerns raised	Response provided
15 September 2021	Consultation with villagers of Ibambiro	Employment opportunities Land registration Compensation	Raised concerns regarding: The availability of jobs for women and local communities more generally. Land registration and compensation procedures. Land conflicts between different heirs and management of compensation on land shared between different family members.	ESIA documentation – including ESMP, which includes employment targets for women) and RAP which includes mechanism for managing land conflicts, to be publicly disclosed.
16 September 2021	Consultation of Kaboya Village, Kamanyola			
28 September 2021	Consultation on property valuation process with PAPs and establishment of RCs in Gatebe	Property valuation	Explanation of the property valuation process to PAPs and establishment of resettlement committees	ESIA documentation – including RAP (including information on valuation process and resettlement committees) to be publicly disclosed.
	Consultation on property valuation process with PAPs and establishment of RCs in Nyagahanga		Explanation of the property valuation process to PAPs and establishment of resettlement committees	
30 September 2021	Training on roles and responsibilities of RCs and documentation of grievances of Nzahaha RC members	Resettlement Committees Grievance mechanism	Presentation of the resettlement committee's role and responsibilities and discussion on existing grievances	ESIA documentation – including RAP (including information resettlement committees and grievance mechanism) to be publicly disclosed.
1-2 October 2021	Meetings with the Resettlement Committees in Bugarama and Nzahaha (respectively located in Gatebe and Nyagahanga)	Land acquisition Compensation	Raised concerns regarding: The fact that the 10 m strip of land closest to the river have not been considered due to a new environmental law, even though people cultivate on it. According to national law, land taken over 5% should be acquired fully but many people are instead remaining with very small plots. Mistakes in official land titles which have counted less land than existing in reality. Non-payment of compensation for people without a land title. Payment of compensation on land shared amongst family members. Landowners will claim the compensation for the crops which will be shared with farmers farming under nyiragabura.	ESIA documentation – including RAP (including information in land acquisition, eligibility and compensation) to be publicly disclosed.
21-22 October 2021	Training of PAP Committees in DRC (locality not specified)	Land acquisition Project benefits	Fear of increased vulnerability due to loss of lands, fear that project will not benefit Nyangezi and Kamanyola, fear that PAPs will not benefit from employment opportunities.	ESIA documentation – including RAP to be publicly disclosed. Local Area Development Plan (LADP) prepared and publicly disclosed
7 October 2021	Discussion on grievances and complaints with RC of Bugarama	Existing grievances	Discussion on existing grievances and complaints	Lessons learnt from past grievances used in the Project RAP
15 October 2021				

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Date	Type of activities	Topics discussed	Main issues and concerns raised	Response provided
20 October 2021	Discussion on grievances and complaints with RC of Nzahaha	Existing grievances	Discussion on existing grievances and complaints	Lessons learnt from past grievances used in the Project RAP
21-22 October 2021	Training of RCs fromv Ibambiro and Kaboya + establishment of a coordination committee with role of overseeing sub-committees	Existing grievances	Discussion on existing grievances and complaints	Lessons learnt from past grievances used in the Project RAP
November 2021	Meeting with Sud Kivu authorities	Catchment soil erosion Compensation	Concern about erosion risks and lack of trees, and about timely payment of compensations.	ESIA documentation to be publicly disclosed. CIA chapter addresses catchment soil erosion issue. Lessons learnt from past grievances used in the Project RAP.
30 November 2021	Discussion with PAPs and local leaders in Nzahaha and Bugarama on land and property valuation process	Property valuation	Explanation of the property valuation process	ESIA documentation – including RAP, which includes information on the property valuation process to be publicly disclosed.
1-2 December 2021	Meeting with Ibambiro Resettlement Committee	Land-related conflicts Land evaluation process	Raised problem of land-related conflicts over land delimitation during land evaluation process, difficulty accessing some lands due to the lack of roads.	ESIA documentation – including RAP, which includes information on the property valuation process to be publicly disclosed.
2022-2023 ESIA, SEP and RAP (REL)				
7 January 2022	Consultation with PAPs in Karhongo and Kamanyola	Project progress Stakeholder Engagement	General update on the project and upcoming consultation activities	ESIA documentation including a Stakeholder Engagement Plan to be publicly disclosed
12 January 2022	Consultation with PAPs in Bugarama and Nzahaha to resolve grievances	Past grievances	Discussion on existing grievances and complaints	Lessons learnt from past grievances used in the Project RAP
24 January 2022	Consultation meeting between EGL and PAPs from Kamanyola and Karhongo, to discuss their appreciation of the land and property valuation processes	Property valuation	Gathering of PAPs' feedback on the property valuation process.	ESIA documentation – including RAP, which includes information on the property valuation process to be publicly disclosed.
25 January 2022	Consultation meeting between EGL and PAPs in Bugarama from Bugarama and Nzahaha Sector to discuss their appreciation of the land and property valuation process	Property valuation	Gathering of PAPs' feedback on the property valuation process.	ESIA documentation – including RAP, which includes information on the property valuation process to be publicly disclosed.

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Date	Type of activities	Topics discussed	Main issues and concerns raised	Response provided
11 February 2022	Consultation between PAPs from Bugarama and Nzahaha Sectors to update them on progress of the project.	Project progress	Discussed mechanisms in place for PAPs to stay informed on project developments.	ESIA documentation including a Stakeholder Engagement Plan to be publicly disclosed
17 February 2022	Meeting in Ibambiro with PAPs from Karhongo to update them on progress of the project.	Project progress	Discussed mechanisms in place for PAPs to stay informed on project developments.	ESIA documentation including a Stakeholder Engagement Plan to be publicly disclosed
18 February 2022	Meeting with local authorities and resettlement committees in Nyangezi and Kamanyola	Stakeholder Engagement	Conduction of a community assessment to collect views and opinions from local leaders and stakeholders towards the preparation of a Stakeholder Engagement Plan.	ESIA documentation including a Stakeholder Engagement Plan to be publicly disclosed
18 February 2022	Meeting with local authorities and resettlement committees in Bugarama	Project progress Compensation	Update of the Project's progress, discussion on land acquisition and clarification on compensation entitlements and conditions.	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed
22 February 2022	Meeting with the resettlement committee members and PAPs in Nzahaha Sector	Project progress Compensation	Update of the Project's progress, discussion on land acquisition and clarification on compensation entitlements and conditions.	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed
March 2022	Stakeholders' Satisfaction Assessment, including PAPs from both DRC and Rwanda.	Stakeholder Engagement Past grievances	Identified issues regarding: Inadequate tools in place to collect feedback from PAPs. Insufficient dissemination of information on the Project and results of different studies which have been undertaken. Lack of regular engagement with PAPs to inform them on progress and important dates. Dissatisfaction of PAPs with length of compensation process.	ESIA documentation including a Stakeholder Engagement Plan to be publicly disclosed. Lessons learnt from past grievances used in the Project RAP.
23 March 2022	Meeting with the resettlement committee members of Nzahaha	Election of Resettlement Committee members	Fixing the date for the election of committee members	N/A
28 March 2022	Meeting with the resettlement committee in Bugarama	Past grievances	Addressing grievances	Lessons learnt from past grievances used in the Project RAP.
04 April 2022	Meeting with resettlement committee members and PAPs from Nyagahanga and Nyenji villages.	Election of Resettlement Committee members	Electing new members of the resettlement committee	N/A
21 April 2022	Meeting with the resettlement committees of Bugarama and Nzahaha, local authorities, EGL, REL and the JIU	Property valuation	Discussion on the land and property valuation process, outlining successes, challenges and lessons learnt	Lessons learnt from past grievances used in the Project RAP.

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Date	Type of activities	Topics discussed	Main issues and concerns raised	Response provided
26 April 2022	Meeting with resettlement committees and local authorities from Kamanyola (Kayenge and Kafunda)	Compensation Past grievance	Identifying the banks that will be used to pay compensation. Resolution of grievances.	Lessons learnt from past grievances used in the Project RAP.
28 April 2022	Meeting with resettlement committees and local authorities from Nyangezi (Ibambiro and Ruduha)	Compensation Past grievance	Identifying the banks that will be used to pay compensation. Resolution of grievances.	Lessons learnt from past grievances used in the Project RAP.
13 May 2022	Meeting with PAPs and resettlement committee members in Nyange Cell	Compensation Land titles	Discussion on compensation entitlements and administrative support for the provision of land titles	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation and assistance for obtaining land titles to be publicly disclosed
20 May 2022	Meeting with PAPs and resettlement committee members in Nyagahanga	Compensation Land titles	Discussion on compensation entitlements and administrative support for the provision of land titles	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation and assistance for obtaining land titles to be publicly disclosed
23 May 2022	Meeting with PAPs and resettlement committee members in Ruganzu	Compensation Land titles	Discussion on compensation entitlements and administrative support for the provision of land titles	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation and assistance for obtaining land titles to be publicly disclosed
28 May 2022	Meeting with resettlement committees and local authorities from Kamanyola (Kayenge and Kafunda)	Compensation Eligibility	Validation of compensation files by the PAPs before compensation. Discussion on the treatment of files for affected people who died before compensation.	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and to be publicly disclosed
30 May 2022	Meeting with resettlement committees and local authorities from Nyangezi (Ibambiro and Ruduha)	Compensation Eligibility	Validation of compensation files by the PAPs before compensation. Discussion on the treatment of files for affected people who died before compensation.	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and to be publicly disclosed
08 June 2022	Meeting with resettlement committees and local authorities in Nachirhongwe, Ruduha, Kayenge and Manda	Past grievances	Resolution of grievances and discussion on compensation payments.	Lessons learnt from past grievances used in the Project RAP.
28 June 2022	Meeting with resettlement committees and local authorities in Nachirhongwe, Ruduha, Kayenge and Manda	Past grievances	Discussing challenges affecting PAPs in the Project area	Lessons learnt from past grievances used in the Project RAP.

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Date	Type of activities	Topics discussed	Main issues and concerns raised	Response provided
29 June 2022 – 01 July 2022	Meeting with PAPs and One Stop Centre Staff in Gihundwe Sector	Compensation Land titles	Facilitation of land title transfers by PAPs	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation and assistance for obtaining land titles to be publicly disclosed
06 July 2022	Meeting with PAPs and local authorities	Compensation Land titles	Provision of support and information on the documentation required for the land transfer process and provision of land titles.	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation and assistance for obtaining land titles to be publicly disclosed
06 July 2022	Meeting with PAPs and local authorities	Compensation Land titles	Provision of support and information on the documentation required for the land transfer process and provision of land titles.	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation and assistance for obtaining land titles to be publicly disclosed
28 July 2022	Meeting with resettlement committees and local authorities in Kamanyola and Nyagezi	Technical studies	Discussion on the activities planned by Tiger Engineering in Manda	N/A
03 August 2022	Meeting with resettlement committee members and local authorities in Bugarama	Project progress	Provision of feedback on the decisions taken at the meeting in Nairobi	N/A
04 August 2022	Meeting with resettlement committee members and local authorities in Nzahaha	Project progress	Provision of feedback on the decisions taken at the meeting in Nairobi	N/A
05 August 2022	Meeting with resettlement committees and local authorities in Nyagezi (Nachirhongwe and Ruduha)	Compensation	Sensitisation of resettlement committee members on the compensation process	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed
06 August 2022	Meeting with resettlement committees and local authorities in Kamanyola (Kayenge and Manda)	Compensation	Sensitisation of resettlement committee members on the compensation process	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed
25 August 2022	Meeting with resettlement committees and local authorities in Nyagezi (Nachirhongwe and Ruduha)	Project progress	Provision of feedback on the decisions taken at the meeting in Nairobi	N/A
26 August 2022	Meeting with resettlement committees and local authorities in Kamanyola (Kayenge and Manda)	Project progress	Provision of feedback on the decisions taken at the meeting in Nairobi	N/A

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Date	Type of activities	Topics discussed	Main issues and concerns raised	Response provided
7 October 2022	Meeting with resettlement committees in Nyagezi (Ruduha and Bujenjere)	HMP	Evaluation of the existence of the batwa community in the Project area and evaluation of their socioeconomic condition.	HMPDP to be prepared and publicly disclosed
7 November 2022 – 11 November 2022	Meeting with the DRC Interministerial Commission, EGL and REL	Project progress	Progress report and tour of the Project area	N/A
29 November 2022	Meeting with General Director of Water Resources	Project progress Hydrological data	Update on the progress of the Project and clarification on the lack of expected impacts downstream in Burundi Provision of information on additional hydrological data collection	N/A
29 November 2022	Meeting with Chief Warden of Rusizi National Park in Burundi	Project progress Hydrological data	Update on the progress of the Project and clarification on the lack of expected impacts downstream in Burundi Provision of information on additional hydrological data collection	N/A
1 December 2022 – 8 December 2022	Meeting with Land Affairs Officials from Walungu Territory	Land acquisition	Verification of the lands to be acquired for the Project	N/A
11 January 2023	Meeting with the resettlement committees of Kamanyola (Manda, Bugabo, Kafunda, Douane)	Compensation Past grievances	Discussion on compensation packages and challenges in the area	Lessons learnt from past grievances used in the Project RAP.
18 January 2023	Meeting with Nzahaha senior officials (Executive secretary of sector and Social Affair and Civil affairs as well as Murya and Nyenji Executive Secretaries), the Social Advisor from Fitchner and Project Steering committee members	Stakeholder engagement	Consultation of Project-affected people to assess how they have been consulted, involved and informed throughout the Project's implementation	ESIA documentation including a Stakeholder Engagement Plan to be publicly disclosed
18 January 2023	Meeting with Bugarama senior officials (Social Affairs and Executive Secretary), the Social Advisor from Fitchner and Project Steering committee members	Stakeholder engagement	Consultation of Project-affected people to assess how they have been consulted, involved and informed throughout the Project's implementation	ESIA documentation including a Stakeholder Engagement Plan to be publicly disclosed
25 January 2023 – 28 January 2023	Meeting with IGEBU General Director and Director of Hydrometereology in Gitega Head Office of IGEBU (Burundian Institute of Geography)	Project progress Hydrological data	Update on Project progress and request of partnership to collect hydrology data through IGEBU stations in the Rusizi National Park	N/A

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Date	Type of activities	Topics discussed	Main issues and concerns raised	Response provided
15 March 2023	Meeting with resettlement committee members in Murya Cell	Past grievance	Resolution of grievances	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed
23 March 2023 – 25 March 2023	Meeting with resettlement committee members in Kamanyola and Karhongo and the donors	Land acquisition Compensation	Discussion on the land acquisition and compensation process	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed
23 March 2023 – 25 March 2023	Meeting with resettlement committee members in Kamanyola and Karhongo and the donors	Land acquisition Compensation	Discussion on the land acquisition and compensation process	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed
1 June 2023	Meeting with resettlement committee members and Bugarama and Nzahaha	Land acquisition Compensation	Update on the progress of the land acquisition and compensation process	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed
2 June 2023	Meeting with resettlement committee members from Kamanyola and Karhongo	Land acquisition Compensation	Update on the progress of the land acquisition and compensation process	ESIA documentation including a RAP, including information on land acquisition, entitlement, eligibility and compensation to be publicly disclosed

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6.3.2.1 Stakeholder Engagement conducted during the 2022 Socioeconomic Surveys

A Stakeholder Engagement during the Qualitative Socioeconomic Surveys

In 2022, SLR also carried out a qualitative socioeconomic survey of the populations inhabiting the villages around the Project's footprint or utilising / owning resources which will be impacted by the Project. The qualitative social survey was undertaken from the 19 January to 2 February 2022. The activities of stakeholder engagement carried out as part of the qualitative survey consisted of:

- Informal discussions with economically and physically displaced people, aimed at understanding their resilience, plans for the future and perception of the Project's stakeholder engagements to date.
- Informal discussions with people who may lose access, to some extent, to natural resources which may be impacted by the project, such as wood collection, medical plants collection and domestic water usage.
- Informal discussions with people who will lose income opportunities as a consequence of land acquisition (land-based wage workers).
- Focus groups with women, men, vulnerable people and local authorities in the Rwandan villages of Nyagahanga, Ryagashyitsi, Ruganzo, Gatebe, Mwaro, Gombaniro and Mubombo, to discuss land acquisition impacts on local livelihoods.
- Focus groups with women, men, vulnerable people and local authorities in the Rwandan villages of Kayenge, Bugano, Kafunda, Nachihembe, Nachirongwe, Ibambiro, Bujenjere and Ruduha, to discuss land acquisition impacts on local livelihoods.
- Formal interviews with local authorities and agronomists to better understand the impact of land acquisitions on land tenure and farming dynamics.

The numbers of people interviewed in DRC and Rwanda, disaggregated by gender, village and interview type are shown Table 6-4.

Table 6-4 - People Interviewed in DRC and Rwanda for the Qualitative Social Survey in 2022

Sector	Cell	Village	Total number of people	No. of women interviewed	No. of men Interviewed	Interview type
Rwanda						
Nzahaha	Murya	Nyagahanga	13	4	9	Focus groups
		Ryagashitsi	9	4	5	Focus groups
		Gatchuriro	20	1	1	Murya Cell Office
				9	9	Batwas focus group
		Reach from reservoir to powerhouse	6	3	3	Informal discussions
	Nyenji	Ruganzo	14	6	8	Focus groups
		Rugunga	1	-	1	Cell Executive Interview
	Rwinzuki	Murambi	2	-	1	Sector Agronomist
				-	1	Health Centre Interview
	Karenge	Gishoma	1	-	1	Head of cooperative interview
Bugarama	Nyange	Nyange Cell Riverside	6	4	2	Informal discussion
		Gatebe	11	5	6	Focus groups
	Pera	Kabsunzu	10	4	6	Focus groups
		Bugarama	5	-	1	Executive of Pera Cell
				-	1	Director of health centre
				-	1	Executive of Nyange Cell
				-	1	Sector Agronomist

Sector	Cell	Village	Total number of people	No. of women interviewed	No. of men Interviewed	Interview type
				-	1	Director of Rice Cooperative
	Ryankana	Mwaro	10	5	5	Focus groups
		Ryankana Cell riverside	10	5	5	Informal discussion
		Mubombo	22	6	15	Focus group
				-	1	Head of Ryankana Cell
		Gombaniro	29	15	14	Focus group
Rwinbogo	Kabajoba	Mushaka	1	1	-	Health centre interview
Total for Rwanda.			180	78	102	
DRC						
Kamanyola	Ngweshe	Bugano	24	2	-	Informal discussion
				9	13	Focus groups
		Kayenge	23	9	11	Focus groups
				-	3	Health Centre
		Kafunda	22	11	9	Focus groups
				2	-	Informal discussion
		Nachihembe	20	10	10	Focus groups
		Rubumba	5	4	1	Health Centre
		Downstream riverside	6	2	4	Informal discussion
Karhongo	Ishamba	Rushebeyi	19	6	13	Focus groups
		Ibambiro	29	10	14	Focus groups
				-	5	Health Centre
		Nachirongwe	23	9	14	Focus groups
		Bujenjeri	22	10	12	Focus groups
		Ruduha	22	-	3	Health Centre
				6	13	Focus groups
Total for DRC			215	90	125	
Grand Total (Rwanda and DRC)			**395**	**168**	**227**	

B Stakeholder Engagement during the Quantitative Socioeconomic Survey

A quantitative socio-economic survey of households affected by the Project's land take in DRC and Rwanda was carried out 28 January 2022 to 10 February 2022 as part of the resettlement process. The survey aimed at collecting socio-economic information on the physically and economically displaced households in DRC and Rwanda by surveying 601 representative household (27% of all affected households).

The survey consisted of a socio-economic questionnaire (See ANNEX E-2) administrated using electronic forms on smartphones. The objective of the survey was to collect socio-economic information on the physically and economically displaced households in DRC and Rwanda, which had been identified in 2022 through a preliminary census. The information collected was related to:

- The demographic profile of the surveyed population, including nationality, ethnicity (in the case of DRC only), language, education, religion, age and gender.
- Current livelihood strategies, types of income generating activities, levels of cash circulating in the economy and existing financial management and risk sharing institutions.
- Land owning and renting trends.
- Access to and use of natural resources.

Six hundred and one (601) households were randomly selected for the survey. This represents a sample of 27% of the affected households, as indicated in the table below. While all physically

displaced households were purposely included in the survey, the remaining economically displaced households were randomly selected from the census's database.

Table 6-5 Distribution of Households Surveyed During the Quantitative Households' Survey (2022)

Groupement (DRC) / Sector (Rwanda)	Number of Affected Households	Number of Surveyed Households	Sample Size
DRC			
Kamanyola	599	190	32%
Karhongo	947	208	22%
Total	1,546	398	26%
Rwanda			
Bugarama	367	60	16%
Nzahah	336	143	43%
Total	703	203	29%
DRC and Rwanda Total			
Total	2,249	601	27%

C Summary of Concerns Raised by Local Communities during the Socioeconomic Surveys

During the qualitative socio-economic survey, villagers raised a number of concerns about the land acquisition process and the consequences that this may have on their livelihoods. The constraints mentioned by the consulted populations were:

- Fear that they would be unable to afford buying new land after the losses due to land acquisition.
- Fear that men would take control of the money from compensation (expressed by women only).
- Fear that compensation money would not cover the costs of moving away, finding new land and either re-building a house or cultivating new crops.
- Fear of being left with the least fertile lands.
- Fear of losing income while trying to find new lands to cultivate.
- Fear of their house or part of their field not being counted (especially the 50m riverside stretch that they are not allowed to cultivate on).

The RAP has taken into account the above concerns and will be publicly disclosed locally. The RAP defines measures and entitlements addressing these concerns.

6.3.2.2 Recap of Stakeholder Engagement with Historically Marginalised /Batwa Communities

A Engagement Conducted by REL in 2023

As part of the project Social and Environmental Assessment to prepare the ESIA and RAP for the Ruzizi III Regional Hydroelectric Power Project, Ruzizi Energy LTD (REL) has collected additional information about the Batwa community in the project area, in Rwanda and DRC.

A.1 Interview with an Historically Marginalized Family

REL conducted an interview with the only one Historically marginalized family impacted by the project in Rwanda. The interview took place with the Historically Marginalized Family and the Social Economic Development Officer of the Cell the 9th of February 2022 in the Ryagashyitsi village, Murya Cell, Nzahaha Sector (Rwanda). The objective of the interview was to assess the living conditions of this impacted Historically Marginalized Family.

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A.2 Interviews with Batwa communities

To collect additional information about the Batwa community in the project area, individual interviews were conducted with nine chiefs of households from Batwa population in Bujenjere and eight others in Ruduha both in Nyangezi cluster, in DRC. Three focus groups were conducted, one in Kamanyola, one in Ruduha, and another one in Bujenjere Nyangezi. All the interviews were conducted the 7 and the 12 October 2022. The interviews have gathered additional information on the socio-economic life of the Historically Marginalized People.

B Engagement Conducted by Anthropolinks in the Frame of the Study of Historically Marginalised People in 2023

Intensive Interviews and focus group discussions were conducted in Swahili in DRC and in Kinyarwanda in Rwanda in April 2024. Interviews have also been conducted with local authority and civil society. A total of 17 interviews have been realized (7 in DRC and 8 in Rwanda).

Table 6-6 Engagement conducted with Historically Marginalised People in DRC and Rwanda

Date	Location	Participants	Number of participants
DRC - Walungu Territory, chefferie Ngweshe,			
18/04/2023	Kamanyola Groupement Ruguengué village	Women of the Twa community	Around 50 persons (women and young girls)
18/04/2023	Kamanyola Groupement Ruguengué village	Men of the Twa community	Around 50 persons (men)
18/04/2023	Kamanyola Groupement Groupement office	Resettlement committee members of Kafunda	11 persons (3 women)
18/04/2023	Kamanyola Groupement Groupement office	Local authorities: Groupement chief and secretary Heads of services for social development, environment and agriculture Ruguengue village head	6 persons
19/04/2023	Karhongo Groupement Nyangezi town	Local authorities: Groupement chief A local NGO representative Resettlement committee coordinator Member of Twa community Member of the Badjinji communiy	5 persons
19/04/2023	Karhongo Groupement Roduha town. Batwa households from Natshirongue and Ibambiro also present.	Local authorities: Groupement chief A local NGO representative Resettlement committee coordinator Member of Twa community Member of the Badjinji communiy	15-20 persons
20/04/2023	Karhongo Groupement Bujenjere village	Batwa people	10 persons (majority of women)
21/04/2023	Kamanyola Groupement Kamanyola town	Kapupu Diwa Mutimanwa, Leader of Indigenous people in DRC Members of several NGOs	1 persons (majority of women)
Rwanda			
19/04/2023	Nzahaha sector	Philippe Ngilende (Social Affairs)	1
19/04/2023	Nzahaha sector	Resettlement committee of Nzahaha sector	6 (3 women, 3 men)
19/04/2023	Nzahaha sector	Samson, HMP from Gachuriro, affected by the Project	1
20/04/2023	Nzahaha sector, Murja cell, Gucuriro village	HMP	7 HMP
20/04/2023	Bugarama sector, Bugarama town	Resettlement committee of Bugarama sector	6 +1 President and vice-president of the Resettlement

Date	Location	Participants	Number of participants
			committee and four members.
20/04/2023	Nyange cell, Bugarama sector, Bugarama town	HMP from Nyange cell	4 (3 women, 1 old man)
21/04/2023	Nzahaha sector, Butambamo cell, Ryarusaro vilage	HMP community of Butambamo cell	6 HMP
21/04/2023	Nyakarenzo sector, Kabuya cell, Mujeroro village	HMP community of Kabuya cell	More than 40

6.3.2.3 Recap of Stakeholder Engagement During the Cumulative Impact Assessment

A Engagement with Institutional Stakeholders

Several institutional stakeholders were met in 2022 during the preparation of the draft Cumulative Impact Assessment (CIA). The purpose of the meetings was to inform the stakeholders of the ongoing ESIA process and interim findings of the assessment, and to collect secondary data and give stakeholders the opportunity to inform the ESIA team of their expectations and concerns. Institutional stakeholders encountered, topics discussed, and feedback are summarised in Table 6-7.

Table 6-7 Engagement with Institutional Stakeholders

Stakeholder	Date	Country
Regidesco	22 Feb. 2022	Burundi
Office Burundais pour la Protection de l'Environnement (OBPE)	22 Feb. 2022	Burundi
Lake Kivu and Ruzizi River Basin Authority (ABAKIR)	25 Feb. 2022	Rwanda
Société Nationale d'Electricité (SNEL)	28 Feb. 2022	DRC
Société Internationale d'Electricité des pays des Grands Lacs (SINELAC)	28 Feb. 2022	DRC
Département de Biologie ISP Bukavu	28 Feb. 2022	DRC
Rwanda Energy Group (REG)	2 March 2022	Rwanda

B Engagement with Communities during the Social Baseline Survey

Potentially affected communities in DRC and Rwanda were given the opportunity to express concerns about the Project and potential impacts and risks during the social survey conducted in January and February 2022. Communities in Burundi were not engaged because no land acquisition is planned in Burundi. In addition, the ESIA has assessed that the incremental impacts on river hydrology, sediment transport and bank erosion in Burundi from hydropeaking operation of Ruzizi III will not be significant compared to the alterations caused by ~50 years of hydropeaking mode of operation of Ruzizi-I and -II.

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C Meetings with Rusizi National Park Authorities

In addition to the meeting held in 2022, a second meeting was held 18 June 2024.

D Focus Group Discussions with Communities

To involve communities in the CIA process, a series of consultations were organised in May 2024. The consultations were in the form of Focus Group Discussions (FGDs). The purpose of the consultations was to inform the communities of the Project activities and to initiate discussions on themes and topics that are of concern to the people. The FGDs were organised in villages near the Ruzizi River in Rwanda, DRC and Burundi. In each village a FGD with both men and women, and with women only were organised. The duration of each FGD was 60-90 minutes, and there were about 8 participants of varying ages and positions in the village participating. The villages, country and dates of the FGDs are provided in Table 6-8 and more details provided in Chapter 12 Cumulative Impact Assessment.

Table 6-8 List of FGDs with Communities

Country	Village	Date of FGD	N° participants	
			Male	Female
Rwanda	Kabeza / Bugarama sector / Rusizi District	17 May 2024	6	5
	Nyangahanga / Nzahaha sector / Rusizi District	17 May 2024	3	5
DRC	Kafunda village / Nyangezi / groupement Kashenyi	23 May 2024	7	8
	Nacihembe village / Kamanyola / groupement Karhongo	24 May 2024	6	5
Burundi	Cibitoke	18 June 2024	3	3

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6.4 Future Consultation Programme

A calendar for future consultations with the communities surrounding the Project has been outlined in the Stakeholder Engagement Plan (see Vol. III Annexes). It includes provisions for the consultation meetings, provision of information material (notice boards, flyers etc.), media communication and public disclosure of Project information (studies as well as progress reports).

6.4.1 Summary of Stakeholder Engagement Plan

A summary version of the Stakeholder Engagement Plan matrix for future engagement is provide in Table 6-9.

Table 6-9 Summary of Future Stakeholder Engagement

Stakeholder	Information Material	Timeframe / Frequency	Location
Direct stakeholders			
Project Affected People	• Community meetings • Information Kits: (Flyers, banners, etc.) • Notice Board • Audio-visual materials • Social media • Radio and Television program • Website • Megaphones	Annually	Project affected villages
Members of resettlement committees	• Community meetings • Information Kits: (Flyers, banners, etc.) • Notice Board • Audio-visual materials • Social media • Radio and Television program	Annually	Project affected villages
Local authorities in the project area in Rwanda and DRC	• Community meetings • Social media • Electronic newsletter • Website	Annually	Offices of authorities
Public in the Project area	• Consultation meeting • Information Kits: (Flyers, banners, etc.) • Notice Board • Audio-visual materials • Social media • Radio and Television program • Website • Quarterly and annual progress report • Electronic newsletter	Annually	Villages in the project area
Civil societies in the Project zone	• Consultation meetings • Social media • Electronic newsletter • Website	Annually	To be determined with the civil societies
Women associations in the Project zone	• Community meetings • Information Kits: (Flyers, banners, etc.) • Notice Board • Audio-visual materials • Social media • Radio and Television program	Annually	Villages in the project area

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Stakeholder	Information Material	Timeframe / Frequency	Location
Indirect stakeholders in DRC			
The leadership of South Kivu Province	• Consultation meeting • Website • Quarterly and annual progress report • Electronic newsletter • Audio-visual materials • Social media • Radio and Television program	Annually	Offices of the leadership
Ministries of the Provincial Government of South Kivu/DRC	• Consultation meeting • Website • Quarterly and annual progress report • Electronic newsletter • Audio-visual materials • Social media • Radio and Television program	Annually	Offices of the ministries
National Society of Electricity	• Consultation meeting • Website • Quarterly and annual progress report • Electronic newsletter • Audio-visual materials • Social media • Radio and Television program	Annually	Offices of the National Society of Electricity
DRC Media in Bukavu, Karhongo and Kamanyola	• Media briefing • Press releases • Invitation to provide coverage in events • Website • Audio-visual materials • Social media	Annually	To be determined with the stakeholder
Indirect stakeholders in Burundi			
Commune Rugombo Province Cibitoke	• Consultation meeting • Letters • REL Website • Information Kits: (Flyers, banners, roll-up banners, etc.) • Electronic newsletter • Audio-visual materials • Social media • Radio and Television program	Annually	Offices of commune authorities
Different ministries in Burundi	• Consultation meeting • Website • Quarterly and annual progress report • Electronic newsletter • Audio-visual materials • Social media • Radio and Television program	Annually	Offices of the ministries
Burundian Office of Revenues	• Consultation meeting • Website • Quarterly and annual progress report • Electronic newsletter • Audio-visual materials • Social media • Radio and Television program	Annually	Ministry's offices

Stakeholder	Information Material	Timeframe / Frequency	Location
REGIDESO	• Consultation meeting • Website • Quarterly and annual progress report • Electronic newsletter • Audio-visual materials • Social media • Radio and Television program	Annually	Offices of REGIDESO
Media in Cibitoki Province, Communica Rugombo	• Media briefing • Press releases • Invitation to provide coverage in events • Website • Audio-visual materials • Social media	Annually	To be determined with the stakeholder
Indirect stakeholders in Rwanda			
Leadership in Western Province	• Consultation meeting • Website • Quarterly and annual progress report • Electronic newsletter • Audio-visual materials • Social media	Annually	Offices of the leadership
Ministries and Agencies in Rwanda	• Consultation meeting • Website • Quarterly and annual progress report • Electronic newsletter • Audio-visual materials • Social media • Radio and Television program	Annually	Offices of the ministries
Media in Rwanda specifically in Western Province, Rusizi District	• Media briefing • Press releases • Invitation to provide coverage in events • Website • Social media	Annually	To be determined with the stakeholder

6.4.2 RAP Engagement Programme

The engagement programme for the implementation of the RAP is not included in the SEP. It will consist of the following activities:

- Disclose the compensation and assistance packages outlined in the RAP to the affected households and local authorities involved in the RAP process.
- Establish and operate the Grievance Redress Mechanism (GRM) (see Figure 6-1).
- Discuss with the affected households the assistance measures defined in this RAP.
- Announce the date of the payment of compensation payment and departure from the acquired land.
- Explain when, how, for how long the RAP will be publicly disclosed.

Table 6-10 below lists the stakeholder engagement actions which will be performed during the RAP implementation.

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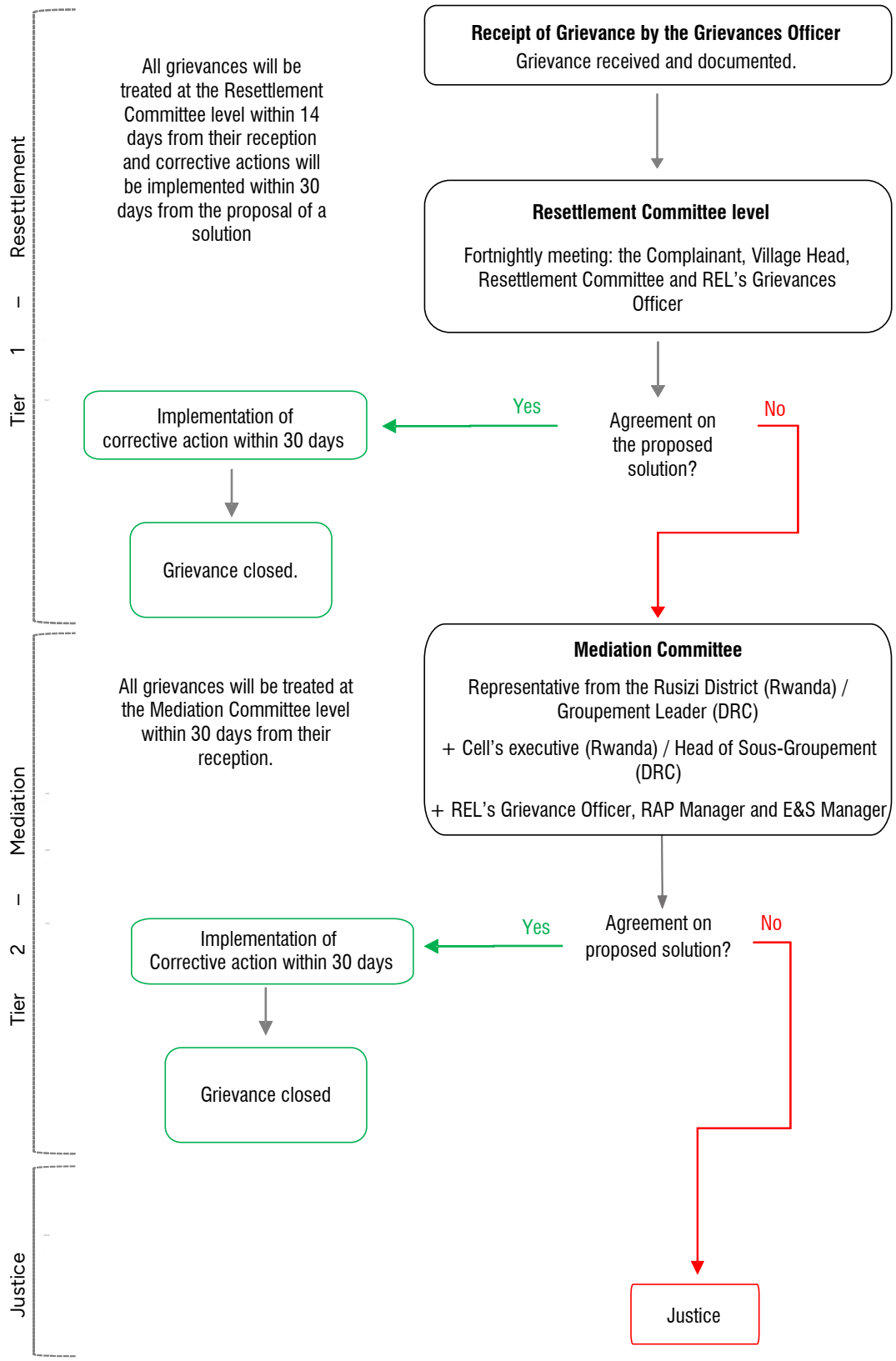


Figure 6-1 - Grievance Redress Mechanism

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Table 6-10 Stakeholder Engagement Actions during the RAP Implementation (TBC)

Steps	Action	Responsibility
1	Provision of information/training to PAPs including: • Financial management of compensation fees. • Effective cohabitation to limit conflicts in families. • Introduction to livelihood restoration programs.	RAP Officer
2	Community meetings with Resettlement Committees to discuss and resolve grievances.	Resettlement Committees
3	Community meetings with PAPs to provide updates on project activities, present compensation packages and the grievances redress mechanism.	RAP Officer
1	Specific focus groups with women and vulnerable households will be performed to ensure that all information has been suitably communicated and that their concerns and opinions are heard.	RAP Consultant / RAP Officer
	Meetings to present entitlements, compensation packages and the grievance redress system to all local authorities in the villages where PAPs are present, including (i) village heads and (ii) sous-groupement heads (DRC) / cell executive secretaries (Rwanda)	RAP Officer
2	Discussion with physically displaced PAPs to set up support measures for the resettlement process	RAP Consultant
	Discussion with physically displaced vulnerable households to define additional assistance measures for resettlement	
3	Discussion with economically displaced households to define livelihood restoration activities	RAP Consultant
4	Engagement of Resettlement Committees and Mediation Committees to set up the GRM	RAP Officer
5	Announcement of the compensation payment date, at a 15-day minimum notice	RAP Officer
6	Announcement of the date of the departure from the acquired land, at a 3-month minimum notice	RAP Officer
7	Implementation of assistance measures during the physical displacement of both vulnerable and non-vulnerable households	NGO / RAP Officer
8	Regular engagement during the provision of livelihood restoration activities	NGO / RAP Officer

6.4.3 Specific Measures for Vulnerable Groups

Some vulnerable individuals may require additional support to ensure that they are able to receive, understand and respond to project-related information in an appropriate way. Table 6-11 lists all groups that may require specific communication channels to receive information on land acquisition and resettlement, alongside the measures that will be implemented to ensure fair and appropriate engagement. These categories of vulnerability were defined during the qualitative socioeconomic survey in 2022 in collaboration with the local population, according to the findings of targeted discussions and workshops on vulnerability. Chapter 8 of the ESIA presents in more detail the methodology used to consult vulnerable people and to identify vulnerability criteria which apply to the local context of the Project area.

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Table 6-11 Specific Engagement Measures to Support Vulnerable PAPs

Vulnerable PAP	Potential Issues Encountered	Supporting Measure
PAPs with visual impairment	Unable to read information on land acquisition	One-on-one discussion with RAP Officer and out loud reading of useful written information.
PAPs with hearing impairment	Unable to (i) join public meetings or focus groups on the land acquisition and resettlement process and (ii) understand information provided	Ensure that a non-disabled person able to communicate non-verbally is accompanying the person at all times during any interaction with project-related parties. If literate, provide written information on all crucial communication with the PAP
PAPs with speaking impairment	Unable to express themselves during any interaction with project-related stakeholders	If literate, provide a piece of paper during public meetings, to ensure that the person will be able to write down questions and comments that will be specifically addressed throughout the discussion If illiterate, ensure that a representative chosen by the individual from within the family or, if unavailable, from an NGO, is available at all times to speak for the PAP and protect his / her interests
PAP with mental disability	Unable to understand Project-related information or to express himself / herself about fears or wishes related to the Project	Ensure that a representative chosen by the individual from within the family or, if unavailable, from an NGO, is available at all times to protect the PAP's interests and communicate information to the rest of the family
PAP with physical impairment (difficult or impossible to walk)	Unable to freely and comfortably join public consultations and grievance redress meetings	Provide transportation with a Project vehicle to all meetings where the presence of the PAP is required
PAPs living over a 45-minute walk to any location for public consultation or private meeting	Unable to join public consultations and grievance redress meetings without losing considerable time from a day's work	Project to set up an appropriate vehicle to transport PAPs to the location of meetings if more distance than a 45-minute walk
Woman-headed households	Many be unable to join meetings due to responsibility taking care of young or multiple children	See Table 6-12
Pregnant women (household heads and household head spouses)	In order to protect the child's and mother's health, the PAP should not walk to reach any events	See Table 6-12
Historically Marginalised / Batwa PAPs	May feel intimidated to join public meetings or to express their thoughts about the Project	Have a community-specific focus group to identify their issues and potential problems during the resettlement process Prepare a Historically Marginalised People Development Plan (HMPDP) in a consultative process, ensuring that special measures are put in place to promote the community's participation in Project activities
Landless PAPs	May need additional information and supporting accessing land in a secure and permanent way	Have a focus group with all landless PAPs, training them on the process to gain a land title, gender-based inequalities in land access

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6.4.4 Specific Gender-related Measures

Women may experience different forms of complications in trying to access Project-related information and to express their fears and wishes regarding the land acquisition and resettlement process. In order to ensure that all women involved, not only female household heads, will be suitably consulted and supported throughout the process, Table 6-12 summarises specific engagement measures which will be taken by the Project.

Table 6-12 Specific Engagement Measures to Support Female PAPs

Potential Issues Encountered	Support Measure
Women-headed households may be unable to join meetings due to their responsibility taking care of young or multiple children	Project to (i) make contact in advance to the household head to ensure that she is aware of the meeting and that she can leave the children with a trusted person and (ii) maximise participation by choosing a location for the meeting which is easily accessible for women.
Pregnant women should not walk to reach any public or individual meetings with project stakeholders, in order to protect her own and the child's health	Project to provide vehicle transportation to all pregnant household heads and all pregnant female spouses that may wish to attend meetings (see Below).
Female spouses of household heads may not have access to the appropriate information through their husbands	Project to provide a female-led and female only focus group with all spouses of household heads, alongside female household heads, to explain the compensation and resettlement process.
	Project to provide a training session for all spouses of household heads, alongside female household heads, to empower women on (i) shared and balanced management of compensation money, (ii) engagement of women in domestic decision-making for resettlement options

6.5 Disclosure of the ESIA Documentation

The ESIA documentation will be publicly disclosed:

- Environmental and Social Impact Assessment (ESIA)
- Resettlement Action Plan (RAP)
- Resettlement Policy Framework (RPF) for quarries and borrow areas
- Gender-Based Violence and Harassment (GBVH) Action Plan
- Environmental and Social Management Plan (ESMP)
- Environmental and Social Commitments Plan (ESCP)
- Watershed and Transboundary Coordination / Dialogue

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7 Environmental Baseline Situation

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Contents

7.1 Climate 7-1

7.2 Geology 7-4

7.2.1 General Geological Context 7-4
7.2.2 Seismicity 7-7
7.2.3 Slope Stability 7-9

7.3 Hydrogeology 7-15

7.3.1 Generalities 7-15
7.3.2 Types of Aquifers 7-15
7.3.3 Aquifer Potential 7-15
7.3.4 Groundwater Exploitation 7-16

7.4 Geomorphology 7-17

7.4.1 General Area Description 7-17
7.4.2 Lake Kivu Outflow to Ruzizi-II Dam 7-18
7.4.3 Ruzizi-II to Ruzizi-III Dam Site 7-19
7.4.4 Reach to be Occupied by the Proposed Ruzizi-III Dam and Reservoir 7-21
7.4.5 Reach Bypassed by the Ruzizi-III Headrace Tunnel 7-23
7.4.6 Ruzizi-III Powerhouse to the confluence with the Ruhwa River 7-24
7.4.7 Tributaries & Sediment Input in the Ruzizi Downstream from the Project 7-26
7.4.8 Estimate of Sediment Loading in the Ruzizi River at the Ruzizi-III dam Site 7-29

7.5 Water Quality 7-33

7.5.1 Generalities 7-33
7.5.2 Lake Kivu and its catchment area 7-33
7.5.3 The Ruzizi River and its Tributaries 7-34

7.6 Hydrology 7-36

7.6.1 Introduction 7-36
7.6.2 Monthly Inflows 7-38
7.6.3 Study Area Hydrology 7-49
7.6.4 Flood Risk 7-68

7.7 Aquatic Ecology 7-70

7.7.1 Regional Context 7-70
7.7.2 Hydrogeomorphological Types 7-71

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

7.7.3 Aquatic Biotopes 7-75
7.7.4 Benthic Diatoms 7-81
7.7.5 Aquatic Flora 7-82
7.7.6 Aquatic Macroinvertebrates 7-84
7.7.7 Fish 7-96

7.8 Terrestrial Ecology 7-120

7.8.1 Protected and Internationally Recognised Areas 7-120
7.8.2 Regional Context 7-124
7.8.3 Vegetation Communities 7-127
7.8.4 Birds 7-146
7.8.5 Mammals 7-159
7.8.6 Herpetofauna 7-167
7.8.7 Threats to Herpetofauna 7-171
7.8.8 Terrestrial Ecological Importance 7-172

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Tables

Table 7-1 Landslide characteristics between Ruzizi II and Ruzizi III 7-10
Table 7-2 Suspended Sediment Concentrations at the Ruzizi III Dam Site 7-30
Table 7-3 Potential Sediment Contribution of Landslides using Guzetti et al Empirical Formula 7-32
Table 7-4 Water Quality of Lake Kivu 7-34
Table 7-5 Water Quality in the Ruzizi Basin 7-35
Table 7-6 Summary of Ruzizi III Catchment Areas 7-36
Table 7-7 Long-term monthly inflows to Ruzizi III: calibration period 1989 – 2006 7-41
Table 7-8 Long-Term Monthly Inflows to Ruzizi III: Recalibration Period 2010 – 2018 7-43
Table 7-9 WEAP Model Monthly Average and Drought Flows (Current Conditions) 7-45
Table 7-10 WEAP Model Monthly Average Flows (Climate Change Conditions) 7-45
Table 7-11 Summary of Feasibility Study monthly inflows 7-47
Table 7-12 Summary of Kamanyola Water Level Monitoring Station Change in Water Level 7-50
Table 7-13 Summary of Variation of Reach Area 7-52
Table 7-14 Summary of Variation of Reach Water Area at Selected Depth Exceedance Thresholds 7-55
Table 7-15 Summary of Variation of Reach Water Area at Selected Velocity Exceedance Thresholds 7-58
Table 7-16 Summary of Variation of Reach Area at Selected Shear Stress Exceedance Thresholds 7-59
Table 7-17 Summary of baseline hydrological inflows in the Ruzizi II – Burundi Border Reach 7-63
Table 7-18 Discharge and Volume Characteristics of the Design and Check Floods 7-68
Table 7-19 Conservation Classification of the Lake Victoria Basin Freshwater Ecoregion 7-70
Table 7-20 Field Water Quality Results 7-80
Table 7-21 Summary of Diatom Results 7-81
Table 7-22 Fish Recorded During the 2022 SLR Surveys 7-97
Table 7-23 Combined Inventory of Fish Species Reported in the Ruzizi River 7-107
Table 7-24 Ecological Fish Guilds, Predominant Habitats and Associated Fish Species in the Ruzizi River 7-112
Table 7-25 Priority Fish Species Identified for the Ruzizi River and their Known Distribution, Ecology and Threats. 7-113
Table 7-26 Current Threats to Aquatic Ecology 7-117
Table 7-27 Protected Areas and Key Biodiversity Areas in the Ruzizi Basin and Catchment Area 7-121
Table 7-28 Summary of Vegetation Communities in the Ruzizi III Project Area 7-137
Table 7-29 Summary of Spatial Cover of Vegetation Communities in the Ruzizi III Project Area 7-138
Table 7-30 Priority Plant Species that could Potentially Occur in the Ruzizi III Project Area 7-141
Table 7-31 Avifaunal Assemblages 7-147
Table 7-32 Threatened and Near Threatened Bird Species Potentially Occurring in the general vicinity of the Project Area 7-154
Table 7-33 Albertine Rift Mountains Endemic Bird Area Species Potentially Occurring in the Project Area 7-157

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Table 7-34 Biome-restricted Bird Species Confirmed to Occur or Potentially Occurring in the Project Area 7-157
Table 7-35 Species Composition of the Mammal Assemblages in the Project Area 7-160
Table 7-36 Potentially occurring Threatened and Near Threatened Mammals in the Project Area 7-164
Table 7-37 Priority Herpetofauna Species Expected in the Project Area 7-168
Table 7-38 Criteria for Determining Conservation Importance of a Receptor 7-172
Table 7-39 Criteria for Determining Functional Integrity of a Receptor 7-173
Table 7-40: Biodiversity Importance Two-way Matrix 7-174
Table 7-41 Criteria for Determining Receptor Resilience 7-174
Table 7-42 Ecological Importance Matrix 7-174
Table 7-43 Guidelines for Interpreting Ecological Importance of Receptors 7-175
Table 7-44 Summary of the Integration of Ecological Importance of Vegetation Communities and Faunal Habitats 7-176
Table 7-45 Assessment of Ecological Importance by Habitat Type/Vegetation Community in PAOI 7-176

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Figures

Figure 7-1 Distribution of Seasons in the Project Area 7-1
Figure 7-2 Distribution of Average Monthly Rainfall at Kamembe Airport (1991-2019) 7-2
Figure 7-3 Average Annual Rainfall at Kamembe Airport (1991-2019) 7-2
Figure 7-4 Max., Min. and Average Monthly Temperatures at Kamembe Airport (1991-2019) 7-2
Figure 7-5 Regional Distribution of Rainfall 7-3
Figure 7-6 Vulnerability Indicators Defined for the Great Lakes Region and Ruzizi Plain 7-4
Figure 7-7 Geological Context of the Kivu Rift Region 7-5
Figure 7-8 Simplified Geological Map of the Project's Area 7-6
Figure 7-9 Seismotectonic Map of the Project's Region 7-8
Figure 7-10 Major Faults and Seismicity Distribution in the EARS 7-9
Figure 7-11 Landslides Observed Between Ruzizi II and Ruzizi III 7-10
Figure 7-12 Slope Risk in the Ruzizi III Inter-basin 7-11
Figure 7-13 – Deformation areas identified on satellite imagery 7-13
Figure 7-14 Photographs of Landslide Areas 7-14
Figure 7-15 Hydrogeological Map of the Lake Kivu and Ruzizi River Basin 7-17
Figure 7-16 Longitudinal profile of the Ruzizi River 7-18
Figure 7-17 Geomorphological Features between Lake Kivu Outfall and Ruzizi-II Dam 7-19
Figure 7-18 Geomorphological Features between Ruzizi-II and Ruzizi-III Dam Sites 7-20
Figure 7-19 Geomorphological Features of the Ruzizi River that will be Inundated 7-21
Figure 7-20 Interpreted Cross-Section Along the Axis of the Ruzizi III dam Wall 7-22
Figure 7-21 River Bed Alluvium at the Project Dam Site 7-22
Figure 7-22 Geomorphological Features of the Ruzizi River in the Dewatered Reach 7-23
Figure 7-23 Geomorphological Features of the Ruzizi Plain 7-24
Figure 7-24 Cemented Coarse Alluvium and Calcrete at the Kamanyola Incompleted Bridge 7-25
Figure 7-25 Geomorphological Features of the Ruzizi Plain 7-26
Figure 7-26 Tributaries Bringing Sediment to the Ruzizi 7-27
Figure 7-27 Landslides and Gully Erosion Along the Ruzizi River 7-28
Figure 7-28 Ruzizi River Delta Development from 1985 to 2021 7-29
Figure 7-29 Regression Laws between Suspended Sediment Concentrations and River Flow Rate 7-30
Figure 7-30 Particle Size Distributions for Bedload at Ruzizi-III Dam Site 7-31
Figure 7-31 Locations of Landslide Areas between Ruzizi-II and -III 7-32
Figure 7-32 Ruzizi III and Contributing Catchments 7-37
Figure 7-33 Annual Precipitation and Evapotranspiration Data 7-39
Figure 7-34 Water Balance Model Performance: Calibration Period 1989 – 2006 7-40
Figure 7-35 Long-Term Monthly Inflows to Ruzizi III: Calibration Period 1989 – 2006 7-41

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PUBLIC DISCLOSURE AUTHORIZED

Figure 7-36 Annual inflows to Ruzizi III: calibration period 1986/9 – 2006 7-41
Figure 7-37 Water Balance Model Performance: Recalibration Period 2010 – 2018 7-42
Figure 7-38 Long-Term Monthly Inflows to Ruzizi III: Recalibration Period 2010 – 2018 7-43
Figure 7-39 Annual Inflows to Ruzizi III: Recalibration Period 2010 – 2018 7-43
Figure 7-40 Lake Kivu Water Levels (2010-2019) 7-46
Figure 7-41 Summary of Feasibility Study Monthly Inflows 7-48
Figure 7-42 Kamanyola (Bugarama Bridge) Water Level Monitoring Station 7-49
Figure 7-43 Kamanyola Water Level Monitoring Station Change in Water Level Seasonality 7-50
Figure 7-44 Selected Daily Water Levels at Kamanyola 7-51
Figure 7-45 Variation of Reach Water Area 7-53
Figure 7-46 Variation of Reach Average Depth 7-54
Figure 7-47 Variation of Reach Water Depth Exceedence as a Percentage of Total Wetted Area 7-56
Figure 7-48 Variation of Reach Average Velocity 7-57
Figure 7-49 Variation of Reach Water Velocity Exceedence as a Percentage of Total Wetted Area 7-58
Figure 7-50 Variation of Reach Average Shear Stress 7-59
Figure 7-51 Variation of Reach Water Shear Stress Exceedence as a Percentage of Total Wetted Area 7-60
Figure 7-52 Hazard Classification of the Reach 7-61
Figure 7-53 Variation in Cross-Section Profile in the Surveyed Reach 7-62
Figure 7-54 Ruzizi II Powerhouse Release Schedules 7-63
Figure 7-55 Summary of Baseline Flows and Water Levels at Selected Key Locations 7-65
Figure 7-56 Summary of Ramp-Up and Ramp-Down Rates at Selected Key Locations 7-65
Figure 7-57 Modelled Flows and Elevations at Key Locations in the Ruzizi II – Burundi Border Reach (1/2) 7-66
Figure 7-58 Modelled Flows and Elevations at Key Locations in the Ruzizi II – Burundi Border Reach (2/2) 7-67
Figure 7-59 Summary of Ruzizi III Design Flood and Check Flood Estimates 7-68
Figure 7-60 Hydrogeomorphological Types - Transitional Zone 7-72
Figure 7-61 Hydrogeomorphological Types - Upper Foothill Zone 7-73
Figure 7-62. Hydrogeomorphological Types - Mountain Headwater 7-74
Figure 7-63 Aquatic Biotope Depth-Flow Categories in the Ruzizi River 7-75
Figure 7-64 Aquatic Biotopes Within the Ruzizi River Upstream of the Ruzizi III Reservoir 7-77
Figure 7-65 Aquatic Biotopes Within the Ruzizi III Reservoir and Dewatered Reach 7-78
Figure 7-66 Aquatic Biotopes Downstream of the Powerhouse and the Burundi Border 7-79
Figure 7-67 Water Level in the Ruzizi River at 16h00 on 21 January 2022 7-80
Figure 7-68 Aquatic Vegetation in the Main Channel and Margins of the Ruzizi River 7-82
Figure 7-69 Aquatic Vegetation in Shallow-Slow Margins of the Ruzizi River 7-83
Figure 7-70 Photographs of Annelida 7-86
Figure 7-71 Photograph of Freshwater Crab *Potamonautes lirrangensis* (Potamonautidae) 7-87
Figure 7-72 Photographs of Stoneflies (Plecoptera) 7-87

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Figure 7-73 Photographs of Mayflies (Ephemeroptera) 7-88
Figure 7-74 Photographs of Anisoptera Adults 7-88
Figure 7-75 Photographs of Zygoptera Adults 7-89
Figure 7-76 Photographs of Odonata Nymphs 7-90
Figure 7-77 Photographs of Caddisflies (Trichoptera) 7-91
Figure 7-78 Photographs of Aquatic Beetles (Coleoptera) 7-92
Figure 7-79 Photographs of Blackflies (Simuliidae) pupal stage 7-93
Figure 7-80 Photographs of Other Flies (Diptera) 7-94
Figure 7-81 Photographs of Snails 7-95
Figure 7-82 Photographs of *Enteromius* Species 7-100
Figure 7-83 Photographs of Other Cyprinid Species 7-101
Figure 7-84 Photographs of Cichlids 7-102
Figure 7-85 Photographs of Siluriformes 7-103
Figure 7-86 Photographs of Introduced Fish Species 7-104
Figure 7-87 Photographs of Current Threats to Aquatic Ecosystems 7-118
Figure 7-88 Protected Areas/KBAs in the Ruzizi River Basin [Source WDPA/Birdlife] 7-123
Figure 7-89 Global Terrestrial Ecoregions within Ruzizi III HPP Project Area 7-125
Figure 7-90 Map of the Potential Natural Vegetation Types in South-western Rwanda 7-126
Figure 7-91a Map of Vegetation and Land Cover Types in the Project Area: Overview Map 7-130
Figure 7-92. Near-Threatened *Milicia excelsa* in Hillslope Thicket near Powerhouse 7-140
Figure 7-93 Photos of Selected Invasive Alien Plant Species Found in the Project Area 7-143
Figure 7-94 Photographs Highlighting Threats to Vegetation Types and Flora 7-144
Figure 7-95 Photographs Showing Degraded Habitats in Project Construction Footprints 7-145
Figure 7-96 Species Accumulation Curve from 10-species List Data from 2022 Bird Survey 7-146
Figure 7-97 Photograph Illustrating the Pair of Common Kestrel (*Falco tinnunculus*) 7-150
Figure 7-98 Map Illustrating the Location of High-Risk Avifauna Species 7-152
Figure 7-99 Confirmed Occurrence of Hippopotamus in the Project Area 7-162
Figure 7-100 Map Illustrating the Distribution of Angolan Colobus (*Colobus angolensis*) 7-163
Figure 7-101 Photographs Illustrating Mammal Species Hunted within the DRC Territory 7-166
Figure 7-102 Species Diversity of Each Herpetofauna Assemblage Expected in the Project Area 7-167
Figure 7-103 Endemism of Herpetofauna Assemblages Expected in the Project Area 7-170
Figure 7-104 Photograph Illustrating a Puff Adder (*Bitis arietans*) 7-171
Figure 7-105a Ecological Importance of Habitats represented in the Project Area: Cover Map 7-178

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7.1 Climate

The Project is located in a tropical climate area with "dry" and "wet" seasons. Rainfall varies with altitude and follows a four-cycle regime. Uplands receive the most rain and there are many local variations linked to relief and the orientation of slopes. The highest parts of the mountains are not necessarily those with the highest rainfall, but rather the western slopes. The seasonal regime consists of a long and a short dry season, and a long and a short rainy season with varying durations, as shown in Figure 7-1.

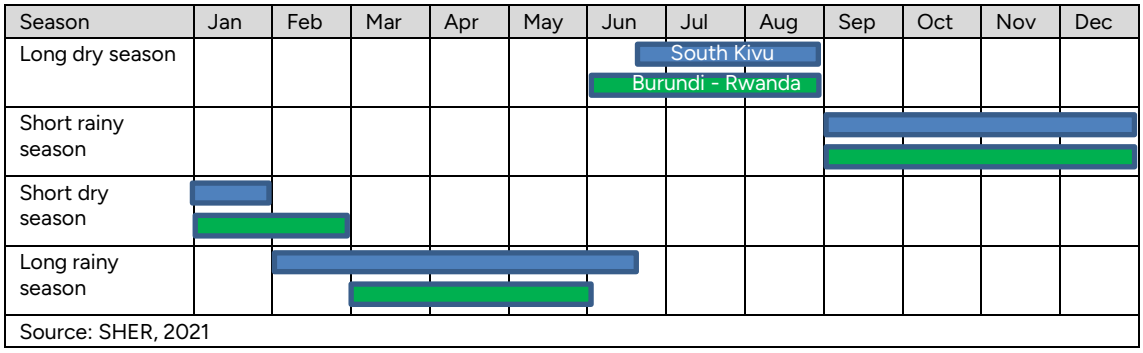


Figure 7-1 Distribution of Seasons in the Project Area

The distribution of average monthly rainfall at Kamambe airport, the closest meteorological station to the Project, is provided in Figure 7-2. Over the 23 years of available data (from 1991 to 2019, with the exception of 1994 to 1997, 2000 and 2001). There is a clear distribution between the long rainy season (March-May), representing 40% of annual precipitation and the short rainy season (September-December), representing 30% of annual precipitation.

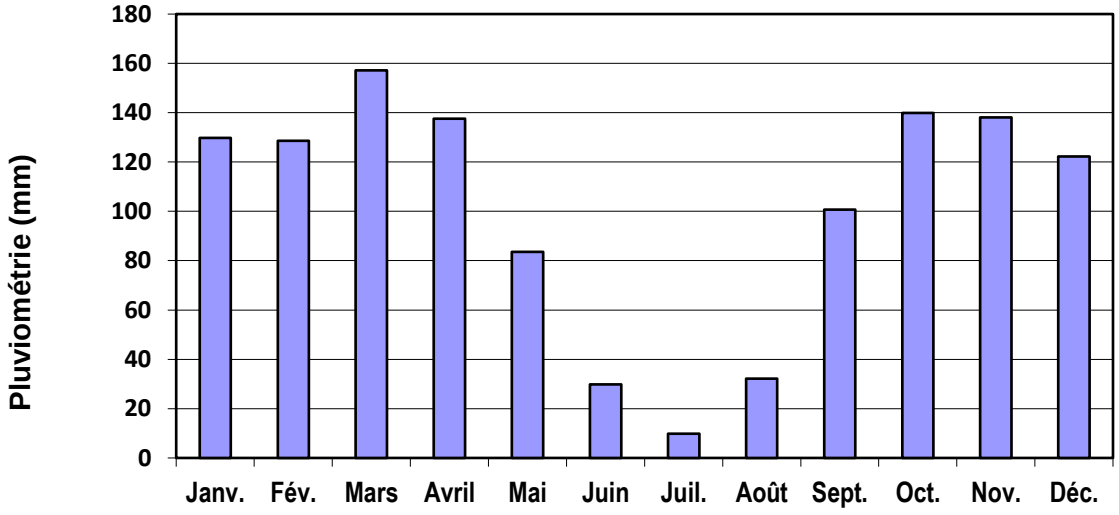
The average annual rainfall for the period from 1991 to 2019 is 1,279 mm, though there are significant inter-annual variations that range from 845 mm (66% of the mean value) to 1,606 mm (125% of the mean) as shown in Figure 7-3. Regional variations in rainfall are illustrated in Figure 7-5.

Moderate temperatures are observed in the Project area (see Figure 7-4), with only small seasonal variations.

Wind is predominantly south-easterly trade winds, though in July these are replaced by very dry north-easterly trade winds. However, local topography influences wind and the corridor formed by the upper Ruzizi Valley, most likely channels the circulation of air from the south to the north. The average wind speed in Rwanda is 1-2 m/s and the maximum monthly wind speeds recorded at Kamembe Airport range from 6-14 m/s from the southeast.

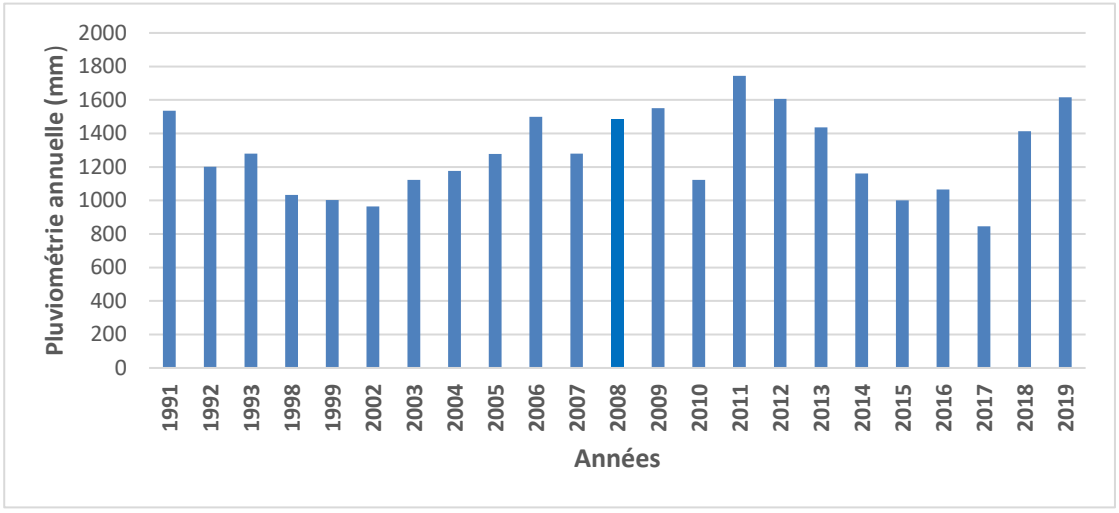
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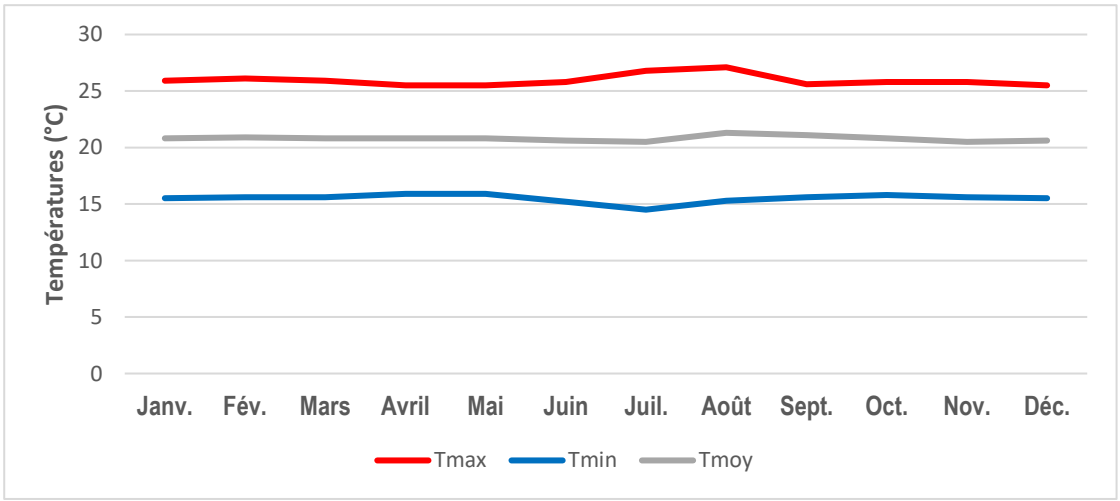
Source: Rwanda Meteorology Agency, 2019

Figure 7-2 Distribution of Average Monthly Rainfall at Kamembe Airport (1991-2019)



Source: Rwanda Meteorology Agency, 2019

Figure 7-3 Average Annual Rainfall at Kamembe Airport (1991-2019)

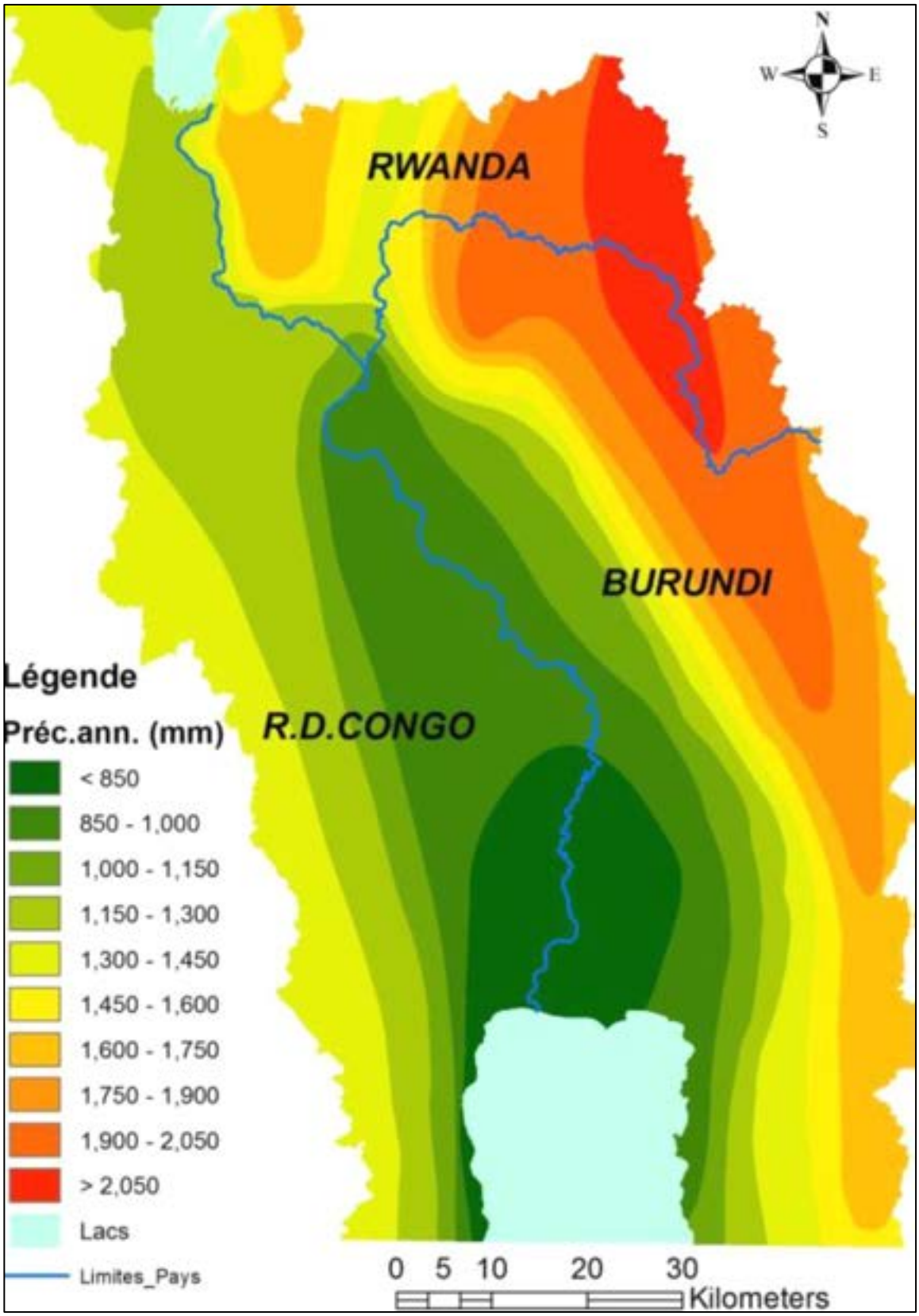


Source: Rwanda Meteorology Agency, 2019

Figure 7-4 Max., Min. and Average Monthly Temperatures at Kamembe Airport (1991-2019)

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Source: Nibigira, 2017

Figure 7-5 Regional Distribution of Rainfall

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According to the Government of the Netherlands, 2019 (as cited in Tractebel, 2020), DRC and Rwanda are estimated to be the most vulnerable to climate change in the Ruzizi Plain due to the high density in this region (2,000 people per km^2), a large dependency on natural resources and an agricultural productivity considered to be particularly low. Vulnerability indicators defined for the Great Lakes Region and Ruzizi Plain are presented in Figure 7-6 below.

Variable	Indicator	Year	Vulnerability level		
			Burundi	DRC	Rwanda
Environmental disasters	Drought	2010	high	high	high
		2030	high	high	high
	Floods and landslides	2010	moderate	moderate	moderate
		2030	high	moderate	moderate
	Storms	2010	low	low	low
		2030	low	low	low
	Wildfires	2010	low	moderate	low
		2030	low	moderate	low
Environmental disasters	Agriculture	2010	acute	high	acute
		2030	acute	severe	acute
	Fisheries	2010	high	severe	moderate
		2030	acute	acute	moderate
Health impact	Hunger	2010	severe	acute	high
		2030	severe	acute	high
Total climate (including the factors above + 15 others)		**2010**	**severe**	**severe**	**high**
		2030	**acute**	**acute**	**severe**

Source: Government of the Netherlands, 2019 (as cited in Tractebel, 2020)
Figure 7-6 Vulnerability Indicators Defined for the Great Lakes Region and Ruzizi Plain

7.2 Geology

7.2.1 General Geological Context

The Project area is part of the West African Great Rift and has undergone numerous folds, deformations and collapses. The geological substratum consists of highly metamorphosed sedimentary rocks of Precambrian age (metasediments), mainly schists and quartzites. During the Miocene epoch (Tertiary era), the region experienced intense volcanic activity which covered the Precambrian substratum with lava rocks such as trachytes, basalts and tuff. Figure 7-7 shows the geological context of the Kivu rift region.

The Ruzizi flows through a trough fault (Bugarama graben) which, before the volcanic period, must have veered northwards (Nile basin). More recently, in the Quaternary era (Pleistocene and Holocene epochs), the river's alluvium was deposited along its course to form islands and low terraces, and further downstream the vast plain of the Ruzizi.

The 2010 Fichtner Feasibility Study describes the succession of geological formations along the incised Ruzizi valley as follows:

- The upstream part, from Bukavu to about 2 km downstream of the Ruzizi II dam, is covered with basalt, tuff and to a lesser extent trachyte. Its geomorphology is characterised by gentle slopes and a relatively wide valley floor.

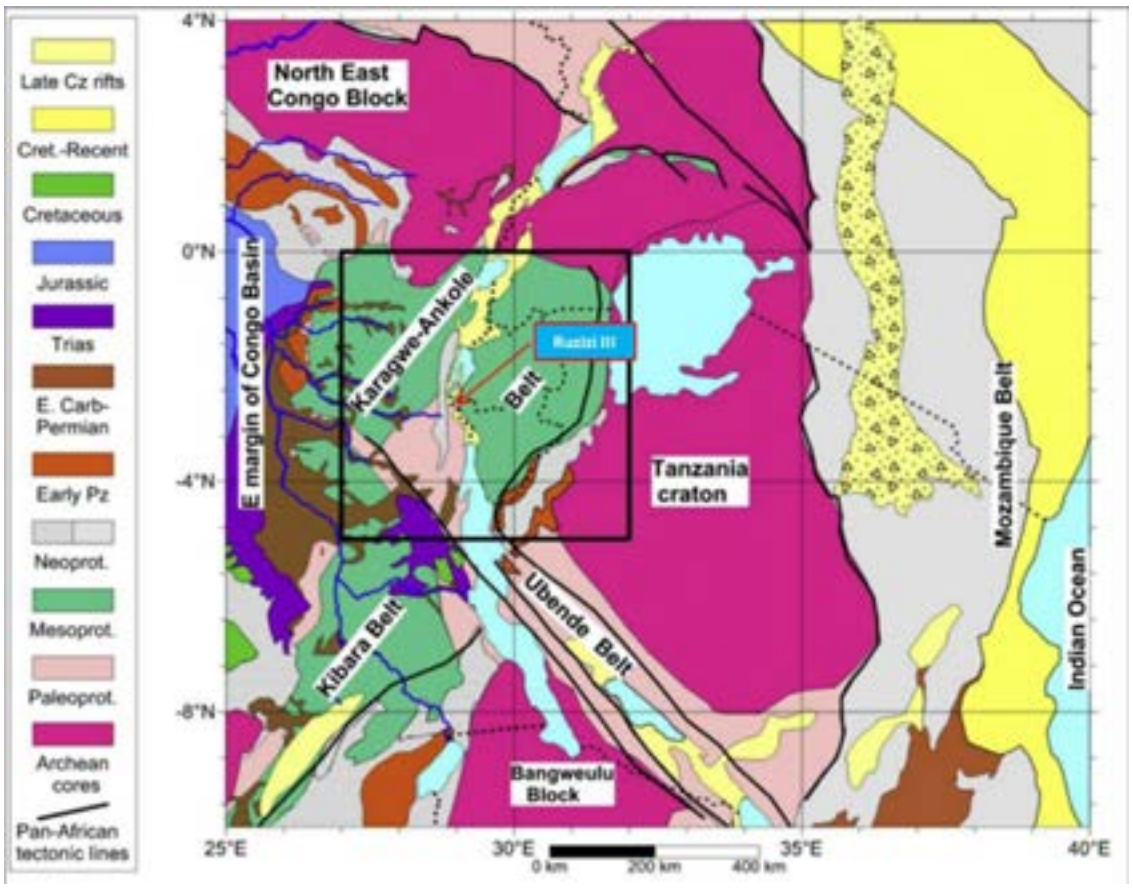
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- The intermediate part starts from the previous site and extends to the site planned for the Original Project's power plant. The basaltic lava gives way to rocks of the Precambrian basement: quartzite, quartzo-schist and micaschist. The V-shaped valley has steep slopes with frequent rocky outcrops. This part is roughly equivalent to the direct impact area.
- The downstream part, beyond the power plant site of the Original Project, is composed of metamorphic rocks and basaltic lava. In this section the Ruzizi River has to bypass or encircle numerous rocky outcrops: its course becomes winding and turbulent. Many rock steps and waterfalls are visible at this level.

Given the border situation, it is not easy to find an accurate, good quality geological map covering both sides of the Ruzizi. Figure 7-8, presents a simplified geological map and shows the dominance of volcanic rocks upstream and of Precambrian metasedimentary rocks further downstream.

At the mouth of the incised valley towards Bugarama/Kamanyola, the substrate consists of boulders and large pebbles deposited by the river over 10,000 years ago (Ilunga, 2007) in the form of an alluvial fan.



Source: Delvaux et al.

Figure 7-7 Geological Context of the Kivu Rift Region

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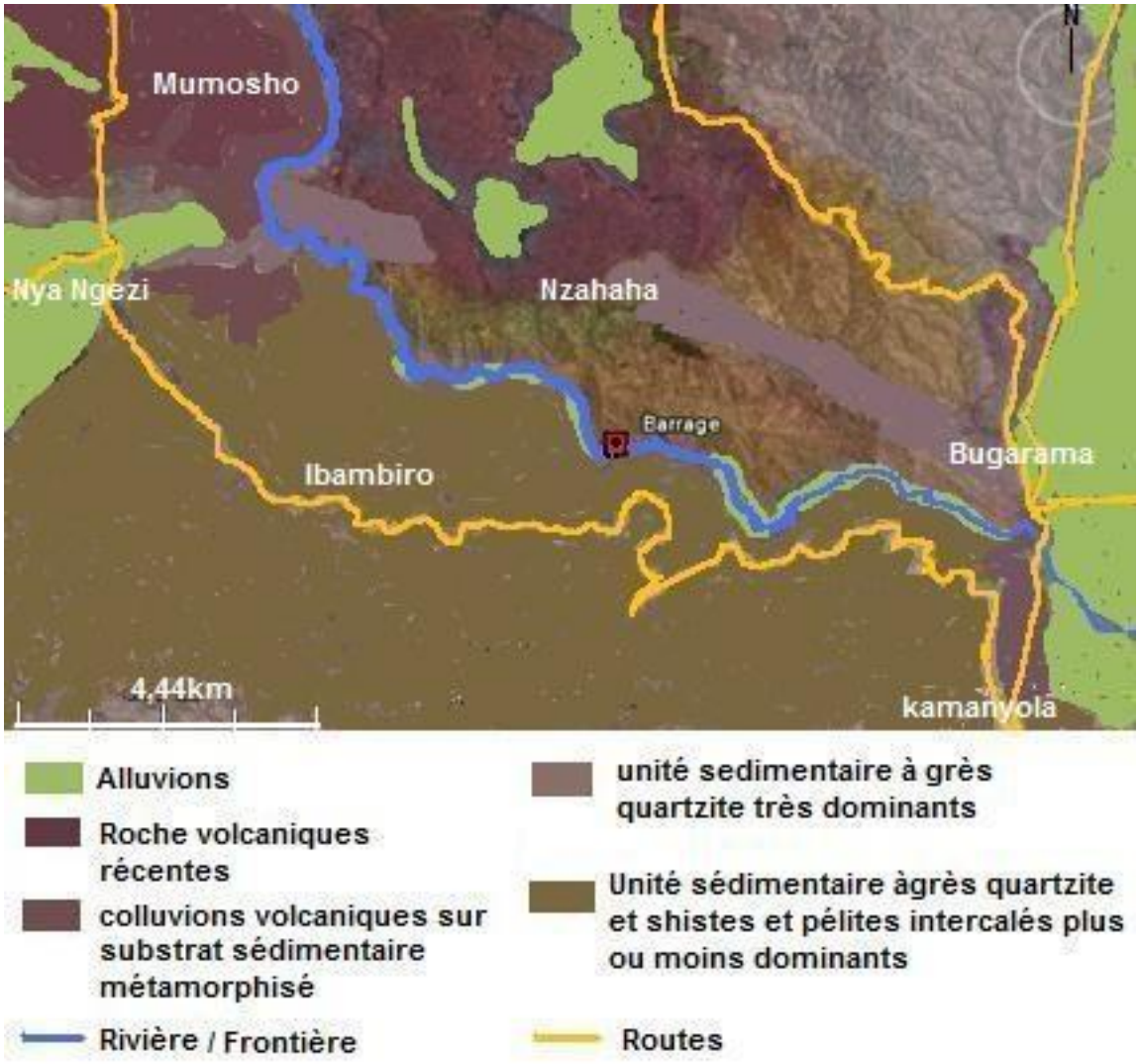


Figure 7-8 Simplified Geological Map of the Project's Area

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7.2.2 Seismicity

7.2.2.1 Geodynamic Context

The project area is located in the context of active rifting, at the junction between the Kivu rift segment and northern Tanganyika rift segment of the East Africa Rift System (EARS). The onshore EARS extends approximately 4000 km, from the Gulf of Aden in the north to the gulf of Mozambique in the south. The EARS is characterized by a series of aligned tectonic basins (rift valleys), separated from each other by relative shoals and generally bordered by uplifted shoulders (Figure 7-10). Each basin is controlled by normal faults and forms a subsiding graben (or trough) up to one hundred kilometres long and 40-60 km wide (Chorowicz, 2005).

The EARS is divided into two branches, an eastern and western rift branch (hereafter referred to ERB and WRB, respectively), surrounding the Tanzanian Archean craton and lying on Proterozoic mobile belts and following their pre-existing crustal-scale fabric trends (e.g. Chorowicz and Sorlien). Rifting along these two rift branches is the consequence of the divergence between the Nubian and the Victorian plate (western rift branch) and between the Victorian and the Somalian plates (eastern branch) (e.g., Calais et al., 2006; Saria et al. 2014).

7.2.2.2 Regional and Local Seismicity

The project is located along the western branch of the EARS, which is the most seismically active zone of the Tanzania craton region. Figure 7-9 shows the local seismotectonic map compiled from the fault mapping of Wood et al. (2015) and Delvaux et al. (2017).

Nine earthquakes of magnitude Mw[1] equal or higher to 6.0 are recorded between approximately 100 and 300 km from the sites. These events are located both along the rift and within the rift margin, at the transition with the Tanzania and Congo craton.

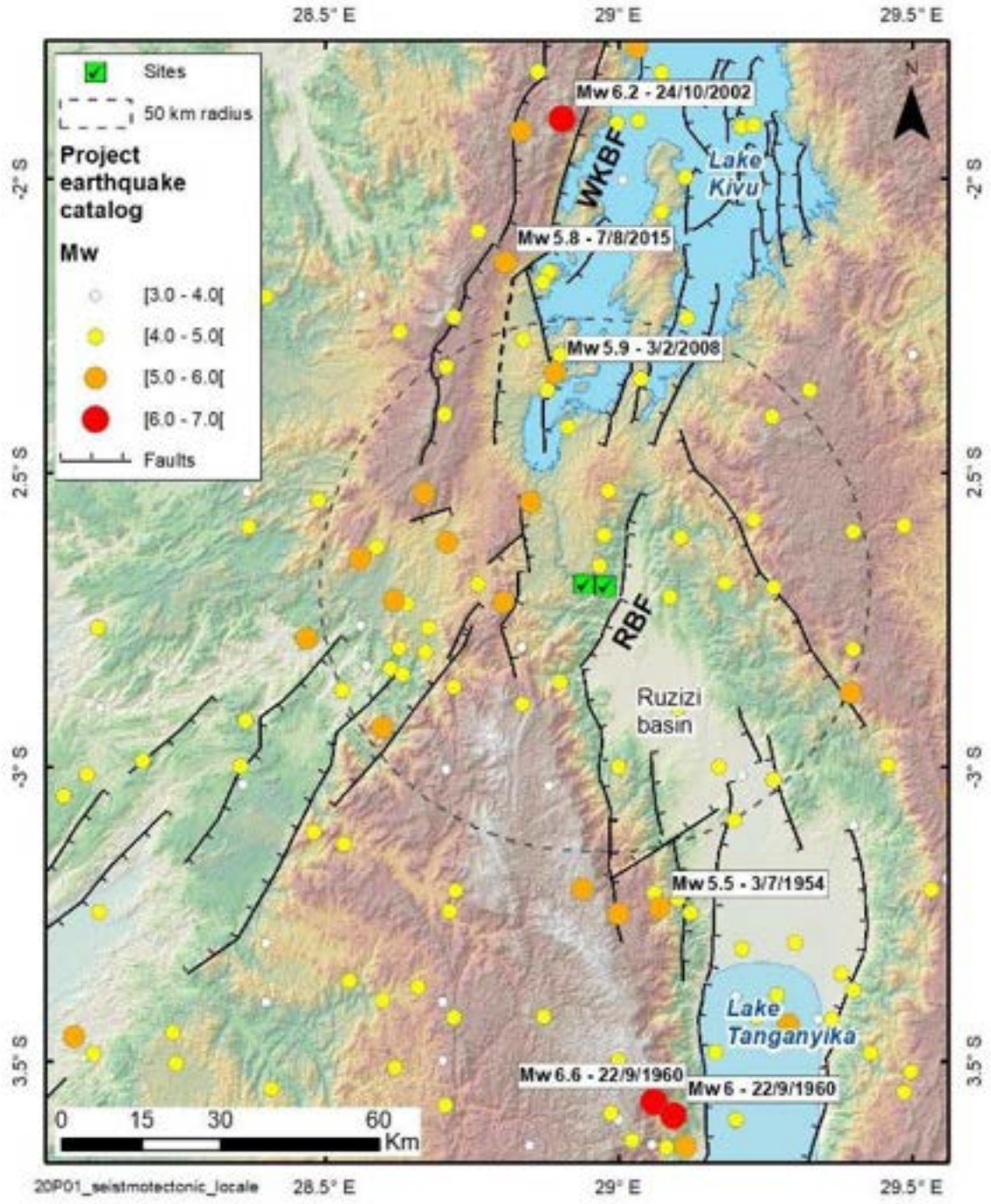
The main events, shown on Figure 7-9, were the following:

- The largest earthquake at a regional scale occurred along the western border of the Kivu rift were the Mw 6.2 (24 October 2002) event that may be related with an activity of the West Kivu Border Fault (WKBF).
- The largest event recorded within a radius of 300 km around Ruzizi dam occurred on the 22 September1960 with a magnitude Mw 6.6, at the north-western edge of the Tanganyika rift zone (Figure 7-9). Two main shocks are recorded for this event (Mw 6.6 and Mw 6.0). This sequence is located at approximately 100 km south of Ruzizi dam III.
- In the southern part of Kivu rift, an earthquake occurred on the 03 February 2008 with magnitude Mw 5.9
- Closer to Ruzizi dam site, six earthquakes of magnitude 5.0 to 5.3 that occurred in 1965, 1977, 1981, 2017 and 2019 are located between 15 and 45 km west from the site. There is only one recorded earthquake in the catalogue within a radius of 10 km around the sites. The closest recorded event is located at approximately 4 km north of both sites and occurred on 5 December 2017 with magnitude Mw 4.8.

[1] Mw is the moment magnitude scale is a measure of an earthquake's magnitude ("size" or strength) based on its seismic moment.

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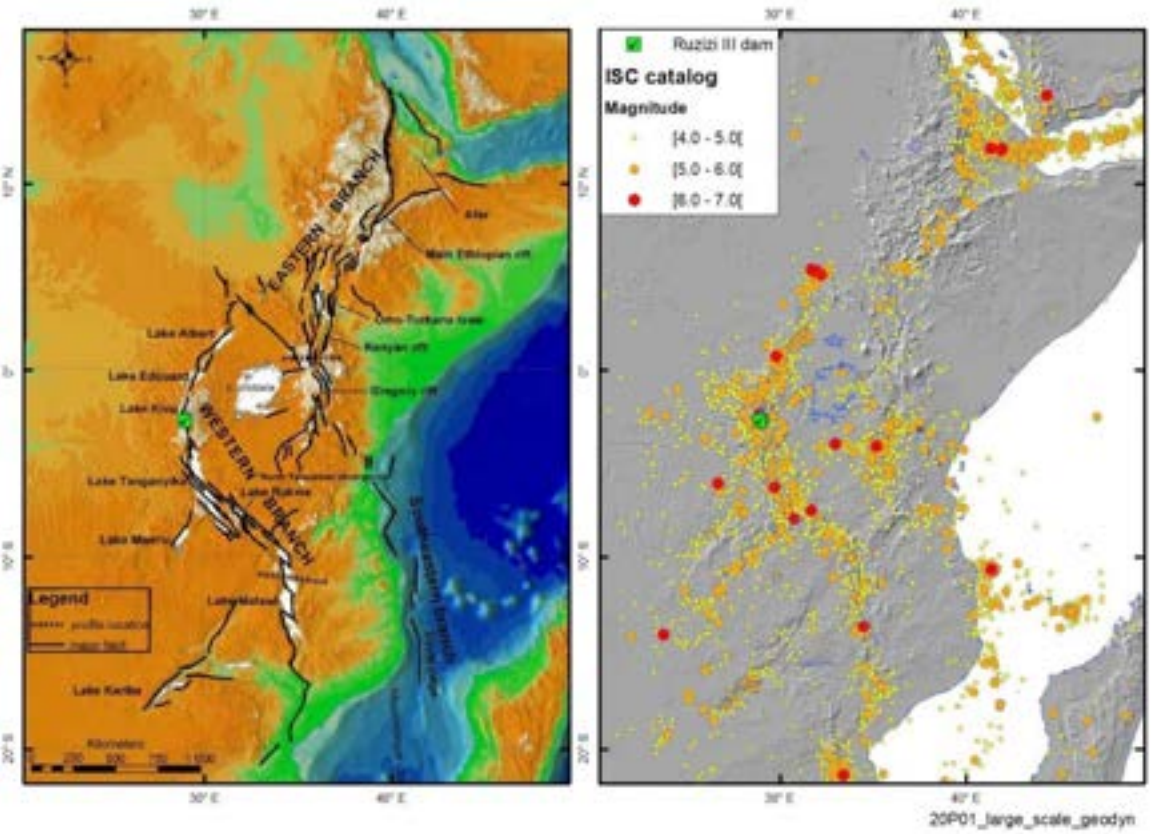


Source: Tractebel, 2021 using data from Wood et al. (2015) and Delvaux et al. (2017).

Figure 7-9 Seismotectonic Map of the Project's Region

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Major Faults of the East African Rift System (Chorowics, 2005)

Seismicity distribution in the East African Rift System (ISC, Earthquake with Magnitude >4, from 1964 to 2020)

Figure 7-10 Major Faults and Seismicity Distribution in the EARS

7.2.3 Slope Stability

7.2.3.1 Potential Landslide Identification

The Project has undertaken slope stability studies to identify potentially unstable areas in the Project area and assess the risk of landslides that could affect the dam or the reservoir as well as other Project's components. The purpose is that the risks can then be addressed in the Project design and risk reduction measures defined. The information presented in the following sub-sections 7.2.3.2 - 7.2.3.5 is key information taken from the Ruzizi III HPP & Dam Final Project Design Report - Appendix E: Stability Assessment of Slopes and Appendix V: Sediment Management Study (Tractebel, 2022). Information on the April 2021 landslide event on the right bank above the dam site is included.

7.2.3.2 Previous Investigations (2008-2009)

Investigations performed by Fichtner in 2008-2009 noted exposed bedrock on very steep slopes. Less steep slopes were noted to be covered by slope debris and colluvium accumulated by slow downslope movement.

An ancient landslide area was identified on the right hillside upstream from the pre-Feasibility Study dam site. A test pit dug in this area indicated that the landslide material consisted of a mixture of rock blocks and fragments, silt and fine-grained sand. The landslide would have been triggered by river undercutting. The presence of a clay-rich sliding surface has been considered unlikely.

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7.2.3.3 2020-2021 Investigations

A Sediment Study

The technical sediment study noted that landslides have been observed in 22 areas between Ruzizi II and Ruzizi III (Figure 7-11). When comparing the two Ruzizi inter-basins, more landslides have been observed between Ruzizi II and Ruzizi III than upstream of Ruzizi II. The general characteristics of these landslides is presented in Table 7-1 below. These landslides have been identified to be the sources of some of the sedimentation materials that can be driven by the Ruzizi River. The slope of the river valley is noted to be a major factor of sedimentation risk within the Ruzizi III inter-basin (Figure 7-12).



Source: Tractebel, 2022

Figure 7-11 Landslides Observed Between Ruzizi II and Ruzizi III

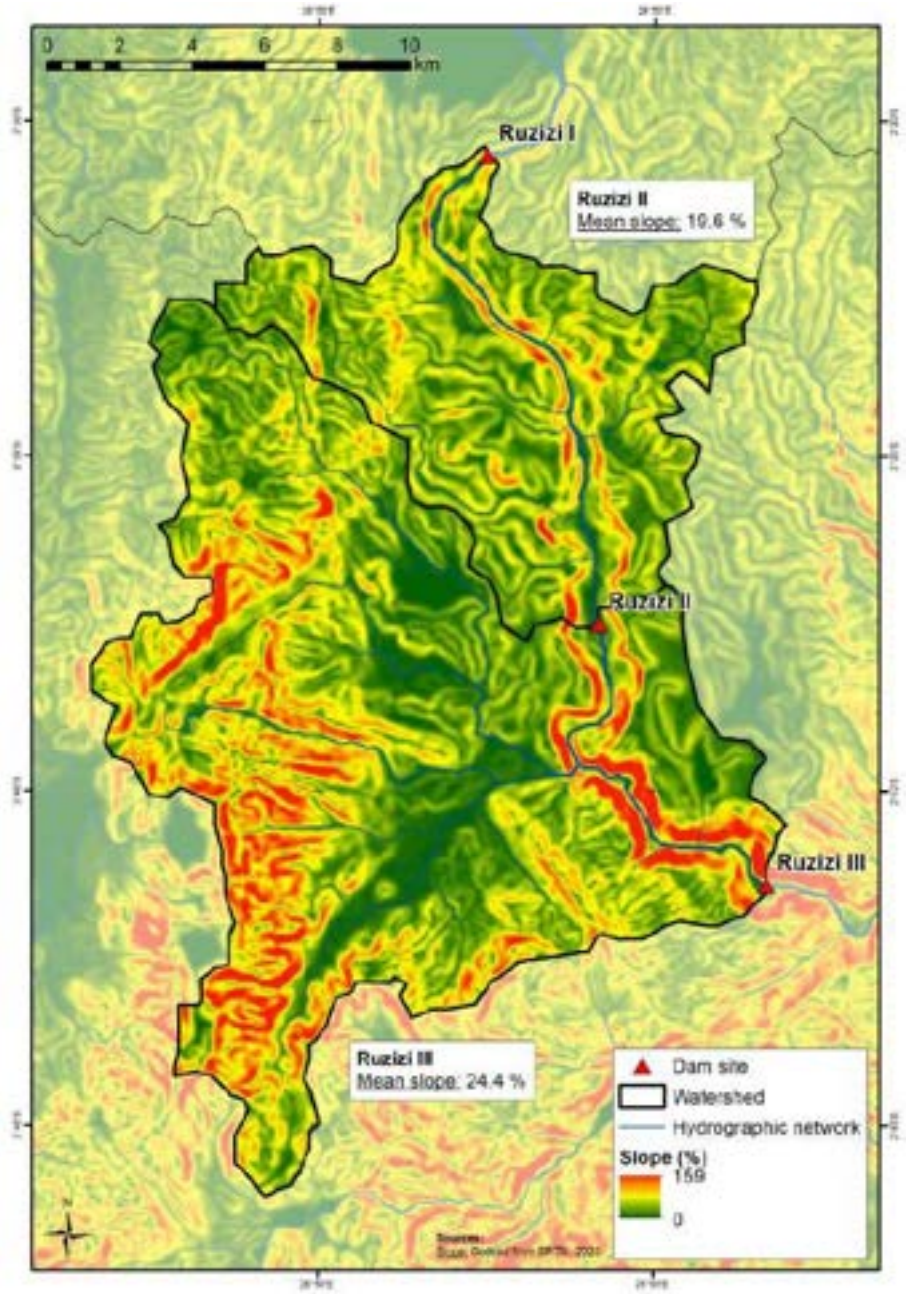
Table 7-1 Landslide characteristics between Ruzizi II and Ruzizi III

Parameters	Data
Number	22
Minimum area (m^2)	428
Maximum area (m^2)	14,049
Average (m^2)	5,350
Total (m^2)	117,703
Source: Tractebel, 2022	

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Source: Tractebel, 2022

Figure 7-12 Slope Risk in the Ruzizi III Inter-basin

7.2.3.4 Interferometry Data and SAR Analysis

In order to detect and characterize any possible slope instability affecting the Project's components, including both reservoirs, an analysis of historical satellite radar images of the area, acquired by the Sentinel-1 (SNT) satellite, from October 2016 to September 2021 was performed by TRE-Altamira. The analysis focused on general slope stability within the defined study area (outlined in red on Figure 7-13) and on areas already identified to be potentially unstable or known to be unstable (approximate areas outlined in navy blue on Figure 7-13).

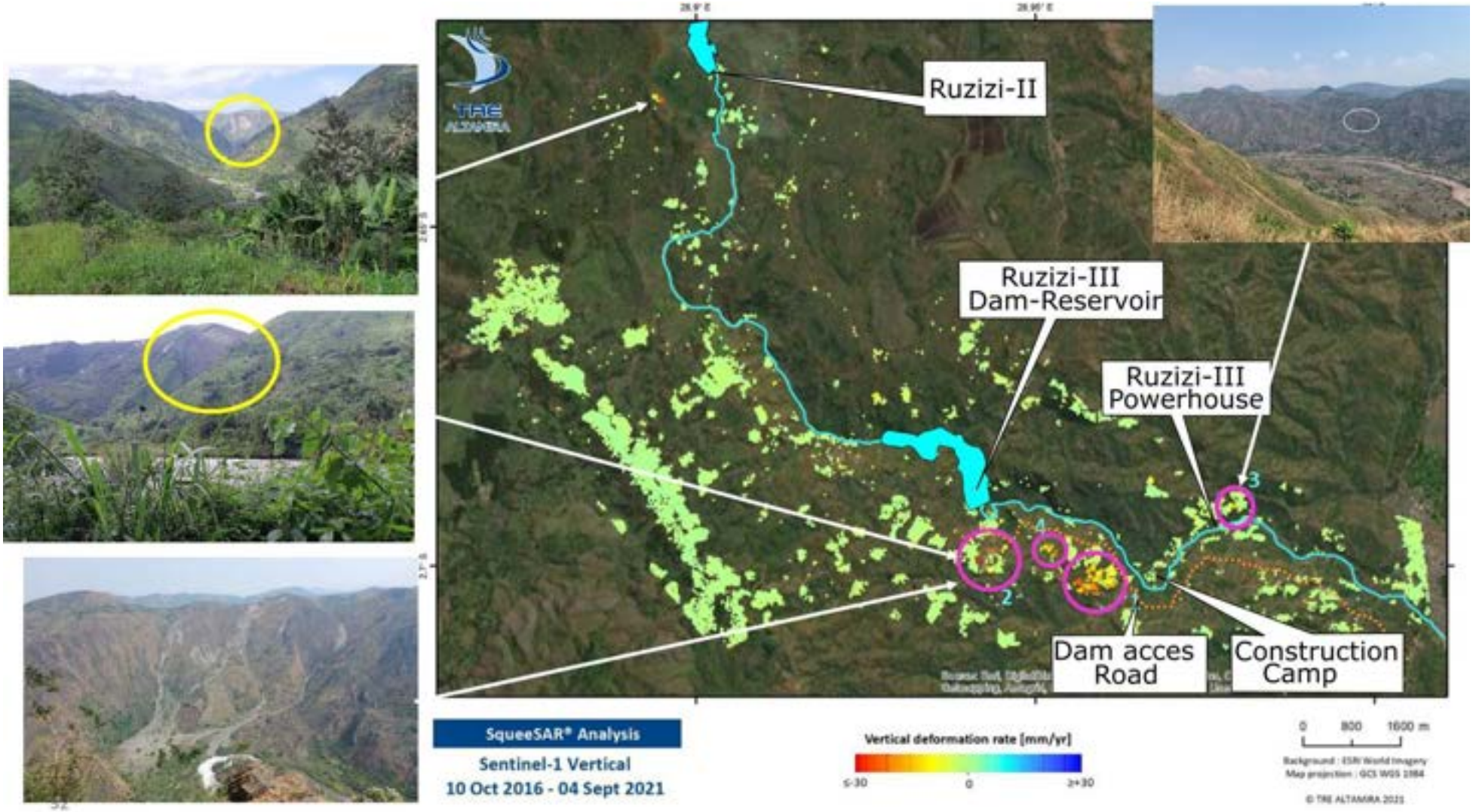
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7.2.3.5 Risk Assessment

As a result, two main deformation areas (1 and 2 on Figure 7-13) have been identified on the South side of the Ruzizi River, downstream of the planned location of the dam. Two secondary deformations (3 and 4 on Figure 7-13) have also been identified. The technical report concludes: (i) Stable slopes at the proposed dam site, (ii) no significant ground displacement upstream the proposed dam site, (iii) unstable slope near the future bridge between Rwanda and DRC (ongoing ground displacement), and (iv) ground displacement in the east of Powerhouse area (likely due to land use).

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Source: TRE Altamira, 2021, modified by SLR

Figure 7-13 – Deformation areas identified on satellite imagery

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View of landslide area n°1



View of landslide area n°2



View of landslide area n°3 (Powerhouse area)

Source: Tractebel, 2021

Figure 7-14 Photographs of Landslide Areas

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7.3 Hydrogeology

7.3.1 Generalities

The information on hydrogeology provided in this subsection is taken from the *Baseline Study for the Basin of Lake Kivu and the Ruzizi River* prepared by SHER Consult for ABAKIR (SHER, 2020).

The basin is characterised by the presence of mostly Precambrian and Phanerozoic indurated terrains, composed of metamorphic rocks (schists, gneiss, quartzite), intrusive magmatic rocks (mainly granitic), and volcanic rocks (mainly basaltic). In addition to these formations constituting the weathered and fissured base present throughout the basin, there are also loose formations consisting of fluvio-lacustrine alluvial deposits from the Quaternary period. These alluvial deposits are mainly found in the Ruzizi plain (middle and lower Ruzizi), as well as in the lower valleys of the most important sub-basins of the study area.

7.3.2 Types of Aquifers

Within these geological formations, four main types of aquifers can be defined in the basin, based on their hydrodynamic properties and aquifer potential:

- Quaternary sedimentary aquifers corresponding to alluvial deposits (fluvio-lacustrine), mainly found in the alluvial plain of the middle and lower Ruzizi. The alluvial plains of secondary rivers can also constitute aquifers in the lower valleys, although their exploitation potential is more limited.
- Superficial aquifers located in the alteration zones of the metamorphic and crystalline Precambrian bedrock (granites, quartzites, gneiss, schists and psammites).
- Discontinuous and deeper aquifers located in fissured zones of metamorphic and crystalline Precambrian bedrock (granites, quartzites, gneisses, shales and psammites).
- Complex aquifers located in the volcanic terrains (basalt, pyroclastic deposits) of the Cenozoic. The Project dam and powerhouse are located in this area.

7.3.3 Aquifer Potential

The most important aquifer potentialities are found in the alluvial aquifer of the Ruzizi plain. This aquifer extends over the whole of the Ruzizi alluvial plain and at the level of the low valleys of its tributaries, over an area of approximately 1,700 km². The thickness of this aquifer can reach 50 to more than 150 m in the Ruzizi plain, and 10 to 30 m in the alluvial deposits of the lower inland valleys.

Groundwater can be mobilised from boreholes, with an expected productivity of more than 10 l/s. This water table is encountered at a shallow depth, often less than 10 m below the ground surface, making it easily accessible from shallow structures. However, it contains high levels of iron and manganese, often exceeding drinking standards.

Interesting potential is also found in granite alteration, which can be particularly water-bearing and provide exploitation rates of up to 5 to 10 l/s from boreholes. Their thickness can reach 100 m. Metamorphic formations offer more limited potential for exploitation, depending on the degree of alteration and cracking encountered, and on the nature of the rock, particularly its clay fraction. The potential for exploitation by drilling is generally more limited, and may not exceed 1 l/sec.

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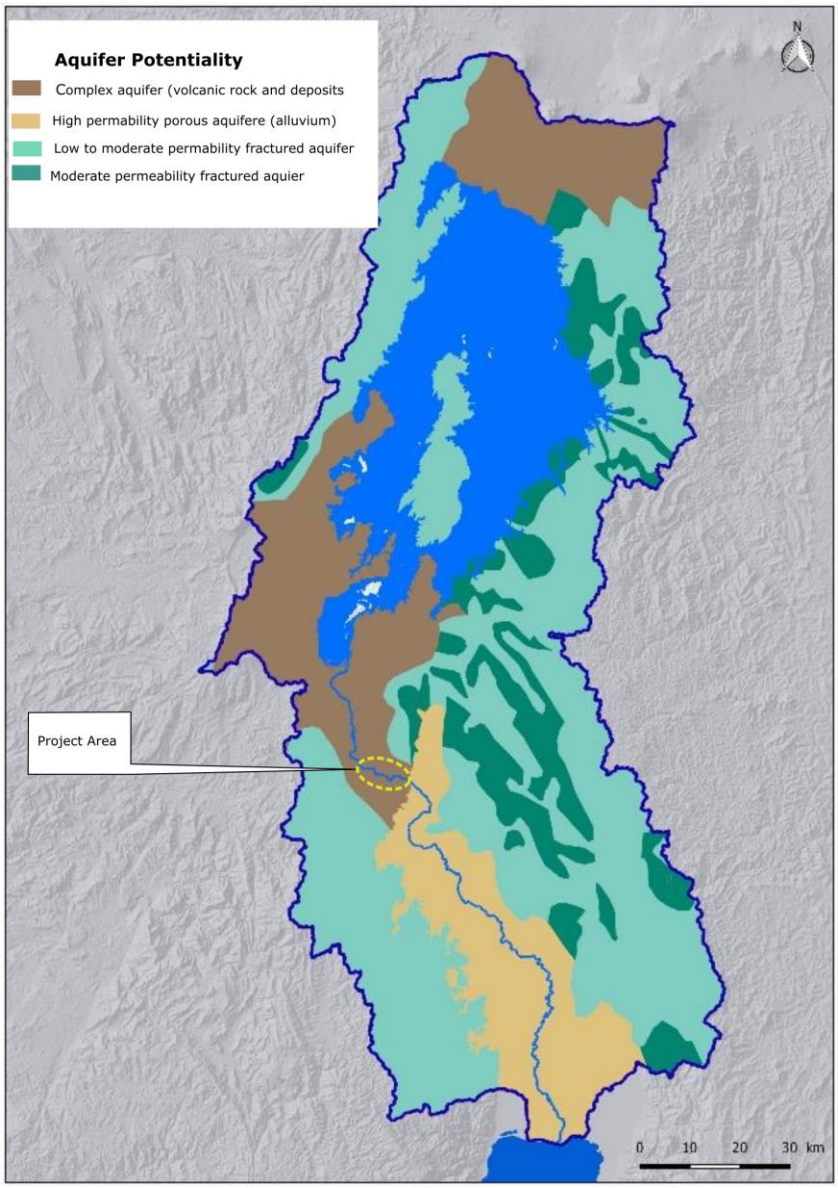
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The aquifer potential of volcanic soils (Cenozoic basalts) is extremely variable and difficult to quantify, as the heterogeneity of this environment is so varied.

7.3.4 Groundwater Exploitation

In the Burundian part of the Ruzizi alluvial plain, there are about fifteen boreholes used for rural hydraulics (IGEBU 2018 inventory). A few boreholes exploiting the aquifers of cracks in the crystalline basement are also identified in the basin, including boreholes in the urban area of Bubanza (granitic context) in Burundi.

Groundwater in the basin is mainly exploited from developed natural springs, mainly for drinking water supply in rural areas. In the Rwandan and Burundian parts of the basin, there are more than 550 springs for drinking water supply, as well as many natural springs (several thousand) that have not been developed but are nevertheless used by local populations without improved access to drinking water. In addition to these, there are also around 70 thermal springs in the basin. An overview of the hydrogeological context, illustrated based on the basin's aquifer potential, is presented in Figure 7-15.



Source: SHER, 2021

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Figure 7-15 Hydrogeological Map of the Lake Kivu and Ruzizi River Basin

7.4 Geomorphology

The river geomorphology has been largely described from high-resolution land-based, satellite and aerial images. The land-based images were captured in 2021 and 2022. The satellite images were available for a range of dates (1985 to 2021) on the GoogleEarth platform which allowed a view of high and low flow conditions and various seasons for the entire length of the river. The aerial images were captured in 2020. This allowed insights into valley confinement, possible flooding extent, the reworking of bars and banks, lateral shifts of the channel, landslides, gully erosion and changes in watercolour which is a proxy for suspended sediment concentration along the main river, tributary streams and river mouth. The descriptions were supported by longitudinal gradient and the geomorphic zones that can be derived from the reach slope and its likely planform, reach type and sediment composition as described by Rowntree and Wadeson (1999). A river longitudinal profile was extracted using Google Earth's elevation model and a river centre line.

7.4.1 General Area Description

The Ruzizi River is located along an active rift zone at the junction between the Kivu and Northern Tanganyika Rift segments of the western branch of the East African Rift System (Seister, 2020; Tractebel, 2021a). The Ruzizi is a relatively young river (~10,000 years old) and formed when volcanic activity blocked the outflow of Lake Kivu northwards to the Nile River, diverting the flow southwards to the Congo River basin (Tractebel, 2021a).

The western branch of the East African Rift System is defined by steep mountains and deep rift valleys (formed by half grabens) with thick sediment fills along the valleys, such as along Lake Kivu (more than 500 m of sediment fill recorded) and the Ruzizi plain approaching Lake Tanganyika (sediment fill of 1,500 m thick) and Lake Tanganyika (sediment fill of up to 3,000 m thick) (Seister, 2020; Tractebel, 2021a).

The Ruzizi River is 168 km long and the first 40 km flows through a steep confined gorge (underlain by volcanic rocks along the upper part followed by schist, quartzites and volcanic intrusions along the lower reach where Ruzizi III will be located) surrounded by steep mountain slopes.

After 40 km the valley opens up, the gradient lowers and the river flows across the broad sedimentary Ruzizi Plain (the floor of the western Rift Valley) (Figure 7-16).

Over the last 50 km the Ruzizi flows along a low gradient floodplain and delta into Lake Tanganyika.

The first 40 km (from Lake Kivu) of the Ruzizi River valley is deeply incised into the surrounding landscape, resulting in steep slopes with no or narrow flood benches/plains lining the river's edge. The river is located along strike-slip faults, tension fractures and tectonic discontinuities with N-S, E-W and NW-SE orientations between the Lake Kivu and the Ruzizi extensional basins, giving the valley floor and river course its zig-zag pattern (Tractebel, 2021a).

The history of the Ruzizi River is characterised by deep excavation, followed by landslides causing temporary damming and sedimentation (Tractebel, 2021a). These events can be observed in the cores that were drilled for the Ruzizi III geotechnical survey. Landslides are a common occurrence, supplying large volumes of sand, silt, rock fragments and large angular rock debris to the lower slopes, floodbenches and river channel. The colluvium on the hillslopes ranges from several metres to more than 20 m thick (Tractebel, 2021a).

Large block accumulations can be up the 10 m thick on the lower hillslopes (Tractebel, 2021a). Along the river the bed consists of a thick (10 -50 m) layer of coarse alluvium

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covered by calcrete (Tractebel, 2021a). Bedrock, indurated alluvium (carbonate cementation forming calcrete) and larger blocks (several cubic meters in volume) form rapids along the river and act as a local base level control (Tractebel, 2021a). Along this steep reach the banks are mostly composed of large rocky material with discontinuous layers of sandy material (Tractebel, 2021a). Large pools are present along gentler longitudinal sections of the river, with sand and gravel bars forming in low energy environments where the channel widens.

Once the Ruzizi River exists the confined gorge, it flows straight across the plain/fan in a southeasterly direction towards the conluence with the Rubyiro and Ruhwa tributaries. The river is partly incised into the plain and has numerous bedrock/cemented steps along its course, with the largest being just upstream of the confluence with the Rubyiro River. From the confluence with the Ruhwa River, the Ruzizi River turns in a southerly direction and flows across the partly incised plain towards Lake Tanganyika via the unconfined active floodplain and delta. These plains are surrounded by steep mountains with a dense drainage network.

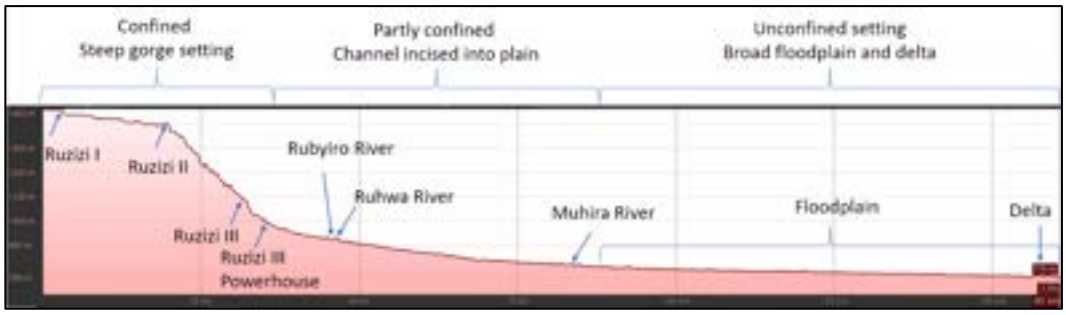


Figure 7-16 Longitudinal profile of the Ruzizi River

Showing the existing and planned hydropower plants and main tributaries (Profile created using Google Earth)

7.4.2 Lake Kivu Outflow to Ruzizi-II Dam

The river gradient is relatively gentle along this reach at 0.0038 m/m and can be classified as a Lower Foothills geomorphological zone (Rowntree and Wadeson, 1999). This zone can be described based on its river gradient as being a mixed bed river with sand and gravel dominating the bed, with localised bedrock controls, forming a pool-rapid sequence with small sections of floodplain (Rowntree and Wadeson, 1999). Based on satellite images this section has long deep pools along lower gradient sections, interspersed by steeper high energy rapids, possibly composed of boulders and bedrock (Figure 7-17). The channel is straight to wandering along the confined valley floor, with the valley floor bending to some degree as it follows geological lineaments. Multiple channels and vegetated bedrock-core islands form along or immediately downstream of the rapid sections. Sediment deposition in the form of bars is not evident from the satellite images, possibly due to the proximity to the outflow of clear water from Lake Kivu and limited lateral sediment input. Agriculture and residential development are widespread along the slopes with some evidence of landslides along steeper hillslopes. Landslides occur along the valley slopes, with 13 landslides mapped with a total area of 16,400 m^2 (Tractebel, 2021b). Debris or alluvial fans are visible along the channel margins.

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Figure 7-17 Geomorphological Features between Lake Kivu Outfall and Ruzizi-II Dam
Satellite imagery showing the confined valley floor, rapid and long pools with a narrow floodplain (Google Earth image date 7/08/2017).

7.4.3 Ruzizi-II to Ruzizi-III Dam Site

The Ruzizi gradient steepens along this reach with an average gradient of 0.0224 m/m and can be categorised as the Transitional geomorphic zone (Rowntree and Wadeson, 1999). Typical characteristics of the Transitional zone is a bedrock and boulder dominated bed with pool-rapid or pool-riffle reach types (Rowntree and Wadeson, 1999). The valley floor is confined with limited floodplain development (Rowntree and Wadeson, 1999). The zonal classification matches the features observed on the satellite images. This steep reach has short pools and long high energy rapids (Figure 7-18). Bedrock, calcrete and large blocky material form the rapids. The channel is relatively straight to wandering and follows the zigzag pattern of the valley floor.

Agriculture is common on the hillslopes and landslide scars suggest sediment contributions directly to the river or tributary channels. A total of 22 landslides with an area of 117,700 m^2 were mapped along the valley margins (Tractebel, 2021b). These features contribute to both fine suspended sediment and coarser bedload material directly to the river network. Sediment deposition is likely on protruding bedrock features forming anastomosing channels, supporting small, vegetated islands. Some small depositional features, such as gravel bars are only visible during very low flows in locations where the channel widens.

Ruzizi II traps most of the coarse bedload sediment from upstream, forming large bars along the top of the reservoir, starving the reach directly downstream of Ruzizi II of sediment. This reach is thus largely starved of bedload sediment from upstream. A larger right bank tributary 4.5 km downstream of Ruzizi II contributes significant volumes of sediment, possibly offsetting some of the sediment trapping by the Ruzizi II reservoir.

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Figure 7-18 Geomorphological Features between Ruzizi-II and Ruzizi-III Dam Sites
Satellite imagery showing the narrow valley floor, steep rapid reach type with limited sediment storage (Google Earth image date 7/08/2017).

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7.4.4 Reach to be Occupied by the Proposed Ruzizi-III Dam and Reservoir

This steep reach can be classified as the Transitional geomorphic zone based on its gradient of 0.0242 m/m. Typical characteristics of the Transitional zone is a bedrock and boulder dominated bed with pool-rapid or pool-riffle reach types (Rowntree and Wadeson, 1999). The valley floor is confined with no or limited floodplain development (Rowntree and Wadeson, 1999). The zonal classification matches the features observed on satellite images. This steep reach has short pools and long rapids, with bedrock, calcrete and large blocky material forming rapids (Figure 7-19). The banks are composed of large blocky material filled with a finer matrix. The relatively straight to wandering channel follows the zigzag pattern of the valley floor.

Widespread agriculture on hillslopes and landslide scars contributes sediment directly to the river or tributary channels. These features contribute to both fine suspended sediment and coarser bedload material forming steep colluvial deposits. Protruding bedrock in the channel form anastomosing channels. Sediment deposition on these islands supports vegetation establishment.



Figure 7-19 Geomorphological Features of the Ruzizi River that will be Inundated
Satellite imagery showing the narrow valley floor, rapids, islands and pool sections (Google Earth imagery date 7/08/2017)

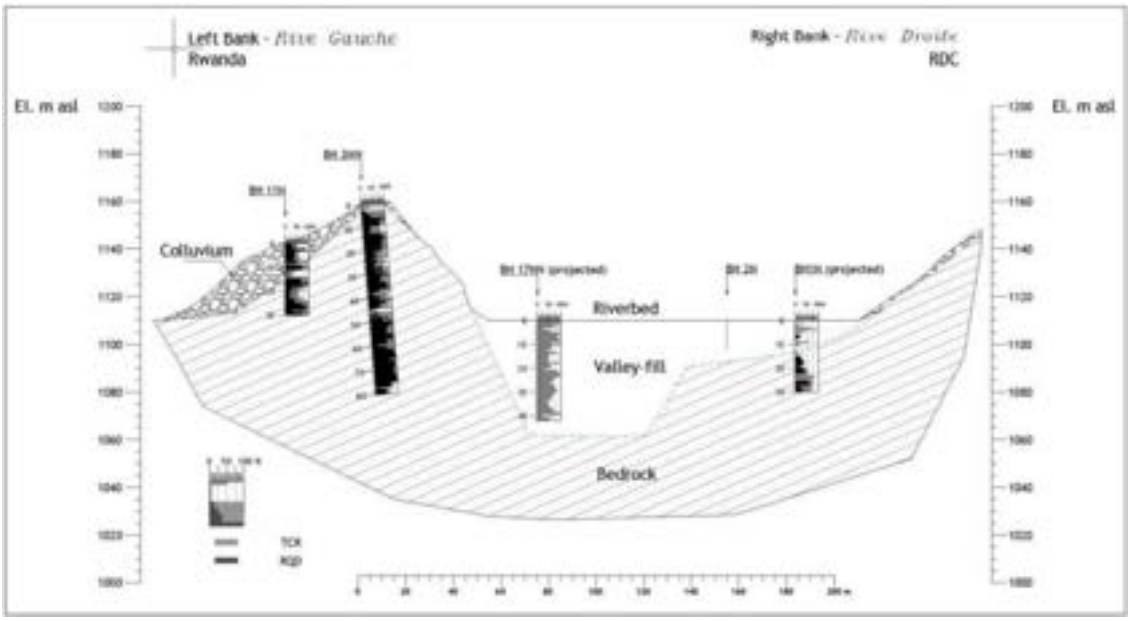
The river bed is composed of a layer of calcrete overlying and binding the deeper coarse-grained alluvium. The alluvium fills a paleo channel to a depth of 40 to 50 m (Figure 7-20; Tractebel, 2021a). The alluvium consists of gravel, cobbles, boulders and sandy layers (Figure 7-21; Tractebel, 2021a). The sandy layers (inorganic silts and fine sands with low plasticity) are associated with periods of damming when landslides block the channel (Tractebel, 2021a). The vertical and lateral variation in alluvial material size can be explained by debris flows, producing layers of large blocky material interspersed by finer material (Tractebel, 2021a). The rapids are formed by bedrock, calcrete and large blocky material that originated from the hillslopes (Tractebel, 2021a).

Modelled flow velocities along this reach are very fast (for a flow of 150 m^3/s) ranging from 0.5 m/s along the deeper pools (~4 m deep) to 5 m/s along steeper shallow sections

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(2 m deep) (Tractebel, 2020a). Limited sediment deposition was observed along this reach due to the narrow valley floor and high energy flow conditions.



Source: Tractebel, 2021a

Figure 7-20 Interpreted Cross-Section Along the Axis of the Ruzizi III dam Wall
TRC = Total Core Recovery, RQO = Rock Quality Designation index.



Figure 7-21 River Bed Alluvium at the Project Dam Site
Cemented Alluvium Exposed on the Bed at the Dam Site (left) and a closeup of a portion of the calcrete layer (right) (Source: Tractebel, 2021a).

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7.4.5 Reach Bypassed by the Ruzizi-III Headrace Tunnel

The Ruzizi River gradient along this reach is 0.0238 m/m and can be classified as falling in the Transitional geomorphological zone. Typical characteristics of the Transitional zone is bedrock and boulder dominated river bed with pool-rapid or pool-riffle reach types (Rowntree and Wadeson, 1999).

The valley floor is confined with limited floodplain development (Rowntree and Wadeson, 1999). The zonal classification matches the features observed on the satellite images (Figure 7-22). This steep reach has mostly short pools (except one long pool) and long rapids. The calcrete/bedrock and large blocky material form rapids Figure 7-22(). The banks are composed of large blocky material filled with a finer matrix. The channel is relatively straight to wandering and follows the abrupt bends of the valley floor.

Agriculture is widespread on the hillslopes and landslide scars suggest sediment input directly to the river or tributary channels.

There is a large right bank tributary (3.2 km downstream of the dam location; just upstream of the Manda monitoring site; Lat -2.700657°; Long 28.964259°) supplying significant sediment volumes to this reach (frequent blanket sediment deposits and channel avulsions on the tributary fan can be seen on satellite images). These features contribute both fine suspended sediment and coarser bedload material to the channel. Small bedrock islands form anastomosing channels. Sediment deposition on these islands supports vegetation establishment.



Figure 7-22 Geomorphological Features of the Ruzizi River in the Dewatered Reach
Satellite imagery showing the narrow valley setting, pool-rapid reach type and widespread agriculture (Google Earth image date 17/08/2020)

The modelled hydraulic output shows the flow velocities are very fast (for flow of 150 m^3/s) ranging from 0.5 m/s along deeper pools (4 – 5 m deep) to 5 m/s along steep shallow sections (2 m deep) (Tractebel, 2020a). Velocities and depths increase for higher discharges, but velocities are competent to mobilise a range of finer bedload sediment, resulting in limited sediment deposition along this reach.

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7.4.6 Ruzizi-III Powerhouse to the confluence with the Ruhwa River

Along this reach, the gradient of the Ruzizi River becomes gentler (0.0059 m/m) and can be classified as the Upper Foothills geomorphological zone. Rowntree and Wadeson (1999) describe this zone as moderately steep with a mixed cobble bed channel supporting pool-rapid and pool-riffle reach types. A narrow floodplain of sand, gravel and cobble can be present.

This description is accurate for this reach despite the transition from the confined valley setting (first two kilometres) to a partly confined plain setting along the plain. The river morphology alternates between shorter pools, rapids and riffles, with fewer pools along the lower sections (Figure 7-23).

The bed elevation is controlled by bedrock/calcrete and larger immobile rocks (Figure 7-24). Islands form where calcrete protrude from the channel floor or larger immobile sediment is deposited. Sediment deposition on these features supports vegetation. The river course is relatively straight across the plain to the confluence with the Rubyiro and Ruhwa Rivers with a narrow floodplain (~100 m wide).

The river and narrow floodplain are incised into the surrounding plain (5 to 10 m based on the SRTM dataset). The banks are composed of coarser alluvial material filled with sandy and clayey material. The banks appear well-vegetated and relatively stable on satellite images despite the fluctuating water levels from Ruzizi II releases, but localised bank erosion has been observed along agricultural fields. It is not clear if the localised bank erosion is due to vegetation clearing (associated with floodplain agriculture) or fluctuating water levels, but possibly driven by both processes.

Agriculture is common on the steep hillslopes, floodplains and surrounding plains, contributing fine sediment to the channel. Most of the tributaries are small and drain the local slopes along the confined upper section. Two large tributaries (Rubyiro and Ruhwa) contribute significant flow and sediment from the northern parts of the drainage basin. The Ruhwa appears more laterally active and turbid on satellite images and shows evidence of transporting and storing large quantities of sand and gravel.



Figure 7-23 Geomorphological Features of the Ruzizi Plain
Satellite imagery showing the narrow floodplain and rapid riffle habitat types (Google Earth image date 27/08/2020)

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Figure 7-24 Cemented Coarse Alluvium and Calcrete at the Kamanyola Incompleted Bridge Source: Tractebel, 2021a).

The modelled hydraulic results for the confined section shows very fast flow velocities (for a flow of 150 m^3/s) ranging from 0.8 m/s along deeper pools (~3 m deep) to 2.5 m/s along steep shallow sections (~2 m deep) (Tractebel, 2020a).

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7.4.7 Tributaries & Sediment Input in the Ruzizi Downstream from the Project

The Ruzizi River downstream of the Ruhwa River confluence flows across the gently sloping Ruzizi Plain towards Lake Tanganyika (Figure 7-25). The plains are surrounded by steep mountains along both sides and drained by tributaries with well-developed drainage networks. The valley floor and steep hillslopes (sides of the Rift valley) are largely used for agriculture, unless within a protected area such as the Nyungwe Forest National Park or Kibira National Park. The land cover is poor on the cultivated lands, driving increased soil erosion (SHER Consult, 2020). Soil erosion is very high for large areas of the Ruzizi River basin (SHER Consult, 2020). A USLE based model predicts 91 t/ha/year on average, with significant inputs from tributaries, such as the Muhira and Nyamagana Rivers with rates of 108 t/ha/year for their respective catchments (SHER Consult, 2020). Predictions for the undisturbed forests, such as the Nyungwe-Kibira Forest, is very low due to the good vegetation cover (SHER Consult, 2020). The steep hillslopes are well connected to the drainage network, enhancing sediment delivery to the Ruzizi River.



Figure 7-25 Geomorphological Features of the Ruzizi Plain
Flanked by steep mountains and the location of several large tributaries with significant sediment loads (indicated by the white arrows)

Satellite images for these tributaries suggest that sediment eroded from the various catchments are effectively transported to the Ruzizi River without significant sediment buffers, such as wetlands, floodplains or lakes along the river courses. Sediment input from these tributaries includes fine suspended sediment, as evident in the highly turbid Ruhwa River, and bedload as seen along the Muhira River (braided channel pattern with large sediment bars; Figure 7-26). Many of the tributaries appear to have higher turbidity compared to the Ruzizi mainstem, indicating that suspended sediment concentrations increase in a downstream direction. The bedload along these tributaries will be mobilised during higher flows and injected into the Ruzizi River.

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Figure 7-26 Tributaries Bringing Sediment to the Ruzizi
Satellite imagery showing contributing significant volumes of sediment to the Ruzizi River (flow direction of the Ruzizi indicated with blue arrows)

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Other direct sources of sediment along the Ruzizi include landslides and gully erosion along the channel margin (Figure 7-27). In Figure 7-27 it can be seen that the landslides inject sediment directly into the Ruzizi River (suspended and bedload sediment), whereas the sediment eroded by the gully is deposited as a fan, storing most of the coarser bedload on the floodplain. Input from the gully will be largely in the form of finer suspended sediment. Limited bank erosion is taking place along the riverbanks of the Ruzizi, and is largely located along a single bank, suggesting that the channel is not actively expanding laterally (bank erosion along both banks).

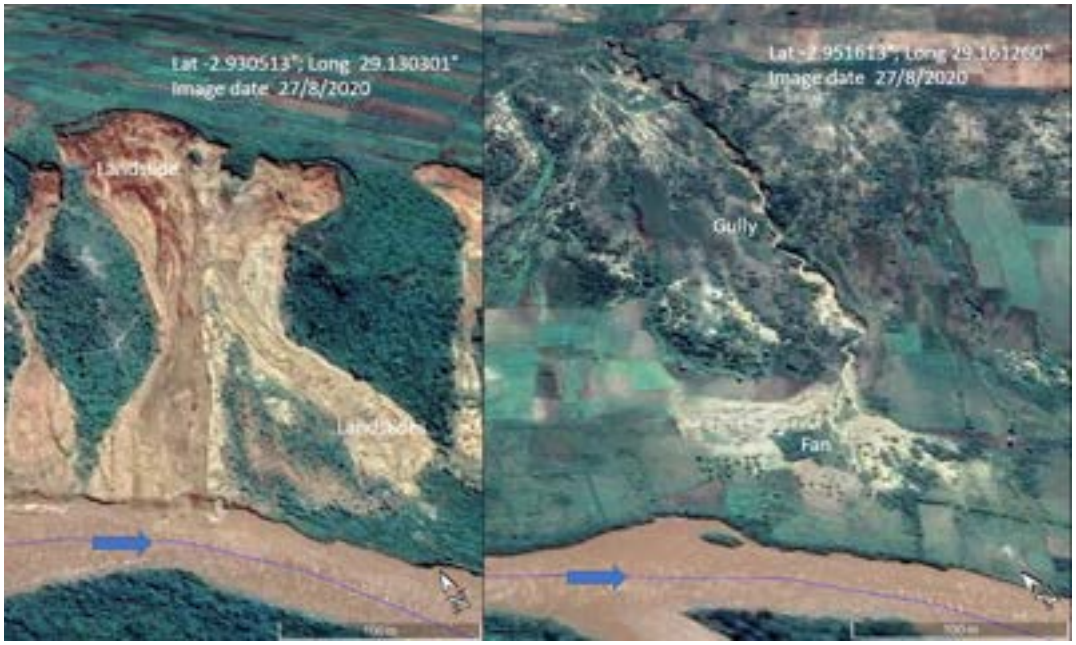


Figure 7-27 Landslides and Gully Erosion Along the Ruzizi River
(Google Earth images)

The Ruzizi River mouth shows high suspended sediment concentrations for the available satellite images from 1985 to 2021 (Figure 7-28). The delta has also expanded continuously over this period supporting the notion that sediment loads are high despite sediment trapping by Ruzizi I and Ruzizi II. These sediment contributions are largely from the Ruhwa River and downstream tributaries.

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Figure 7-28 Ruzizi River Delta Development from 1985 to 2021
Satellite imagery, the blue line is the modern river centre line and is static for all images

7.4.8 Estimate of Sediment Loading in the Ruzizi River at the Ruzizi-III dam Site

The information provided in the following paragraphs is taken from the Project's Feasibility Study and specifically the Sediment Management Study (Tractebel, 2022). The Sediment Management Study has cited information from the Project's 2010 Feasibility Study (Fichtner, 2010), Sediment studies for Ruzizi-I and -II (Studio Petrangeli, 2013a and 2013b) and suspended sediment measurements by Tiger Engineering Company (2020).

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7.4.8.1 Sediment Inflow from Lake Kivu

Lake Kivu acts as a large sediment trap and the outflow has a very very low suspended sediment concentration. It has therefore been assessed that there is negligible inflow of sediment into the Ruzizi River from Lake Kivu.

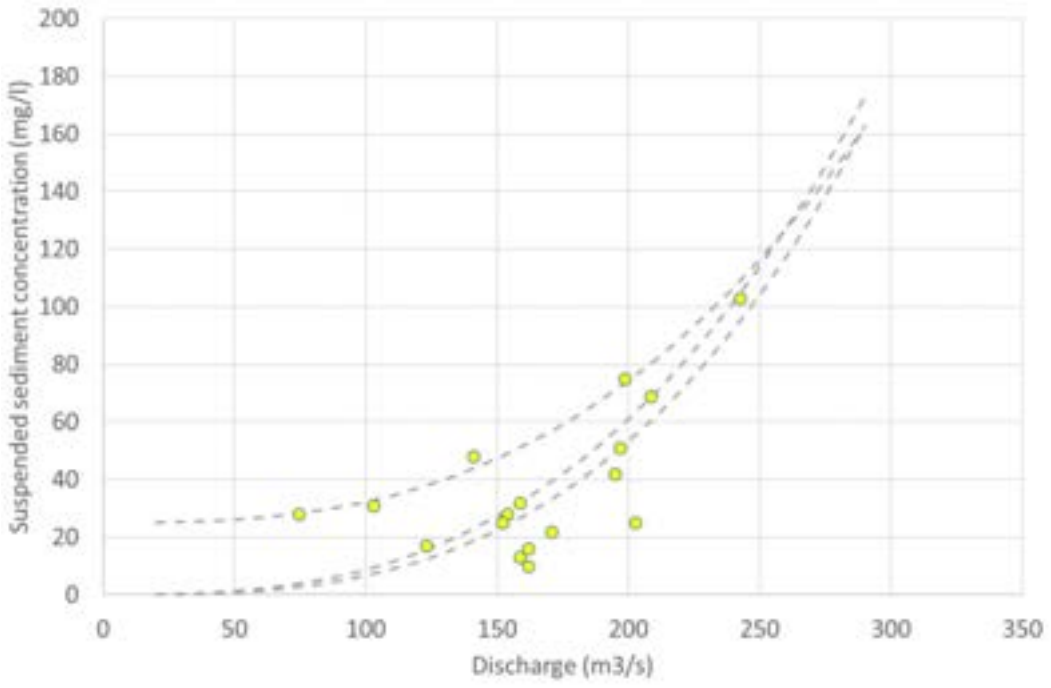
7.4.8.2 Measurement of Suspended Sediment Concentration in the Ruzizi River

Suspended sediment in the Ruzizi River at the Ruzizi-III dam site was measured in November 2020 (Tiger Engineering Company, 2020). A total of 21 samples were collected, each taken from 4 depths, and river flow rates were recorded using an Acoustic Doppler Control Profiler. The suspended solids concentrations are provided in Table 7-2.

Three regression laws were established to show the relationship between river flow rate and suspended solids concentration (see Figure 7-29).

Table 7-2 Suspended Sediment Concentrations at the Ruzizi III Dam Site

Date	Suspended Solids Concentration (mg/l)	River flow rate (m3/s)	Date	Suspended Solids Concentration (mg/l)	River flow rate (m3/s)
7 Nov. 2020	28	153.7	11 Nov.	32	158.7
7 Nov.	31	102.9	11 Nov.	28	74.5
7 Nov.	25	202.5	15 Nov.	48	140.9
8 Nov.	13	158.7	15 Nov.	74	76.6
8 Nov.	16	162.0	15 Nov.	103	242.5
8 Nov.	25	152.0	15 Nov.	75	198.6
10 Nov.	22	170.7	16 Nov.	42	194.7
10 Nov.	17	123.0	16 Nov.	69	208.5
11 Nov.	10	162.0	16 Nov.	51	196.7
Source: (Tiger Engineering Company, 2020)					



Source: (Tractebel, 2022)

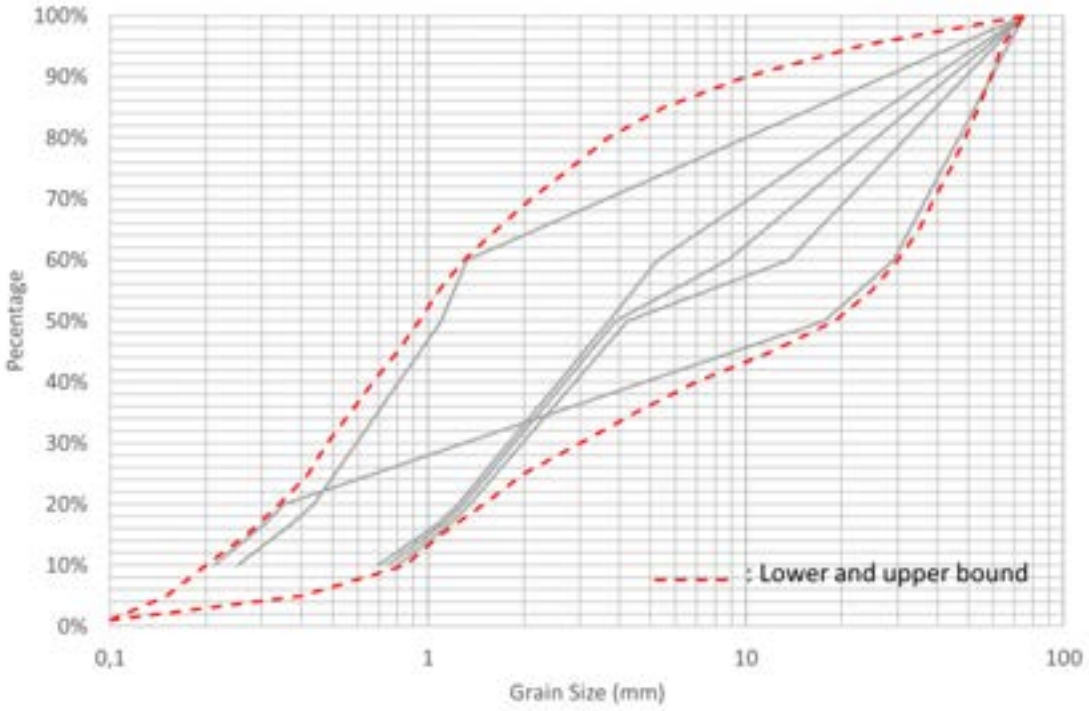
Figure 7-29 Regression Laws between Suspended Sediment Concentrations and River Flow Rate

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7.4.8.3 Measurement of Bedload Sediment Particle Size Distribution

Five bedload samples were taken, and particle size distribution determined. The distribution is representative of sands and gravels with some small cobbles. The particle size distribution is shown in Figure 7-30.



Source: (Tractebel, 2022)
Figure 7-30 Particle Size Distributions for Bedload at Ruzizi-III Dam Site

7.4.8.4 Assessment of Sediment Load

A **Suspended Sediment**

The long-term suspended sediment load was calculated using the hourly river flow time series for the period 1989-2008 (20 years) and the regression laws between suspended sediment concentration and river flow rate (see Figure 7-29).

It has been computed that the annual load varies in the range of 22,700 to 78,800 tonnes/year, with a mean annual value of 44,500 tonnes.

B **Bedload**

The bedload was assessed using the ratio between suspended load and bedload, using the empirical formula developed by P.Y. Julien (2010) and Van Rijn (1993). For the conditions at the Ruzizi III dam site, the empirical formula predicts that bedload and suspended load are equivalent, i.e. the annual load varies in the range of 22,700 to 78,800 tonnes/year, with a mean annual value of 44,500 tonnes.

C **Overall Sediment Load**

The overall sediment load is predicted to be between 45,400 to 157,600 tonnes per year with a mean annual value of 89,000 tonnes.

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7.4.8.5 Contribution from Landslides

The assessment of landslide contribution to the sediment load of the Ruzizi River was computed using the empirical relationship between the landslide area (A) and the volume of materials (V) developed by Guzetti et al (2009).

$$V\ (m^3) = k.A^{\alpha}$$

With k = 0.074 and α = 1.45

The potential contribution of landslides is presented in Table 7-3 and the location of the landslide areas shown in Figure 7-31.

Table 7-3 Potential Sediment Contribution of Landslides using Guzetti et al Empirical Formula

Landslide ID	Area (m^2)	Contribution Volume between 2010 and 2020 (m^3)	Landslide ID	Area (m^2)	Contribution Volume between 2010 and 2020 (m^3)
1	12,911	67,628	12	3,779	11,387
2	14,049	76,439	13	428	484
3	3,621	10,704	14	1,992	-
4	3,245	9,130	15	6,379	18,245
5	8,375	36,104	16	4,858	16,391
6	4,248	13,493	17	3,834	11,629
7	2,389	5,623	18	1,346	2,549
8	4,186	11,491	19	3,466	-
9	13,267	58,389	20	4,511	-
10	3,798	11,471	21	7,952	-
11	3,459	10,016	22	5,610	20,194
Note: Values show the results of a diachronic analysis to assess the contribution over a 10-year period between July 2010 and September 2020 by comparison of satellite images					
Source: Tractebel (2022)					



Source: (Tractebel, 2022)

Figure 7-31 Locations of Landslide Areas between Ruzizi-II and -III

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7.5 Water Quality

The information provided in the following paragraphs is taken from the *Baseline Study for the Basin of Lake Kivu and the Ruzizi River* prepared by SHER Consult for ABAKIR (SHER, 2020).

7.5.1 Generalities

The major problem in relation to surface water quality is the massive erosion observed in the basin, with an average soil loss value of around 100 t/ha/year in the basin. This erosion generates extremely high and widespread turbidity in most of the basin's watercourses. The phenomena of sediment transport in the watercourses and sediment accumulation, which are associated with the extreme turbidity observed, constitute the major problem facing the basin.

In addition to the alteration of surface water quality due to erosion and the massive transport of sediment to the rivers and Lake Kivu, the water resources of the basin are also threatened by various forms of pollution linked to urbanisation and industrialisation, especially in large cities such as Bukavu or Goma. Other threats to the quality of the basin's water resources come mainly from mining and industrial discharges. On the agricultural level, although the use of chemical fertilisers and phytosanitary products is globally moderate in the basin, their use may be locally more significant (especially in large farms in the Ruzizi plain) and may lead to surface and groundwater pollution in this area.

7.5.2 Lake Kivu and its catchment area

The water in Lake Kivu is of the soda-magnesian carbonate type, low in calcium and rich in potassium. The pH of the water is very high at the surface, with values of the order of 9, and decreases at depth tending towards neutralisation.

The waters of Lake Kivu are influenced by the salt content of the volcanic lava in the region and show consistent concentrations of soluble cations and anions that increase with depth. Electrical conductivity and concentrations of major elements are relatively high at the surface of the lake, with electrical conductivity values of the order of 1,000 to 1,500 µS/cm and a salinity of the order of 1 g/l. Due to the permanent stratification of the lake and the existence of thermal springs at the bottom of the lake, these values increase with depth. Nitrates and nitrites become less abundant at depth, but phosphates are much more abundant than at the surface.

Very little data on the physicochemical quality of Lake Kivu is available, and the same is true for the rivers that form part of its catchment area: regular monitoring of the water quality (physico-chemical, bacteriological, biological) of the lake and its tributaries is very limited to date, with the exception of the data from Rwanda, which is included in the Rwanda Water Portal. Data from nine stations are thus available for Rwanda in the Lake Kivu watershed, six stations in rivers and three on the shore of the lake.

Table 7-4 overleaf shows the average measured values of pH, electrical conductivity, dissolved oxygen and turbidity for the three Lake Kivu stations with data. A generally basic pH and a high electrical conductivity exceeding 1,000 µS/cm are observed.

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Table 7-4 Water Quality of Lake Kivu

Parameter	Unit	City of Rubavu	Bralirwa	City of Kibuye
pH	-	9.1	8.8	7.5
Conductivity	µS/cm	1,751	1,708	1,180
Dissolved Oxygen	mg/l	6.5	2.3	7.4
Turbidity	NTU	25	22	6
Source: SHER, 2020				

7.5.3 The Ruzizi River and its Tributaries

The hydrography of the Ruzizi plain is dominated by the Ruzizi River and its tributaries. The chemical composition of the water of the Ruzizi River is complex because it changes as a result of the contributions of its tributaries. The water quality of these rivers is controlled by the type of soil, geology and anthropological activities in the catchment area. The latter are a major source of environmental pollution and can cause a significant impact on public health.

In its upper course, in addition to the waters of the lake, the Ruzizi River collects the high salinity waters from the volcanic regions of South Kivu and the waters of the thermal springs. The Ruzizi River retains in its upper course many of the physicochemical characteristics of the water of Lake Kivu: pH close to 9, electrical conductivity of around 1000 µS/cm, high ionic concentrations (above 1 g/l), and low Ca/Mg ratio. Phosphates are observed in non-negligible quantities, while nitrate and nitrite concentrations are very low.

After crossing the volcanic areas and entering the plain, the salinity decreases from upstream to downstream, an effect due to the dilution by the tributaries of the low salinity Moyenne Ruzizi. The water of the Ruzizi is diluted along its course by the contribution of the waters of the tributaries, which are milder and much less mineralised. However, there is an increase in sulphates from upstream to downstream, which are thought to originate in the areas crossed by the Ruzizi and in the thermo-mineral springs located in the plain.

The water of the Ruzizi River shows strong seasonal variations in mineralisation, with the highest values being reached in the dry season. Indeed, in the rainy season, the inputs of low mineralised water from the tributaries of the Ruzizi River are more important and this results in a stronger dilution of the highly mineralised water coming from Lake Kivu.

The tributaries of the Ruzizi show, overall, pH values close to neutrality, and a very low electrical conductivity (rarely exceeding 200 µS/cm). The major ions are also present in low concentrations compared to the Ruzizi.

The primary source of the salinity of the Ruzizi River and the soils of the Ruzizi plain would therefore be linked to the volcanism of Kivu and the hydrothermalism of its watershed. Appreciable quantities of cations (Na, K, Mg and Ca) would come from the alteration of volcanic rocks. As for the anionic constituents, the primary source of the CO_3^{2-}/HCO_3^- would be the atmosphere while the ions $Cl^-$and SO_4^{2-} and part of the carbonates would be of hydrothermal and volcanic origin. Sulphates would also come from active hydrothermalism in the rift of Lake Tanganyika. Large quantities of ions are poured into the Ruzizi and eventually reach Lake Tanganyika.

As the waters of the Ruzizi are in equilibrium with the water table of the Ruzizi plain, salts diffuse into the soil profile and are brought back into the surface layers by capillary rise. In the event of overflow during the rainy season, the soil becomes impregnated with salts and, in the dry season, the salts are brought to the surface by evapo-concentration. Factors such as the topography, the proximity of the lake, the semi-arid climate and poorly managed irrigation would facilitate the concentration of salts in the soils in Lower Ruzizi.

Ultimately, the Ruzizi would have the role of transporting ions whose primary source would be the meteoric alteration of basic rocks, hydrothermalism and the recent volcanism of South Kivu. Their accumulation in the soils of the Ruzizi plain would be

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accentuated by the combined effect of climate, topography and the proximity of the lake. The soils of the Ruzizi delta, due to its proximity to Lake Tanganyika, would be under the direct influence of the lake's waters and would receive, in addition to salts from the volcanism of South Kivu, salts from the sub-lacustrine hydrothermalism of Tanganyika.

In order to estimate the impact of anthropogenic activities on the surface water environment, a study of the water quality (physicochemical and bacteriological parameters) of the Ruzizi River and its major tributaries was carried out in 2018 (SMEC, 2018). The results of this study highlight the following elements of surface water quality for the Ruzizi River and its tributaries:

- Very high turbidity, with measured values generally between 300 and 1,000 NTU, regularly exceeding this high value.
- Very locally high values of Phosphates, Chlorides and Ammonium, without this problem being significant on the scale of the basin and the main sub-basins.
- High concentrations of iron and manganese.
- Dissolved oxygen in freshwater quality standards, generally in the range 4-9 mg/l.
- Generalised and very high bacteriological contamination (total coliforms and E-Coli).

Apart from this one-off study, very little data is available on the physicochemical quality of the rivers in the Ruzizi catchment area: regular monitoring of water quality (physicochemical, bacteriological, biological) is very limited to date, with the exception of the data from Rwanda, which is included in the Rwanda Water Portal. Data from four stations are thus available for Rwanda in the Ruzizi catchment area. Table 7-5 below shows the average measured values of pH, electrical conductivity, dissolved oxygen and turbidity for the four river stations. A basic to neutral pH and high turbidity are observed in relation to the very significant erosion phenomena that characterise most of the sub-basins in the area.

Table 7-5 Water Quality in the Ruzizi Basin

Parameter	Unit	Ruzizi River upstream	Kamanyola River	Rubyiro River	Ruhwa River
pH	-	7.4	6.7	8.7	7.0
Conductivity	µS/cm	-	575	200	66
Dissolved Oxygen	mg/l	-	7	6.7	7.7
Turbidity	NTU	-	380	440	455
Source: SHER, 2020 (using data from Rwanda Water Portal)					

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7.6 Hydrology

7.6.1 Introduction

The hydrological baseline assessment includes the following components:

- An assessment of the monthly inflows to Ruzizi III and study area inflows including: i) intervening catchment inflows between Ruzizi II and Ruzizi III; ii) Rubyiro River inflows; and iii) Ruhwa River inflows.
- An assessment of the study area hydrology including: i) observed water level variations at the Kamanyola (Bugarama Bridge) water level monitoring station; and ii) modelled hydrological / hydraulic characteristics for the "Ruzizi III Reach" between the proposed dam wall and powerhouse locations, and the "Ruzizi II – Burundi Border Reach". The "Ruzizi III Reach" represents the proposed future "dewatered reach" and as such an analysis of reach area, depths, velocities, shear stress, and hazard is presented for the current range of observed flows (i.e., from 10 m^3/s to 160 m^3/s). The "Ruzizi II – Burundi Border Reach" represents the current study area (upstream of Burundi) that is subject to hydropeaking effects, and as such an analysis of variation in flow and level, and ramp-up and ramp-down rates, for selected key locations along the reach is presented.
- A summary of flood risk at the proposed Ruzizi III dam wall location, with a primary focus on extreme flood events (the 10,000-year return period design flood and the 100,000-year return period check flood).

Table 7-6 provides a summary of the catchment areas in the Ruzizi III study area. It can be seen that a significant proportion of the catchment upstream of Ruzizi III (7,687 km^2) is controlled by the Lake Kivu outlet (7,329 km^2, or 95%). The total catchment area to the Burundi border – including the River Ruhwa catchment – is 8,687 km^2, which includes the River Rubyiro catchment (350 km^2, or 4% of the total catchment) and the River Ruhwa catchment itself (618 km^2, or 7% of the total catchment).

Table 7-6 Summary of Ruzizi III Catchment Areas

Description	Cumulative catchment area (km^2)	Intervening catchment area (km^2)
Lake Kivu outlet	7,329	
Ruzizi II (4.8 km upstream intervening catchment)	7,471	142
Ruzizi catchment upstream of right-bank 'intervening catchment'	7,480	9
Right-bank intervening catchment (between Ruzizi II and Ruzizi III)	177	
Ruzizi III (7.2 km downstream intervening catchment)	7,687	30
Ruzizi catchment to upstream River Rubyiro	7,718	31
River Rubyiro catchment	350	
Ruzizi catchment to upstream River Rubyiro	8,069	1
River Ruhwa	618	
Ruzizi catchment to Burundi border	8,687	

Figure 7-32 overleaf illustrates the location of Ruzizi III and the contributing catchment areas.

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Figure 7-32 Ruzizi III and Contributing Catchments

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7.6.2 Monthly Inflows

7.6.2.1 Introduction

The monthly inflows to Ruzizi III are determined by both the outflow from Lake Kivu and inflows in the intervening catchment area between the Lake Kivu outlet and the Ruzizi III dam wall site. Outflows from Lake Kivu, and how such outflows vary with the long-term variation in lake water level, are by far the most significant contributor to Ruzizi II inflows.

Many studies have been undertaken to estimate outflows from Lake Kivu. Of particular interest is the 'Hydrology and Sedimentation Review' undertaken in 2020 as part of the Ruzizi III Feasibility Study, a 'Baseline Study for the Basin of Lake Kivu and the Ruzizi River' undertaken in 2020 for ABAKIR, and a study undertaken in 2014 modelling Lake Kivu water level variations over the period 1941 – 2011 (Muvungja et al, 2014).

These studies suggest that the long-term outflow from Lake Kivu is approximately 71 – 86 m^3/s, but that a more recent average outflow (for the period 2010 – 2018) may be as high as 106 m^3/s. It is suggested that this recent change may reflect land-use change in the Lake Kivu catchment. However, this difference may also be attributable to long-term cyclical behaviour observed in Lake Kivu (and East African lakes in general) and hydrological / hydro-meteorological dataset uncertainty associated with a sparse data network.

7.6.2.2 Feasibility Study Analysis (2020)

The 'Hydrology and Sedimentation Review' (Tractebel, February 2020) presents the analysis undertaken to derive estimates of long-term inflows to Ruzizi III. It includes a review of previous studies undertaken in 2010 (Fichtner Feasibility Study) and 2016 (Tractebel Due Diligence Review) and presentation of hydro-meteorological datasets including Lake Kivu and Lake Victoria water level variation (1950-2016). No analysis was undertaken to assess inflows for tributaries downstream of Ruzizi III.

A water balance modelling approach has been applied to estimate outflows from Lake Kivu, based on direct lake precipitation and evaporation, and precipitation over the catchment draining to Lake Kivu.

$$Q_{in}^{sim} = (P - E) \cdot A_{Lake} + \varphi \cdot P \cdot (A_{RB} - A_{Lake})$$

The model was calibrated against historical estimates of lake inflow for the periods 1950 – 1960 and 1989 - 2006, itself derived from observed lake water levels and outflows based on operation of Ruzizi I.

$$Q_{in}^{obs} = \Delta H_{Lake}^{obs} \cdot A_{Lake} + Q_{out}^{obs}$$

Precipitation and evaporation datasets (1901-2018) are from the University of East Anglia's Climate Research Unit (CRU)[2]. A mask of the Lake Kivu catchment area has been used to define the spatial extent of the precipitation dataset, evapotranspiration data is obtained from 0.5 ° raster cells located over Lake Kivu.

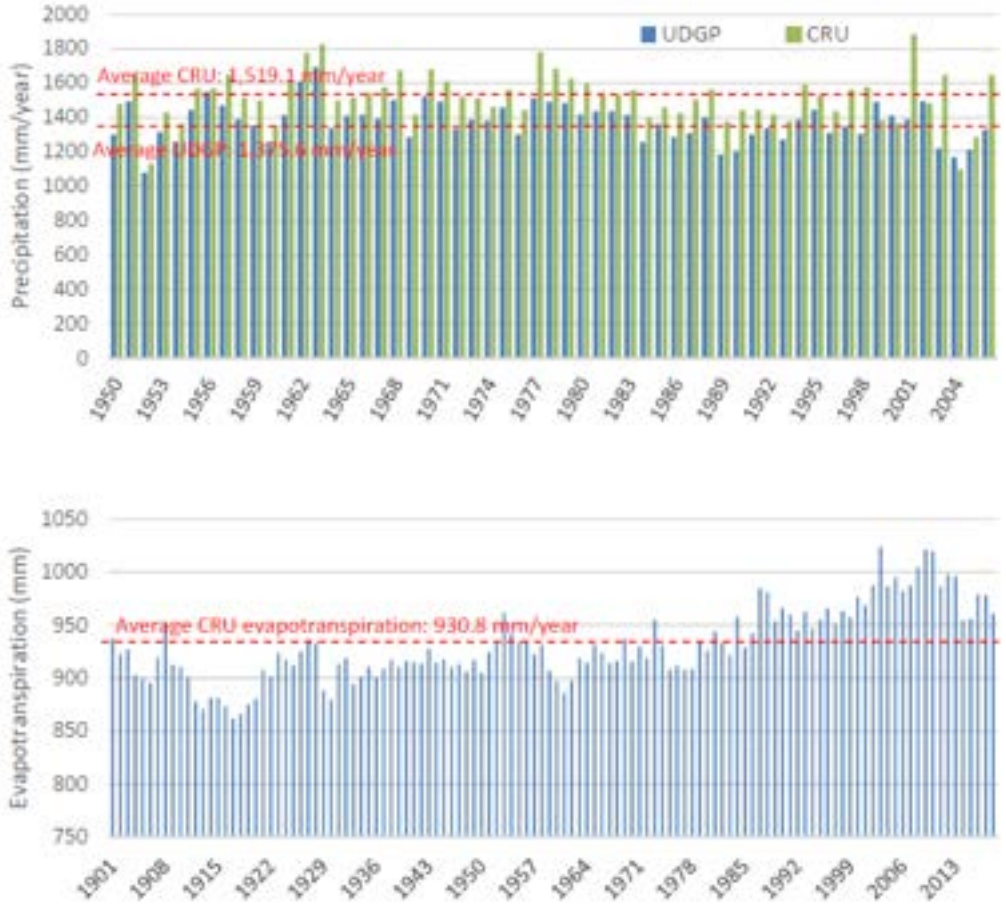
Annual precipitation (1950-2006) and evapotranspiration (1901-2018) are shown in Figure 7-33[3]. This shows a long-term average precipitation of 1519 mm/year and a long-term average evapotranspiration of 931 mm/year. The comparison of precipitation data shows that the CRU LTA is approximately 10% higher than the UDGP LTA, the evapotranspiration

[2] The CRU rainfall dataset contained a number of identified inconsistencies for the period 2009-2018. These values have been replaced with data from the CHIPS dataset.
[3] The annual average rainfall data is shown alongside UDGP rainfall that was used in the 2010 Feasibility Study.

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data shows a clear upward trend dating from the mid-1970s through to approximately 2010.



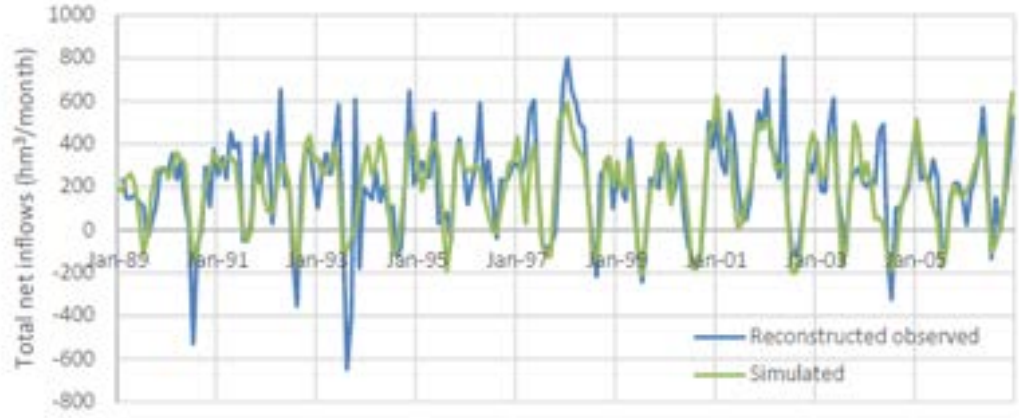
Source: Tractebel, 2020

Figure 7-33 Annual Precipitation and Evapotranspiration Data

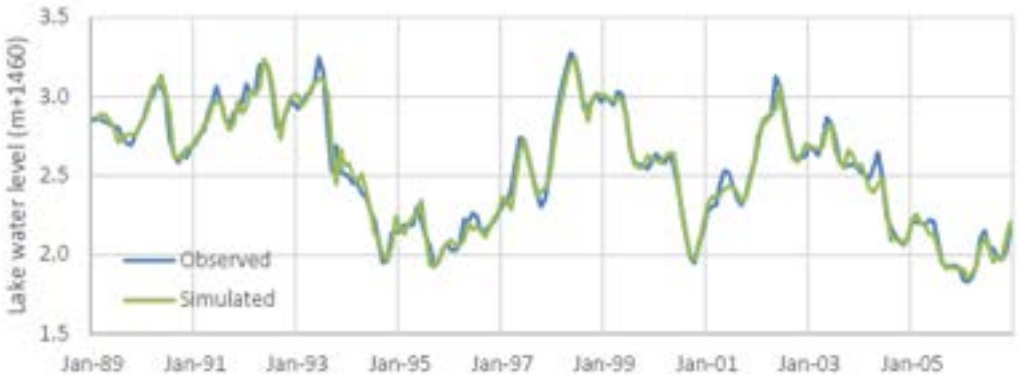
The water balance model was initially calibrated over the period 1989 – 2006 to predict a runoff coefficient of 0.17 (bias = 0.1%). Model performance in terms of lake net inflows and lake water levels is shown in Figure 7-34. The model was verified for the historical period 1950 – 1960 (bias = 17.7%).

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Variations of Lake Kivu's Total Net Inflow (1989-2006) (Tractebel, 2020)



Variations of Lake Kivu's Water Level (1989-2006) (Tractebel, 2020)

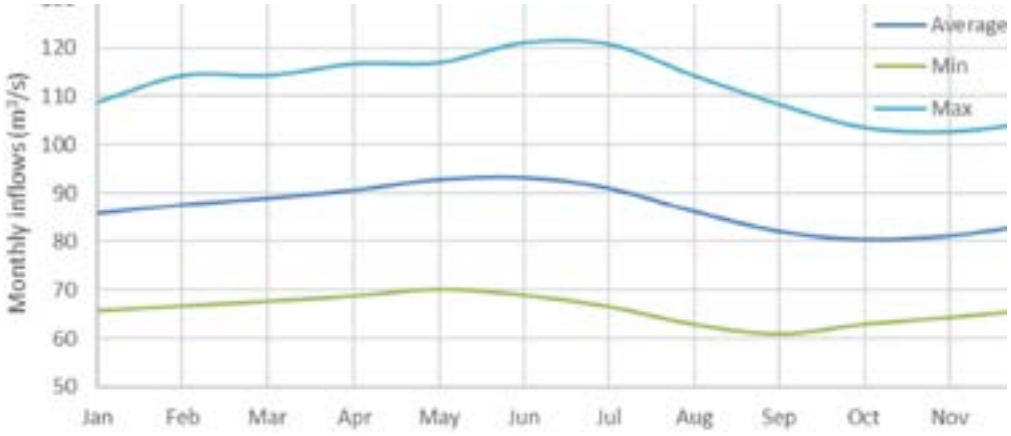
Figure 7-34 Water Balance Model Performance: Calibration Period 1989 – 2006

Applying the calibrated water balance model to the period 1901 – 2018, the annual average lake net inflow is estimated as 83.9 m^3/s.

Based on Ruzizi I management rules and relationships established with Lake Kivu water levels, and the application of the runoff coefficient (0.17) applied to the intervening catchment between Ruzizi I and Ruzizi III, the **Ruzizi III annual average inflows have been estimated as 86.9 m^3/s**. Long-term monthly average flow estimates (1901-2018) are shown in Figure 7-35 and Table 7-7. The variation in annual inflow is shown in Figure 7-36. A strong cyclical pattern to estimated inflows is apparent. Inflows for the period 1980 onwards tend to be lower than the longer-term average.

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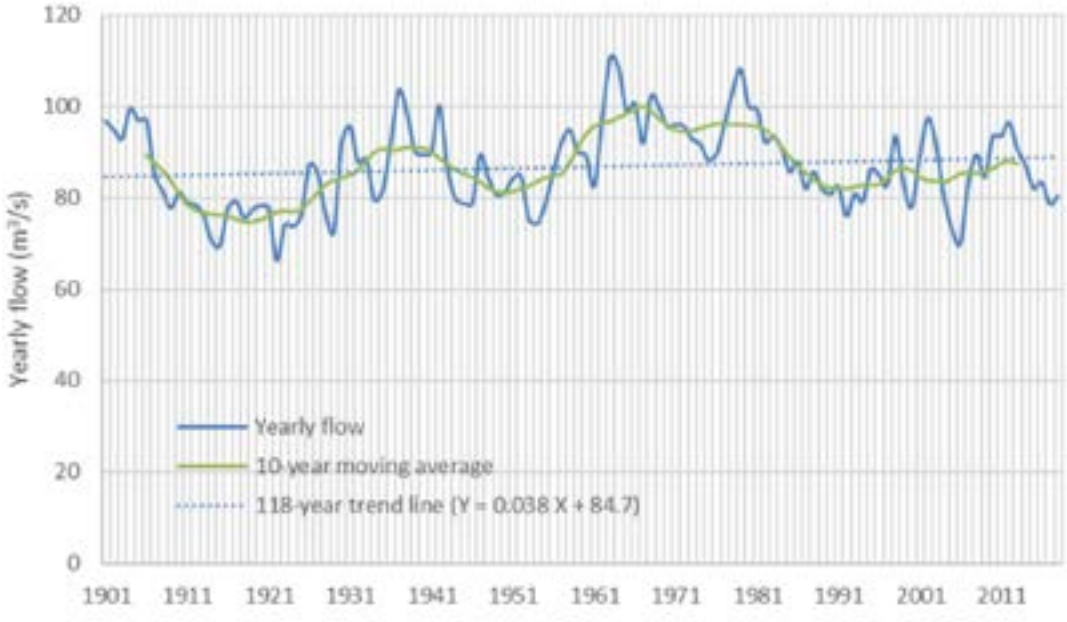


Monthly Distribution of Ruzizi III's Inter-Annual Inflows (1901-1918) (Tractebel, 2020)

Figure 7-35 Long-Term Monthly Inflows to Ruzizi III: Calibration Period 1989 – 2006

Table 7-7 Long-term monthly inflows to Ruzizi III: calibration period 1989 – 2006

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum (m³/s)	109	114	114	117	117	121	121	114	108	104	103	105	111
Average (m³/s)	86	88	89	91	93	93	91	86	82	80	81	83	87
Minimum (m³/s)	66	67	68	69	70	69	66	63	61	63	64	66	66



Source: Tractebel, 2020

Figure 7-36 Annual inflows to Ruzizi III: calibration period 1986/9 – 2006

Following receipt of energy production data for Ruzizi II for the period 2010 – 2019, a comparison of actual production and modelled production was undertaken. This concluded that average turbinated flows at Ruzizi II for the period 2010 – 2019 was 99 m³/s, as opposed to a long-term inflow estimate of 85 m³/s from the initial model calibration.

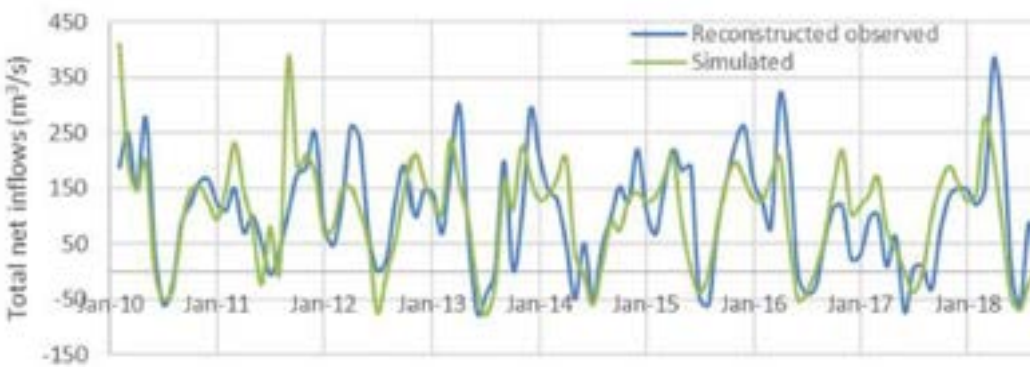
This higher estimate of recent annual average flow has not been attributed neither to a change in precipitation as the CRU monthly average precipitation is reported as 126.4 mm

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for 2010 – 2018 and 122.8 mm for 1989 – 2006, an increase of just 3%[4, 5], nor to a change in temperature. Rather it is proposed that the change in reported annual average flow could be attributable to a change in rainfall-runoff relationship due to land cover change.

Accordingly, the water balance model was recalibrated using data for the period 2010 – 2018 and a revised runoff coefficient of 0.26 was obtained (bias = 0.0%). The recalibrated model performance with respect to lake net inflows is shown in Figure 7-37.



Variations of Lake Kivu's Total Net Infows (2010-2018) (Tractebel, 2020)

Figure 7-37 Water Balance Model Performance: Recalibration Period 2010 – 2018

Applying the recalibrated water balance model to the period 1901 – 2018, the annual average lake net inflow is estimated as 105.6 m^3/s (26% greater than the value obtained during initial calibration).

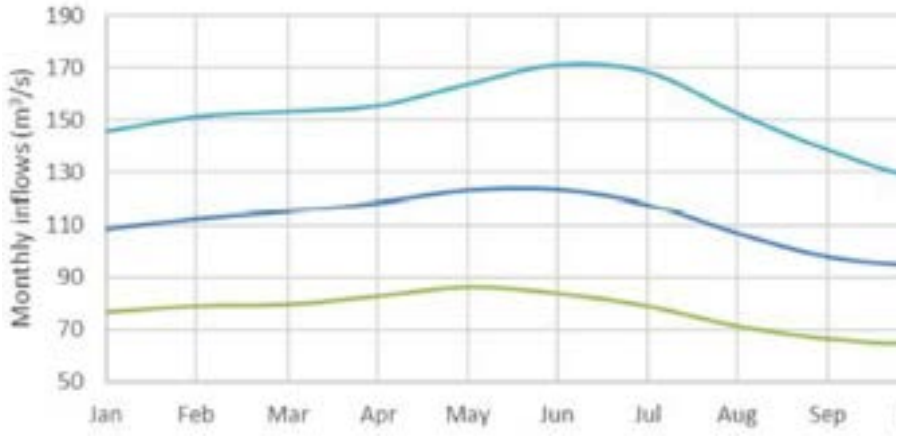
Applying the recalibrated runoff coefficient (0.26) to the intervening catchment between Ruzizi I and Ruzizi III, the recalibrated **Ruzizi III annual average inflows have been estimated as 109.9 m^3/s**. Long-term monthly average flow estimates (1901-2018) are shown in Figure 7-38 and Table 7-8. The variation in annual inflow is shown in Figure 7-39. A strong cyclical pattern to estimated inflows is apparent. Inflows for the period 1980 onwards tend to be lower than the longer-term average.

[4] Note however that no assessment has been made regarding possible differences in temperature / evapotranspiration during the two distinct periods 1989 – 2006 and 2010 – 2018. Data presented suggests that evapotranspiration may have been lower in this later period.

[5] Note also that a quality review of CRU data can be readily undertaken using the Google Earth interface CRU TS v. 4.04 Google Earth Interface (uea.ac.uk). This shows the location of the 0.5 ° grid cells, and associated time-series data for temperature, diurnal temperature range, precipitation, and vapour pressure, and the location, status, and data values of associated station data. See Annex for further information.

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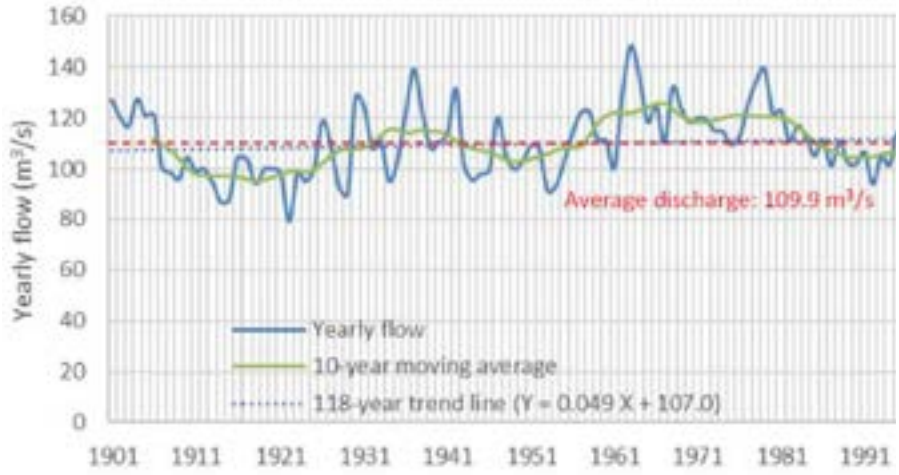


Monthly Distribution of Ruzizi III's Inter-Annual Inflows (Period 1901-1918) (Tractebel, 2020)

Figure 7-38 Long-Term Monthly Inflows to Ruzizi III: Recalibration Period 2010 – 2018

Table 7-8 Long-Term Monthly Inflows to Ruzizi III: Recalibration Period 2010 – 2018

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum (m^3/s)	146	151	153	155	164	171	168	152	139	129	134	140	148
Average (m^3/s)	108	112	115	119	123	123	118	107	98	95	97	103	110
Minimum (m^3/s)	77	79	80	83	86	84	79	71	67	65	68	74	79



Variations of the Yearly Inflows to Ruzizi III (1901-2018) with Upgraded Calibration (Tracebel, 2020)

Figure 7-39 Annual Inflows to Ruzizi III: Recalibration Period 2010 – 2018

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7.6.2.3 Other Analysis

A 'Baseline Study for the Basin of Lake Kivu and the Ruzizi River' was undertaken for ABAKIR in 2020 (Sher Consult, 2020). This study included: (i) presentation of river flow based on data available from the Rwanda Water Resources Board "Water Portal"; (ii) the development of a water balance model providing flow estimates at key locations in the basin including at the outlet of Lake Kivu and at Kamanyola (upstream of the confluence of the Ruzizi and Ruhwa rivers); (iii) the development of a Water Evaluation and Planning (WEAP) model; and iv) land use evolution. The report provides summarises of catchment characteristics including catchment area, precipitation, potential evapotranspiration, and runoff. Runoff coefficients of approximately 54% are given for the intervening catchment upstream of Kamanyola, based on average monthly runoff coefficients derived from catchment precipitation and gauged data for the Nyangama tributary in Burundi.

WEAP model results for average conditions (50% exceedance) and drought conditions (80% exceedence) for Lake Kivu outflows, inflow contributions from the right-bank and left-bank of the intervening catchment upstream of Kamanyola, and for the Ruhwa river[6] for "current" conditions are from the ABAKIR baseline study are summarised below in Table 7-9 and Table 7-10 which summarise the Lake Kivu outflows and total flow at Kamanyola under "climate change" conditions. Average lake outflows are given as 78 m^3/s and flows at Kamanyola are given as 94 m^3/s. Elsewhere in the report, average flows are reported as 71 m^3/s for the Lake Kivu outlet and 89 m^3/s at Kamanyola (in Section 11.2 of the baseline study report).

Change in land use is presented based on use of the European Space Agency Climate Change Initiative (ESA-CCI) global land cover datasets from 1992 and 2016 (in section 9 of the baseline study report). This suggests that for the study area as a whole over this period, agricultural land has increased from approximately 16% to 45%, prairie and shrub cover has decreased from approximately 46% to 23% and forest cover has decreased from approximately 35% to 30%.

Muvundja et al (2014) also present estimates of Lake Kivu outflows based on water balance modelling of lake water level variations over the period 1941 – 2011. Long-term estimates of lake outflow of 86 m^3/s are reported (for the period 1941 – 1991). The variation in lake levels and lake outflows are reported to be dependent on lake precipitation and evaporation, catchment runoff processes (both surface and subsurface runoff), and deep subaquatic groundwater discharge (SGD). Indeed, lake precipitation and evaporation rates for Lake Kivu (and for East-African lakes in general) are considered to be comparable, with catchment runoff processes contributing approximately 55% to the lake outflow and SGD processes contributing approximately 45%. More generally, a regional surface runoff coefficient of approximately 0.3 is reported.

The relationship between lake levels and precipitation and sea surface temperature in the Indian Ocean is also discussed. Average precipitation is reported as approximately 1,400 mm/year, and average lake evaporation is reported to be approximately 1,530 mm/year, although a range of 800 mm to 1,800 mm is also given. Similarly, a catchment average potential evapotranspiration of 1,100 mm/year and a range of average potential evapotranspiration of 900 mm to 1,500 mm is reported.

[6] Flows for the Ruhwa river have been derived from reported contributing catchment areas for the Ruhwa river and for the modelled group of sub-catchments 'RU-RG-HA', i.e., the left-bank group of catchments immediately downstream Kamanyola. The Ruhwa is assumed to contribute 32% of the 'RU-RG-HA' inflows based on a comparison of catchment area.

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Table 7-9 WEAP Model Monthly Average and Drought Flows (Current Conditions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average inflows (50% exceedance) (m^3/s)													
Lake Kivu outflow	82.0	80.0	83.0	89.0	94.0	85.0	71.0	67.0	66.0	68.0	75.0	78.0	78.2
Intervening catchment inflows – right-bank	7.7	7.2	8.4	7.8	8.0	3.1	1.7	4.6	5.6	4.6	6.5	7.0	6.0
Intervening catchment inflows – left-bank	11.3	10.7	12.9	13.4	13.6	4.7	1.8	7.0	8.5	7.8	9.6	10.2	9.3
Total at Kamanyola	101.0	97.9	104.3	110.2	115.6	92.8	74.5	78.6	80.1	80.4	91.1	95.2	93.5
Ruhwa inflows	18.2	18.6	20.7	25.3	24.8	5.3	1.8	9.8	12.2	13.3	16.0	16.5	15.2
Drought inflows (80% exceedance) (m^3/s)													
Lake Kivu outflow	45.0	45.0	47.0	53.0	55.0	47.0	34.0	30.0	30.0	34.0	42.0	44.0	42.2
Intervening catchment inflows – right-bank	6.4	6.4	7.1	7.1	6.0	2.1	1.2	3.2	4.2	3.7	5.3	6.2	4.9
Intervening catchment inflows – left-bank	8.9	9.3	10.8	11.7	10.5	2.8	1.4	4.3	6.1	6.2	7.9	8.9	7.4
Total at Kamanyola	60.3	60.7	64.9	71.8	71.5	51.9	36.6	37.5	40.3	43.9	55.2	59.1	54.5
Ruhwa inflows	14.9	15.2	16.1	21.1	19.6	3.1	0.9	5.5	9.6	11.0	13.8	14.0	12.1

Table 7-10 WEAP Model Monthly Average Flows (Climate Change Conditions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average inflows (50% exceedance) (m^3/s)													
Lake Kivu outflow	82.0	80.0	83.0	89.0	94.0	85.0	71.0	67.0	66.0	68.0	75.0	78.0	78.2
Total	100.3	97.4	103.7	109.6	115.1	92.5	74.1	78.1	79.2	79.5	90.5	94.5	92.9
Drought inflows (80% exceedance) (m^3/s)													
Lake Kivu outflow	45.0	45.0	47.0	53.0	55.0	47.0	34.0	30.0	30.0	34.0	42.0	44.0	42.2
Total	90.9	78.1	87.2	92.0	92.8	60.0	41.1	49.8	54.9	56.2	72.0	77.9	71.1

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7.6.2.4 Ruzizi I and II Production Data

Production data for Ruzizi I and Ruzizi II for the period 2009 to 2019 was obtained via Tractebel. Monthly hourly average production data (MW) and derived flows (m^3/s), and tables relating Lake Kivu water level (mAOD) to outflow (m^3/s) and production (MW) have been reviewed. Excluding any environmental flow releases, releases from Ruzizi I and Ruzizi II are estimated as 95.5 m^3/s and 101.1 m^3/s respectively.

Lake Kivu water levels for the period 2010 – 2019 are shown in Figure 7-40. Compared with levels experienced during the period 1989 – 2006 (as shown in Figure 7-34), it can be seen that lake levels tend to be higher in the period 2010 – 2019 than in the period 1989 – 2006.

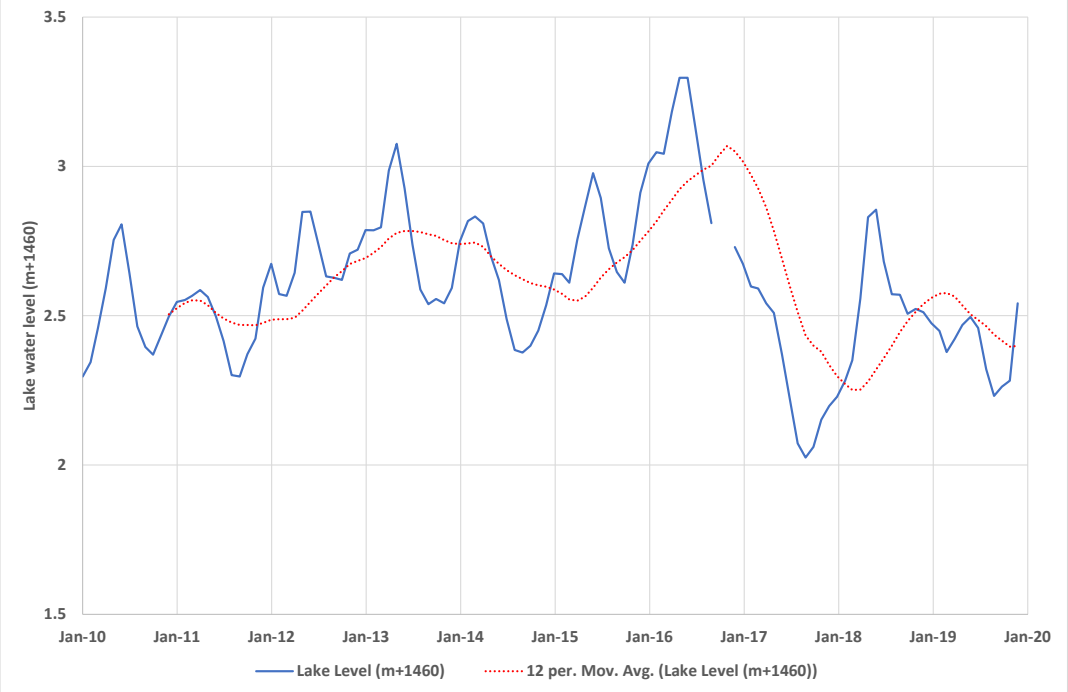


Figure 7-40 Lake Kivu Water Levels (2010-2019)

The recent Ruzizi I and Ruzizi II production data and derived inflows were used in the Feasibility Study analysis (2020) in the recalibration of the hydrological model (see previous section for further details).

7.6.2.5 Summary

The current best estimate of hydrological inflows upstream of Ruzizi III dam wall are as provided by the recalibrated hydrological model presented as part of the Feasibility Study (2020), suggesting an annual average inflow of 109.9 m^3/s, and an annual average lake outflow of 105.6 m^3/s.

This average lake outflow / Ruzizi III inflow is notably larger than other estimates as discussed herein (e.g., initial Feasibility Study hydrological model development, ABAKIR's 'Baseline Study of the Basin', and Muyundia et al.'s 2014 study into Lake Kivu outflows).

Table 7-11 and Figure 7-41 summarise the monthly inflows from the Feasibility Study initial hydrological model and the recalibrated model.

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Table 7-11 Summary of Feasibility Study monthly inflows

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Initial Model (m^3/s)													
Dry	68.0	70.0	71.9	73.9	76.0	76.0	74.9	69.0	65.0	63.0	64.9	66.0	70.9
Normal	83.0	85.0	85.5	87.0	89.0	89.5	87.0	83.0	79.0	76.5	77.0	79.5	83.0
Wet	98.3	100	101	104	107	107	105	99.3	95.0	92.2	94.0	97.0	98.2
Recalibrated Model (m^3/s)													
Dry	84.0	92.1	93.4	95.9	101	101	97.9	87.9	78.9	75.9	77.9	83.7	90.9
Normal	108	111	115	117	121	122	116	106	97.0	93.0	96.0	102	109
Wet	135	135	139	146	152	151	142	131	119	116	119	129	131

The reported difference has been attributed by the Feasibility Study to a change in land use in the upper Lake Kivu basin. However, it is noted that the calculated differences in inflows may also be attributed to hydrological and hydro-meteorological observational uncertainty in, for example, the Lake Kivu level-outflow relationship, and catchment average precipitation and evapotranspiration, and lake evaporation estimates.

The water balance model adopted in the Feasibility Study is relatively simplistic. It can be differentiated from Muyundia et al.'s water balance model by the absence of consideration of deep subaquatic groundwater discharge (SGD) and characterised by its adoption of the University of East Anglia's Climate Research Unit (CRU) time-series datasets. It is noted that the CRU time-series datasets are derived from both satellite data and local individual stations, and that the inclusion of local data is typically sparse in Rwanda and varies over time. The brief review of CRU data presented in the Annex shows that less local data is available for the period post-2000, and as such, estimates of precipitation and evapotranspiration for this period have a greater associated uncertainty.

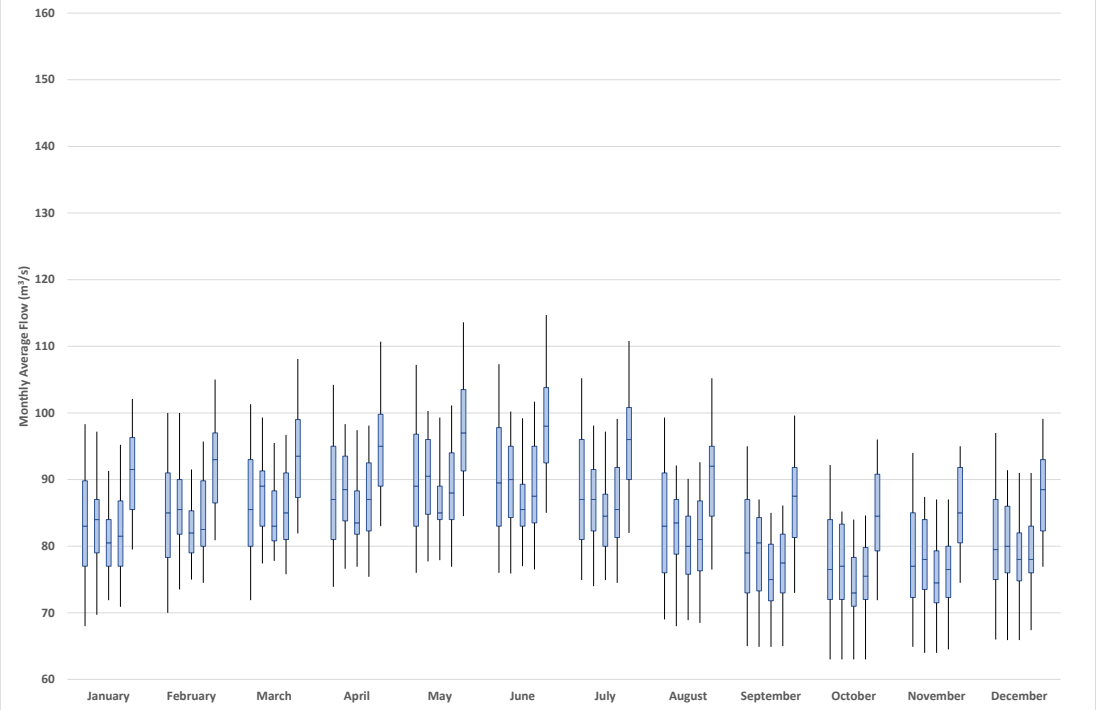
Furthermore, it is noted that long-term cyclical water level behaviour is observed in Lake Kivu (and East African lakes in general), and that differences in the estimated long-term average inflows to Ruzizi III may (in part) be attributed to this variation.

Accordingly, it is recommended that the current Feasibility Study Ruzizi III inflows (as reported in Table 7-8) are considered "current" estimates, and that previous Feasibility Study estimates of inflows are considered as "historic" estimates.

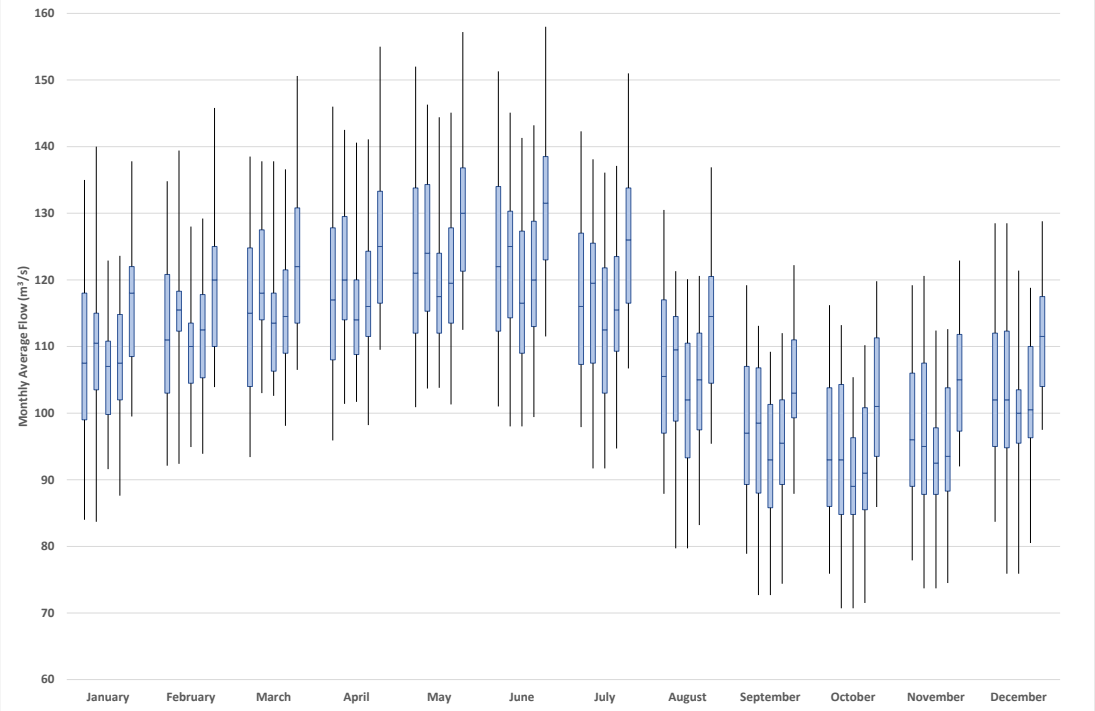
Less information is available to estimate the inflows into the study area downstream of Ruzizi III. However, the ABAKIR 'Baseline Study of the Basin' provides a useful source of information that can be adopted as current "best estimates", recognising that hydrological inflows from downstream tributaries are significantly lower than those from upstream Ruzizi III.

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Initial Model Monthly Inflows (above)



Recalibrated Model Monthly Inflows (above)

Figure 7-41 Summary of Feasibility Study Monthly Inflows

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7.6.3 Study Area Hydrology

7.6.3.1 Introduction

The hydrology in the study area between Ruzizi III dam wall and the border with Burundi is determined both by the outflow from Lake Kivu and inflows from the intervening catchment but also at a sub-daily level by the operation of Ruzizi I and Ruzizi II.

The Feasibility Study (2020) presents an analysis of power production for the (future) Ruzizi cascade, i.e., for the operation of Ruzizi I, II, and III. A key component of this analysis is that the cascade shares the same demand curve for power production, and that the installed capacity for both Ruzizi II and Ruzizi III is 150 m^3/s. In the absence of comprehensive hydrological monitoring, the optimised outflows from Ruzizi II, whilst not matching current / historic operation, provide an appropriate reference for considering the baseline hydrology in the study area.

7.6.3.2 Water Level Monitoring

The Rwanda Water Resources Board (RWB) 'Water Portal' makes available surface water data and includes lake level data at the Lake Kivu outlet and river level data at Kamanyola (Bugarama Bridge).



View from Bugarama Bridge View from left bank

Figure 7-42 Kamanyola (Bugarama Bridge) Water Level Monitoring Station

Lake level data is available for the Lake Kivu outlet for: i) manually-read data at 08:00, 12:00, and 17:00 for the period 01/03/2016 – 31/03/2017; and ii) telemetry-read data at irregular hourly intervals for the period 02/09/2021 – 08/01/2022. There is limited utility of these datasets due to their short duration and irregular recording. Kamanyola river level data availability includes 15-minute telemetry level data for the period 01/06/2018 onwards.

The Kamanyola river level data illustrates the impact of the existing operation of Ruzizi II and the associated hydropeaking effects. Table 7-12 summarises the frequency of river level change exceeding selected thresholds (1 m and 1.5 m) within selected short durations (2 hours; 1 hour; 45 minutes; 30 minutes) during the 3-year period June 2018 to May 2021. It can be seen that:

- A change of water level of more than 1 m in a 1-hour duration occurs on average approximately 1 day in 3.
- A change of water level of more than 1 m in a 30-minute duration occurs on average approximately 1 day in 5.
- A change of water level of more than 1.5 m in a 1-hour duration occurs on average approximately once per fortnight.

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- A change of water level of more than 1.5 m in a 30-minute duration occurs on average approximately once per 50 days.

Table 7-12 Summary of Kamanyola Water Level Monitoring Station Change in Water Level (Jun-2018 – May-2021)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
River level change exceeding 1 m													
In 2 hours	53	43	39	31	32	18	9	6	20	34	37	62	384
In 1 hour	47	39	32	29	28	17	8	5	16	29	34	59	343
In 45 mins	38	30	29	27	27	17	8	5	14	25	32	54	306
In 30 mins	21	21	21	19	22	14	6	5	12	22	22	38	223
River level change exceeding 1.5 m													
In 2 hours	15	11	12	12	14	7	1	0	5	11	10	19	117
In 1 hour	9	10	9	9	12	7	0	0	4	7	6	14	87
In 45 mins	6	7	9	8	8	6	0	0	4	5	4	9	66
In 30 mins	3	3	4	3	1	3	0	0	2	2	1	1	23

Figure 7-43 summarises the seasonality of "exceedance events".

It can be seen that the exceedance events tend to occur during the period October to May, with the maximum number of recorded exceedance events occur in December.

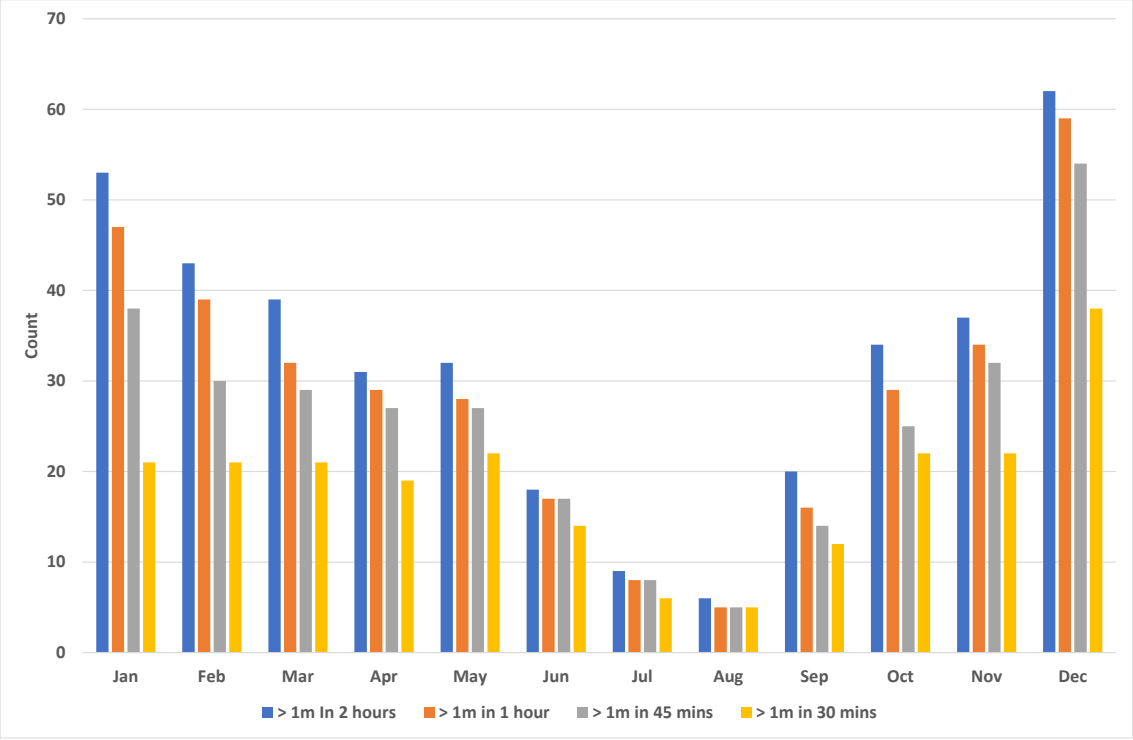


Figure 7-43 Kamanyola Water Level Monitoring Station Change in Water Level Seasonality (Jun-2018 – May-2021)

Figure 7-44 shows the variation in daily water levels at Kamanyola for selected days (the first day of each month) in 2019. This illustrates the variation in water levels in terms of the differences between daily maximum and daily minimum water levels, and the difference in timing of daily minimum water levels. The effects of Ruzizi II hydropeaking are not predictable and differ from optimised operational rules.

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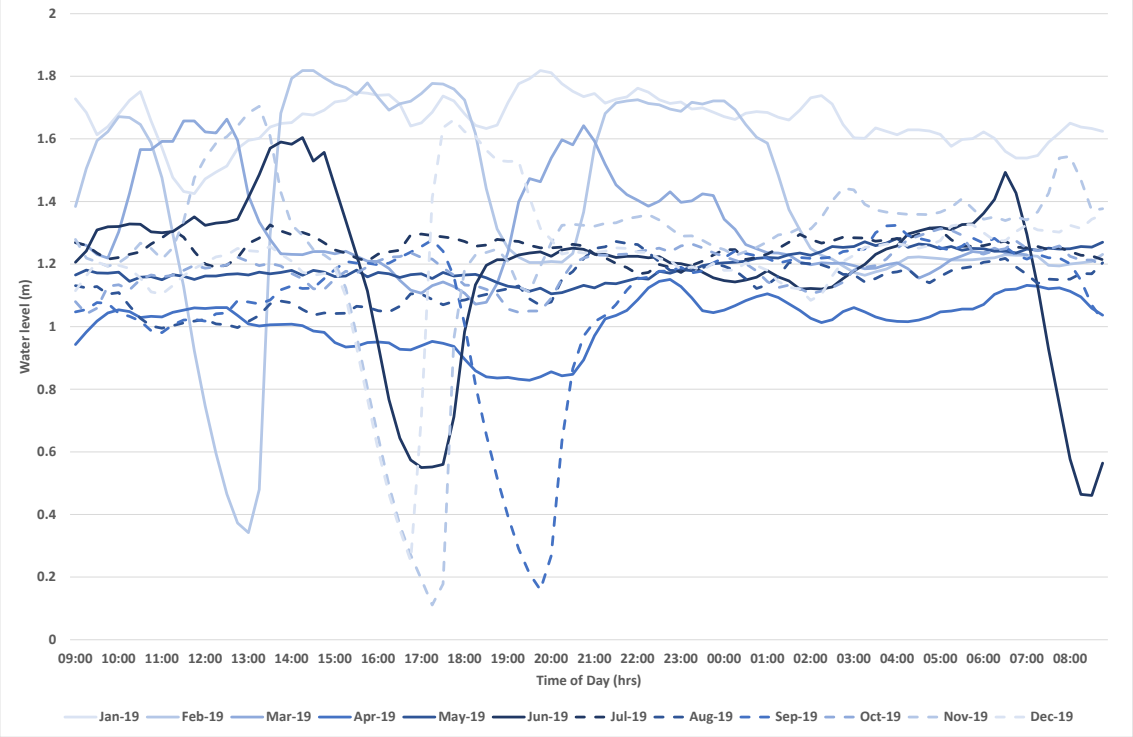


Figure 7-44 Selected Daily Water Levels at Kamanyola (2019)

The Rwanda Water Resources Board (RWB) 'Water Portal' also provides reports on river flow monitoring. Reports are available for the period 2018-2019 and for 2020. However, the data presented shows that flow monitoring on the Ruzizi (and Rubyiro and Ruhwa) is infrequent and as such the estimation of river flow is uncertain. The 2020 report flows at Kamanyola and on the Ruhwa and Ribyiro rivers were measured in November 2020 at 156 m^3/s, 13.5 m^3/s and 4.41 m^3/s respectively.

Additional water level monitoring has also been undertaken by the Project during the period 10/02/2023 – 11/03/2023 at both the Manda monitoring site (located approximately 2 km downstream of the proposed Ruzizi III dam wall location) and the Rusizi monitoring site in Burundi (located approximately 120 km downstream of Ruzizi III / 14 km upstream of Lake Tanganyika). At both locations, water level has been monitored daily during the period 7h00 to 18h00 at 15-minute intervals.

The water level monitoring data from 2023 clearly shows the significant attenuation in observed water levels along the length of the Ruzizi River:

- At Manda, the average daily range of observed water levels is 1.25 m, with a rate of change of 70 cm/hour. It is noteworthy that there is little intervening flow into the Ruzizi upstream of Manda - as Manda is upstream of main tributaries (Ribyiro and Ruhwa).
- At Rusizi upstream Lake Tanganyika, the average daily range of observed water levels is 0.07 m, with a rate of change of 0.3 cm/hour.

The impact of existing hydropeaking is unlikely to be observable at the lower end of the Ruzizi River in Burundi, including the Rusizi National Park which is confirmed by park authorities. Rather, due to the large distance downstream and large intervening catchment area, the small daily variation in water levels at this location are at least as likely to be associated with natural hydrological processes.

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7.6.3.3 Modelled Hydrological / Hydraulic Characteristics

A Introduction

The "River Channel Hydraulics" report (December 2020), produced as part of the Ruzizi II Feasibility Study, describes the analysis and modelling undertaken in order to develop high flow level-flow rating curves at selected sites of interest between the Ruzizi II dam wall and powerhouse. A HEC-RAS 1D hydraulic model was developed for the river reach between the dam wall and approximately 1.4 km downstream of the powerhouse based on cross-section survey data and local LiDAR data.[7] During model development, any discrepancies between cross-section survey data and LiDAR were removed by adjusting the survey data.

The hydrological and hydraulic characterisation is presented in this section of the baseline assessment in order to provide important contextual information that informs the subsequent environmental flow assessment (provided in Chapter 10)..

B The Ruzizi III Reach

The existing HEC-RAS model of the reach between the Ruzizi III dam wall and approximately 1.4 km downstream of the powerhouse includes the post-Ruzizi III dewatered reach. The model has been obtained and re-run for a range of steady state flows in order to provide a hydraulic characterisation of the reach representing the proposed Ruzizi III dewatered reach. Flows over a range of 10 m^3/s to 160 m^3/s have been modelled as, due to the hydropeaking operation of Ruzizi II, these correspond to the typical flow range currently observed in the reach.

The approximately 5.5 km dewatered reach has an average width of 63 m and a total wetted area of approximately 354,000 m^2. Table 7-13 and Figure 7-45 shows how the reach wetted area varies with flow. It can be seen that:

- At a flow of 10 m^3/s (minimum flow), the total wetted area is 157,000 m^2 (48% of wetted area for natural flow conditions and 44% of peak flow conditions).
- At a flow of 90 m^3/s (typical off-peak flow), the total wetted area is 307,000 m^2(over a wetted area of 87% and 94% of peak and natural flow conditions respectively);
- At a flow of 160 m^3/s (typical peak flow), the total wetted area is 354,000 m^2 (over a wetted area of 100% and 109% of peak and natural flow conditions, respectively).

Table 7-13 Summary of Variation of Reach Area

Flow (m^3/s)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
Area (000 m^2)	157	195	223	244	259	273	284	296	307	318	325	331	338	343	349	354
Area as % of Maximum at 160 m^3/s (peak flow rate)																
	44 %	55 %	63 %	69 %	73 %	77 %	80 %	84 %	87 %	90 %	92 %	94 %	95 %	97 %	99 %	100 %
Area as % of Maximum at 110 m^3/s (average annual flow for natura conditions																
	48 %	60 %	69 %	75 %	80 %	84 %	87 %	91%	94 %	98 %	100 %	102 %	104 %	106 %	107 %	109 %

[7] The cross-section survey data is more thoroughly described in the "Draft Report of Ruzizi Bathymetric Survey for Ruzizi III HEPP" report (Tiger Engineering Company Limited, January 2021). An ADCP was used to survey cross-sections at 68 out of 80 planned locations – 12 locations were not able to be surveyed due to the high level of turbulence. The ADCP surveyed data was extended onto the riverbanks using Total Station topographic survey.

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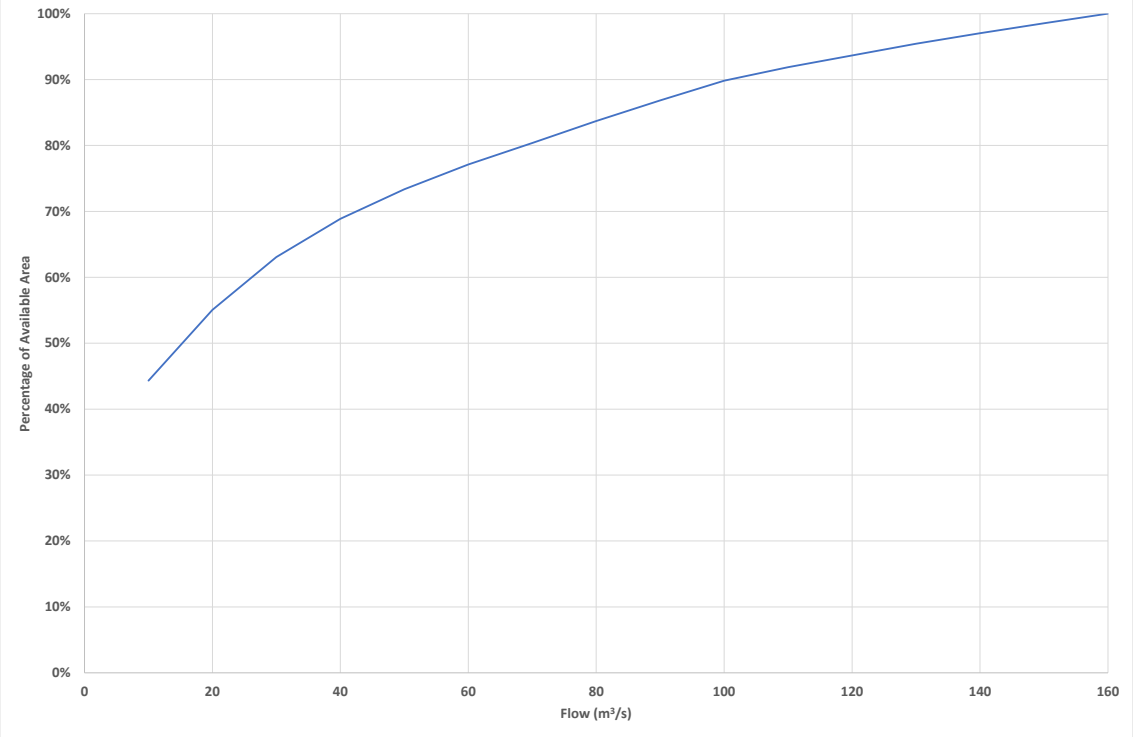


Figure 7-45 Variation of Reach Water Area

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The Tennant Method percentage width requirements are approximately 60%, 65%, and 85%, for 10% MAF, 30% MAF and 60% MAF. Equating width with area, a flow of 26 m^3/s, 33 m^3/s, and 83 m^3/s would be required in the reach to meet these requirements.

Figure 7-46 shows how the average depth in the reach varies with flow:

- At a flow of 10 m^3/s (minimum flow), the average depth is 0.55 m (over 44% and 48% of peak and natural flow conditions respectively);
- At a flow of 90 m^3/s (typical off-peak flow), the average depth is 1.15 m (over a wetted area of 87% and 94% of peak and natural flow conditions respectively); and
- At a flow of 160 m^3/s (typical peak flow), the average depth is 1.60 m (over a wetted area of 100% and 109% of peak and natural flow conditions respectively).

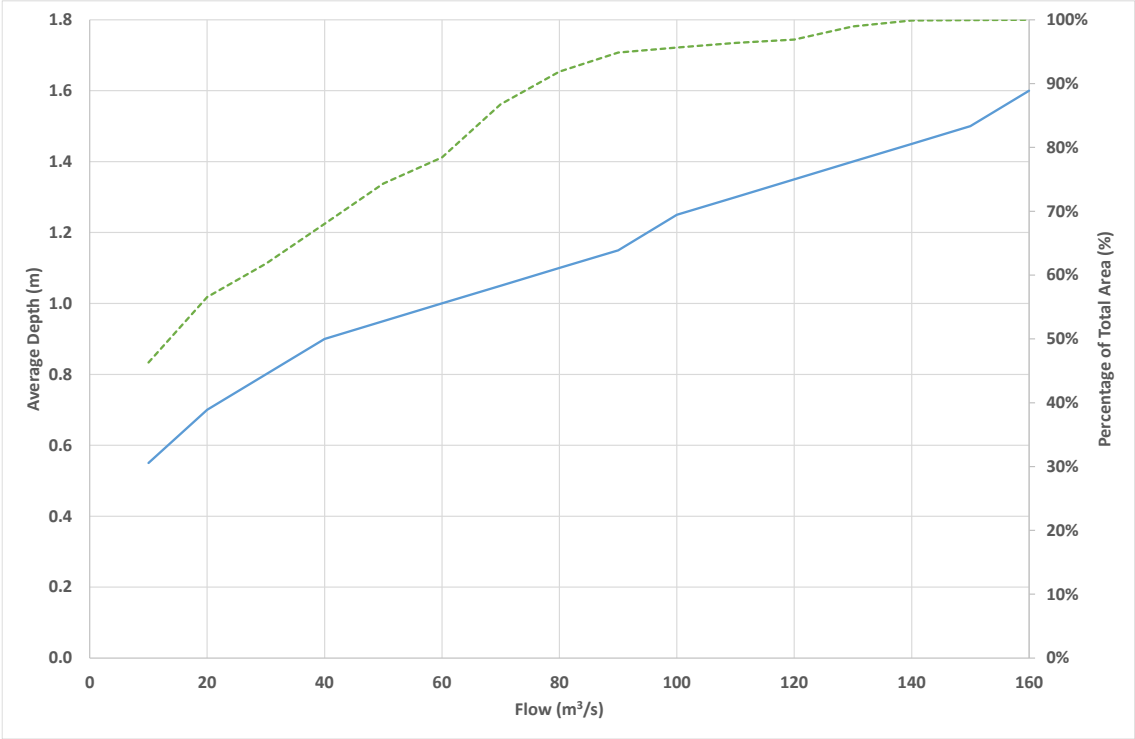


Figure 7-46 Variation of Reach Average Depth

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Table 7-14 and Figure 7-47 provide further insight into how the depth of water in the reach varies over a similar flow range[8]. For example:

- At a flow rate of 10 m^3/s (minimum flow), 91,000 m^2 (26%) is at least 0.5 m deep, 40,000 m^2 (11%) is at least 1 m deep, and 6,000 m^2 (2%) is at least 2 m deep.
- At a flow rate of 90 m^3/s (typical off-peak flow), 265,000 m^2 (75%) is at least 0.5 m deep, 192,000 m^2 (54%) is at least 1 m deep, and 69,000 m^2 (20%) is at least 2 m deep.
- At a flow rate of 160 m^3/s (typical peak flow), 335,000 m^2 (95%) is at least 0.5 m deep, 287,000 m^2 (81%) is at least 1 m deep, and 131,000 m^2 (37%) is at least 2 m deep.

Table 7-14 Summary of Variation of Reach Water Area at Selected Depth Exceedance Thresholds

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
D > Min	164	200	219	241	263	278	307	325	336	339	341	343	350	354	354	354
D > 0.25	130	174	197	216	233	253	271	286	310	328	332	337	339	341	344	347
D > 0.5	91	130	167	191	202	216	234	252	265	280	300	316	325	328	332	335
D > 1.0	40	71	92	108	127	147	167	182	192	203	216	233	248	256	268	287
D > 2.0	6	12	14	25	32	41	50	62	69	78	87	97	104	112	122	131
D > 3.0	-	1	2	3	3	5	9	11	13	15	21	22	26	30	33	35
D > 4.0	-	-	-	-	-	-	-	1	2	2	2	3	3	4	5	8
D > 5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[8] % wetted area is expressed as a % of wetted area of peak flows at 160 m^3/s. Wetted area expressed as a % of natural flow conditions at 110 m3/s are not indicated but are 2-3% higher.

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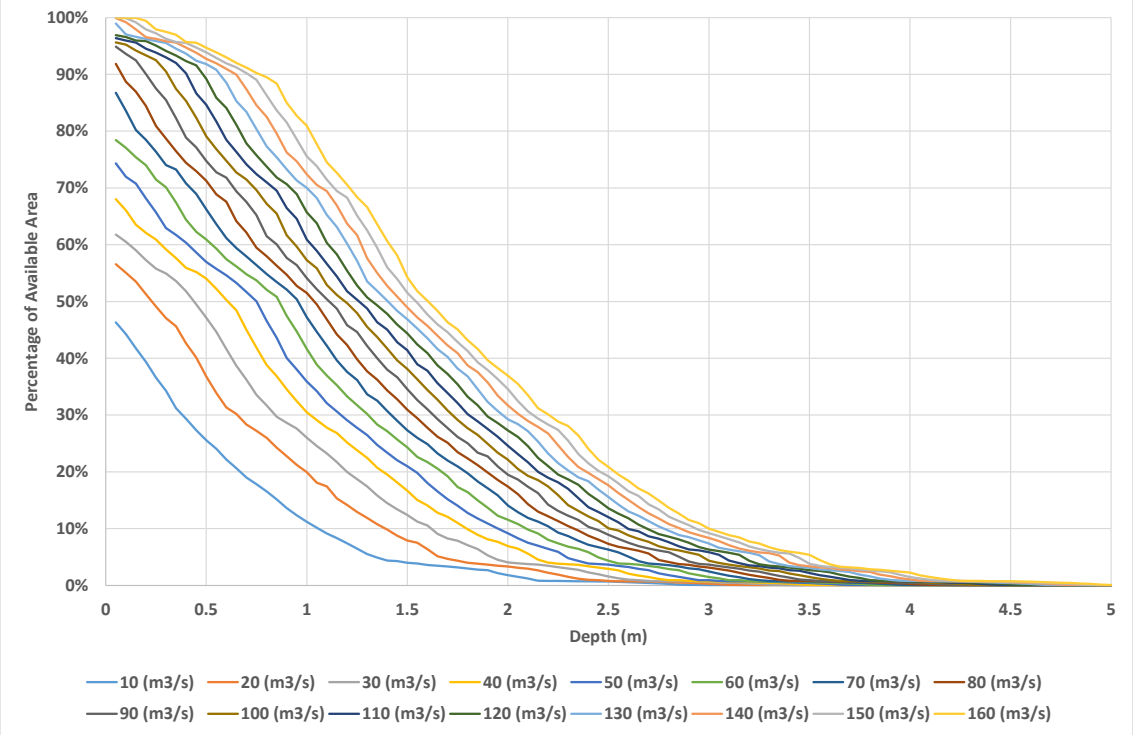


Figure 7-47 Variation of Reach Water Depth Exceedence as a Percentage of Total Wetted Area

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The Tennant Method percentage depth requirements are approximately 0.33 m, 0.5 m, and 0.67 m, for 10% MAF, 30% MAF and 60% MAF.

Figure 7-48 shows how the average velocity in the reach varies with flow:

- At a flow of 10 m^3/s (minimum flow), the average velocity is 0.55 m/s (over 44% and 48% of peak and natural flow conditions respectively);
- At a flow of 90 m^3/s (typical off-peak flow), the average velocity is 0.80 m/s (over a wetted area of 87% and 94% of peak and natural flow conditions respectively); and
- At a flow of 160 m^3/s (typical peak flow), the average velocity is 1.15 m/s (over a wetted area of 100% and 109% of peak and natural flow conditions respectively).

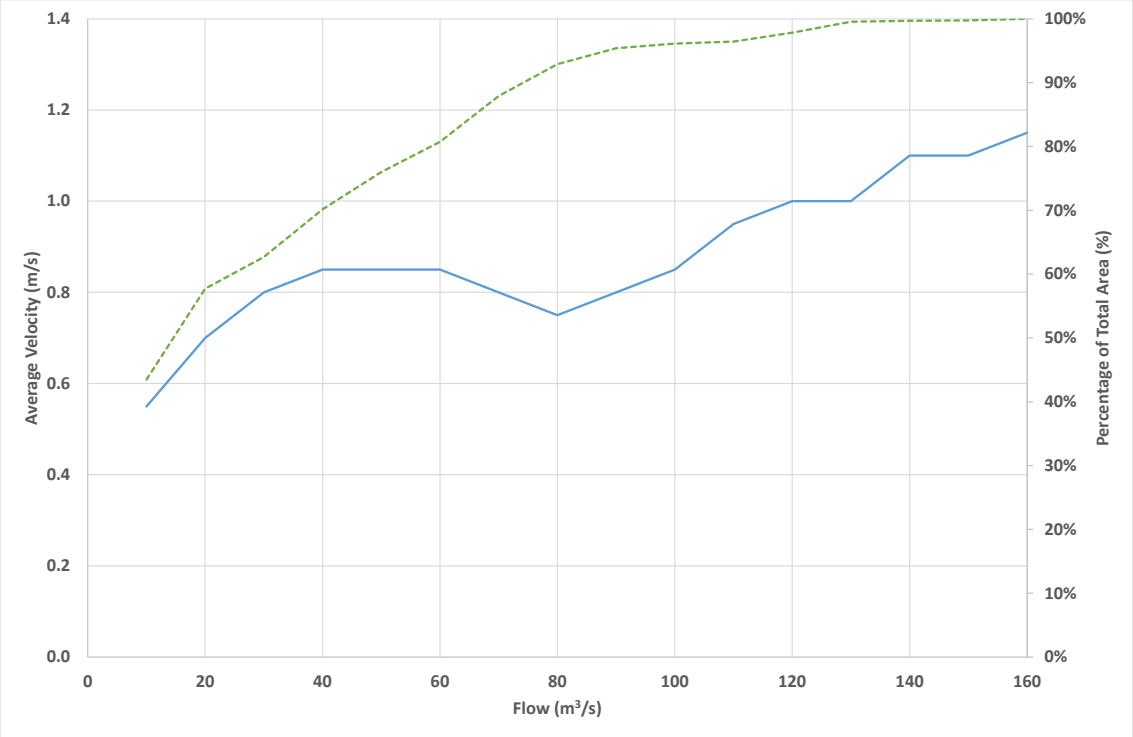


Figure 7-48 Variation of Reach Average Velocity

Table 7-15 and Figure 7-49 provide further insight into how the velocity of water in the reach varies over a similar flow range[8]. For example:

- At a flow rate of 10 m^3/s (minimum flow), 82,000 m^2 (23%) is at least 0.5 m/s fast, 37,000 m^2 (10%) is at least 1 m/s fast, and 3,000 m^2 (1%) is at least 2 m/s fast.
- At a flow rate of 90 m^3/s (typical off-peak flow), 323,000 m^2 (91%) is at least 0.5 m/s fast, 138,000 m^2 (39%) is at least 1 m/s fast, and 48,000 m^2 (14%) is at least 2 m/s fast.
- At a flow rate of 160 m^3/s (typical peak flow), 339,000 m^2 (96%) is at least 0.5 m/s fast, 185,000 m^2 (52%) is at least 1 m/s fast, and 98,000 m^2 (28%) is at least 2 m/s fast.

The Tennant Method percentage velocity requirements are approximately 0.25 m/s, 0.5 m/s, and 0.6 m/s, for 10% MAF, 30% MAF and 60% MAF.

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Table 7-15 Summary of Variation of Reach Water Area at Selected Velocity Exceedance Thresholds

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
V > Min	154	205	222	249	270	286	312	330	339	341	342	347	353	354	354	355
V > 0.5	82	121	137	205	225	250	281	298	323	325	327	332	338	338	339	339
V > 1.0	37	66	82	100	116	120	129	132	138	144	145	176	184	184	184	185
V > 2.0	3	10	13	34	36	36	39	40	48	50	51	52	69	75	96	98
V > 3.0	-	-	-	8	9	9	12	13	11	37	37	39	41	44	44	44
V > 4.0	-	-	-	-	-	-	-	-	-	10	10	11	11	12	12	12
V > 5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

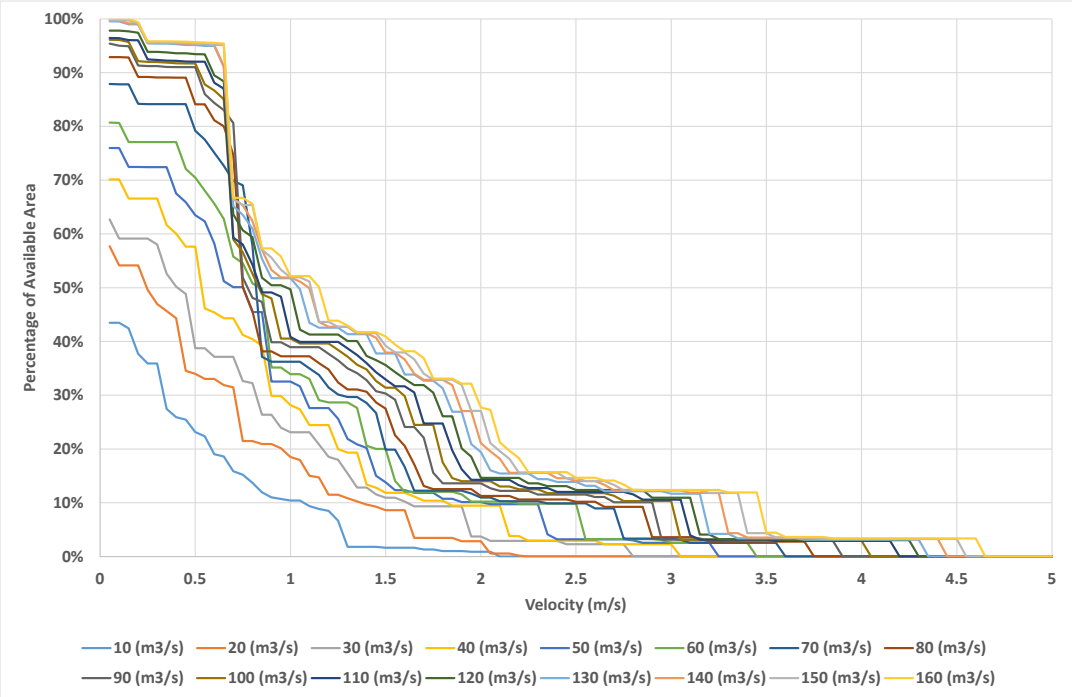


Figure 7-49 Variation of Reach Water Velocity Exceedence as a Percentage of Total Wetted Area

Figure 7-50 shows how the average shear stress in the reach varies with flow:

- At a flow of 10 m^3/s (minimum flow), the average shear stress is 15 N/m^2 ((over 44% and 48% of peak and natural flow conditions respectively);
- At a flow of 90 m^3/s (typical off-peak flow), the average shear stress is 30 N/m^2 (over a wetted area of 87% and 94% of peak and natural flow conditions respectively); and
- At a flow of 160 m^3/s (typical peak flow), the average shear stress is 55 N/m^2 (over a wetted area of 100% and 109% of peak and natural flow conditions respectively).

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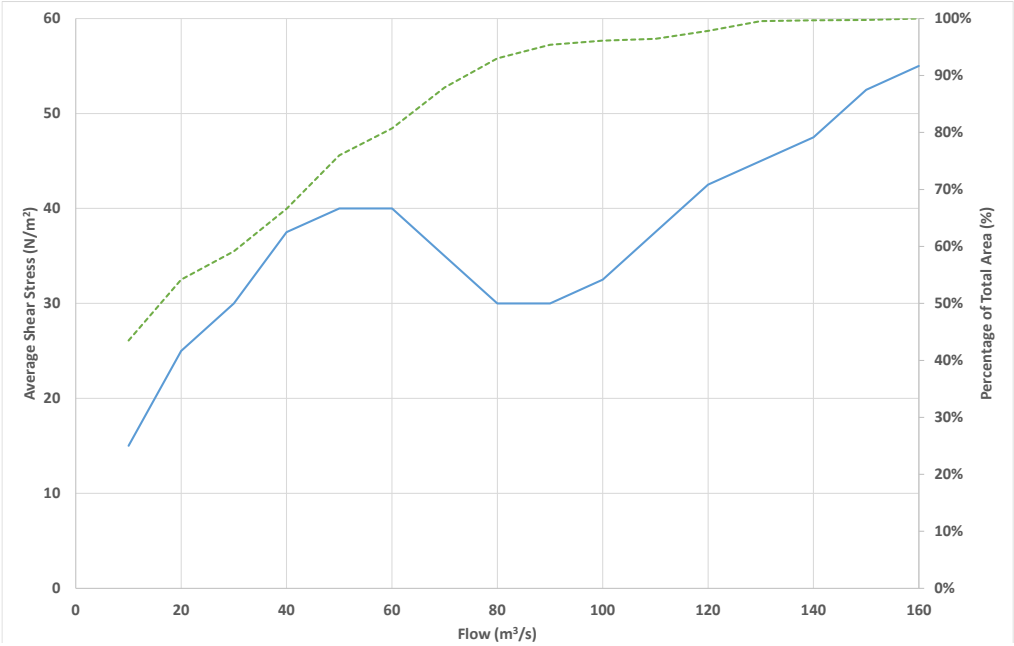


Figure 7-50 Variation of Reach Average Shear Stress

Table 7-16 and Figure 7-51 provide further insight into how the shear stress[9] in the reach varies over a similar flow range[8]. For example:

- At a flow rate of 10 m^3/s (minimum flow), 90,000 m^2 (25%) has a shear stress of at least 10 N/m^2, 39,000 m^2 (11%) of at least 50 N/m^2, and 24,000 m^2 (7%) of at least 100 N/m^2.
- At a flow rate of 90 m^3/s (typical off-peak flow), 324,000 m^2 (91%) has a shear stress of at least 10 N/m^2, 138,000 m^2 (39%) of at least 50 N/m^2, and 112,000 m^2 (32%) of at least 100 N/m^2.
- At a flow rate of 160 m^3/s (typical peak flow), 340,000 m^2 (96%) has a shear stress of at least 10 N/m^2, 185,000 m^2 (52%) of at least 50 N/m^2, and 145,000 m^2 (41%) of at least 100 N/m^2.

Table 7-16 Summary of Variation of Reach Area at Selected Shear Stress Exceedance Thresholds

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
τ > 0.5	154	192	210	236	270	286	312	330	339	341	342	347	353	354	354	355
τ > 2.5	130	188	210	236	257	274	299	317	325	328	330	335	339	341	341	342
τ > 10	90	123	173	205	229	250	281	299	324	327	328	333	339	339	339	340
τ > 25	66	106	132	157	178	198	245	265	272	187	197	212	222	223	228	234
τ > 50	39	74	85	104	112	120	129	132	138	141	142	150	154	159	182	185
τ > 100	24	38	46	63	72	84	94	109	112	114	122	126	135	135	145	145
τ > 200	4	12	33	34	35	36	42	43	47	48	51	52	55	55	55	56

[9] Reported shear stress thresholds are the approximate critical thresholds (higher range values) for sediment mobility for medium sand, very coarse gravel, and fine cobbles.

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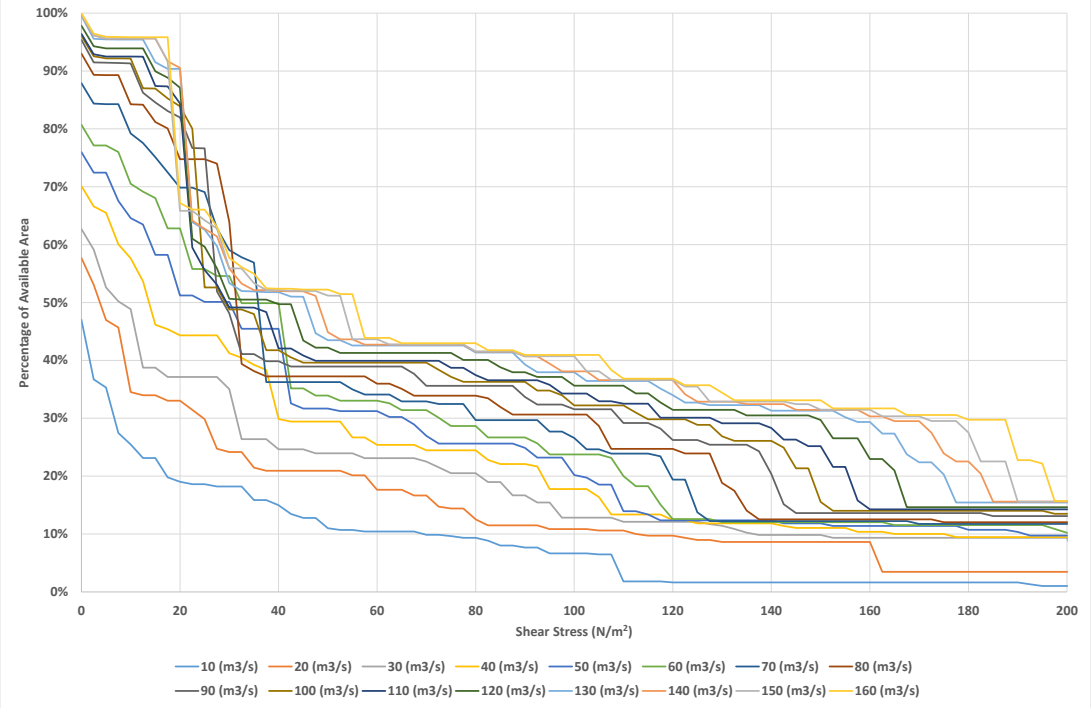


Figure 7-51 Variation of Reach Water Shear Stress Exceedence as a Percentage of Total Wetted Area

The reach water depth and velocity data has also been combined to provide an estimate of hazard (using the classification system developed by the Australian Water Research Laboratory).

Figure 7-52 summarises the hazard classification of the reach over the modelled range of flows (where class 1 is “very low” hazard and class 6 is “very high” hazard). It can be seen that, as expected, hazard generally increases with flow magnitude (as both depth and velocity increase):

- At a flow rate of 10 m^3/s (minimum), 34.4% of the reach is considered to be at a hazard rating of 3 or less, and 12.7% is of the reach is considered to be at a hazard rating of 4 or more.
- At a flow rate of 90 m^3/s (typical off-peak flow), 25.3% of the reach is considered to be at a hazard rating of 3 or less, and 70.1% is of the reach is considered to be at a hazard rating of 4 or more.
- At a flow rate of 160 m^3/s (typical peak flow), 3.4% of the reach is considered to be at a hazard rating of 3 or less, and 96.6% is of the reach is considered to be at a hazard rating of 4 or more.

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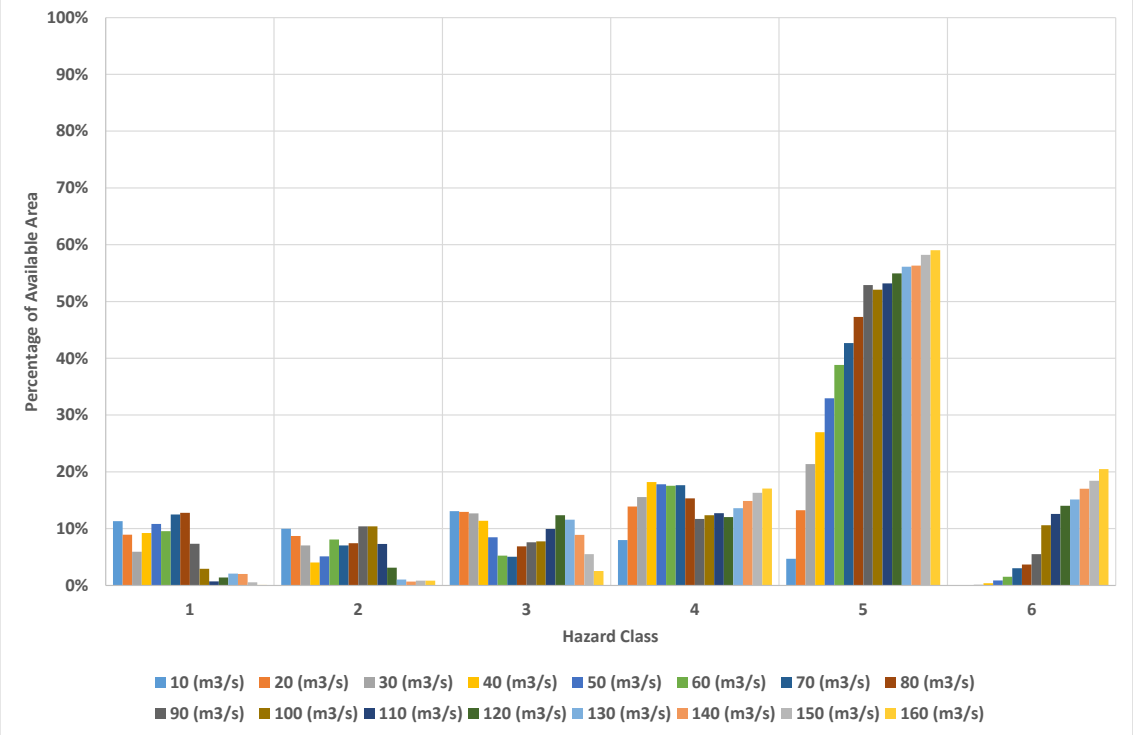


Figure 7-52 Hazard Classification of the Reach

The hydrological and hydraulic characteristics in the reach show a reach that is subject to a high level of sub-daily variation in river flow. The total wetted area typically varies between 157,000 m^2 and 354,000 m^2. Compared with average flow conditions, it both shrinks to half of its usual size and expands by approximately one-sixth of its usual size on a daily basis. Average depth changes on a typical day between 0.55 m and 1.60 m. Average velocity changes on a typical day between 0.55 m/s and 1.15 m/s. Within reach variations of depth and velocity are noticeably higher[10], with depths varying by between 0.15 m and 3 m, and velocities varying by between 0.15 m/s and 3.45 m/s.

C The Ruzizi II – Burundi Border Reach

The existing HEC-RAS model of the reach between the dam wall and approximately 1.4 km downstream of the powerhouse has been used as the basis for constructing a 1D hydraulic model of the full reach between the Ruzizi II dam wall and (just below) the confluence with the River Ruhwa.

Surveyed cross-section data has been reviewed and synthetic cross-sections generated for the non-surveyed reaches. The synthetic cross-sections explicitly take into account both the general pattern of in-bank river geomorphology and local variation. Figure 7-53 illustrates the variation in cross-section profile in the surveyed reach, illustrating the range of depths[11] (expressed as a percentage of maximum depth) surveyed across each cross-section profile.

[10] Reported variations are based on the 10% and 90% exceedance percentile range for modelled reach depths and velocities.
[11] The range of surveyed depths is expressed in terms of exceedance percentiles.

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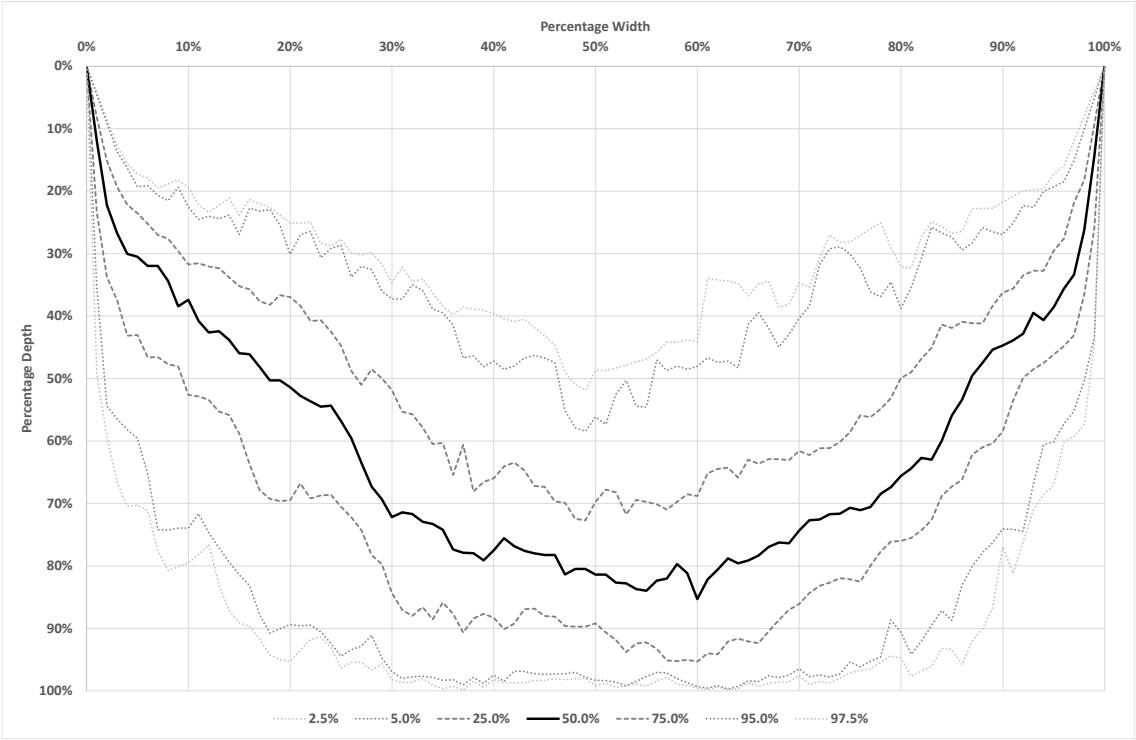


Figure 7-53 Variation in Cross-Section Profile in the Surveyed Reach

Cross-section width has been estimated from satellite imagery. Bank-full levels have been defined with reference to available DTM data, ALOS 30m data in the reach downstream of Bugarama Bridge and 2m photogrammetry data (Fichtner, 2009)[12] in the remainder of the (non-surveyed) reach upstream of Bugarama Bridge. The DTM data bank-full long profile was reviewed – and included use of field observations (January 2022) of the river profile– to smooth out local discrepancies. Field observations were also used in assigning roughness values to the synthetic cross-sections. As with the existing HEC-RAS model, the main channel was assigned a Manning's n value of 0.07, out-of-bank was assigned a value of 0.1.

Five baseline scenarios have been modelled, based on the optimised reservoir operation schedules presented in the Feasibility Report:

- "Very dry" conditions (95% exceedance probability);
- "Dry" conditions (90% exceedance probability);
- "Normal" conditions (50% exceedance probability);
- "Wet" conditions (10% exceedance probability); and
- "Very wet" conditions (5% exceedance probability).

Table 7-17 summarises the model inflows adopted for each of these scenarios. The model inflows include: i) Ruzizi II environmental flow; ii) Ruzizi II powerhouse release; iii) 'intervening catchment' inflows; iv) River Rubyiro inflows; and v) River Ruhwa inflows.

[12] Etude de Faisabilité pour l'Aménagement Hydroélectrique de Ruzizi III, VOLUME IV : TOPOGRAPHIE, Rapport final.

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Table 7-17 Summary of baseline hydrological inflows in the Ruzizi II – Burundi Border Reach

Conditions	Ruzizi II Environmental Flow (m^3/s)	Ruzizi II powerhouse release (m^3/s)	Intervening Catchment Flow (m^3/s)	Total Flow to Ruzizi III (m^3/s)	River Rubyiro Flow (m^3/s)	River Ruhwa Flow (m^3/s)
Very Dry	10.8	See Figure 7-54	1.3	78.3	3.7	8.2
Dry	10.8		1.6	84.3	4.6	10.1
Normal	10.8		2.4	108.4	6.9	15.2
Wet	10.8		3.7	131.1	10.6	23.4
Very Wet	10.8		4.9	139.2	14.1	31.0

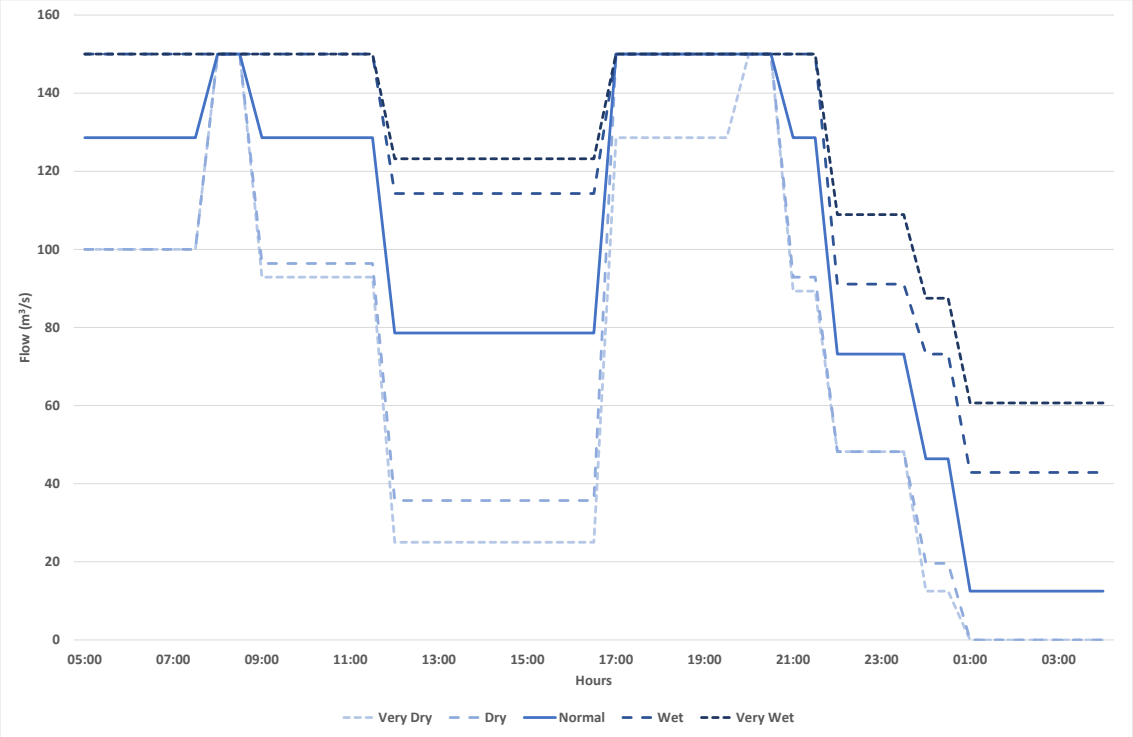


Figure 7-54 Ruzizi II Powerhouse Release Schedules

The model has been run for a 48-hour duration (repeated daily schedule). The operational schedule has been implemented such that changes between flow values are assumed to occur over a 30 minute-duration (based on current operational conditions at Ruzizi II). The 1D Finite Volume Solver has been used to improve model stability and performance for the observed flow conditions.

Modelled flow and water levels are reported for selected key locations:

- Downstream Ruzizi II dam wall / powerhouse release;
- Downstream intervening catchment;
- Downstream Ruzizi III powerhouse release location;
- Upstream Bugarama Bridge / Kamanyola Monitoring Station;
- Upstream Rubyiro tributary;
- Upstream Burundi border / Ruhwa tributary; and
- Downstream Burundi border / Ruhwa tributary.

Figure 7-55 and Figure 7-56 summarise the maximum flow (m^3/s), minimum flow (m^3/s), flow range (m^3/s), maximum water level elevation (mAOD), minimum water level elevation (mAOD), water level elevation range (m), and water level ramp-up and ramp-down rates (cm/min) for selected durations (15-minute, 30-minute, and 60-minute).

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Location	Flow Range	Max Flow (m^3/s)	Min Flow (m^3/s)	Flow Range (m^3/s)	Max Elevation (mAOD)	Min Elevation (mAOD)	Elevation Range (m)
Ruzizi II dam wall / powerhouse release	**"Very Dry" (95% exceedence)**	161	11	150	1,368.43	1,366.86	1.57
Downstream intervening catchment		162	12	149	1,273.25	1,271.45	1.80
Ruzizi III powerhouse release		160	12	148	979.62	977.95	1.67
Upstream Bugarama Bridge		160	12	148	947.55	945.74	1.81
Upstream Rubyiro tributary		158	12	146	929.80	927.82	1.98
Upstream Burundi border		162	16	146	920.01	918.81	1.20
Downstream Burundi border		171	25	146	908.82	907.65	1.17
Ruzizi II dam wall / powerhouse release	**"Dry" (90% exceedence)**	161	11	150	1,368.44	1,366.86	1.58
Downstream intervening catchment		162	12	150	1,273.26	1,271.46	1.80
Ruzizi III powerhouse release		162	12	150	979.63	977.96	1.67
Upstream Bugarama Bridge		162	12	150	947.57	945.75	1.82
Upstream Rubyiro tributary		162	12	150	929.84	927.83	2.01
Upstream Burundi border		167	17	150	920.03	918.83	1.20
Downstream Burundi border		178	28	150	908.86	907.70	1.16
Ruzizi II dam wall / powerhouse release	**"Normal" (50% exceedence)**	161	23	138	1,368.44	1,367.05	1.39
Downstream intervening catchment		163	26	138	1,273.26	1,271.75	1.51
Ruzizi III powerhouse release		163	26	138	979.64	978.31	1.33
Upstream Bugarama Bridge		163	26	138	947.58	946.09	1.49
Upstream Rubyiro tributary		163	26	138	929.84	928.21	1.63
Upstream Burundi border		170	33	138	920.04	919.06	0.98
Downstream Burundi border		185	48	138	908.89	907.95	0.94
Ruzizi II dam wall / powerhouse release	**"Wet" (10% exceedence)**	161	54	107	1,368.44	1,367.41	1.03
Downstream intervening catchment		165	57	107	1,273.27	1,272.24	1.03
Ruzizi III powerhouse release		165	57	107	979.65	978.80	0.85
Upstream Bugarama Bridge		165	57	107	947.59	946.62	0.97
Upstream Rubyiro tributary		165	57	107	929.86	928.77	1.09
Upstream Burundi border		176	69	107	920.07	919.41	0.66
Downstream Burundi border		200	93	107	908.97	908.37	0.60
Ruzizi II dam wall / powerhouse release	**"Very Wet" (5% exceedence)**	161	72	89	1,368.44	1,367.58	0.86
Downstream intervening catchment		166	76	89	1,273.28	1,272.47	0.81
Ruzizi III powerhouse release		166	76	89	979.65	979.01	0.64
Upstream Bugarama Bridge		166	76	89	947.60	946.83	0.77
Upstream Rubyiro tributary		166	76	89	929.87	929.01	0.86
Upstream Burundi border		181	91	89	920.09	919.58	0.51
Downstream Burundi border		213	124	89	909.02	908.57	0.45

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Figure 7-55 Summary of Baseline Flows and Water Levels at Selected Key Locations

Location	Flow Range	15-min max. ramp-up rate (cm/min)	15-min max ramp-down rate (cm/min)	30-min max. ramp-up rate (cm/min)	30-min max ramp-down rate (cm/min)	60-min max. ramp-up rate (cm/min)	60-min max ramp-down rate (cm/min)
Ruzizi II dam wall / powerhouse release		3.3	-2.2	2.8	-1.8	1.8	-1.1
Downstream intervening catchment		6.5	-1.7	4.3	-1.6	2.3	-1.2
Ruzizi III powerhouse release	**"Very Dry" (95% exceedence)**	7.9	-0.9	4.4	-0.8	2.2	-0.8
Upstream Bugarama Bridge		8.7	-0.9	4.7	-0.8	2.4	-0.7
Upstream Rubyiro tributary		8.9	-0.8	5.1	-0.8	2.6	-0.7
Upstream Burundi border		5.7	-0.5	3.1	-0.5	1.6	-0.5
Downstream Burundi border		5.7	-0.5	3.1	-0.5	1.6	-0.5
Ruzizi II dam wall / powerhouse release		3.3	-1.9	2.8	-1.6	1.8	-1.0
Downstream intervening catchment		6.5	-1.5	4.3	-1.4	2.3	-1.0
Ruzizi III powerhouse release	**"Dry" (90% exceedence)**	7.8	-0.8	4.4	-0.8	2.2	-0.7
Upstream Bugarama Bridge		8.7	-0.8	4.7	-0.8	2.4	-0.7
Upstream Rubyiro tributary		9.0	-0.8	5.1	-0.8	2.6	-0.7
Upstream Burundi border		5.7	-0.5	3.1	-0.5	1.6	-0.4
Downstream Burundi border		5.5	-0.5	3.0	-0.4	1.5	-0.4
Ruzizi II dam wall / powerhouse release		3.0	-1.6	2.9	-1.4	2.0	-0.9
Downstream intervening catchment		5.7	-1.2	4.0	-1.1	2.2	-0.9
Ruzizi III powerhouse release	**"Normal" (50% exceedence)**	6.7	-0.7	3.8	-0.7	2.0	-0.6
Upstream Bugarama Bridge		7.9	-0.8	4.4	-0.7	2.2	-0.7
Upstream Rubyiro tributary		7.6	-0.8	4.7	-0.8	2.4	-0.7
Upstream Burundi border		5.0	-0.5	2.8	-0.4	1.4	-0.4
Downstream Burundi border		4.9	-0.5	2.8	-0.4	1.4	-0.4
Ruzizi II dam wall / powerhouse release		2.9	-1.7	2.5	-1.4	1.7	-0.9
Downstream intervening catchment		3.6	-1.2	2.8	-1.1	1.6	-0.8
Ruzizi III powerhouse release	**"Wet" (10% exceedence)**	3.7	-0.8	2.5	-0.7	1.4	-0.6
Upstream Bugarama Bridge		4.8	-0.9	3.0	-0.8	1.6	-0.7
Upstream Rubyiro tributary		4.6	-0.8	3.3	-0.8	1.8	-0.7
Upstream Burundi border		2.7	-0.5	1.9	-0.4	1.1	-0.4
Downstream Burundi border		2.7	-0.4	1.8	-0.4	1.0	-0.4
Ruzizi II dam wall / powerhouse release		2.5	-1.1	2.1	-1.0	1.4	-0.6
Downstream intervening catchment		2.6	-0.9	2.1	-0.8	1.3	-0.5
Ruzizi III powerhouse release	**"Very Wet" (5% exceedence)**	2.5	-0.6	1.8	-0.5	1.1	-0.4
Upstream Bugarama Bridge		3.1	-0.7	2.2	-0.6	1.3	-0.5
Upstream Rubyiro tributary		3.1	-0.6	2.4	-0.6	1.4	-0.5
Upstream Burundi border		1.7	-0.3	1.3	-0.3	0.8	-0.3
Downstream Burundi border		1.6	-0.3	1.2	-0.3	0.8	-0.3

Figure 7-56 Summary of Ramp-Up and Ramp-Down Rates at Selected Key Locations

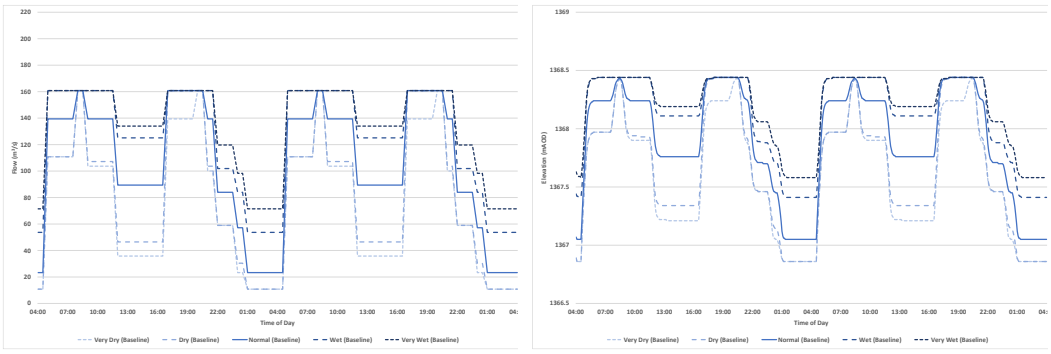
Figure 7-57 and Figure 7-58 provide a graphical summary of how flows and water levels vary over a 48-hour period at the selected key locations, for a variety of different inflow conditions (“very dry”, “dry”, “normal”, “wet”, and “very wet”).

This complements the summary previously provided in tabular format and clearly shows the variation on daily flows and levels throughout the day, associated with the morning and afternoon peak power productions periods, and also provides a clear illustration of how daily water level variation is lower towards the downstream part of the reach, due in large part to the influence of tributary inflows.

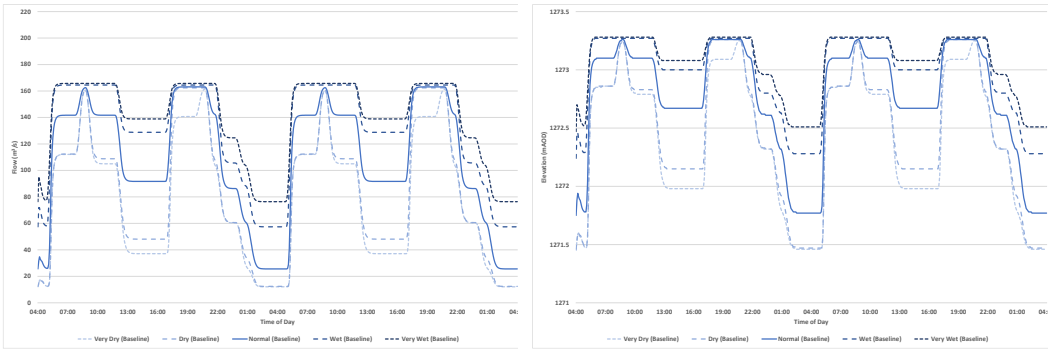
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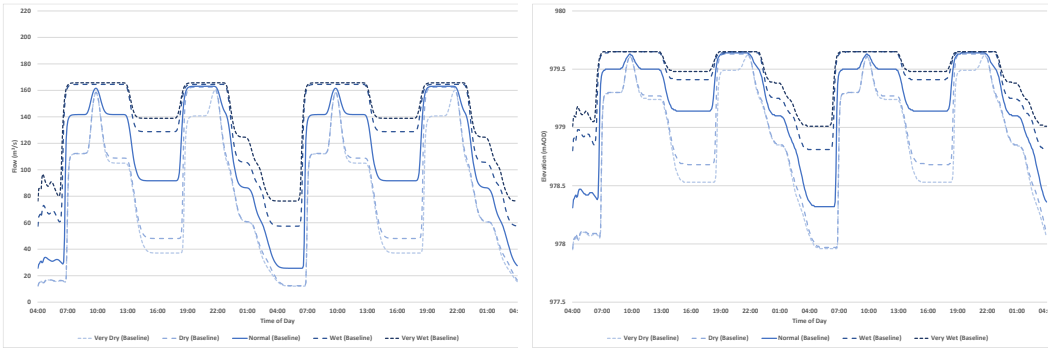
48-hour hydrographs (left) and limnigraphs (right) for different flow conditions



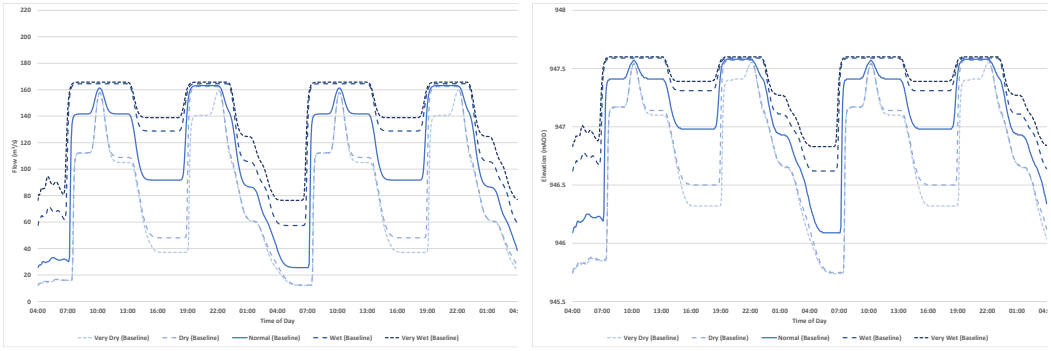
Downstream Ruzizi II dam wall / powerhouse release



Downstream intervening catchment



Downstream Ruzizi III powerhouse release location



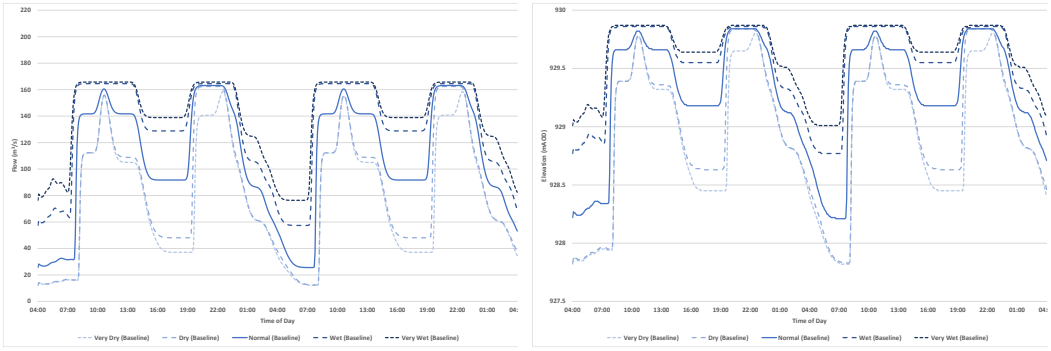
Upstream Bugarama Bridge / Kamanyola Monitoring Station

Figure 7-57 Modelled Flows and Elevations at Key Locations in the Ruzizi II – Burundi Border Reach (1/2)

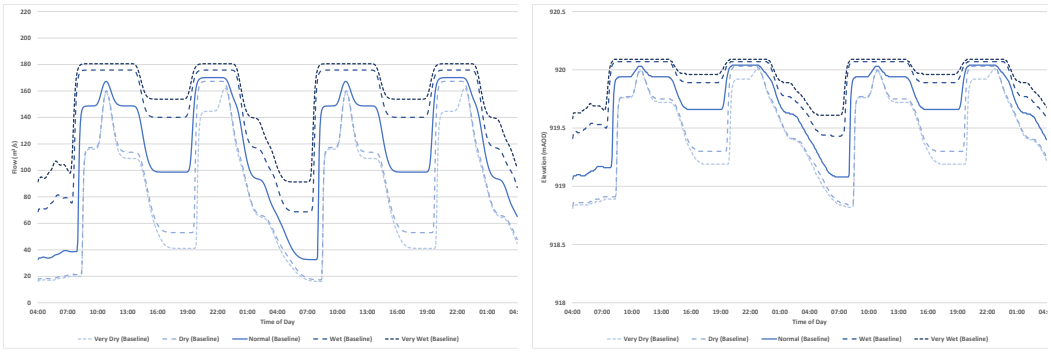
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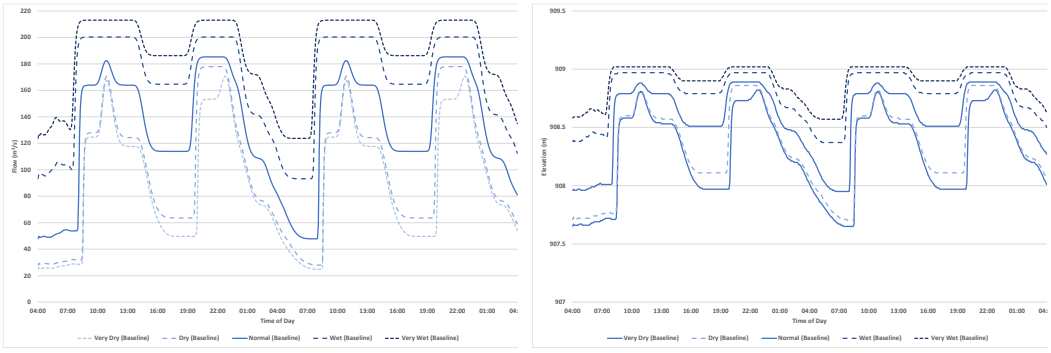
48-hour hydrographs (left) and limnigraphs (right) for different flow conditions



Upstream Rubyiro tributary



Upstream Burundi border / Ruhwa tributary



Downstream Burundi border / Ruhwa tributary

Figure 7-58 Modelled Flows and Elevations at Key Locations in the Ruzizi II – Burundi Border Reach (2/2)

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7.6.4 Flood Risk

The 'Hydrology and Sedimentation Review' undertaken in 2020 as part of the Ruzizi III Feasibility Study summarises the key issues related to the current flood risk at the proposed Ruzizi III dam wall location, and hence its associated flood security. The Natural Resources Conservation Service (NRCS) Unit Hydrograph method and the Rational Method have been applied to estimate the flood hydrograph of the reservoir spillway design flood and check flood.

It is reported that the Unit Hydrograph Method has adopted use of CN=81 such that a runoff coefficient of 30% is defined. This has been applied to the intervening contributing catchments between Ruzizi I and II (26.7 km^2) and between Ruzizi II and III (173.6 km^2).

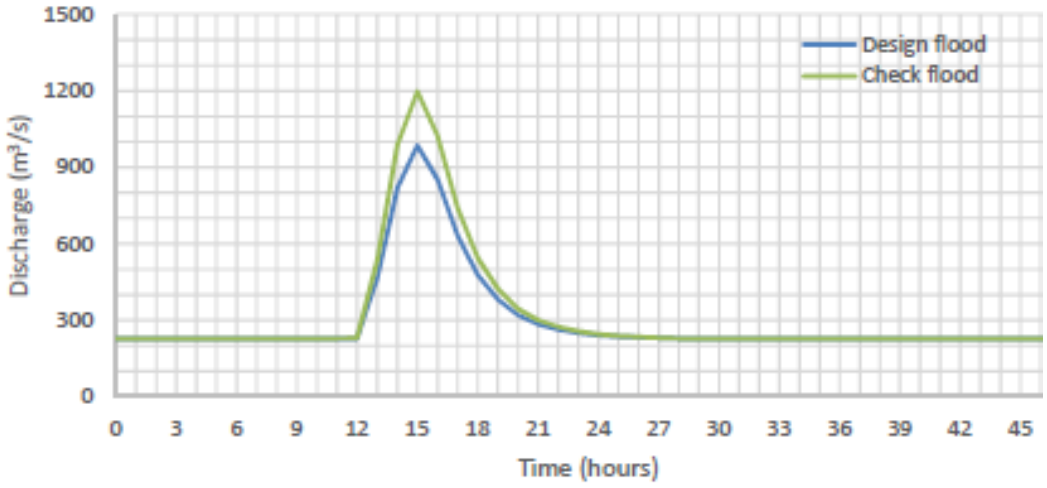
Rainfall Intensity-Duration-Frequency (IDF) curves based on data at Bugarama and Kamembe have been used, for a return period range of 2-years to 100-years. Rainfall depths for the 3-hour "critical storm" for the 10,000-year and 100,000-year return period events have been extrapolated from the IDF curves using a Gumbel distribution.

The intervening catchment floods are combined with the spill capacity of Ruzizi I (227 m^3/s) to provide an estimate of the "whole catchment" flood inflow hydrographs. Results summaries are presented for a range of return periods, the estimates for the design flood and check flood are as given in

Figure 7-59. It should be noted that flood peaks are largely dependent on flood estimates for the intervening catchments but flood volumes are more closely associated with the contribution from Ruzizi I.

Table 7-18 Discharge and Volume Characteristics of the Design and Check Floods

Flood	Q_{24h} (m^3/s)	Q_{3h} (m^3/s)	Q_p (m^3/s)	V_{24h} (hm^3)	V_{48h} (hm^3)	V72h (hm^3)	$V_{storage}$ (hm^3)
Design flood	362.9	884.8	985.7	31.4	51.0	70.6	2.0
Check flood	400.9	1,069.1	1,197.9	34.6	54.3	73.9	4.1
Source: Tractebel, 2020							



Global Hourly Hydrographs for the Design and Check Floods at Ruzizi III (Tractebel, 2020)

Figure 7-59 Summary of Ruzizi III Design Flood and Check Flood Estimates

It is reported that given a Ruzizi III design full release capacity of 700 m^3/s, flood storage of 2.0 hm^3 and 4.1 hm^3 is required to store the design and check floods.

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The 'Feasibility Study' itself reports that the Ruzizi III spillway has been designed based on a Design Flood of 986 m^3/s and a Safety Evaluation Flood of 1,420 m^3/s. That is, the Design Flood is based on the calculations presented above whereas the Safety Evaluation Flood also incorporates a "climate change" contribution, i.e., an 18% increase in peak flow (see 'Application of the Hydropower Sector Climate Resilience Guide' (Tractebel, August 2020)). An ungated labyrinth weir spillway has been designed to be located on the dam wall left abutment rock spur.

The flood estimates have been compared with preceding studies and have been considered comparable. However, it is noted that no attempt has seemingly been made to locally validate the estimates of design floods. There is both a large discrepancy in peak flow estimates between the Unit Hydrograph method and the Rational Method at a wide range of return periods (10-yr to 1,000-year) and a high degree of extrapolation uncertainty in the estimates of design flood and check flood rainfall totals.

It can also be noted that the Ruzizi III flood security estimates can be related to both the current baseline and future post-Ruzizi III downstream flood risk and impacts.

During the field mission undertaken in January 2022, it was also reported by local communities that flooding of riparian agricultural land occurs on a regular basis at various locations along the reach between Ruzizi III and the downstream tri-point border. For example, one report suggested annual short duration flooding a short distance upstream of the confluence with the River Rubyiro to a depth of approximately 0.7 m every April / May, resulting in extensive crop damage.

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7.7 Aquatic Ecology

The Aquatic Ecology Assessment was based on a desktop and field assessment approach. The methods used and the respective assumptions and limitations are provided in Annex D.

7.7.1 Regional Context

The Ruzizi River falls within two freshwater ecoregions: 1) Lake Victoria Basin; and 2) Lake Tanganyika Freshwater Ecoregion (FEOW 2020). The proposed HPP is located within the former, and includes the upper portion of the Ruzizi River, from Lake Kivu to ~90 river-km downstream, near the confluence of the Kagunizi River in Burundi. The lower ~40 km of the Ruzizi River falls within the Lake Tanganyika Freshwater Ecoregion (FEOW 2020).

The Lake Victoria Basin Freshwater Ecoregion supports a high diversity of freshwater fish, of which 79% are endemic to this ecoregion. The biological distinctiveness of this ecoregion is classified as "Globally Outstanding"; the global conservation status is classified as "Critical"; and conservation priority is classified as "Very High" (Table 7-19).

Table 7-19 Conservation Classification of the Lake Victoria Basin Freshwater Ecoregion

Biological Distinctiveness	Conservation Status	Priority Class
Globally Outstanding	**Critical**	**I – Very High**
Continentally Outstanding	Endangered	II – High
Bioregionally Outstanding	Vulnerable	III – Moderate
Nationally Important	Relatively Stable	IV – Low
	Relatively Intact	V – Very Low

Source: Oyugi and Chapman (2008)

Lake Victoria is the centre of fish diversity and endemism for this ecoregion, with the total number of fish species found here being estimated at over 600. All but four of these are haplochromine cichlids and several hundred have yet to be undescribed (Sayer, Máiz-Tomé, *et al*. 2018). Predation by Nile perch (*Lates niloticus*) following their introduction in the 1980s, compounded by habitat degradation in the wider basin, are believed to have driven around 200 of these species to extinction. The rivers draining into Lake Victoria, the largest being the Kagera, support a lower diversity of river-adapted fauna.

The Ruzizi River flows from Lake Kivu into Lake Tanganyika, and the fish composition is characterised by species from these two lakes rather than species from Lake Victoria. Lake Tanganyika is the oldest (9-12 million years (MY)) of the two, and because of its depth, one of the most stable lakes in Africa (Cohen, Soreghan, *et al.* 1993). As a result, its cichlid fauna has undergone explosive adaptive radiation and speciation, supporting a genetically, morphologically, ecologically and behaviourally more complex and diverse cichlid flock than elsewhere in Africa (Salzburger, Meyer, *et al*. 2002). Indeed, the haplochromine cichlids are believed to have originated in Lake Tanganyika and seeded other water bodies in Africa, including Lakes Malawi and Victoria (Pauquet, Salzburger, *et al*. 2018). Of the 287 fish species found in the lake, 57 are cichlids, of which 49 are endemic (Abell, Thieme, *et al*. 2008). Because of its linkage via the Lukuga River to the Congo Basin, the fish fauna of the Ruzizi Basin bears many affinities with the Congo basin.

Lake Kivu has a lower fish diversity (29 species, including five introduced species) compared with either of the Lakes Tanganyika or Victoria (Snoeks, Kaningini, *et al.* 2012). The paleolimnology of the Lake Kivu shows that it was much less stable than Lake Tanganyika and that it initially drained north towards Lake Edward and the Nile River basin during the Pleistocene. However, uplift resulting from the Virunga volcanoes likely caused it to become endorheic until the link via the Ruzizi River to Lake Tanganyika became established (Haberyan and Hecky 1987, Snoeks, Kaningini, *et al*. 2012). As a result, and

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because of Lake Tanganyika's links to the Congo Basin, it is now part of the latter's drainage. The earlier link to the Victoria Basin explains why the lake's fish species community more closely resembles the latter basin's fauna more so than it does the Tanganyikan or Congo faunas (Snoeks, Kaningini, *et al*. 2012). This explains the presence of species such as *Enteromius kerstenii,* which is found in Lake Kivu, the Ruzizi River as well as the middle Kagera River in the Lake Victoria Basin. Like the other lakes in the region, Lake Kivu was affected by a period of aridity 10,000-15,000 years ago, and while not completely drying out, high salinity levels may have contributed to the lower diversity of fish currently found (Snoeks, Kaningini, *et al*. 2012).

The river fish fauna differs from either of the two lake's fish fauna in composition and structure, with a higher proportion of rheophilic (flowing water) species, such as the Amphiliid and Mochokid catfish, together with the larger rheophilic cyprinids (*Labeobarbus* species). The cichlids which occur in the river are either likely to be incidental, or those species better adapted to rheophilic conditions. Historically, the Ruzizi has been an important dispersal corridor between Lakes Kivu and Tanganyika for species like the Lake Rukwa minnow (*Raiamas moorii*), which is thought to have colonised Lake Kivu from Lake Tanganyika, and the Ripon barbel (*Labeobarbus altianalis*), which is thought to have colonised in the opposite direction (Snoeks, Kaningini, *et al*. 2012). This latter species is also found in the Victoria Basin, suggesting the common drainage this basin once shared with Lake Kivu.

7.7.2 Hydrogeomorphological Types

Three hydrogeomorphic aquatic ecosystem types were identified within the Project AoI: two in the Ruzizi River, and one in a tributary, as follows:

Type:	**1) Transitional Zone (Ruzizi River)**
Description:	Mostly a single, confined channel, but anastomosed in places (Figure 7-60)
Width:	20 to 60 m wide, but anastomosed areas up to 300 m wide
Gradient:	0.0238 to 0.0244 (moderate)
Sites:	R01 to R10 (i.e. the Full Supply Level, proposed dam and tailrace outlet)
Substrates:	Gravel - F (2-8): 0 Gravel - M (8-16): 2 Gravel - C (16-64): 3 Cobble - Small (64-128): 3 Cobble - Large (128-250): 4 Boulder - Small (250-500): 5 Boulder - Medium (500-1000): 2 Boulder - Large (1000-4000): 1 Bedrock: 2 Waterfall: 0 **Rating categories** 0 = not present 1 = rare (>0–5%) 2 = sparse (>5–25%) 3 = common (>25–50%) 4 = abundant (>50–75%) 5 = predominant (>75–95%) 6 = near-entire (>95–100%)
Soils:	Umbric Acrisols (left bank), which are characterised by acidic conditions, low nutrients; and with clay-rich subsoil; and Umbric Ferrasols (right bank), which are leached soils characterized by low nutrients (Jones *et al.* 2013).

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Figure 7-60 Hydrogeomorphological Types - Transitional Zone

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Type:	**2) Upper Foothill (Ruzizi River)**
Description:	Mostly a single, unconfined channel, but with multiple channels in places (Figure 7-61)
Width:	Mostly 30 to 60 m wide, but up to 200 m wide in areas with islands
Gradient:	0.0059 (gentle)
Sites:	R12 to R14 (downstream of the proposed HPP)

Substrates:

Sand - Fine (0.125-0.5)	2
Sand - Coarse (0.5-2.0)	0
Gravel - F (2-8)	1
Gravel - M (8-16)	1
Gravel - C (16-64)	2
Cobble - Small (64-128)	2
Cobble - Large (128-250)	4
Boulder - Small (250-500)	4
Boulder - Medium (500-1000)	0
Boulder - Large (1000-4000)	0
Bedrock	0
Waterfall	0

Rating categories
0 = not present
1 = rare (>0–5%)
2 = sparse (>5–25%)
3 = common (>25–50%)
4 = abundant (>50–75%)
5 = predominant (>75–95%)
6 = near-entire (>95–100%)

Soils: Undifferentiated Nitisols, which are deep red soils with well-developed structure and derived from iron-rich rocks, such as basalt (Jones *et al.* 2013).



Figure 7-61 Hydrogeomorphological Types - Upper Foothill Zone

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Type:	**3) Mountain Headwater (Tributary)**
Description:	Small tributary of the Ruzizi River on the left bank (Rwanda), comprising a single, confined channel (Figure 7-62). These tributaries were mapped but they were too narrow to map instream habitats.
Width:	Mostly 2 m wide
Gradient:	0.283 (steep)
Sites:	T1, within the proposed Full Supply Level
Substrates:	Sand - Fine (0.125-0.5): 3 Sand - Coarse (0.5-2.0): 2 Gravel - F (2-8): 1 Gravel - M (8-16): 2 Gravel - C (16-64): 3 Cobble - Small (64-128): 3 Cobble - Large (128-250): 4 Boulder - Small (250-500): 4 Boulder - Medium (500-1000): 2 Boulder - Large (1000-4000): 2 Bedrock: 2 Waterfall: 0 **Rating categories** 0 = not present 1 = rare (>0–5%) 2 = sparse (>5–25%.) 3 = common (>25–50%) 4 = abundant (>50–75%) 5 = predominant (>75–95%) 6 = near-entire (>95–100%)
Soils:	Umbric Acrisols (left bank), which are characterised by acidic conditions, low nutrients and with clay-rich subsoil (Jones *et al.* 2013)



Figure 7-62. Hydrogeomorphological Types - Mountain Headwater

A further three hydrogeomorphic types were recorded in tributaries, as listed in Annex D, but these were not detailed further for the purposes of this report as they were outside the Project AoI.

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7.7.3 Aquatic Biotopes

Aquatic biotopes within the three hydrogeomorphic zones were dominated by following depth-flow categories (Figure 7-63):

Transitional Zones (R01 to R10)	Upper Foothill (R12 to R14)	Mountain Headwater (T1)
• Deep – Very Fast (cascades) • Deep – Fast (rapids) • Deep – Slow (pools)	• Deep – Fast (rapids) • Shallow – Slow (runs)	• Shallow – Fast (Note: these were too narrow to map)



Figure 7-63 Aquatic Biotope Depth-Flow Categories in the Ruzizi River

[A) Deep-Very Fast; B) Deep-Slow; C: Shallow-Slow; D) Deep-Fast; E) Shallow-Fast]

7.7.3.1 Distribution of Aquatic Biotopes

Aquatic biotopes within the Full Supply Level of the proposed HPP reservoir comprised the following (Figure 7-64):

- One stretch of Deep-Very Fast Cascade, extending for ~650 m, and sufficient to present a potential natural barrier to upstream migration of some species of fish.
- Two areas of Shallow-Fast Riffle, which are likely to be important spawning areas for *Labeobarbus* species.
- Two stretches of Deep-Fast Rapids, with a total length of ~1,600 m.

Aquatic biotopes within the dewatered area of the proposed HPP comprised the following (Figure 7-65):

- Five stretches of Deep-Very Fast Cascade, with a total length of ~1,600 m.
- Seven stretches of Deep-Fast Rapids, with a total length of ~2,700 m.

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- One area of Shallow-Fast Riffle, ~600 m downstream of the proposed HPP, which is likely to be important spawning areas for *Labeobarbus* species.
- Two stretches of Deep-Slow Pools, with a total length of ~1,200 m.

Aquatic biotopes downstream of the proposed tailrace outlet comprised the following (Figure 7-66):

- Mostly Deep-Fast Rapids.
- One area of Deep-Flow Pool.
- One area of Shallow-Fast Riffle, ~4,300 m downstream of the proposed tailrace outlet.

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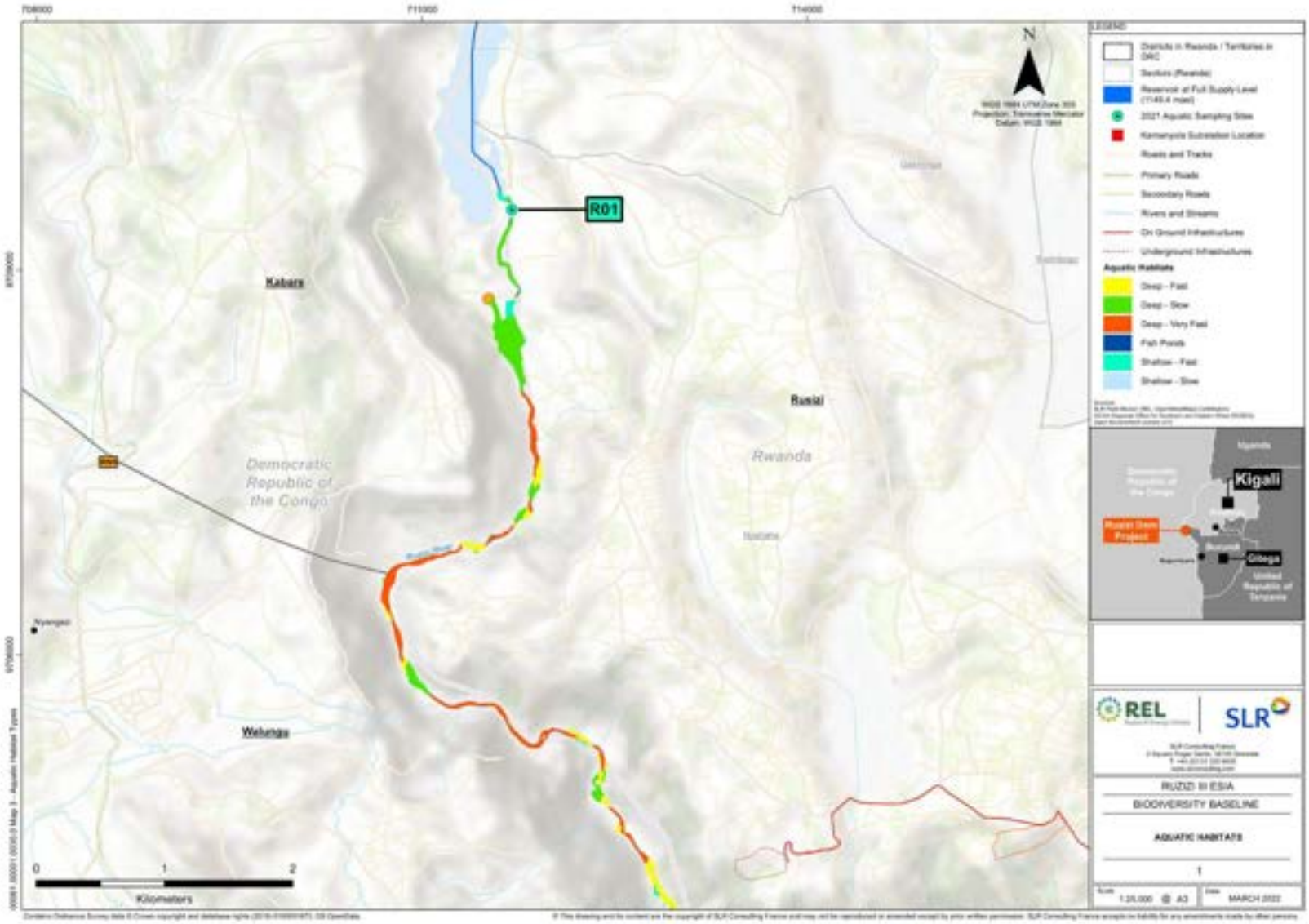


Figure 7-64 Aquatic Biotopes Within the Ruzizi River Upstream of the Ruzizi III Reservoir

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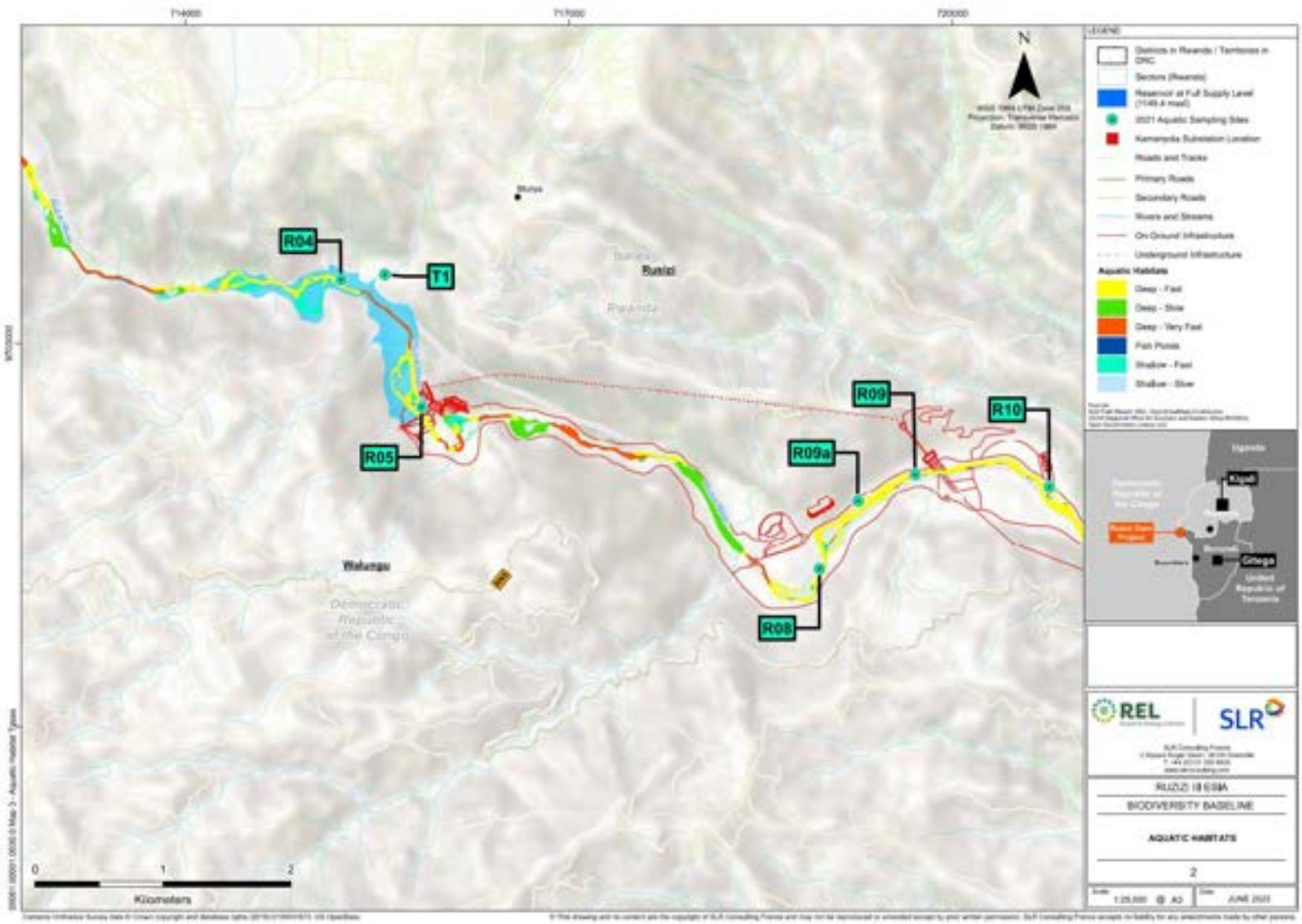


Figure 7-65 Aquatic Biotopes Within the Ruzizi III Reservoir and Dewatered Reach
Note: Proposed Ruzizi III Dam is at survey site R05, while tailrace outlet lies between R09 and R10

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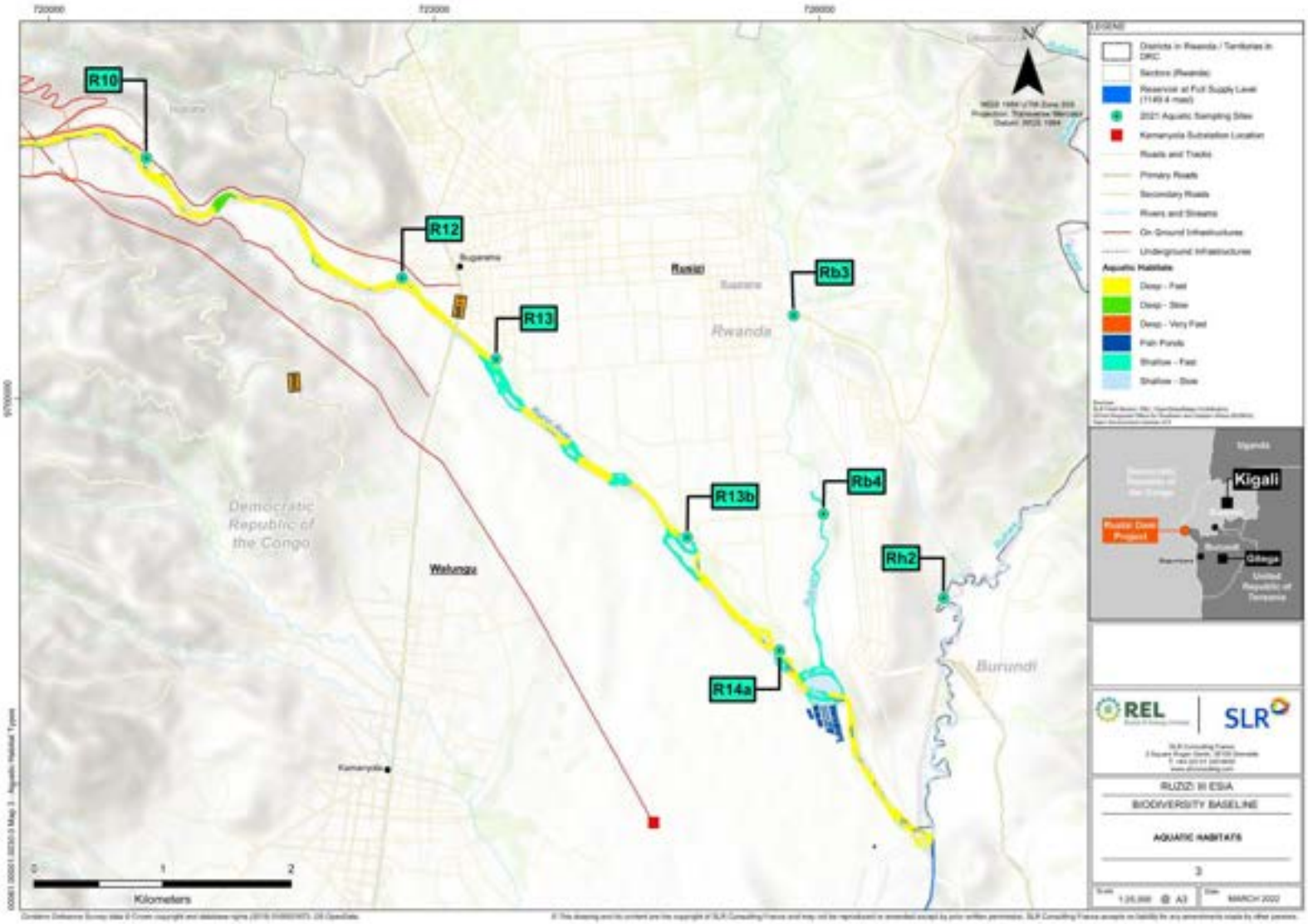


Figure 7-66 Aquatic Biotopes Downstream of the Powerhouse and the Burundi Border

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7.7.3.2 Water Levels

Water levels in the Ruzizi River during the field survey in January 2022 were high for most of the survey period, but there were short periods of lower water level, when turbines at Ruzizi II were closed. A sudden short-term drop in water level was noted at the permanent stage at S2.696590, E28.962200, on 21 January 2022. The water level at this site dropped from 2.65 to 2.53 m (12 cm) in about 40 minutes between ~15h20 and 16h00 (Figure 7-67).



Figure 7-67 Water Level in the Ruzizi River at 16h00 on 21 January 2022

7.7.3.3 Water Quality

Water in the Ruzizi River in January 2022 was light brown and had low to moderate turbidity that ranged between 5 and 39 NTU (Table 7-20). The pH was alkaline and ranged between 8.8 and 8.9 (Table 7-20). Conductivity was elevated and ranged between 105 and 108 mS/m (Table 7-20). Similar results were reported previously (Sher 2020, Mulungula 2020).

Table 7-20 Field Water Quality Results

Code	Colour	Turbidity (NT)	pH	Conductivity (mS/m)	Date
Ruzizi River					
R04 #	Light Brown	5	8.8	105	2022/01/20
R09	Light Brown	15	8.8	108	2022/01/21
R12	Light Brown	39	8.8	108	2022/01/12
R13	Light Brown	8	8.8	110	2022/01/22
R14a	Light Brown	7	8.9	108	2022/01/22
Tributaries					
Rb4	Reddish-Brown	107	7.5	27	2022/01/22
Rh2	Reddish-Brown	757	7.6	8	2022/01/23

Water in the lower Rubyiro River at Rb4 on 22 January 2022 was reddish-brown and had elevated turbidity of 107 NTU (Table 7-20). The pH was circum-neutral at 7.5, and conductivity was moderate at 27 mS/m (Table 7-20).

Water in the lower Ruhwa River at Rh2 on 23 January 2022 was reddish-brown and had extreme elevated turbidity of 757 NTU (Table 7-20). The pH was circum-neutral at 7.6, and conductivity was low at 8 mS/m (Table 7-20).

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7.7.4 Benthic Diatoms

Diatom analysis results are summarised in Table 7-21. Detailed results are presented in Annex D.

Table 7-21 Summary of Diatom Results

Code	No of Species	SPI Score	PTV (%)	Deformities (%)	Class	Category
R01	31	6.8	5.5	0	Poor	D/E
R04	10	7.4	0.3	0	Poor	D/E
R09	17	5.5	7.8	0	Bad	E

SPI = Specific Pollution Index; BDI=Biological Diatom Index; PTV=Pollution Tolerant Valves

Site R01

The SPI Score at Site R01 in January 2022 was 6.8 (D/E Ecological Category). Biological water quality prevailing at the time of sampling was *Poor.* While organic load was low, nutrient levels and salinity concentration was elevated. Nutrient levels had the biggest influence on diatoms at this site. Further analysis of the various indices within OMNIDIA suggested that pollution levels were moderate. Species diversity was the highest of the three sites sampled. *Luticola* species occurred at highest abundance and suggested that sedimentation rates were high. *Luticola* species are mostly found in terrestrial and sub-aerial habitats and washed into streams when flow increases. The dominance of motile species within the diatom community, suggested that nutrients were elevated and most probably increasing, as motile species are superior competitors for nutrients in nutrient-rich environments and can physically avoid stress within the benthic mat by moving to resource-rich microhabitats (Passy *et al*. 2007). The dominance of *Nitzschia* species and *Amphora pediculus* reflected the nutrient-rich conditions. According to Cholnoky (1968), *Nitzschia* species are abundant in waters with readily available nutrients. *Amphora pediculus* has an optimum for total nitrogen, total phosphorus and dissolved oxygen concentrations (DOC) of 1.99 mg/L, 0.05 mg/L, and 1.46 mg/L, respectively (Tan *et al*. 2014). Valve deformities were absent, suggesting that metal toxicity was below detection limits.

Site R04

The SPI Score at Site R04 in January 2022 was 7.4 (D/E Ecological Category). Biological water quality prevailing at the time of sampling was *Poor.* While organic load was low, nutrient levels and salinity concentrations were high. Nutrient levels had the biggest impact on the site and increased from Site R01. Further analysis of the various indices within OMNIDIA suggested that pollution levels were large and increased from Site R01. Species diversity was the lowest of the three sites sampled. *Luticola* species dominated the diatom community by 67%, suggesting sudden flow fluctuation and high sedimentation rates. As observed at Site R01, motile species were prolific, with *Nitzschia* species dominating. This reflected high nutrient levels that increased between Site R01 and R04. Valve deformities were absent, suggesting that metal toxicity was below detection limits.

Site R09

The SPI Score at Site R09 in January 2022 was 5.5 (E Ecological Category). The water quality prevailing at the time of sampling was *Bad* and ecologically unacceptable. Organic load was the highest at this site compared to the other two sites sampled. The data suggested that salinity concentration and nutrient levels increased to levels that were concerning. Further analysis of the various indices within OMNIDIA suggested that pollution levels were serious, increasing from Site R04. Species composition was similar to Sites R01 and R04, with *Luticola* and *Nitzschia* species dominating. The abundance of *Luticola* species decreased between Site R04 and R09, suggesting that sediment loading decreased between the sites. However, nutrient levels increased notably and were reflected by the increased abundance of *Nitzschia* species at Site R09. *Nitzschia palea* was sub-dominant and is typical of phosphate enriched or organically polluted waters (Teply and Bahls, 2006). According to Davey *et al.* (2008) this species has an optimum filterable phosphorus between 0.35 and 1 mg/L and can tolerate a broad range of phosphorus concentrations. Valve deformities were absent, suggesting that metal toxicity was below detection limits.

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7.7.5 Aquatic Flora

Submerged vegetation in the main channel of the Ruzizi River comprised extensive mats of the filamentous alga *Cladophora glomerata* (Figure 7-68 A). This species is the most abundant alga in alkaline streams and rivers throughout the world, and is typically associated with polluted conditions, especially elevated concentrations of phosphate (Burkholder 2009). This plant was evident on the stream bed when flows were dropped on the 27 February 2022, and this indicated that the riverbed was not light-limited. This plant appears to be the most important primary producer in the Ruzizi River, and as such, constitutes the base of the aquatic food chain. The food chain in the Ruzizi River therefore is founded mainly on a monoculture of this species, which is typically associated with ecological disturbance, such as pollution.

The filamentous cyanobacterium *Phormidium* sp. was also noted at most sites in the Ruzizi River, but in lower abundance than *C. glomerata* (Figure 7-68 B). This genus is typically associated with polluted water with elevated concentrations of nutrients (Soltani *et al*. 2012). The river margins and bed were also colonised by patches of the aquatic moss *Barbula* sp. (Figure 7-68 C). There was a notable absence of floating weeds, such as water hyacinth, *Pontederia crassipes*.

There was no evidence of any Podomastaceae aquatic plants on rocks at any of the surveyed sites. Only one species of this family – *Tristicha trifaria* – which is IUCN listed as Least Concern and based on GBIF records is recorded in the Ruzizi River basin with no specific records from the Ruzizi River itself.

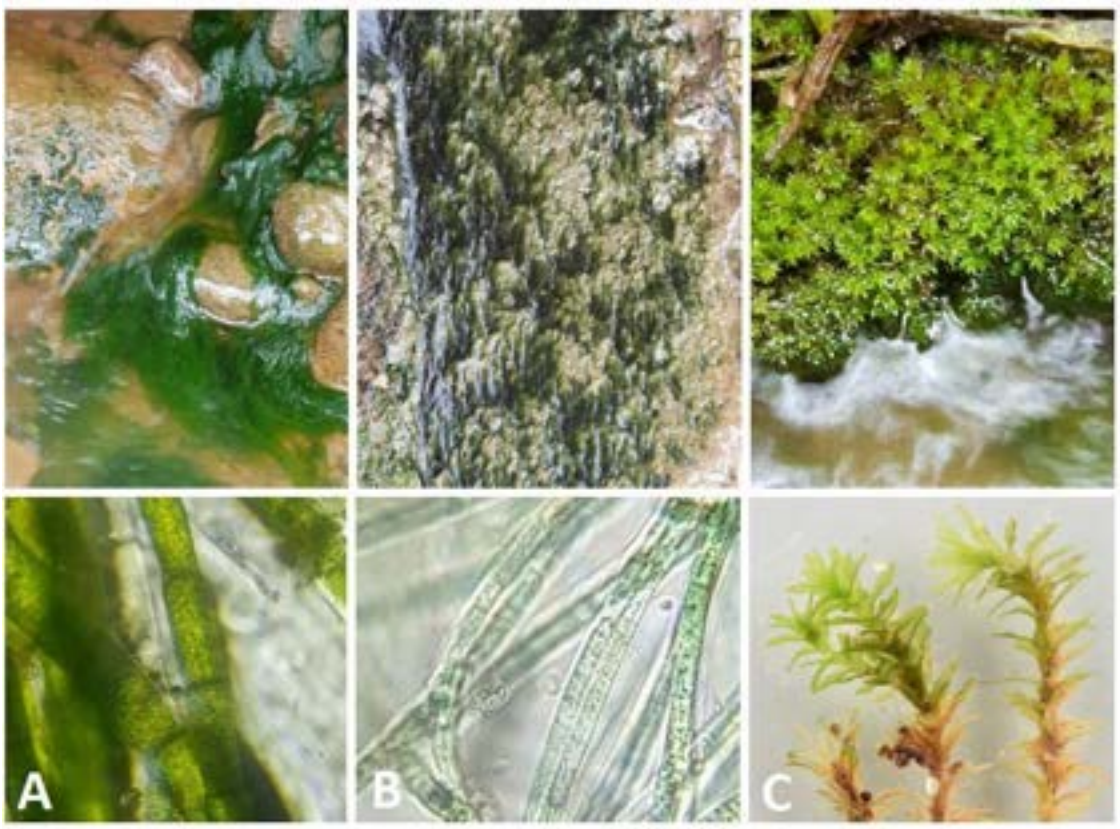


Figure 7-68 Aquatic Vegetation in the Main Channel and Margins of the Ruzizi River
[A) *Cladophora glomerata* (Cladophoraceae); B) *Phormidium sp.* (Phormidiaceae); C) *Barbula sp.* (Pottiaceae)]

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Emergent vegetation was dominated by the reed *Phragmites mauritianus.* Slow-Shallow margins of the Ruzizi River supported growth of various submerged or emergent herbs and grasses, and included Sago weed *Stuckenia pectinata*, *Ludwigia* cf. *palustris*, *Setaria geminata*, and the alien grass *Paspalum notatum* (Figure 7-68). There were also small patches of the alien sedge *Cladium mariscus* (Cyperaceae).

The wetland habitats within the river and along the river margins were typically small with several used for agriculture (where accessible during low flow) or for fish farming. These wetlands are subject to regular daily hydropeaking from upstream hydropower plants, and none were considered ecologically significant. Riparian wetland vegetation is discussed in Section 7.8.3.2.



Figure 7-69 Aquatic Vegetation in Shallow-Slow Margins of the Ruzizi River
[A) *Stuckenia pectinata* (Potamogetonaceae); B) *Ludwigia cf. palustris* (Onagraceae); C) *Setaria geminata* (Poaceae); D) *Paspalum notatum* (Poaceae).]

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7.7.6 Aquatic Macroinvertebrates

Aquatic macroinvertebrates recorded during the field surveys in January and February 2022 are listed in Annex D. The following section presents and discusses the results.

7.7.6.1 Diversity

The diversity of aquatic macroinvertebrates recorded in the Project AoI during the field surveys in 2022 was very low. The composition of taxa was dominated by true flies (Diptera), which comprised eight families; dragonflies and damselflies (Odonata), which comprised five families; and mayflies (Ephemeroptera), which comprised four families. The diversity of hydraulic habitats was high, and although the stream bed was largely embedded, there was sufficient instream habitat available to support a high diversity of macroinvertebrates. The low diversity of aquatic macroinvertebrates is attributed mainly to the impacts of short-term variations in water level associated with the operation of Ruzizi II. The lower diversity may also be attributed, in part, to the abundance of the filamentous alga *Cladophora glomerata,* which is likely to be unpalatable to many grazing macroinvertebrates. Furthermore, naturally elevated concentrations of salts may have contributed to the low diversity of macroinvertebrates by eliminating some of the more sensitive taxa, such as mayflies (Oligoneuridae).

7.7.6.2 Abundance

The abundance of aquatic macroinvertebrates recorded in the Project AoI during the field surveys in 2022 was very low, even when water levels were dropped on the 27 February 2022 to enable sampling on this day. The most common taxa were non-biting midges (Chironomidae), and the Stonefly *Neoperla spio* complex (Perlidae). The low abundance of aquatic macroinvertebrates is attributed to the impacts of short-term variations in water level associated with the operation of Ruzizi II. The fauna was characterised by taxa with moderate lifecycles (3-6 months). This suggests that ecological conditions were stable, and that the low abundance constituted typical conditions rather than a response to recent change. An implication of the low abundance of macroinvertebrates is that there was very little for insectivorous fish to feed on.

7.7.6.3 Present Ecological State

A Ruzizi River

The balance of evidence collected in January and February 2022 indicated that the Present Ecological State (PES) of aquatic macroinvertebrates in the Project AoI was *Seriously Modified* (Category E). This conclusion was based on the following lines of evidence: 1) SASS5 Data; 2) Indicator Species; 3) Drifting Stages; 4) Adult Odonata (RDBI); and 5) Malaise (Insect) Trap Data.

The findings of this assessment were compared with the study undertaken by Dusabe *et al.* (2022) to evaluate the influence of the existing Ruzizi I and Ruzizi II HEPP. The study sampled the macroinvertebrate community at eight stations from December 2015 to August 2017 every three months to cover both wet and dry seasons. Samples were collected at sites upstream and downstream of Ruzizi I and Ruzizi II. Additional samples were collected further downstream of Dam II at Manda/Ngomo and Kamanyola. The findings of the study were in alignment with this assessment, wherein the Ruzizi supports a low diversity of macroinvertebrates. The study confirmed the presence of more pollution tolerant species and scarcity of sensitive species upstream and downstream of Ruzizi I and II dams. It attributed the low macroinvertebrate diversity to a combination of naturally saline water from Lake Kivu, the effect of hydropeaking dams and riverbank disturbance and domestic pollution. Lake Kivu is a species-poor lake because of its geological history and catastrophic volcanic events that affect also its current limnology, and consequently the lake's environmental condition affects the Ruzizi River

The paper argues that there is no significant difference in macroinvertebrates between impounded and riverine habitats. However, the data is not directly comparable between the upstream Ruzizi River with its two impoundments and the downstream river partly due to the effect of more saline water from Lake Kivu but also because sampling methods used in the

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reservoir are not appropriate for standing water. The results actually appear to suggest that the low diversity in both dams and rivers in the upper Ruzizi may reflect the impact of dams on the downstream reach. The paper does not change the findings of this report that assess the Middle Ruzizi River as Modified Habitat as the data on fish and inverts indicate that the primary ecological functions and species composition are fundamentally modified by human activity.

A.1 SASS5 Data Field Survey 1

Sampling macroinvertebrates in January 2022 was limited by high water levels such that it was not possible to apply the South African Scoring System (SASS5) to each site that was sampled. However, an approximate SASS5 Score for the Project AoI was derived by pooling the data from all the sites that were sampled. Detailed results of this analysis are presented in Annex D. The results indicated seriously modified conditions for aquatic invertebrates. A total of 22 SASS5 taxa was recorded, and these gave an approximate SASS5 Total Score of 124, and an approximate Average Score per Taxon (ASPT) of 5.6. Sixteen (16) of the 22 SASS5 taxa recorded (i.e. 73%) are classified as tolerant or highly tolerant of water quality deterioration (sensitivity value <7). The most sensitive taxon recorded was the Stonefly *Neoperla spio* (Plecoptera), which has a sensitivity rating of 12/15. The most common taxa recorded were non-biting midges (Chironomidae), which have a low SASS5 sensitivity rating of 2/15. The Proportion of Sediment-Sensitive taxa (PSI) was low (0.3), indicative of elevated suspended sediments. The proportion of air-breathing taxa was moderate (18%), and this is higher than expected for a river that appears to be well-oxygenated. Functional feeding groups comprised a dominance of predators (43%), and this is typically associated with disturbance and an ecosystem that is in poor health. The ecological system therefore appeared to be functionally compromised. However, no alien macroinvertebrate taxon was recorded.

A.2 SASS5 Data Field Survey 2

SASS5 was applied to data on macroinvertebrates collected at Bugarama (Site R12) when water levels were dropped on the 27 February 2022. Detailed results of this analysis are presented in Annex D. The results indicated seriously modified conditions, and this confirmed the results from the previous survey. A total of 11 SASS5 taxa was recorded, and these gave a Total Score of 58, and an approximate Average Score per Taxon (ASPT) of 5.3. Eight of the eleven SASS5 taxa recorded (i.e. 73%) are classified as tolerant or highly tolerant of water quality deterioration (sensitivity value <7). The most sensitive taxon recorded was the Stonefly *Neoperla spio* (Plecoptera), which has a sensitivity rating of 12/15. Abundances of all taxa were very low, except for Stonefly, which was common. The Proportion of Sediment-Sensitive taxa (PSI) was low (0.5), and this suggests suspended sediments were moderately elevated. The proportion of air-breathing taxa was moderate (18%), and the same as the pooled data from the previous survey. Functional feeding groups were dominated by predators (58%), and this is typically associated with an ecosystem that is disturbed and in poor health. The ecological system therefore appeared to be functionally compromised. However, no alien macroinvertebrate taxon was recorded.

1) Indicator Species

Four species of macroinvertebrates that are typically associated with modified habitats were recorded as follows:

- Baetis harrisoni, a mayfly (Ephemeroptera) species that is highly tolerant of water quality deterioration and typically associated with polluted urban streams;
- Simulium hargreavesi, a blackfly (Simuliidae) that is typically associated with impoundment outlets and seasonal streams;
- Simulium adersi, a blackfly (Simuliidae) that is typically associated with slow-flowing polluted streams; and
- *Palpopleura lucia*, a dragonfly (Libellulidae), that is typically associated with open, standing or temporary wetlands.

2) Drifting Stages

No drifting macroinvertebrates were recorded in the water column, indicating that macroinvertebrate populations were low, and the aquatic ecosystem was in poor health.

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3) Adult Odonata

The Rwandan Dragonfly Biotic Index (RDBI) was applied to the combined data on Odonata species collected from the Ruzizi River in January 2022 to derive an approximate RDBI Score. A total of 11 species of Odonata was recorded, and these gave a Total Score of 23, and an approximate RDBI Score of 2.1. The result indicated that the Ruzizi River ecosystem was in poor health.

4) Malaise Trap

A baited malaise trap set ~200 m from the Ruzizi River for five days caught large numbers of terrestrial flies, flying ants and wasps, but aquatic insects were largely absent. Aquatic insects trapped included mostly non-biting midges (Chironomidae), biting midges (Ceratopogonidae), micro-caddis (Hydroptilidae), Hydropsychid caddis (*Hydropsyche* sp.), and blackflies (Simuliidae). The result provided further evidence that the Ruzizi River ecosystem was in poor health.

B Mountain Headwaters

The Present Ecological State of the Mountain Headwater site at T1 in the Ruzizi III reservoir area in January 2022 was considered *Largely Modified*. The stream supported a low diversity of macroinvertebrates (four taxa only). The low diversity of macroinvertebrates is attributed to elevated concentrations of suspended material associated with subsistence agriculture in the catchment.

7.7.6.4 Ecological Sensitivity

Data collected in January and February 2022 indicated that the Ecological Sensitivity of aquatic macroinvertebrates in the Ruzizi River was *Low*. This conclusion was based on composition of taxa that were recorded during the field surveys (listed in Annex D).

A Segmented Worms (Annelida)

Five species of segmented worms were recorded, four in the Ruzizi River and one attached to a catfish (*Clarias gariepinus*) in the Rubyiro River (Figure 7-70).

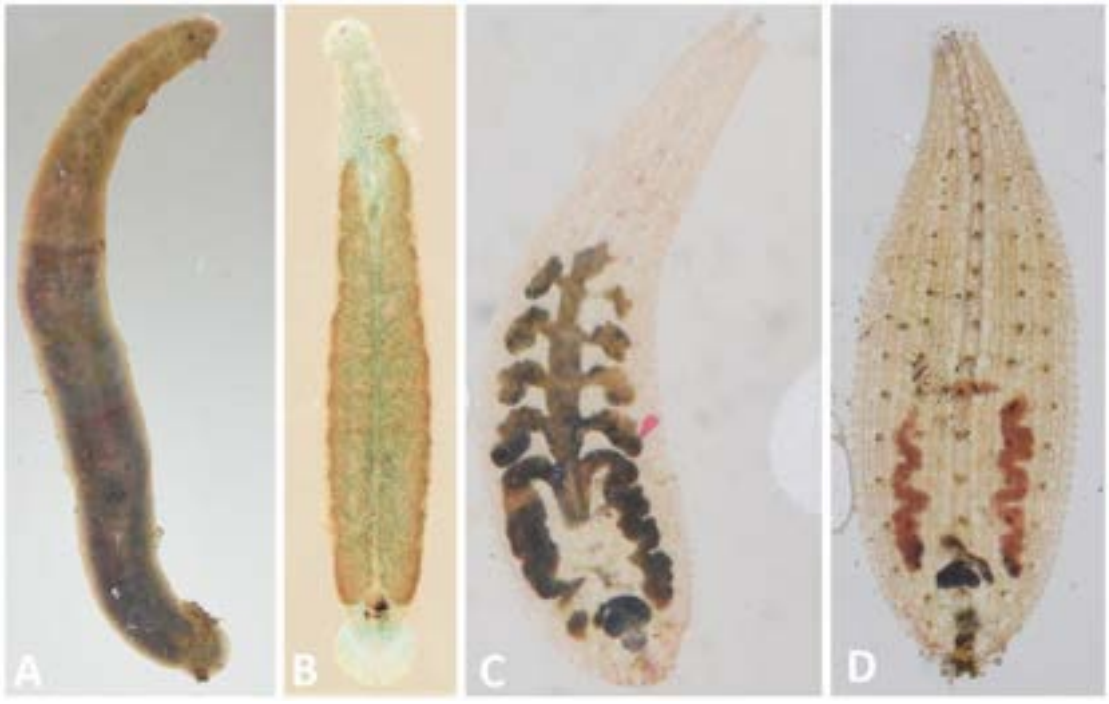


Figure 7-70 Photographs of Annelida
[A) *Salifa perspicax* (Salifidae) at R01; B) Glossiphonidae, attached to the catfish *Clarias gariepinus* at Rb3; C) *Alboglossiphonia sp.* (Glossiphonidae); D) *Aliolimnatis sp.* (Hirudinidae).]

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B **Freshwater Crab (Brachyura)**

One species of freshwater crab, namely *Potamonautes lirrangensis* was recorded (Figure 7-71). Five specimens of this species were recorded in and around the funnel trap that was set at Site R09a, so this species appears to be common in the Project AoI. This species is common and widespread in East Africa and is listed by the IUCN as Least Concern (LC).



Figure 7-71 Photograph of Freshwater Crab *Potamonautes lirrangensis* (Potamonautidae) from Site R09a

C **Stoneflies (Plecoptera)**

One species of Stonefly, *Neoperla spio* complex, was recorded (Figure 7-72). This species was recorded at Sites R01 and R13 in January 2022, both as larvae and exuviae, and appeared to be common in the Project AoI. This was confirmed at Site R12 on 27 February 2022, when water levels were lowered to allow the stream bed to be sampled. This species was the most common macroinvertebrate in the Ruzizi River at R12 at the time of the second survey. This was the most sensitive macroinvertebrate recorded in the Project AoI and is therefore a potential useful indicator species for long-term monitoring.



Figure 7-72 Photographs of Stoneflies (Plecoptera)
[A) *Neoperla spio* (Perlidae); B) *Neoperla spio* exuviae (case)

D **Mayflies (Ephemeroptera)**

Seven species of mayflies were recorded, which is low for a river the size of the Ruzizi River. The species recorded included the highly tolerant *Baetis harrisoni* (Figure 7-73).

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Figure 7-73 Photographs of Mayflies (Ephemeroptera)
[A) *Afroptiloides sp.* (Baetidae); B) *Baetis harrisoni* (Baetidae); C) *Baetis sp.* (Baetidae); D) *Tricorythus sp.* (Tricorythidae); E) *Dicercomyzon sp.* (Dicercomyzidae)]

E **Dragonfly Adults**

Six species of Dragonfly (Anisoptera) were recorded, including four species of Libellulidae, all of which are widespread and highly tolerant species (Figure 7-74).

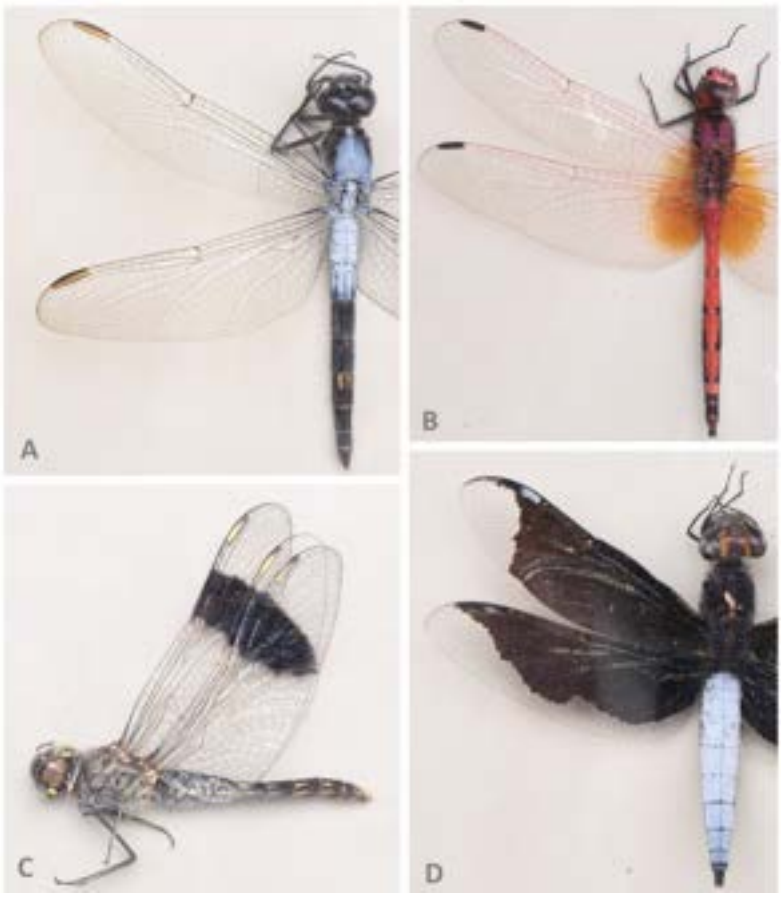


Figure 7-74 Photographs of Anisoptera Adults
[A) Nesciothemis farinosa (Libellilidae); B) Trithemis arteriosa (Libellulidae); C) Brachythemis leucosticta (Libellulidae); D) Palpoleura lucia (Libellulidae)]

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F Damselfly Adults

Five species of damselflies (Zygoptera) were recorded, including the flow dependent *Platycypha caligata* (Figure 7-75).



Figure 7-75 Photographs of Zygoptera Adults
[A) *Pseudagrion massaicum* (Coenagrionidae); B) *Phaon irridipennis* (Calopterygidae); C) *Platycypha caligata* (Chlorocyphidae); D) *Pseudagrion kersteni* (Coenagrionidae); E) *Pseudagrion hamoni* (Coenagrionidae)]

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G Odonata Nymphs

Four species of Odonata nymphs were recorded, including the flow dependent *Zygonyx natalensis* (Figure 7-76).



Figure 7-76 Photographs of Odonata Nymphs
[A) *Zygonyx natalensis* (Libellulidae); B) *Phyllomacromia contumax* (Macromiidae); C) *Platycypha caligata* (Chlorocyphidae); D) *Nesciothemis farinosa* (Libellulidae)]

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H Caddisflies (Trichoptera)

Three caddisfly taxa were recorded, of which one (Hydroptilidae), was recorded during the first survey only in the malaise trap set near Site R12 (Figure 7-77). Larvae were confirmed at Site R12 when water levels were dropped on the 27 February 2022. The diversity of caddisflies was low for a river the size of the Ruzizi River.



Figure 7-77 Photographs of Caddisflies (Trichoptera)
[A, B&E) *Hydropsyche* sp. (Hydropsychidae); C) Hydroptilidae; D) *Ecnomus* sp. (Ecnomidae)]

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I Beetles (Coleoptera)

Three aquatic beetle taxa were recorded, of which one (Gyrinidae), was recorded only in the Mountain Headwater at T1 (Figure 7-78). The diversity of aquatic beetles was low for a river the size of the Ruzizi River.



Figure 7-78 Photographs of Aquatic Beetles (Coleoptera)
[A) *Potamodytes sp.* (Elmidae); B) Gyrinidae; C) *Stenelmis sp.* (Elmidae)]

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J Blackflies (Simuliidae)

Four species of blackflies (Simuliidae) taxa were recorded: two in the Ruzizi River and two in the Mountain Headwater at T1 (Figure 7-79). The diversity of blackflies was low for a river the size of the Ruzizi River. The two species recorded in the Ruzizi River are common and widespread throughout sub-Saharan Africa. The most abundant blackfly species in the Ruzizi River was *Simulium hargreavesi*, which is typically associated with seasonal rivers and impoundment outlets. Onchocerciasis is transmitted to humans through exposure to repeated bites of infected blackflies of the genus *Simulium*. The two most abundant species recorded are not vectors of Onchocerciasis (Vatandoost, 2022). *Simulium damnosum* is the primary vector of Onchocerciasis within the region, but this species was not recorded within the sub-catchment, and therefore, an increase in Onchocerciasis is not expected.



Figure 7-79 Photographs of Blackflies (Simuliidae) pupal stage.
[A) *Simulium dentulosum*, at T1; B) *S. perforatum*, at T1; C) *S. hargreavesi*, at R01; D) S. adersi, at R01)]

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K Other Aquatic Flies (Diptera)

Five other aquatic fly taxa were recorded, including *Sepedon* sp. (Sciomyzidae) at Site R08 (Figure 7-80). Members of the family Sciomyzidae are cosmopolitan and feed exclusively on snails, including bilharzia snails. The diversity of aquatic flies for a river the size of the Ruzizi River was low.



Figure 7-80 Photographs of Other Flies (Diptera)
[A) *Sepodon sp.* (Sciomyzidae); B) *Pelina sp.* (Ephydridae); C) *Simulium cf. hargreavesi* (Simulidae); D) Chironomidae]

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L Freshwater Snails

Two species of freshwater snail were recorded in the Project AoI but it is uncertain if they were carrying cercariae for the transmission of bilharzia. These were:

- *Bulinus truncatus,* recorded in a fish-pond adjacent to the Ruzizi River at Site R12 in February 2022 (Figure 4-22A). This species is a host for urinary bilharzia among humans.

- *Biomphalaria pfeifferi*, recorded in the Ruzizi River at Sites R01, R08 and R10 in January 2022 (Figure 7-81B). This species is an intermediate host of rectal bilharzia among humans.



Figure 7-81 Photographs of Snails
[A) Bulinus *truncatus* (Planorbidae); B) *Bioamphalaria pfeifferi* (Planorbidae)

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7.7.7 Fish

A 2022 Fish Survey Results

Fish species recorded at sites surveyed for this report in January and February 2022 using electrofishing are listed in Table 7-22. Detailed data are presented in Annex D. Supplementary data from previous studies are reported on later in the report.

A total of 22 species in seven families were recorded in the Ruzizi (17), Rubyiro (4) and Ruhwa (2) Rivers. A total of 629 fish were enumerated in electrofishing (453) and from local fish catches (176). The Nile tilapia (*Oreochromis niloticus*) was the most common fish in local fisher catches, followed by Grauer's Kivu haplo (*Haplochromis* cf. *graueri*) – a Lake Kivu endemic – at Site R01, the most upstream site on the Ruzizi River and immediately downstream of Ruzizi II. Electrofishing catches at Site R01 were dominated by the Lake Rukwa minnow (*Raiamas moorii*) (Danionidae) (68). Also found here was the redspot barb (*Enteromius kerstenii*), Ripon's barb (*Labeobarbus altianalis*) and the alien Tanganyika killifish (*Lamprichthys tanganicus*).

Burton's haplo (*Haplochromis burtoni*) was most abundant in electrofishing catches at sites R04, R04a, R05, R08, R09 and R10. Also caught at these sites were guppies (*Poecilia reticulata*) (an introduced species) the Sudan catfish (*Bagrus docmak*), *Enteromius taeniopleura*, Ripon's barb (*Labeo altianalis*) and the redeye labeo *Labeo cylindricus* (the latter species also being recorded from Site 14a).

Hore's haplo (*Ctenocrhomis horei*) was abundant in electrofishing catches at site R12 and R13 on the Ruzizi River (72 and 80, respectively). The highest abundances (5 and 4, respectively, at each of the aforementioned sites) of *L. altianalis* were also recorded, as were East African redfin barbs (*Enteromius apleurogramma*).

Eight specimens of *Amphilius* cf. *kivuensis* (8 individuals) were collected at Rb1 on the Rubyiro River by electrofishing and 6 and 9 *C. asymetricaudalis* (EN) were collected from Sites Rb2a and Rb2b, respectively. Only one species – *E. taeniopleura* – was collected from the Ruhwa River. A brief description of the key species caught follows.

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Table 7-22 Fish Recorded During the 2022 SLR Surveys

		IUCN Red List		Ruzizi River												Rubyiro River				Ruhwa
Fish Family	Fish Species		R01	R04a	R04	R05	R08	R09	R09a #	R10	R12	R12#	R13	R13b	R14a	Rb1	Rb2a	Rb2b	Rb3	Rh2
Cypriniformes																				
Cyprinidae	*Enteromius apleurogramma*	LC	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
	Enteromius cf *taeniopluera*	LC	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	X
	Enteromius kerstenii	LC	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Enteromius cf *pellegrini*	LC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
	Labeo cf *cylindricus*	LC	-	-	-	-	-	-	X	(X)	-	X	X	-	(X)	-	-	-	-	-
	Labeobarbus altianalis	LC	X	-	-	-	-	-	-	-	X	(X)	X	-	-	-	-	-	X	-
	Labeobarbus sp. A	?	-	-	-	-	-	-	-	(X)	-	-	-	-	-	-	-	-	-	-
Danionidae	*Raiamas moorii*	LC	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Cyprinodontiformes																				
Poeciliidae	*Poecilia reticulata**	LC	-	-	-	-	X	-	-	X	X	X	X	-	-	-	-	-	-	-
	*Lamprichthys tanganicanus **	LC	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cichliformes																				
Cichlidae	*Haplochromis* cf *graueri*	LC	(X)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Haplochromis sp.		-	-	-	-	-	-	-	-	(X)	-	-	-	-	-	-	-	-	-
	Haplochromis cf *astatodon*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	*Haplochromis burtoni**	LC	-	X	X	X	X	X	-	-	X	X	-	-	-	-	-	-	-	-
	Haplochromis sp. *nov.*		-	(X)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ctenochromis horei	LC	-	-	-	-	-	-	X	X	X	X	X	-	-	-	-	-	-	-
	Oreochromis niloticus	LC	(X)	-	-	-	-	-	-	-	X	(X)	(X)	-	-	-	-	-	-	-
Siluriformes																				
Amphiliidae	*Amphilius* cf *kivuensis*	?	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Bagridae	*Bagrus docmak*	LC	-	-	-	-	-	-	-	X	(X)	-	-	(X)	(X)	-	-	-	-	-
Clariidae	*Clarias gariepinus*	LC	(X)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
	Clarias liocephalus	LC	-	X	-	X	-	-	-	-	-	X	X	-	-	-	-	-	-	-
Mochokidae	*Chiloglanis asymetricaudalis*	EN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-
	Total Number of Species (Species Richness)		**8**	**2**	**2**	**2**	**2**	**1**	**2**	**6**	**8**	**7**	**6**	**1**	**2**	**1**	**1**	**1**	**2**	**2**

 # = Recorded on 27th February 2022 **Species awaiting confirmation* ** = introduced species* *X = presence* *(X) = fisher catches*

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A.1 Enteromius Barbs

Of the small-bodied *Enteromius* barbs, *E. kerstenii* (Figure 7-82 D) is the most common barb in Lake Kivu as well as being present in the Ruzizi River. The species is widespread through east, central and southern Africa and can be found in the Lake Victoria Basin, Okavango, Cunene and Zambezi systems. *E. pellegrini* (Figure 7-82 A) is widespread through the Lakes Kivu, Tanganyika and Albert basins. This species is closely related and therefore morphometrically similar to *Enteromius neumayeri* which has a slightly wider distribution including the Lake Victoria Basin and coastal streams of Kenya and Tanzania (Mlewa 2013). However, the latter's current distribution is uncertain and its presence in the Ruzizi River is considered unlikely (Banyankimbona, Emmanuel, *et al.* 2012). *E. apleurogramma* (Figure 7-82 B) is widespread through the Lake Victoria, Edward, Rukwa and Kivu basins and known to occur in the Ruzizi and Malagarasi Rivers – thus occurring in both river and lake environments. It is common in channelled valley-bottom wetlands and papyrus swamps. Unlike the aforementioned species *E. taeniopleura* (Figure 7-82 D) is associated more strongly with the Tanganyikan-Congo basin and with rivers draining into Lake Tanganyika – not the lake itself – as well as the Lukuga River linking the lake to the Congo system. Migration by *Enteromius* barbs is known to occur, but they are likely to take place over short distances than the larger-bodied cyprinids discussed below.

A.2 Large-Bodied Cyprinids

The *Labeobarbus* genus is one of the most speciose genera in Africa and includes a group of 127 large-bodied hexaploid cyprinids from Africa and the Arabian Peninsula (Vreven, Musschoot*, et al*. 2018). This species is widely distributed through the lake and inflowing rivers of the Lake Victoria Basin, the Nzoia and Nyando Rivers in Kenya (Mugo and Tweddle, 1999) and Lake Kyoga in Uganda. Whitehead (1959 cited in Welcomme, 2003) classed *L. altianalis* as long-distance migrators (over 80 km). The Ruzizi River is the southern limit of its range (FishBase team RMCA and Geelhand, 2018c).

The *Labeobarbu*s genus was represented in the SLR 2022 catches by the ripon barbel *L. altianalis* (Figure 7-83 B), where it was recorded in the Ruzizi River at Ruzizi I, downstream of Ruzizi III and lower Rubyiro River. The CRBEC/CRSNE survey recorded it as frequent near Bugarama bridge and at sites further downstream. Results indicate migration up the Middle Ruzizi River.

A further two *Labeobarbus* species were caught in the 2022 surveys (Figure 7-83 C & E), with slight morphological differences and possibly representing morphotypes from hybridisation (Kisekelwa CRBEC, *pers. comm.*). Investigations by CRSNE and CRBEC are ongoing into the taxonomy of the *Labeobarbus* genus.

Labeobarbus somereni was recorded in the SOFRECO 2011 surveys above and downstream of the proposed Ruzizi III dam site in the Lower Ruzizi River. CRSNE/CRBEC surveys recorded it frequently near the Bugarama bridge (downstream of Ruzizi III) and at several downstream sites. Results also suggests an ability to migrate up the rapids in the Middle Ruzizi.

Another large-bodied cyprinid identified in the SLR 2022 surveys was *Labeo cylindricus*, widespread throughout southern, central and eastern Africa. It is considered part of the *Labeo forskalii* group of species which are closely related and difficult to distinguish morphologically (Reid 1985, D. Tweddle SAIAB, *pers. comm.*). As for *L. somereni*, it was also recorded by CRSNE/CRBEC at sites downstream of Bugurama Bridge and in the lower Ruzizi.

The vulnerable *Labeobarbus leleupanus* was not recorded in the SLR 2022 survey and was only recorded at the lower reaches of three tributary sites (Nyakagunda, Nyamangana and Kaburantwa) by CRSNE/CRBEC (at least 34 km downstream of Ruzizi III project site).

A.3 Haplochromine Cichlids

Six cichlid species were caught in the Ruzizi during the the January 2022 survey. Both Grauer's Kivu haplo (*Haplochromis graueri*) (Figure 7-84D) and Regan's Kivu haplo (*Haplochromis* cf *astatodon*) (Figure 7-84 B) are Lake Kivu endemics. *Haplochromis* sp. (Figure 7-84 C) has not been identified and *Haplochromis* sp. nov. (Figure 7-84 F) has been previously collected by Jos Snoeks in the Kagenga tributary of the Ruzizi and is an undescribed species (Snoeks, Royal Museum for Central Africa, *pers. comm.*). *Haplochromis burtoni* (not shown) is common in Lake

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Tanganyika lagoons associated with inflowing rivers. It is also known to inhabit the rivers of the upper Congo, as well as the Ruzizi, Malagarasi and Kagera Rivers (the latter where it may have been introduced) (De Vos, Snoeks, *et al.* 2001). Like other lake and river dwelling, it is very likely primarily a lacustrine (lake) species in the early phases of adaptive divergence between river and lake populations (Rajkov, Weber, *et al*. 2018). Haplochromine cichlids are a diverse group of fish that many of which have not been identified to species level.

Hore's haplo *Ctenochromis horei* (Figure 7-84 E) is a Lake Tanganyika endemic but is common in rivers including the Lukuga River draining into the Congo Basin and the Ruzizi (Kullander and Roberts 2012). It is piscivorous occurring on sand bottoms in the lake (Brichard 1989, IUCN 2021, Kullander and Roberts 2012), but like *H. burtoni* is likely in the early phases of adaptive divergence between river and lake populations.

Astatoreochromis vanderhosti is considered a junior synonym of *Astatoreochromis straelini* (Banyankimbona, Vreven, *et al.* 2013).

A.4 Tilapiine Cichlids

The Nile tilapia (*Oreochromis niloticus*) (Figure 4-25 A) is native to Lake Kivu, and is also present in Lake Albert, Edward-George and Tanganyika (Snoeks, Kaningini, *et al*. 2012). *Oreochromis tanganicae* is not usually associated with rivers but occurs in Lake Tanganyika.

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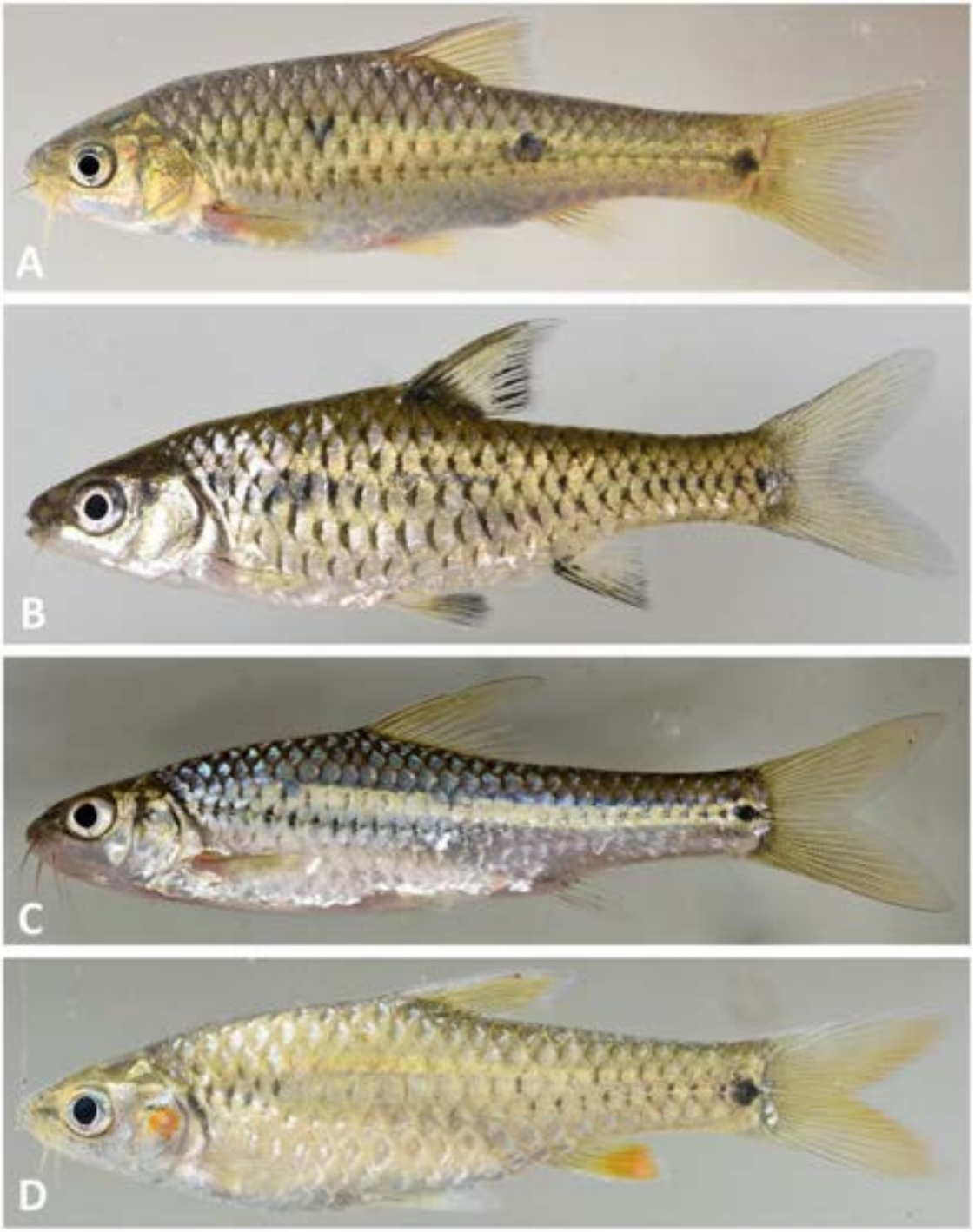


Figure 7-82 Photographs of *Enteromius* Species

[A) *Enteromius cf. pellegrini;* B) *E. apleuogramma;* C) *E.* c.f. *arcislongae*; D) *E. kerstenii*]

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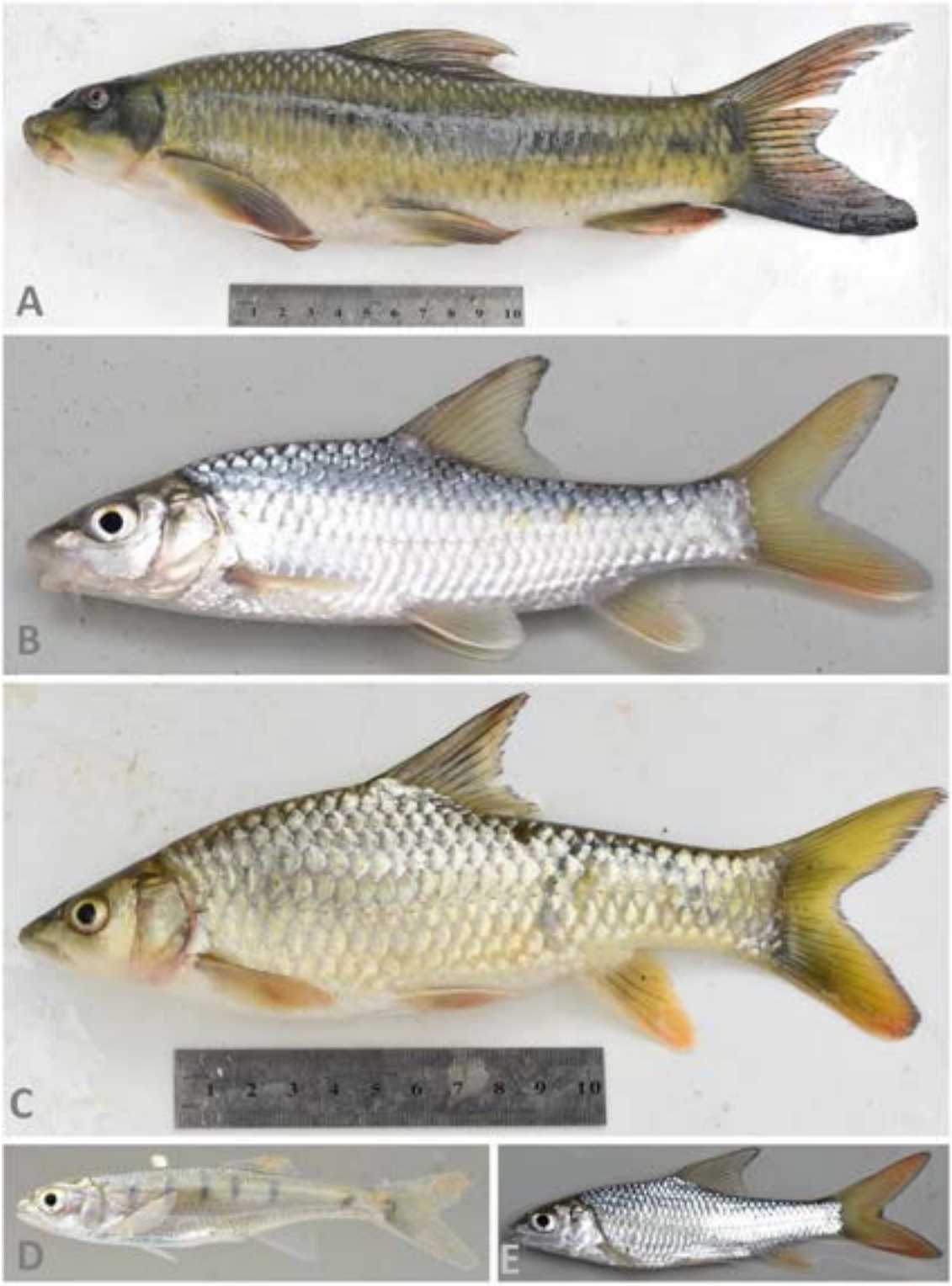


Figure 7-83 Photographs of Other Cyprinid Species

[A) *Labeo* cf. *cylindricus;* B) *Labeobarbus* cf. *altianalis;* C) *Labeobarbus* sp.*;* D) *Raiamas moorii;* E) *Labeobarbus* sp.]

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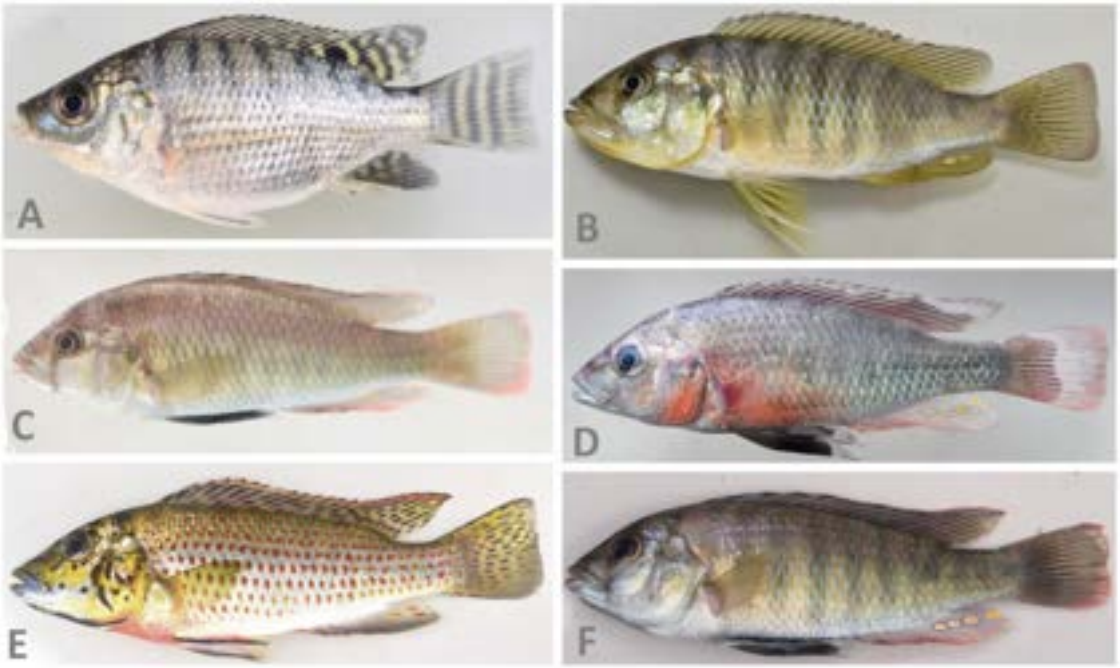


Figure 7-84 Photographs of Cichlids

[A) *Oreochromis niloticus;* B) *Haplochromis asatodon;* C) *Haplochromis* sp *nov.;* D) *Haplocrhomis graueri;* E) *Ctenochromis horei;* F) *Haplochromis* sp. *nov.*]

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A.5 Siluriform Catfishes

Five species of Siluriform catfishes were caught in the Ruzizi River in January 2022, including Bagrid – the Sudan catfish (*Bagrus docmak*) (Figure 7-85 A), and two species of Clariid catfish: the sharptooth catfish (*Clarias gariepinus*) (Figure 7-85 C), and the smooth-head catfish (*Clarias liocephalus*) (Figure 7-85 E).



Figure 7-85 Photographs of Siluriformes
[A) *Bagrus docmak*; B&D) *Chiloglanis asymetricaudalis*; C&G) *Clarias liocephalus*; E&H) *Clarias gariepinus*; F) *Amphilius* cf. *kivuensis*.]

All three of these species are widely distributed – *C. gariepinus* being cosmopolitan throughout Africa, *C. liocephalus* occurring throughout central Africa, while the *B. docmak* is known from the Ruzizi northwards to the Lake Victoria Basin and the Nile system.

A single Amphiliid catfish – morphologically consistent with *Amphilius* cf. *kivuensis* (Figure 7-85 F) – was caught in the upper reaches of the Rubyiro River. This species is known from the Congo Basin, Ruzizi and Lake Tanganyika and the Kagera River (Marlier 1953).

The Ruzizi *Chiloglanis ruziziensis* is Critically Endangered and is a restricted range species to the Ruzizi Basin where it has been recorded

The longtail suckermouth (*Chiloglanis asymetricaudalis*) (EN) (Figure 7-85 B) is known from the Ruzizi Basin but is also more widely distributed in the south to the Luiche River, an affluent river flowing into the east of Lake Tanganyika (Friel and Vigliotta 2011). Several were caught in the Rubyiro tributary in the January 2022 survey but it is expected to occur in low numbers in the mainstem Ruzizi River in rapids (where it is difficult to sample).

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A.6 Introduced Species

Lamprichthys tanganicanus (Figure 7-86 A), a native of Lake Tanganyika has appeared in Lake Kivu fishery catches since 2006. It is believed that the species was accidently introduced from Lake Tanganyika into Lake Kivu with the deliberate introduction of *Limnothrissa miodon* since it is unlikely to have been able to negotiate the natural rapid barriers on the Ruzizi River (Nshombo and Matabaro 2010). Although not reported from the Ruzizi River, the guppy (*Poecilia reticulata*), a native of South America (Figure 7-86 B) and a common aquarium species was found by both the SLR and SOFRECO survey teams. *Oreochromis leucostictus* (not shown) is thought to have been introduced into swamps on the Ruzizi plains (Banyankimbona, Emmanuel, *et al*. 2012)

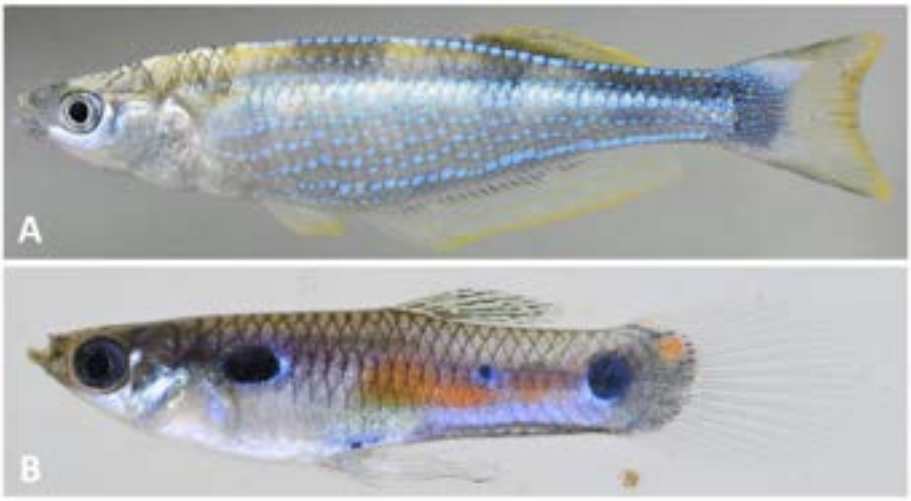


Figure 7-86 Photographs of Introduced Fish Species
[A) *Lamprichthys tanganicanus;* B) *Poecilia reticulata.*]

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B Comparison with Previous Studies

(CR) in the Ruhwa and Muhira Rivers near the confluence with the Ruzizi River. It appears that these two highly threatened rock catlets prefer the tributaries to the mainstem river. However, based on an informal interview with a local fisherman during the May 2024 supplementary field survey, *Chiloglanis* spp. occur within the Ruzizi River mainstem. No information of catch rates and size classes were obtained.

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Table 7-23 summarises the fish species recorded for the Ruzizi River from various inventories including Banyankimbona, Emmanuel, *et al*. 2012, IUCN 2021, SOFRECO 2021; the SOFRECO (2010, 2011, 2021) and SLR (2022) field studies. It also includes occurrence data provided by the Centre of Research in Biodiversity, Ecology, Evolution and Conservation (CRBEC) in Bukavu and Research Centre in Natural Sciences and Environment (CRSNE) at the University of Burundi from surveys conducted in the mainstem Ruzizi River and tributaries between Ruzizi I HPP and the Ruzizi River mouth at Lake Tanganyika between 2017 and 2022 (CRBEC/CRSNE 2023, unpublished report).

For the cichlids, the main difference between the inventoried lists and field studies is the predominance of Haplochromines which were caught mainly in the upper reaches of the Ruzizi River. This suggests a sampling bias toward lentic waters (Ruzizi I & II reservoirs) in the SOFRECO surveys, but also the colonisation of the Ruzizi River by lake species promoted by the increased availability of lentic habitat afforded by these waterbodies. Ten species of haplochromine were recorded in the upper Ruzizi by CRBEC/CRSNE while the SLR survey recorded four species.

Among the Cypriniformes, *Labeo cylindricus*, *Labeobarbus altianalis* and the Lake Rukwa minnow *Raiamas moori* are the most commonly reported in field studies. The other *Labeobarbus species* (*L. caudovittatus*, *L. leleupanus* (VU), *L. somereni* and *L. tropidolepis*) were absent from recent catches in the Ruzizi III project area by SOFRECO and SLR, but all except *L. tropidolepis* were confirmed in CRBEC/CRSNE surveys downstream of Bugurama Bridge, with *L. somereni* more prevalent in the lower Ruzizi River near Lake Tanganyika.

The SLR and CRBEC/CRSNE surveys detected a greater diversity of *Enteromius* barbs (5/6 species) than the SOFRECO surveys (2 species) including: *E. apleurogramma*, *E*. cf. *taeniopleura*, *E*. *kerstenii*, and *E* cf. *pellegrini*. Of the mormyrids only individuals of*Cyphomyrus dischorhynchus* were reported in the lower Ruzizi River during the CRBEC/CRSNE surveys. While *C. gariepinus* and *C. liocephalus* are common Siluriform catfishes in catches, only the 2022 SLR survey found *A. kivuensis*. Both the 2022 SLR survey and CRBEC/CRSNE surveys recorded *C. asymetricaudalis* (EN) in tributaries of the Ruzizi River: Rubyiro River (SLR 2022) and Nyakagunda and Nyamagana Rivers (CRBEC/CRSNE surveys). CRBEC/CRSNE also recorded *Chiloglanis ruziziensis* (CR) in the Ruhwa and Muhira Rivers near the confluence with the Ruzizi River. It appears that these two highly threatened rock catlets prefer the tributaries to the mainstem river. However, based on an informal interview with a local fisherman during the May 2024 supplementary field survey, *Chiloglanis* spp. occur within the Ruzizi River mainstem. No information of catch rates and size classes were obtained.

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Table 7-23 Combined Inventory of Fish Species Reported in the Ruzizi River

Order	Family/Scientific Name	Common Name	IUCN Status	Restricted Range /Alien	INVENTORIES				FIELD STUDIES			
					Banayankimbona *et al.* (2012)*	IUCN (2021)	SOFRECO (2021) Annex 5	SOFRECO (2010)	SOFRECO (2011)	SOFRECO (2021) Photos	SLR (2022)	CRBEC/CRSNE (2017-2022)*
	Protopterus aethiopicus	Marbled lungfish	LC		+		+					+
CERATODONTIFORMES	**Protopteridae**											
	Protopterus aethiopicus	Marbled lungfish	LC		+		+					+
CHARACIFORMES	**Alestidae**											
	Alestes macrophthalmus	Torpedo Robber	LC		+	+	+					
	Brycinus imberi	Spot-tail	LC		+	+	+					
	Micralestes stormsi		LC		+	+	+					+
CICHLIFORMES	**Cichlidae**											
	Astatoreochromis straeleni	Bluelip haplo	LC	RR	+	+	+					
	Astatoreochromis vanderhorsti		LC	RR		+						
	Astatotilapia burtoni	Burton's haplo	LC	RR	+	+	+	+	+		+	+
	Astatotilapia stappersii		LC	RR	+	+	+					+
	Aulonocranus dewindti		LC			+						
	Coptodon rendalli	Redbreast tilapia	LC			+						+
	Ctenochromis horei	Hore's haplo	LC	RR	+	+	+	+	+		+	+
	Gnathochromis pfefferi		LC	RR		+						
	Haplochromis adolphifrederici	Frederich's Kivu haplo	NE	Ke						+		+
	Haplochromis astatodon	Regan's Kivu haplo	NE	Ke				+	+		+	+
	Haplochromis crebridens		LC									+
	Haplochromis graueri	Grauer's Kivu haplo	LC	Ke		+	+	+	+		+	+
	Haplochromis insidae	Snoek's Kivo haplo	LC	Ke						+		+
	Haplochromis kamiranzovu	Kamiranzovu haplo	LC	Ke				+	+	+		
	Haplochromis microchrysomelas	Orangetail Kivu haplo	LC	Ke						+		+
	Haplochromis olivaceus	Olive Kivu haplo	LC	Ke						+		+
	Haplochromis paucidens	Trimorphic Kivu haplo	LC	Ke				+	+	+		+
	Haplochromis rubescens	Red Kivu haplo	LC	Ke						+		
	Haplochromis scheffersi	Scheffers' Kivu haplo	LC	Ke				+	+			
	Haplochromis vittatus	Striped Kivu haplo	LC	Ke						+		+
	Oreochromis leucostictus	Blue spotted tilapia	LC	Alien	+	+	+					+
	Oreochromis macrochir	Longfin tilapia	VU	Alien	+		+					+
	Oreochromis mweruensis	Mweru tilapia	LC				+					
	Oreochromis niloticus	Nile tilapia	LC	Alien		+	+	+	+	+	+	+
	Oreochromis tanganicae	Tanganyika tilapia	LC	RR	+							
	Tylochromis polylepis		LC			+						

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Order	Family/Scientific Name	Common Name	IUCN Status	Restricted Range /Alien	INVENTORIES				FIELD STUDIES			
					Banayankimbona *et al.* (2012)*	IUCN (2021)	SOFRECO (2021) Annex 5	SOFRECO (2010)	SOFRECO (2011)	SOFRECO (2021) Photos	SLR (2022)	CRBEC/CRSNE (2017-2022)*
CLUPEIFORMES	**Clupeidae**											
	Limnothrissa miodon	Lake Tanganyika sardine	LC	Alien			+	+	+	+		+
CYPRINIFORMES	**Cyprinidae**											
	Acapoeta tanganicae	Mbaraga	LC	RR	+	+	+					
	Chelaethiops congicus		LC			+						
	Clypeobarbus congicus	Congo barb	LC		+	+	+					
	Enteromius apleurogramma	East African redfinned barb	LC		+	+	+	+	+		+	+
	Enteromius arcislongae		LC								+	
	Enteromius cf. *lineomaculatus*											+
	Enteromius innocens	Inconspicious barb	LC									+
	Enteromius kerstenii	Redspot barb	LC			+					+	+
	Enteromius lineomaculatus	Line-spotted barb	LC		+	+	+					
	Enteromius lufukiensis		NT	RR	+	+	+					
	Enteromius neumayeri	Neumayer's barb	LC		+	+	+					
	Enteromius oligogrammus		LC		+	+	+					
	Enteromius pellegrini	Pellegrin's barb	LC		+	+	+		+		+	+
	Enteromius taeniopleura		LC	RR	+	+	+				+	
	Enteromius urostigma		LC			+						
	Labeo cylindricus	Redeye labeo	LC		+	+	+	+	+	??	+	+
	Labeobarbus altianalis	Ripon barbel	LC		+	+	+	+	+	+	+	+
	Labeobarbus caudovittatus		LC		+	+	+					
	Labeobarbus cf. *caudovitattus*											+
	Labeobarbus leleupanus	Leleup's carp	VU	RR	+	+	+					+
	Labeobarbus somereni	Someren's barb	LC		+	+	+			+		+
	Labeobarbus tropidolepis		LC	RR	+	+						
	Danionidae											
	Raiamas marqueti		NE									+
	Raiamas moorii	Lake Rukwa minnow	LC	RR	+	+	+	+	+	+	+	+
	Raiamas salmolucius		LC			+						
CYPRINODONTIFORMES	**Poeciliidae**											
	Lacustricola pumilus	Tanganyika lampeye	LC		+	+	+					
	Lamprichthys tanganicanus	Tanganyika killifish	LC	RR			+			+	+	+
	Poecilia reticulata	Guppy	LC	Alien			+				+	

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Order	Family/Scientific Name	Common Name	IUCN Status	Restricted Range /Alien	INVENTORIES				FIELD STUDIES			
					Banayankimbona *et al.* (2012)*	IUCN (2021)	SOFRECO (2021) Annex 5	SOFRECO (2010)	SOFRECO (2011)	SOFRECO (2021) Photos	SLR (2022)	CRBEC/CRSNE (2017-2022)*
OSTEOGLOSSIFORMES	**Mormyridae**											
	Cyphomyrus discorhynchus	Zambesi parrotfish	LC		+		+					+
	Mormyrus longirostris	Eastern bottlenose mormyrid	LC		+		+					
	Petrocephalus catostoma	Churchill	LC			+						
	Pollimyrus nigricans	Dark stonebasher	LC		+	+	+					
PERCIFORMES	**Anabantidae**											
	Ctenopoma muriei	Ocellated labyrinth fish	LC		+	+	+					
	Latidae											
	Lates mariae	Bigeye lates	VU			+						
SILURIFORMES	**Amphiliidae**											
	Amphilius kivuensis		NE		+		+				+	
	Amphilius platychir	Mountain barbel	LC		+		+					
	Amphilius ruziziensis		NE	RR			+					
	Amphilius uranoscopus	Stargazer mountain catlet	LC		+	+						
	Zaireichthys brevis		LC				+					
	Bagridae											
	Bagrus docmak	Sudan catfish	LC		+	+	+				+	+
	Claridae											
	Clarias alluaudi	Alluaud's catfish	LC		+	+						
	Clarias gariepinus	Sharptooth catfish	LC		+	+	+		+	+	+	+
	Clarias liocephalus	Smoothhead catfish	LC		+	+	+		+	+	+	
	Clarias sp.											+
	Clarias theodorae	Snake catfish	LC				+					
	Clarias werneri	Werner's catfish	LC		+	+	+					+
	Claroteidae											
	Auchenoglanis occidentalis	Bubu	LC			+						
	Chrysichthys brachynema	Kibonde	LC					+	+			
	Chrysichthys sianenna	Kanimba	LC	RR		+						
	Malapteruridae											
	Malapterurus electricus	Electric catfish	LC			+						
	Mochokidae											
	Chiloglanis asymetricaudalis	Longtail suckermouth	EN	RR	+	+	+				+ Ruby iro	+ Nyakagunda & Nyamagana
	Chiloglanis lukugae		LC			+	+					

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Order	Family/Scientific Name	Common Name	IUCN Status	Restricted Range /Alien	INVENTORIES				FIELD STUDIES			
					Banayankimbona *et al.* (2012)*	IUCN (2021)	SOFRECO (2021) Annex 5	SOFRECO (2010)	SOFRECO (2011)	SOFRECO (2021) Photos	SLR (2022)	CRBEC/CRSNE (2017-2022)*
	Chiloglanis ruziziensis	Ruzizi suckermouth	CR	RR	+	+	+					+ Ruhwa & Muhira
	Synodontis melanostictus		NE		+							
SYNBRANCHIFORMES	**Mastacembelidae**											
	Mastacembelus frenatus	Longtail spiny eel	LC		+	+	+					

Ke = endemic to Lake Kivu RR = Restricted-Range A = Alien; * Survey data (unpublished) cover Upper to Lower Ruzizi from Ruzizi I HPP to Ruzizi River mouth at Lake Tanganyika.
(*Note: Banayankimbona *et al* (2012) data relate to Ruzizi Basin including tributaries)

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C Fish Habitat Associations and Ecological Guilds

Ecological guilds group species according to similar morphological, physiological, behavioural and life history adaptations rather than by taxonomic relatedness. This assumes that species with similar adaptations will respond to environmental change and variability in similar ways. The guild concept is therefore useful for evaluating the effects of change on diverse river fish communities (Aadland 1993, Baumgartner, Conallin, *et al*. 2014, Leonard and Orth 1988, Welcomme, Winemiller*, et al*. 2006). It should be noted that these are broad guilds and fish species listed in each may not be restricted to a specific guild. The extreme phenotypic plasticity of fish also means that many species may fall in more than one guild (Rajkov, Weber, *et al*. 2018).

Fish guilds can be classed according to preferences for flowing-water (lotic), standing-water (lentic) and those that are tolerant of a wide range of conditions (eurytopic). Many of those in the lentic and eurytopic guilds will adapt to lake or reservoir environments. The lotic guild includes main channel residents that select moderate to high water current speeds and rocky, or gravel substrates. Other criteria applied to the classification of fish guilds include reproductive strategy after Balon (1975) and resistance to anoxia which may require specialised adaptations like ancillary breathing apparatuses (Welcomme, Winemiller, *et al*. 2006). While the guilds assigned here are adapted from Welcomme, Winemiller*, et al*. (2006), the number of guilds has been reduced and the terminology simplified for the sake of expedience.

The **lotic riffle-rapid guild** includes species that occur in the main channel in river segments with a steep relief (e.g., the Ruzizi River), high current speeds and large coarse bed elements (i.e. riffles or rapids). They may have suckers or spines that enable them to grip rocks and an elongated body shape to enable them to live in interstitial spaces. They require fast-flowing well-oxygenated water to complete their life cycles. Examples in the Ruzizi Basin include the *Chiloglanis* and Amphiliid catfishes (Table 7-24). This guild is particularly sensitive to sedimentation of riffle areas, dewatering and variable flow velocities (e.g. under hydropeaking flow regimes.

The **lotic lithophilic guild** includes species that are seasonal longitudinal migrants, breeding and often feeding in rocky riffles or rapids. The large-bodied cyprinids (*Labeobarbus*) fall into this guild and these fishes will often undertake medium to long distance migrations for reproductive purposes (Table 7-24). This guild is particularly sensitive to loss of river connectivity due to damming or insufficient flow to aerate eggs over the breeding season. Lotic floodplain species will use floodplains for breeding and undertake lateral (but also longitudinal) medium distance migrations onto spawning grounds. The abundance and biomass of these species are often closely correlated with the size of the flood and degree of inundation (Welcomme, Halls, *et al.* 2004). In the Ruzizi River this guild is represented by the Alestidae, *Labeos* and tilapias (*Oreochromis*).

The **lotic pool guild** inhabits deeper pools or slackwaters along river margins, they tend to feed on invertebrate drift from riffles or rapids and may be sensitive to long periods of no flow, particularly if this is accompanied by anoxic conditions. They may breed either in the rocky substrata of riffles or among plants. Many of the *Enteromius* barbs fall into this guild.

Semi-lotic guilds (riparian, pool and benthic) will occupy the interface between flowing and standing water, using often vegetated bays and inlets with slackwaters along the channel margins. Some of the haplochromine cichlids and *Enteromius* barbs in the Ruzizi River will fall into this guild. The semi-lotic pool guilds may be found in higher gradient river segments with typical pool-riffle-pool sequences. While they may spend most of their time in pools, they use faster-flowing riffles for drift feeding and possibly breeding. This guild will be sensitive to long periods of no-flow. Again, some of the *Enteromius* barbs and haplochromine cichlids may be found in this guild.

The **Semi-lotic benthic guild** feed on macroinvertebrate prey deeper in the water column along vegetated river margins of river channels and may migrate onto floodplains. The mormyrids which are included in this guild have the ability to generate a weak electric field for detecting prey. These fish are particularly sensitive to the adverse effects of dams on their invertebrate prey communities (Blake 1977). Fishes in this guild may populate floodplains for breeding and feeding.

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Table 7-24 Ecological Fish Guilds, Predominant Habitats and Associated Fish Species in the Ruzizi River

Ecological Guild		Predominant Habitat	Description	Migration	Species
Lotic (flowing-water)	Riffle-rapid	Rapids and rocky areas, high gradient river segments with alternating pool-riffle-pool sequences	Rheophilic small-sized, elongated, or flattened body form. Equipped with suckers or spines.	Mostly non-migratory	*Chiloglanis asymetricaudalis, C. lukugae, C. ruziziensis, Amphilius kivuensis, A. platychir, A. ruziziensis. A. uranoscopus, Zaireichthys brevis*
	Lithophilic	Main channel	Main channel residents. Moderate to high water current speeds. Rock and sand substratum spawners.	Longitudinal medium distance seasonal migrations between downstream and upstream spawning habitats	*Labeobarbus altianalis, L. caudovittatus, L. leleupanus, L. somereni, L. tropidolepis*
	Floodplain	Floodplain	River fish that use floodplains for breeding and nursery habitats. River reaches adjoined by seasonally inundated floodplain. Sometimes semi-pelagic eggs and larvae.	Medium distance seasonal longitudinal and lateral migrations onto floodplains for spawning. Intolerant of anoxia.	*Alestes macrophthalmus, Brycinus imberi, Micralestes stormsi*, some *Labeo* species
Semi-lotic (Intermediate between flowing and non-flowing water)	Riparian	Slackwaters and backwaters, along channel margins and riparian areas	Intermediate between flowing- and standing-water guilds. Inlets, bays, side channels and swamps, with shallower water, slower current speeds and emergent vegetation.	Short distance migrations in the main channel or up tributaries and side-channels	Some *Haplochromis, Oreochromis* and *Astatoreochomis* sp. (e.g. *Astatoreochromis straeleni*) Some *Enteromius* barbs
	Pool	Pools in high gradient river segments with alternating pool-riffle-pool sequences	Sensitive to long periods without flow. Lithophilic phytophilic breeding habits.	Short-distance migrations	Some *Enteromius* barbs
Eurytopic (generalist)	Benthic	Main channel and slackwaters benthic (bottom-dwelling)	Channel margins and fringes of the marginal vegetation in the main channel. Moderate to low water current speeds. Intolerant of anoxia.	Short distance lateral migrations onto floodplains	*Cyphomyrus discorhynchus, Mormyrus longirostris, Petrocephalus catostoma, Pollimyrus nigricans, Synodontis melanostictus*
Lentic (standing-water)	Plesiopotamonic/ Paleopotamonic	Floodplains & wetlands seasonally or permanently disconnected to main channel	Tolerance for hypoxia/anoxia. Heavily vegetated river margins and floodplains with reedbeds and papyrus.	Variety of migration strategies. Protopterid movements only associated with foraging	*Protopterus aethiopicus* *Ctenopoma muriei, Clarias gariepinus, Clarias liocephalus,* some Tilapias
	Lacustrine	Lakes and open waterbodies	Predominantly lake-dwelling species that may incidentally occupy river habitats.	Little or no migration	*Haplochromine* cichlids
No preference	Eurytopic	Able to colonise a wide variety of aquatic habitats	These species are widely tolerant of a range of water quality and flow and non-flow conditions. They generally increase in numbers when rivers are degraded.	Variety of migration strategies	*Clarias gariepinus*, *Oreochromis mossambicus*

Terminology
Lotic: affinity standing water
Lentic: affinity for flowing water
Eurytopic: generalist across several habitats
Slackwater: slow flow on channel margins

Lithophilic: requiring gravels or cobbles in the main channel
Phytophilic: requiring vegetation in the main channel or foodplain
Eupotamonic: main channel consisting of the centre of the channel and the riparian zone with upper (rhithronic), middle and lower (potamonic) zones.

Parapotamonic: backwaters and slackwaters of the main channel, floodplain habitat sometimes disconnected from the main channel during low flow.
Plesiopotamonic: connected lagoons and channels and floodplain lakes.
Paleopotamonic: floodplains and wetlands occurring in the floodplain margins that may be groundwater fed only connected to the main channel by very high floods

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Lentic species include those adapted to lakes or floodplain pans and lagoons which may be seasonally (plesiopotamonic) or permanently (paleopotamonic) disconnected from the main channel during the dry season. These fishes are able to persist in these areas until the next flood. This group will include species with a high tolerance for anoxia include the Protopteridae and Clariid catfish (Table 7-24). Although the clariids are a metropolitan species and will occur throughout the Ruzizi, many of the other fishes in this guild will be restricted to the wetlands of the lower Ruzizi where it flows into Lake Tanganyika.

Lacustrine species include the endemic haplochromine cichlids in Lakes Kivu and Tanganyika which may colonise slow or no-flow conditions along river margins or in artificial reservoirs in the mainstem Ruzizi.

Eurytopic fishes tolerate a wide range of water quality, aquatic habitat and flow conditions. They will generally increase in numbers to pest proportions in degraded river systems. Examples include the *Oreochromis mossambicus* and clariid catfishes.

D Distribution and Biology of Priority Species

Priority species in the Ruzizi River are listed in (Table 7-25). These have been selected either on the basis that they are (1) an indicator species – i.e., (2) representative of one of the guilds listed in Section C which is expected to undergo change in distribution or abundance as a result of hydropower development, or (3) populations that are likely to be significantly impacted as a result of any one or combination of the following criteria: specialised habitat or migratory requirements, restricted-range (or Ruzizi endemic) and conservation importance. Apart from *A. straeleni*, which is regarded as primarily fluviatile (river-dwelling) haplochromid, range-restricted endemic haplochromids (*Ctenochromis horei, Gnathochromis pfefferi*) have been excluded since the river environment is considered marginal for this group. *A. vanderhorsti* is excluded because it is considered a junior synonym of *A. straeleni.*

Table 7-25 Priority Fish Species Identified for the Ruzizi River and their Known Distribution, Ecology and Threats.
(Note* - indicates that it was caught in the 2022 SLR fish surveys)

Species	Importance	Description
CICHLIFORMES		
Cichlidae		
Astatoreochromis straeleni	Range-restricted, semi-lotic riparian guild	The bluelip haplo is a range-restricted species with its global extant distribution including lake Kivu and the northern shores of Lake Tanganyika including the Ruzizi and Malagarasi Rivers. The taxonomic status of populations found in the Lukuga River (DRC) have yet to be determined. It is considered a fluviatile haplochromid, inhabiting clear tributaries and moving into associated swamps during the flood season. In the Ruzizi it occurs in swampy pools associated with the river and is especially common in the Gatumba swamps, seldom in the main channel (Banyankimbona, Emmanuel, *et al.* 2012; 2013, IUCN 2021). It is an invertivorous mouthbrooder likely breeding during the dry season (Dec-Jan) (Banyankimbona, Vreven, *et al.* 2013).
CYPRINIFORMES		
Cyprinidae		
Acapoeta tanganicae	Range-restricted, migratory, evolutionarily distinctive	Once considered endemic to Lake Tanganyika, *A. tanganicae* has subsequently been found in a tributary of the Songwe River draining into Lake Rukwa western Tanzania (Genner, Turner, *et al.* 2015). Although it has been recorded from inshore rocky areas of the lake, the species is considered migratory and common in rivers where it frequents rapids (Eccles 1992). Although *A. tanganicae* is listed as Least Concern by the IUCN, Adeoba, Tesfamichael, *et al.* (2019), have suggested this species has a high conservation priority due its Evolutionary Distinctiveness (ED), a measure of the evolutionary uniqueness of a species – *A. tanganicae* ranking top out of 539 African cyprinids evaluated (*Acapoeta* being a monospecific genus). No individuals of *A. tanganicae* have been caught in recent surveys.
Enteromius lufukiensis	Range-restricted, Near Threatened,	This species is known from rivers draining the western shores of Lake Tanganyika and the Ruzizi It is also reported from the Luama River, Congo River Basin, DRC (Poll 1953). It is classified by the IUCN as NT as

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Species	Importance	Description
	semi-lotic pool/riparian guild	its extent of occurrence is less than 20,000 km² and area of occupancy less than 2,000 km². Populations are threatened by agricultural expansion, deforestation leading to erosion and increased sedimentation and turbidity in the catchment (Ntakimazi 2018). No specimens of this species have been caught in recent surveys.
*Labeobarbus altianalis**	Migratory, lotic-lithophilic guild	The ripon barbel is widely distributed through the lake and inflowing rivers of the Lake Victoria Basin, the Nzoia and Nyando Rivers in Kenya (Mugo and Tweddle, 1999) and Lake Kyoga in Uganda. Populations in the Ruzizi River are regarded as the southernmost distribution of the species which was first described from specimens collected from the latter river and Lake Kivu (Banister 1973). Mugo and Tweddle (1999) suggest that there may be distinct river and lake-dwelling populations, with those from lakes moving upriver to spawn. *L. altianalis* are reported as rheophilic gravel-bed spawners like many other species in the African *Labeobarbus* genus and migrate upstream to spawn during the wet season (Witte and De Winter, 1995 cited in Sunda Kemunto, 2018). Whitehead (1959 cited in Welcomme, 2003) classed *L. altianalis* as long-distance migrators (over 80 km), potentially indicating that this species could migrate from as far downstream as the Ruzizi River mouth at Lake Tanganyika. This species is believed to have been impacted by overfishing and the introduction of more efficient gillnets into Lake Victoria in the 1980s and 1990s (Sunda Kemunto, 2018), and it is possible the same might apply to Lakes Tanganyika and Kivu.
Labeobarbus leleupanus	Vulnerable, Migratory, lotic-lithophilic guild	*L. leleupanus* is restricted to the Lake Tanganyika Basin. IUCN EOO shows the species occurring throughout Lake Tanganyika, but museum records suggest it is mostly known from the Ruzizi River Basin (MRAC 1997). Low abundances of this species have been inferred from rare fisheries catches in the lake, suggesting low abundances here which may possibly be the result of under-sampling of the Ruzizi River. Like many other African large-bodied *Labeobarbus,* this species is likely to belong to the lotic lithophilic guild and likely migratory over medium to long distances. Populations are threatened by agricultural expansion, deforestation leading to erosion and increased sedimentation and turbidity in the catchment (Ntakimazi 2006b). Although not caught in the SLR 2022 survey, L. *leleupanus* was confirmed by CRBEC/CRSNE in lower tributaries of the Ruzizi River between 2016 and 2018 (unpublished data). The species ecology is poorly known but is assumed to migrate during the increase in flows during the onset of the long-wet season in October as other large African cyprinid species. The SLR 2022 surveys were undertaken during January and February suggesting that while peak migration may have been completed, the species is likely to use the mainstem reach, at least the lower reaches.
Labeobarbus somerini	Migratory, lotic-lithophilic guild	*L. somerini* occurs in the Ruzizi, Malagarasi and the middle and upper Kagera Rivers. It is also known from fast-flowing rivers in the Ruwenzoris flowing into Lake Edward (Banister 1973). It is believed to prefer the headwaters of rivers at high altitudes to a limit of 1600 m (Eccles 1992, Greenwood 1966). Like the other African large-bodied *Labeobarbus* species described here, it is likely to belong to the lotic lithophilic guild and be migratory over medium to long distances. The population status is unknown, but it is considered rare (FishBase team RMCA and Geelhand 2018). This species was caught by SOFRECO in 2021 upstream and downstream of Ruzizi III HPP and by CRBEC/CRSNE mainly in the lower tributaries of the Ruzizi River but also at the Bugurama Bridge.
Labeobarbus tropidolepis	Migratory, lotic-lithophilic guild	*L. tropidolepis* is endemic to the Lake Tanganyika Basin where it is common in inshore catches. It also occurs in affluent rivers including the Malagarasi (Natakimazi and Hanssens 2018) and like *L. altianalis* migrates up rivers to reproduce. It is likely to belong to the lotic lithophilic guild and be migratory over medium to long distances. Threats to the species include fishing pressure as well as agricultural expansion, deforestation leading to erosion and increased sedimentation and turbidity in the catchment (Natakimazi and Hanssens 2018). This species has not been caught in recent surveys by SOFRECO, SLR or CRBEC/CRSNE.
Labeobarbus caudovittatus		*Labeobarbus caudovittatus* is a migratory species, widely distributed with records from several Central and West African countries, including the Democratic Republic of the Congo, Gabon, Burundi, Angola and Zambia, and Rwanda including the Ruzizi River (De Vos and Thys van den Audenaerde 1990). It is considered to occur in several other river systems affluent to Lake Tanganyika including the Malagarisi and Lukuga Rivers. The global status of its populations is largely unknown, but it is not

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Species	Importance	Description
		considered threatened at global level (Moelants 2010) but is assessed as Near Threatened in East Africa where it is threatened by fishing pressures and regression of habitat due to farming (Ntakimazi; IUCN redlist). It was collected in the Middle Ruzizi by SOFRECO 2021 and by the CRBEC/CRSNE in unpublished surveys downstream of Ruzizi III.
SILURIFORMES		
Mochokidae		
*Chiloglanis asymetricaudalis**	Endangered (EN), range-restricted, lotic riffle-rapid guild	The longtail suckermouth (EN) is known from Ruzizi Basin but is also more widely distributed in the south to the Luiche River, an affluent river into Lake Tanganyika (Friel and Vigliotta 2011). The species is well adapted for inhabiting fast-flowing riffle-rapid habitats in rivers. It is especially adapted for living and feeding in these types of habitats by having a flattened, elongated body form with a sucker mouth that enables it to feed on algae and invertebrates in fast currents. Its Area of Occupancy (AOO) is deemed less than 500 km^2 (Hanssens and Ntakimazi 2006). The species is especially susceptible to sedimentation of riffles and rapids which in the Ruzizi catchment results from agricultural expansion and deforestation. Note: several individuals were confirmed in the upper Rubyiro River by SLR in 2022 but were not confirmed in the Ruzizi River mainstem during that survey. They have also been caught by CRBEC/CRSNE in other tributaries of the Ruzizi River but not the mainstem. However, the presence of *Chiloglanis* species in the Ruzizi River mainstem was reported by local fishermen in May 2024, although likely to be rarely caught. This is likely due to fishing methods and difficulty of accessing river bottom habitats preferred by rock catlets but also because of water depth and velocity. It is predicted that numbers are also likely reduced due to upstream hydropeaking. Whether the fishermen referred to *C asymetricaudalis* or *C ruziziensis* is unclear.
Chiloglanis ruziziensis	Critically Endangered (CR), range-restricted, lotic riffle-rapid guild	*C. ruziziensis* is endemic to the Ruzizi River Catchment and has an Extent of Occurrence (EOO) <100 km^2 and an AOO <10 km^2 (Ntakimazi 2006a). Like *C. asymetricaudalis, C. ruziziensis* (CR) is well adapted to fast-flowing riffle-rapid habitats in rivers. It is especially adapted for living and feeding in these types of habitats by having a flattened, elongated body form with a sucker mouth that enables it to feed on algae and invertebrates in fast currents. Like the former species, *C. ruziziensis* is especially susceptible to sedimentation of riffles and rapids which in the Ruzizi catchment is results from agricultural expansion and deforestation. Note: It was not confirmed during surveys by SOFRECO in 2021 or SLR in 2022 and was not confirmed in the Ruzizi mainstem in surveys by CRBEC/CRNS between 2017-2022. However, the presence of *Chiloglanis* species in the Ruzizi River mainstem was reported by local fishermen in May 2024, although likely to be rarely caught. This is likely due to fishing methods and difficulty of accessing river bottom habitats preferred by rock catlets but also because of water depth and velocity. It is predicted that numbers are also likely reduced due to upstream hydropeaking. Whether the fishermen referred to *C asymetricaudalis* or *C ruziziensis* is unclear.
Amphiliidae		
Amphilius ruziziensis	Range-restricted, lotic riffle-rapid guild	A recent taxonomic study of a species described as *Amphilius jacksonii* revealed higher morphological differences than expected and the Ruzizi *Amphilius* was determined to be a different species. Originally thought to be *Amphilius platychir*, Thomson, Page, *et al*. (2015) described *Amphilius ruziziensis* from the river itself and the northeastern tributaries of Lake Tanganyika. Its conservation status is unknown since it has not been assessed. *Amphilius* species are adapted to fast-flowing rocky streams at high elevation, feeding off the substratum on benthic aquatic macroinvertebrates including chironomids, ephemeropterans and trichopterans. It has a thickened first ray on its pectoral and pelvic fins which enable it to cling to rocks (Thomson and Page 2022). Reproduction coincides with rainy season likely in response to increased flow (Marriott, Booth, *et al.* 1997). This species was not detected in any surveys by SOFRECO in 2021; SLR in 2022, or CRBEC/CRNS between 2017-2022.

E Fish Migration & Seasonal Changes in Fish Distribution

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Migratory behaviour in African fish species, including those of the Ruzizi River, are poorly understood. There is insufficient seasonal data to reliably infer the importance of fish migration on their life cycles, either in terms of seasonality, migration distance or reliance on tributaries or rapids for spawning.

Prior surveys on the Ruzizi River have not reliably detected seasonal shifts in distributions that confirm migratory behaviour. However, fish migration is inferred from the SOFRECO fish surveys in August and October 2021 by the presence of larger numbers of *Labeo* species distributed further upstream in October than in August. In addition, the SLR team observed aggregations of fish at the base of the spillway of Ruzizi II in January 2022. Discussion with security guards posted at Ruzizi II revealed that migrating fish were sometimes stranded by down-ramping of the hydropower facility, during which time they were easily targeted by local fishers.

SOFRECO's 2010 and 2011 fish surveys found evidence of reduced relative abundances of *L altianalis* downstream of the existing hydropower facilities and attributed this to the barrier these structures represent to upstream fish migration, as well as the fact that the fish passes on Ruzizi I and Ruzizi II dams, have not functioned for over twenty years as a result of poor maintenance, the accumulation of debris and insufficient flows (SOFRECO 2021). Similarly, SHER Consult Ltd (2020) highlighted the barrier these dams pose to fish migration – particularly *L. altianalis* – and the fact the fish passage facilities are poorly maintained. They suggest that migratory fish such as *Labeobarbus* could be using the tributaries to breed. Aside from *L. altianalis*, *L. cylindricus*, *Acapoeta tanganicae* and all the other *Labeobarbus* cyprinids will likely be migratory over medium to long distances (>30 km). It is considered likely that fishes belonging to the lotic lithophilic guild (comprising *L. altianalis, L. caudovittatus, L. leleupanus, L. somereni,* and *L. tropidolepis*) migrate up the Ruzizi River from the Ruzizi floodplains at Lake Tanganyika for spawning purposes, and that young-of-the-year will disperse downstream following spawning. However, only *L. altianalis, L. cylindricus* and *L. somereni* have been caught in recent surveys (2010-2021).

F Fish Barriers

There are two existing and one potential barrier to fish migration on the Ruzizi River:

- *Ruzizi I HPP*. Ruzizi I HPP (28 MW) located on the Ruzizi River ~4 km downstream of the outflow from Lake Kivu. This facility was constructed in 1959, and controls the levels in the lake;
- *Ruzizi II HPP*. Ruzizi II HPP (45 MW) is located another 16 km downstream of Ruzizi I and ~20 km from the Lake Kivu outlet. This facility has been in operation since 1989. The Ruzizi II HPP possesses a fish ladder in an attempt to mitigate against the barrier effect, but it is currently not functioning and due to be rehabilitated; and
- *Natural barriers*. There is at least one cascade on the Ruzizi River, ~12 km downstream of Ruzizi II (see Figure 7-63 A), that may present an obstacle to some non-migratory fish species under certain flow conditions. However, it is evident that several migratory fish such as *L. altianalis, L. cylindricus* and *L. somerini* navigate these rapids as they have been recorded upstream of the proposed Ruzizi III HPP location.

Below Ruzizi II HPP the river is unobstructed by other dams for 140 km to Lake Tanganyika. Ruzizi III HPP would reduce the navigable river for migratory fish by an additional 13 km of the Middle and Lower Ruzizi without barriers for 130 km.

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7.7.7.2 Current Threats to Ruzizi River

Threats to the aquatic ecology of the Ruzizi River observed during the field survey in January 2022 are summarised in Table 7-26.

Table 7-26 Current Threats to Aquatic Ecology

Type of Threat	Description of Threat
Water Level Fluctuations	The main cause of ecological deterioration observed in the Project AoI during the field survey in January 2022 was attributed to short-term fluctuations in water level associated with the operation of Ruzizi I and II.
Solid Waste	Solid waste constituted a serious threat to aquatic ecosystems in the Project AoI. The waste appeared to be generated mostly from the city of Bukavu, the capital of South Kivu Province, DRC. Some of the waste was removed from the turbine intakes at Ruzizi II and burnt on site, leading to localised air pollution. However, most of the waste was carried downstream, and some accumulated in quieter backwaters within the Project AoI (Figure 7-87 A).
Suspended Solids	Elevated concentrations of suspended solids constituted a serious threat to aquatic ecosystems in the Project AoI. A plankton net left in the Ruzizi River for 30 minutes to collect drifting macro-invertebrates caught nothing but fine sand and plastic waste. The main cause of elevated sediments is attributed to subsistence agriculture, particularly on steep slopes and within riparian zones. Many of the tributaries sampled, including the lower Rubyiro River, had no or few aquatic macroinvertebrates or fish, and their absence was attributed to the abrasive action of suspended sediments. No fish were recorded at Rb2 in the Rubyiro River, the type locality of *Chiloglanis ruziziensis*.
Climate Change	The effects of climate change on aquatic ecosystems within the Project AoI are unknown, but it is likely that climate change has already increased the frequency and intensity of flash floods, and this is likely to have aggravated the problems associated with soil degradation (Sher 2020). Increased soil degradation and the consequent landslides will result in increased sediment loads in the Ruzizi River and aggravate the issue of sediment accumulation in Ruzizi-I and -II reservoirs. Increased sediment load leads to habitat degradation due to the abrasive of suspended sediment, and consolidated substrate and gravel habitat loss at deposition sites.
Migration Barriers	As described above, Ruzizi I and Ruzizi II H pose barriers to fish migration. During periods of suitable flow, *Labeobarbus* species migrate upstream until they reach the Ruzizi II impoundment. Fish accumulate below the impoundment and between hydropeaking periods the water level within the Ruzizi River drops causing some fish to become stranded, allowing people to easily collect the fish (as observed in January 2022). This confirms that the dam constitutes a complete barrier to upstream migration of fish (although its non-functional fish ladder is due to be rehabilitated). The cascade of rapids downstream of Ruzizi III may constitute a partial barrier for some species although it appears that *Labeobarbus* species are able to navigate them upstream.
Alien Fish	Several alien fish have been recorded in the Ruzizi River which predate on or displace indigenous fish. These include Nile tilapia *Oreochromis niloticus*, Longfin tilapia *O. macrochir*, blue-spotted tilapia *O. leucostictus*, Lake Tanganyika sardine *Limnothrissa miodon*, Tanganyika killifish *Lamprichthys tanganicanus*, and the guppy *Poecilia reticulata*. *Lamprichthys tanganicanus*, a native of Lake Tanganyika has appeared in Lake Kivu fishery catches since 2006. It is believed that the species was accidently introduced from Lake Tanganyika into Lake Kivu with the deliberate introduction of *Limnothrissa miodon* since it is unlikely to have been able to negotiate the natural barriers on the Ruzizi River (Nshombo and Matabaro 2010). *Poecilia reticulata*, a native of South America and a common aquarium species was found by both the SLR and SOFRECO survey teams. *Oreochromis leucostictus* and *O. niloticus* is thought to have been introduced into swamps on the Ruzizi plains (Banyankimbona, Emmanuel, *et al.* 2012). Both were prevalent in the lower Ruzizi River (CRBEC/CRSNE 2015-2022, unpublished)
Aquaculture	The farming of monosex Nile tilapia (*O. niloticus*) in floating cages takes places on Lake Kivu at several locations from Rwanda and the DRC and it is seen as an important component of food security and livelihoods in the region. Some of these sites are on the Ruzizi River, downstream of Ruzizi III. The environmental risks of aquaculture include organic pollution, introduction of pathogens, invasive species introductions and the use of chemicals and pharmaceuticals (SOFRECO 2010).
Overfishing	Before the introduction of *L. miodon* for fisheries purposes, the artisanal fishery on Lake Kivu was poorly developed and based on the endemic haplochromine species with an annual production of not more than 1500 t (Snoeks, Kaningini, *et al.* 2012). Catches of *L. miodon* represented 75% of the total catch and the stock was estimated at 4000 tonnes in 2018 with stocks in Lake Kivu considered stable and sustainable (Tessier, Richard, *et al.* 2020). However, illegal fishing in the lake is threatening fish stocks, with 404 cases reported in 2018 (RNP 2018).

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Type of Threat	Description of Threat
	The extent of fisheries within the Project AoI has not been quantified but is primarily performed by subsistence fishers largely for household consumption although some are reportedly sold in Bugarama. During the May 2024 survey, several fishermen were observed to use the Ruzizi River around the town of Bugurama (Rwanda) during periods of low flow. A local fisherman provided the local names of the groups that comprise the dominance of their catch. These names were searched on fishbase and the following species or groups were identified: Ishonzi – *Clarias* spp. Intama - *Mormyrus kannume;* Ikijagari – *Chiloglanis* spp.; Umukenya – *Raiamas moori;* Iningu – *Labeo* spp. and Imbaraga – *Petrocephalus catastoma.*



Figure 7-87 Photographs of Current Threats to Aquatic Ecosystems

[A) Solid Waste; B) Ruzizi II spillway – River Regulation; C) Riparian Cultivation; D) Fishing; E) Aquaculture; F) Washing and Ablutions; G) Alien Fish Species.]

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7.7.7.3 Aquatic Habitat Status

Aquatic habitats in the Project AoI were classified as "modified" in accordance with definitions provided in ESS6 and IFC PS6. It's modified status is specifically linked to erratic hydropeaking flow fluctuation in the catchment caused by upstream hydropeaking from Ruzizi I and II, as well as water pollution from Bukavu and other settlements. Although the majority of aquatic biota recorded were indigenous besides a few alien fish species, the diversity and abundance are significantly lower than expected and ecological functions of the Ruzizi River within the Project AoI were assessed as '*seriously modified*'.

Indicators of its modified status include marginal riverine habitats and all instream habitats above the lowest water level being largely devoid of aquatic life because of frequent exposure associated with short-term (sub-daily) fluctuations in water level. Other drivers of ecological deterioration were elevated nutrients and solid waste associated with the upstream City of Bukavu, and elevated sediments associated with the cultivation of most of the catchment areas that drain into the Project AoI. Aquatic flora was dominated by a monoculture of the filamentous alga *Cladophora glomerata*, a typical indicator of polluted water. The presence of this alga on the stream bed at about 0.5 m depth indicated that light was not limited, although deeper areas are likely to be light limited because of elevated turbidity. The composition of benthic diatoms also indicated elevated concentrations of nutrients and suspended sediments. The diversity and abundance of aquatic macroinvertebrates was very low, so there was little food to support insectivorous fish species. Low abundance of macroinvertebrates is attributed mainly to short-term fluctuations in water level but is also likely to be associated with the abrasive nature of suspended sediments and bedload. Furthermore, the composition of fish species showed measurable changes from historical records, indicating a change in fish community structure. Given the lack of macroinvertebrates in the Ruzizi River, it is suspected that migratory *Labeobarbus* species feed in the lower floodplain reaches in Burundi and swim up only to spawn in rapids, and are unlikely to feed upstream.

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7.8 Terrestrial Ecology

The Terrestrial Ecology Assessment was based on a desktop and field assessment approach, with two field surveys undertaken. The methods used in the assessment and the respective assumptions and limitations are provided in Annex C.

7.8.1 Protected and Internationally Recognised Areas

7.8.1.1 Protected Areas

The World Database on Protected Areas (WDPA)[13] indicates that the Project is not situated within any Protected Areas (PAs), although five PAs are located in the vicinity of the Ruzizi River catchment, and one is located in the lower reaches of the Ruzizi River. Two of the PAs in the catchment are in the DRC (Kahuzi-Biega National Park, Itombwe Mountains), two in Rwanda (Nyungwe National Park, Cyamudongo Forest) and one in Burundi (Kibira National Park). The only PA along the Ruzizi River is the Rusizi National Park in Burundi, which is located approximately 80 km downstream of the Ruzizi III HPP at the point where the river enters Lake Tanganyika. A more detailed description of the PAs is given in Table 7-27 and the locations of these in relation to the Project are shown in Figure 7-88. The Project is not predicted to impact on the integrity of any PAs.

7.8.1.2 Key Biodiversity Areas

The World Key Biodiversity Areas database[14] was searched for Key Biodiversity Areas (KBAs) in the vicinity of the Ruzizi River and its catchment area. All of the PAs described in Section 7.8.1.1 are also designated as KBAs as well as Important Bird Areas (IBAs) and are thus indicated on the map in Figure 7-88. One KBA that is not a PA is the Lake Kivu Catchment KBA, located in the DRC and Rwanda. Although the KBA title implies that the catchments of the rivers feeding the lake are included, the KBA only comprises the lake and its islands, an area of 243,227 ha. This is because the KBA has been designated entirely on aquatic features, including one endangered (EN) fish (*Lates microlepis*) and two EN freshwater crabs (*Potamonautes gonocristatus* and *Potamonautes idjiwiensis*). Even though the above PAs and KBAs are located in the Ruzizi catchment or along its lower reaches, they represent a wide range of habitats, altitudes and landscapes that are not represented in the Project Area. The Project is not predicted to impact on any KBAs.

7.8.1.3 Ramsar Sites

The Convention on Wetlands is a 1971 treaty between governments that provides a framework for the conservation and wise use of the world's most important wetlands and their resources. Over 90% of the UN member states are signatories and have provided lists of wetlands that are considered to be of global importance, which are referred to as Ramsar Wetlands. Only one Ramsar Wetland is located along the Ruzizi River, namely the Rusizi National Park ('Parc National de la Rusizi (Site No. 1180)) in Burundi[15]. The site covers approximately 10,600 ha and comprises the Ruzizi River delta at the junction of the river and Lake Tanganyika, as well as a portion of the lower Ruzizi River floodplain above the delta. Habitats include the permanent inland delta, freshwater lakes, rivers and associated wetlands. The site has been recognised as an important wintering site or stopover point for migratory waterbirds and a breeding site for resident waterbirds. It also supports populations of threatened species such as hippopotamus (VU) and Nile crocodile (VU). The wetland supports important processes that provide ecosystem services

[13] https://www.protectedplanet.net/country/COD
[14] https://www.keybiodiversityareas.org/kba-data
[15] https://rsis.ramsar.org/ris/1180

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such as sediment trapping, carbon sequestration and nutrient cycling, and provides resources for human livelihoods such as fishing, livestock grazing and cultivation (rice, sugar cane, cotton). Major threats to the wetland include erosion, unsustainable utilisation of natural resources, and the use of pesticides and fertilizers for agriculture[16]. The project is not predicted to impact on the integrity of this Ramsar site as there only a small alteration to water level variations, which are already altered by Ruzizi I and Ruzizi II. Ruzizi National Park starts 88 km downstream of Ruzizi III and extends into the outflow of the river into Lake Tanganyika at 131 km (i.e. approximately 43 km of the lower Ruzizi River).

Table 7-27 Protected Areas and Key Biodiversity Areas in the Ruzizi Basin and Catchment Area

Protected Area	Description
Kahuzi-Biega National Park (DRC) – 6,689 km^2	Kahuzi-Biega National Park is located along the western edge of the Albertine Rift in eastern DRC, west of Lake Kivu. The Kahuzi-Biega National Park is located outside of the Ruzizi Basin approximately 14 km and 36 km to the northwest of the basin and PAOI at its nearest point, respectively. In addition, none of the river systems traversing the park drain into the Ruzizi. It comprises two large sections that are connected by a forested corridor. Two large mountains are prominent in the park, namely Mt Kahuzi (3,300 m) and Mt Biega (2,900 m). The park comprises dense primary montane forest with some bamboo, as well as areas of woodland, swamp and peatbog. The western extension of the park comprises a vast undulating tract of transition and lowland forest (~600 to 1,500 masl). The park was originally established to protect a population of Grauer's gorilla (Critically Endangered (CR) and it is still one of the strongholds for this species. Other highly threatened species include African forest elephant (CR), chimpanzee (EN), Mt. Kahuzi climbing mouse (CR) and red-collared mountain babbler (EN). Habitats in this PA are not represented by remaining portions of habitat in the Ruzizi III PAOI.
Itombwe Mountains (DRC) – 6,009 km^2	The Itombwe Mountains are a range of mountains south-west of Lake Kivu in South Kivu province (DRC). The mountain range partially overlaps with the eastern portion of the Ruzizi basin, located approximately 25 from the PAOI at its nearest point. It was declared a national reserve by the Institut Congolais pour la Conservation de la Nature (ICCN) in 2006. Itombwe is known to support at least 1035 plant species and 772 terrestrial vertebrates (of which at least five are endemic), including highly threatened species such as Grauer's gorilla (CR), Chimpanzee (EN), Congo Bay owl (EN) and Prigogine's nightjar (EN), and restricted-range species such as Itombwe Massif clawed frog (EN), Luvubu reed frog (EN) and white-striped reed frog (EN). The reserve comprises over 5,000 km^2 of montane forest and grassland (Kujirakwinja & Plumptre, 2016). The headwaters of the Ulindi River that are located within the Itombe Mountains partially overlap the Ruzizi Basin, but these drain west. There is no river connectivity between Itombwe and the Ruzizi River, and habitats are not represented by remaining portions of habitat in the Ruzizi III PAOI.
Nyungwe National Park (Rwanda) - 1019 km^2	Nyungwe forest is situated in south-west Rwanda between Lake Kivu and the international border with Burundi, where it is contiguous with Kibira National Park. The Congo-Nile watershed is situated within the park and comprises a range of mountains that reach 2,600–2,900 masl, dividing the park into two distinct sections. The western section comprises dense forest between 1,700 and 2,000 masl on soils derived from schists. The eastern part supports mostly secondary forest with many clearings and is on granite-derived soils. Summits and rocky areas have low Erica-dominated scrub forest, while bamboo stands are extensive in the south-east. These parks overlap with the western portion of the Ruzizi Basin covering an area of approximately 100,000 ha and located approximately 20 km to the east and north-east of the PAOI. Montane bogs are a feature of the western part of Nyungwe, with Kamiranzovu being the largest alpine peat bog in Africa. The forest supports populations of threatened mammals such as chimpanzee (EN), L'Hoest's monkey (VU), Angolan colobus (VU) and owl-faced monkey (VU), and birds such as Shelley's crimsonwing (EN), red-collared mountain-babbler (EN) and Congo Bay owl (EN). These parks are the source of several major tributaries of the Ruzizi River, including the Rubyiro and Ruhwa Rivers.
Cyamudongo Forest Reserve (Rwanda) – 415 ha	Cyamudongo forest is a small relict forest that is an outlier of the much larger Nyungwe Forest with its entirety located within the Ruzizi Basin. It is located close to the town of Nyakabuye near the border with the DRC, approximately 14 km from the PAOI. The forest has been a designated forest reserve since 1933. Vegetation differs from Nyungwe in being denser and having fewer clearings. A number of plant and vertebrate species are only known in Rwanda from this forest. A small population of chimpanzee (EN) is reportedly present in the forest.

[16] https://rsis.ramsar.org/ris/1180

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Protected Area	Description
	Numerous Albertine Rift bird endemics are present, although none of the highly threatened species occurring in Nyungwe are present due to the lower altitude.
Kibira National Park (Burundi) – 37 km^2	This national park is located in north-western Burundi and is contiguous with Nyungwe Forest in Rwanda, with which it forms a continuous montane forest block of 130 ,000 ha. Only about 16% of the remaining forest is considered to be primary forest, most of which is found on the wetter, western mountain slopes. Montane bogs and bamboo thickets are also supported in the park, The forest supports populations of threatened mammals such as chimpanzee (EN), L'Hoest's monkey (VU), Angolan colobus (VU), and birds such as Shelley's crimsonwing (EN), red-collared mountain-babbler (EN) and Grauer's swamp warbler (VU). This park is the source of several tributaries that drain into the lower Ruzizi River.
Rusizi National Park (Burundi) – 6.2 km^2	Rusizi National Park is located north-west of Bujumbura along the border with the DRC at the southern end of the Ruzizi Basin. It comprises a floodplain of about 2 km wide and 35 km long along the east bank of the Ruzizi River and a smaller area of delta where the Ruzizi enters Lake Tanganyika, with the main Bujumbura – Uwinka road separating these two areas. The delta is a mixture of islands and channels covered with *Phragmites* and papyrus swamps, while the northern floodplain comprises *Hyphaene* palm savannah. The delta section of the park is an important area for migratory waterbirds, such as Madagascar pond heron (EN), great snipe (NT), lesser flamingo (NT) and Eurasian curlew (NT) as well as other threatened species such as hippopotamus (VU) and Nile crocodile (VU). It is threatened by uncontrolled settlement, agriculture and fishing. *The park is situated approximately 80 km downstream of the Ruzizi HPP outfall.*

[Source: https://www.protectedplanet.net/country/COD; https://www.keybiodiversityareas.org/]

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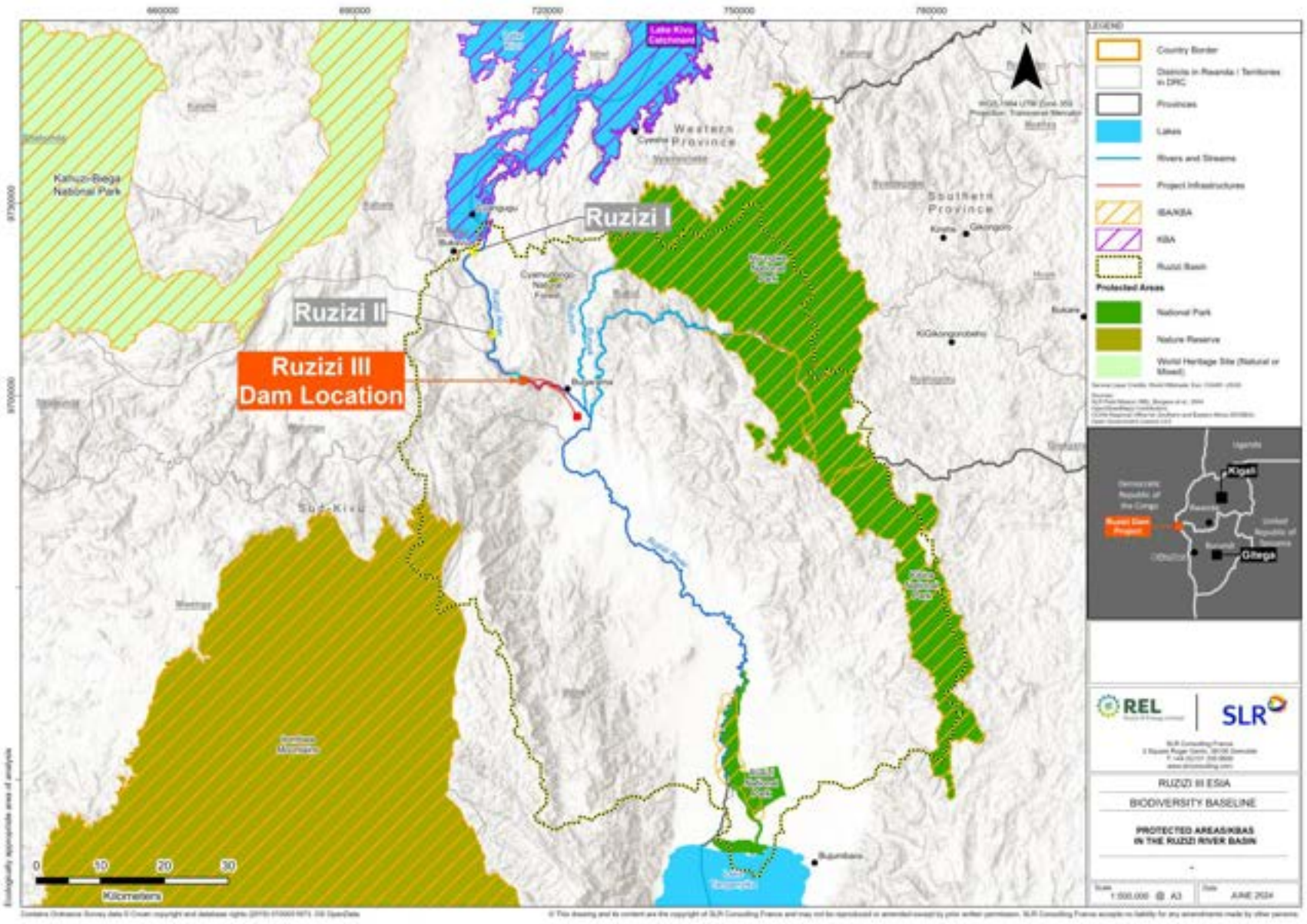


Figure 7-88 Protected Areas/KBAs in the Ruzizi River Basin [Source WDPA/Birdlife]

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7.8.2 Regional Context

7.8.2.1 Terrestrial Ecoregions

The Ruzizi III Project is situated within the Albertine Rift Montane Forests terrestrial ecoregion (AT0101) (Figure 7-89). This is one of the top ten species richness hotspots in Africa, supporting more vertebrates than any ecoregion in Africa with an estimated 1149 species, including 732 avifauna species and 221 mammal species (Burgess *et al*. 2004). The Albertine Rift Montane Forests also have the highest number of endemic avifauna and mammal species for any ecoregion on mainland Africa. The ecoregion has been classified as Endangered by Burgess *et al.* (2004) and listed as a Class 1 Ecoregion (Globally Important and Highly Threatened Ecoregions), one of only 32 ecoregions in Africa that have been classified as such. It also has the second highest extinction risk score for any ecoregion in Africa.

Although the Ruzizi III Project is situated in a critically threatened and globally significant ecoregion, the Project is located in a severely degraded part of the ecoregion that is characterised by mostly modified habitat and a high proportion of agricultural lands and nearby settlement. None of these habitats are likely to support the high species diversity and endemism typical of the ecoregion and few of the many threatened species of this ecoregion are likely to be present in the project area.

7.8.2.2 National Conservation Priorities for Rwanda

The latest National Biodiversity Strategy and Action Plan (NBSAP) for Rwanda (2016) contains specific conservation priorities to enhance protection of the following: i) Nyungwe Forest National Park and to link it with Cyamudongo Natural Forest; ii) the Volcanoes National Park; iii) Akagera National Park, and iv) Lake Kivu Islands. No mention is made of the Ruzizi River as a priority river system connecting to Burundi's Rusizi National Park and Ramsar Site. Burundi does not appear to have compiled an NBSAP that outlines its conservation priorities.

No national species red lists have been compiled for Rwanda or Burundi.

7.8.2.3 Regional Vegetation Types

A Overview

The Vegetation and Climate change in East Africa project (VECEA) has produced a map of the Potential Natural Vegetation of East Africa, covering seven countries (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia) (Lillesø *et al.* 2011). According to the Potential Natural Vegetation Map (https://vegetationmap4africa.org), the potential natural vegetation of the Ruzizi Valley between Kamembe and the Burundi border comprises three distinct vegetation mosaics:

- Evergreen and Semi-evergreen Bushland and Thicket and Riverine Wooded Vegetation Mosaic - between Kamembe and the approximate position of the proposed dam wall.
- Lake Victoria *Euphorbia dawei* Scrub Forest and Lake Victoria *Strychnos potatorum* Scrub Forest Mosaic – from the dam wall to Bugarama.
- Freshwater Swamp - between Bugarama and the Burundi border (including the lower Rubyiro River).

The potential natural vegetation of the plateau above the Ruzizi River is classified by VECEA as Lake Victoria transitional rain forest. The location of the project area within these vegetation types is indicated in Figure 7-90.

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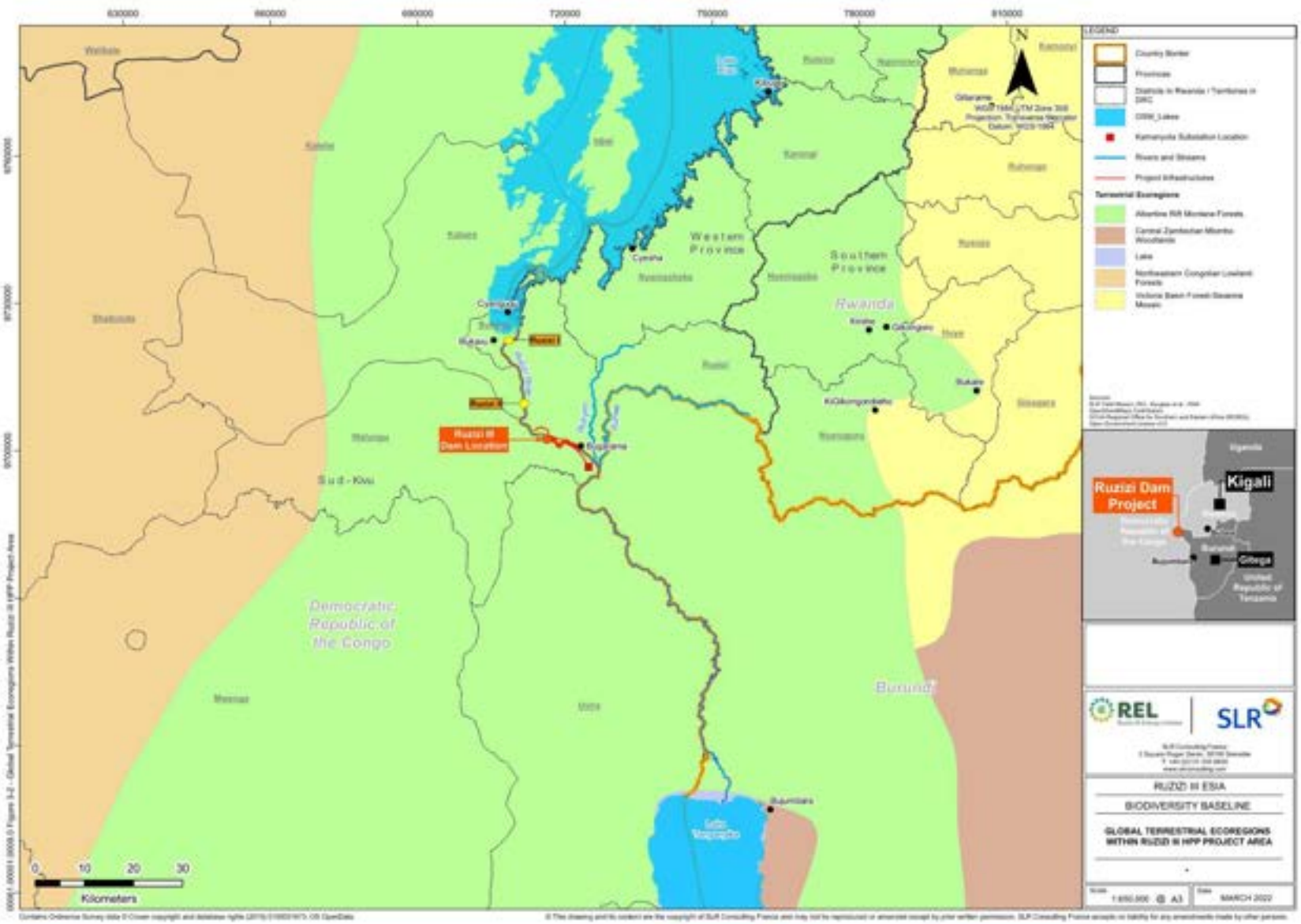


Figure 7-89 Global Terrestrial Ecoregions within Ruzizi III HPP Project Area
Source: Burgess *et al.,* 2004

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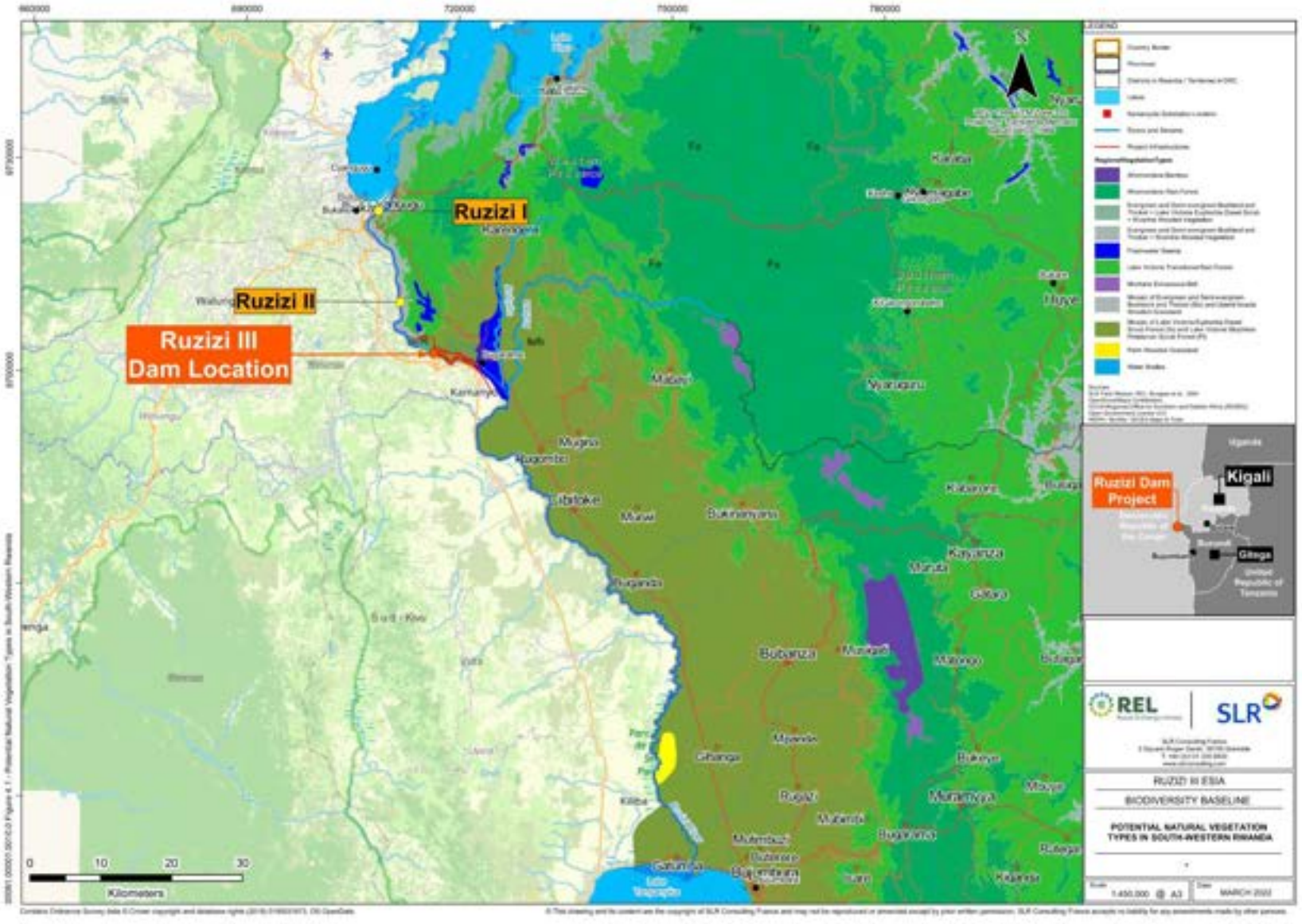


Figure 7-90 Map of the Potential Natural Vegetation Types in South-western Rwanda
[Source: VECEA]

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No natural vegetation representing the Lake Victoria *Euphorbia dawei* Scrub Forest and Lake Victoria *Strychnos potatorum* Scrub Forest Mosaic was located downstream of the dam wall and little of this remains in the vicinity of Bugarama town. No extensive areas of Freshwater Swamp vegetation remain along the Ruzizi Valley between Bugarama and the Burundi border, as well as in the lower reaches of the Rubyiro River, with only narrow, fragmented strips being located along the riverbanks of the Ruzizi.

The main vegetation mosaic that is still represented by natural vegetation in the Ruzizi Valley is the Evergreen and Semi-evergreen Bushland and Thicket and Riverine Wooded Vegetation Mosaic. The two vegetation types which make up this mosaic are described in more detail below.

B Evergreen and Semi-evergreen Bushland and Thicket

Evergreen and Semi-Evergreen Bushland and Thicket occurs is characteristic of drier slopes of mountains in East Africa and often forms the ecotone between Afromontane Forest and Deciduous Bushland. It has always been a localised vegetation type in western Rwanda where it is mostly confined to river valleys and the shores of Lake Kivu. Much of the vegetation type has been lost through extensive agriculture and today it is mostly confined to steep, rocky slopes that are difficult to cultivate. Characteristic trees and woody shrubs include *Senegalia brevispica, Vachellia hockii, Allophylus africanus, Cussonia holstii, Dodonaea viscosa, Dombeya burgessiae, Grewia similis, Olea europaea, Searsia natalensis* and *Carissa edulis*. *Euphorbia candelabrum* is a diagnostic emergent succulent tree. Characteristic lianes include *Capparis tomentosa, Pterolobium stellatum* and *Cissus* species.

C Riverine Wooded Vegetation

The main structural form of Riverine Wooded Vegetation occurring along the Ruzizi River is Riverine Forest or Thicket. Within western Rwanda the vegetation type is confined to the banks of perennial rivers such as the Ruzizi or as scattered fragments along the shore of Lake Kivu. Typical Riverine Forest / Thicket tree species include *Diospyros mespiliformis, Ficus sycomorus, F. vallis-choudae, Syzygium guineense, Senegalia polyacantha, Albizia grandibracteata, Antidesma venosum* and *Bersama abyssinica*, whereas typical shrub or liane species include *Allophylus africanus, Annona senegalensis, Capparis tomentosa, Dovyalis macrocalyx* and *Maesa lanceolata*.

7.8.3 Vegetation Communities

Two hundred and twenty-five (225) plant species were recorded in the project area during fieldwork (Annex C), of which a relatively high proportion (47 species, or 21%) are alien invasive species. Plant families that are well represented are Fabaceae (25 species), Asteraceae (22 species), Poaceae (20 species), Moraceae (10 species) and Malvaceae (9 species).

Five distinct vegetation communities were identified in the Ruzizi III project area during the desktop phase and ground-truthed during fieldwork. These were classified on the basis of floristic composition (dominant and diagnostic species), physical structure (canopy cover, presence of sub-canopy strata) and position in the landscape (e.g. hillslopes, cliffs, riverbanks). Each of these vegetation types is indicated on the maps of the project area (Figure 7-91a, b, c, d). Detailed descriptions of each community are given below, while a summary of each vegetation community and representative photographs are presented in Table 7-28.

7.8.3.1 Riparian Thicket

Riparian Thicket is located along the banks of the Ruzizi River between the upper end of the reservoir and the powerhouse area, as well as along a few of the larger seasonal tributaries of the river (Figure 7-91). This would have been a more extensive vegetation community in the past, but now is a highly fragmented community, comprising mostly small, disconnected strips of thicket along the riverbanks. In most places the riverbanks have been cleared for cultivation

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of crops such as maize, cassava or sorghum. No Riparian Thicket was encountered along the floodplain between Bugarama and the Burundi border. An estimated 3 ha are likely to be lost through dam construction and inundation, while 5.9 ha could be negatively impacted through extraction along the dewatered stretch and an additional 1 ha could be impacted through vegetation clearance along access roads and other infrastructure (Table 7-29).

Vegetation structure is Low to Tall Thicket (sensu Edwards, 1983), with a closed woody canopy and sparse herbaceous understory. The canopy is dominated by tree species such as *Sterculia tragacantha, Ficus vallis-choudae, F. sycomorus, Trema orientalis, Albizia gummifera, A. grandibracteata* and *Bridelia micrantha*. Lianes or scrambling shrubs are quite prominent in certain patches, including species such as *Grewia forbesii, Cardiospermum grandiflorum* and *Cissampelos mucronata*. Where an herbaceous understory is present, soft shrubs such as *Acalypha* cf. *bipartita, A. ornata* and *Hoslundia opposita* are dominant. Grasses are sparse in the understory but do include a few shade-loving species such as *Setaria lindenbergiana* and *Oplismenus* species. Invasive alien plants such as *Lantana camara, Tithonia diversifolia* and *Parthenium hysterophorus* are prominent in some patches of Riparian Thicket. Seventy-six (76) species were recorded in Riparian Thicket during fieldwork, representing 34% of the project area species list (Annex C). Floristic composition is most similar to Hillslope Thicket / Forest, with which it shares 40 species.

No threatened, near threatened or restricted-range species were confirmed to occur in Riparian Thicket. Even though the vegetation community has some functional importance (e.g. riverbank stabilisation, flood attenuation) it only has Moderate Ecological Importance due to being highly fragmented (impacting functional integrity) and densely invaded by alien plants in some thicket patches.

Riparian thicket occurs as narrow strips along riverine and stream courses. Several portions of Riparian Thicket in the project area have been heavily invaded by alien plants (e.g. *Lantana camara, Tithonia diversifolia*), particularly along seasonal tributaries. Portions of riparian thicket with indigenous species are highly fragmented and its ecological functionality is compromised and therefore this habitat is assessed as Modified.

7.8.3.2 Riparian Wetland

The Riparian Wetland vegetation community is confined to relatively narrow strips of recently deposited alluvium (sand, gravel) in discrete places along the banks of the Ruzizi River as well as most of the islands in the river (Figure 7-91). This would have had a more extensive distribution in the project area historically, but many areas have been cultivated with crops such as tree tomato (*Solanum betaceum*), cassava (*Manihot esculenta*) and maize (*Zea mays*). Riparian Wetland covers approximately 3 ha of the reservoir basin and 3.5 ha of the downstream reaches between the reservoir and the powerhouse (i.e. dewatered reach) (Table 7-29). Given that the Riparian Wetlands occur as small discrete habitats along the banks of the lower reaches of the Ruzizi between Bugarama and the Burundi border, they have not been mapped.

Vegetation structure is Tall Grassland (sensu Edwards 1983) on more recently colonised alluvium, where reeds (*Phragmites mauritianus*) and tall grasses (*Hyparrhenia* species) are dominant, but this changes to Low Shrubland when Riparian Wetlands become colonised over time by shrubs such as *Pluchea ovalis, Mimosa pigra, Tithonia diversifolia* and *Lipotriche scandens*. Grasses and sedges are prominent life forms in Riparian Wetlands, including species such as *Leersia hexandra, Sporobolus africanus, Cyperus cyperoides, Cyperus* cf. *dives, Cyperus* cf. *dubius* and *Cynodon dactylon*. Frequent flooding of these wetlands results in frequent deposition of seeds, particularly of herbaceous invasive alien species, which easily become established on the alluvium substrate, e.g. *Ageratum conyzoides* and *Parthenium hysterophorus*.

Thirty-three (33) species were recorded in Riparian Wetlands during fieldwork, representing 15% of the project area species list (Annex C). Floristic composition is most similar to areas of cultivation, with which it shares 17 species (many of which are invasive alien species).

Riparian Wetlands can play an important role in water quality amelioration, by trapping sediment and enhancing nutrient uptake; removal of water quality impurities (such as phosphorous), and

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flood attenuation. However, the riparian wetlands along the Middle Ruzizi in the project area of influence play a relatively minor role in regulating and supporting ecosystem services due to their small and fragmented occurrence and fast flow of the Ruzizi River where the volume of water has insufficient time to be attenuated by the wetlands. The riparian wetlands in the lower Ruzizi River are, however, of greater importance for regulating services.

No threatened, near threatened or restricted-range species were confirmed to occur in Riparian Wetlands. The wetlands have some functional importance (particularly flood attenuation) but functional integrity has been compromised by habitat fragmentation, modification (through cultivation) and invasion by alien plants, and it has relatively low conservation importance because of a low number of potentially occurring SCC. As a result, it only has a Moderate Ecological Importance.

Riparian Wetlands within the PAOI are highly fragmented and of small size as the majority of the alluvium has been converted into agricultural fields, with only interspersed patches of indigenous vegetation. Given the degraded status of riparian wetlands along the Middle Ruzizi River, and their reduced ecological status and functioning, these wetlands were classified as Modified.

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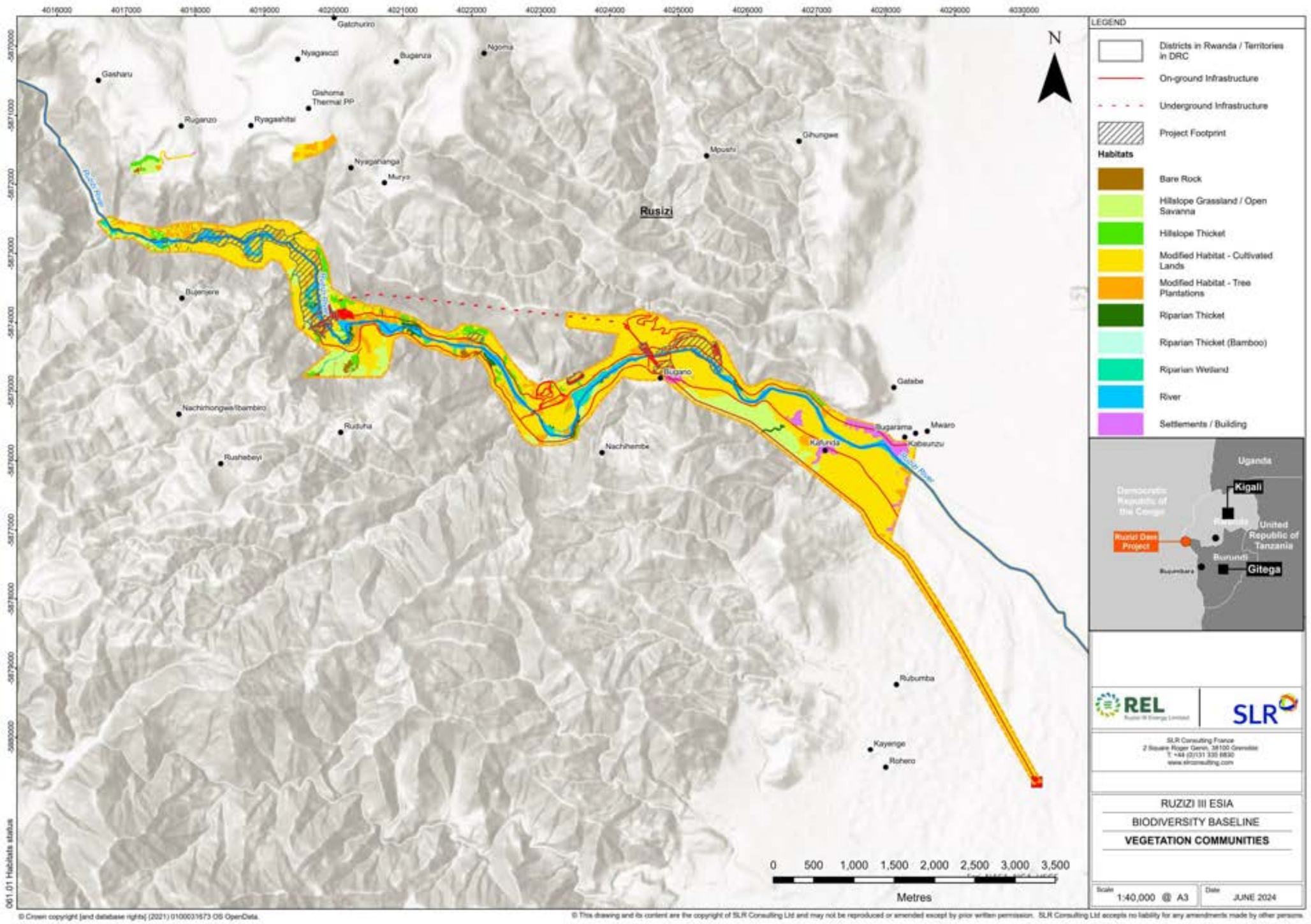


Figure 7-91a Map of Vegetation and Land Cover Types in the Project Area: Overview Map

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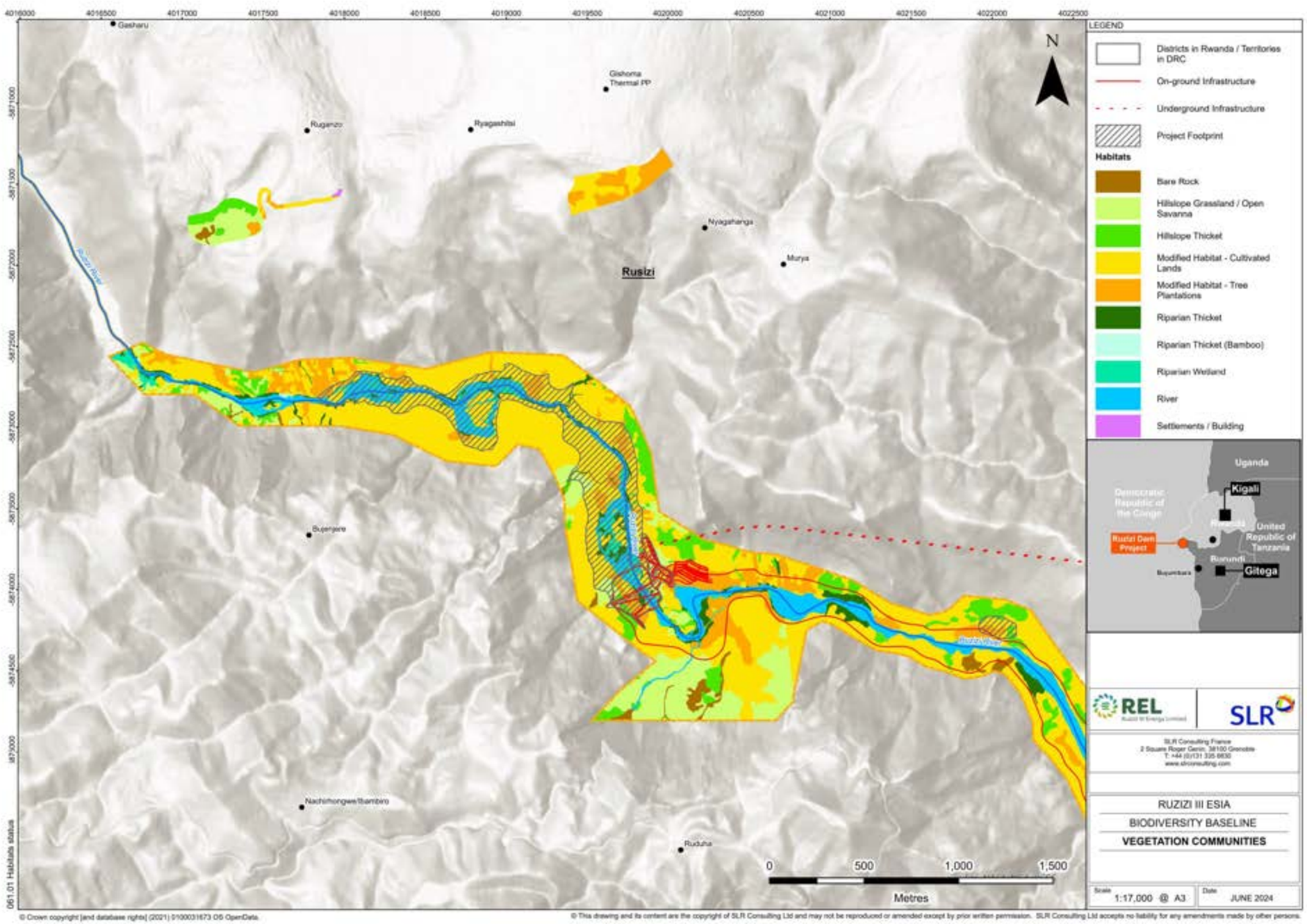


Figure 7-91b Map of Vegetation and Land Cover Types in the Project Area: Reservoir

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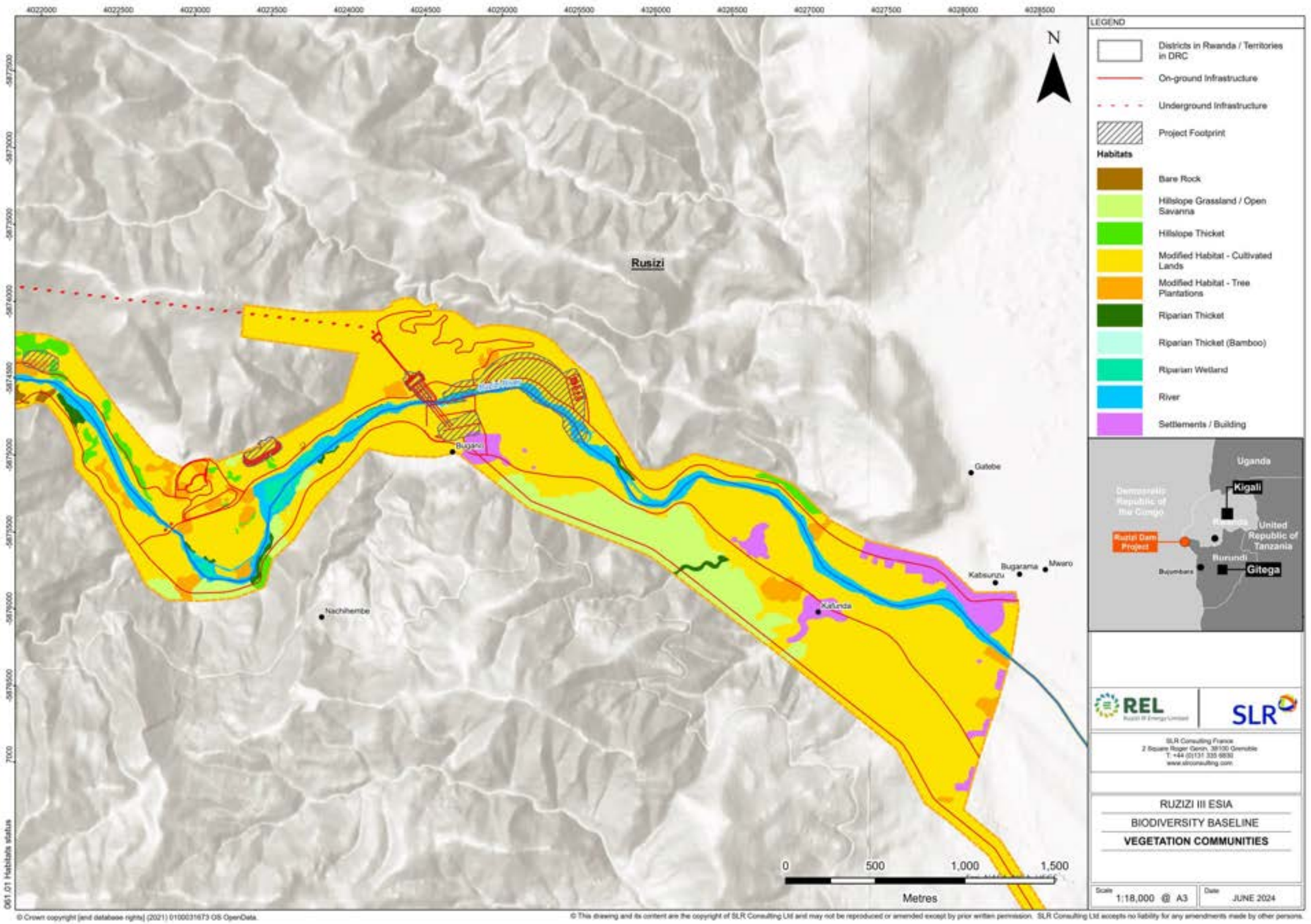


Figure 7-91c Map of Vegetation and Land Cover Types in the Project Area: Ruzizi HPP Downstream Reach

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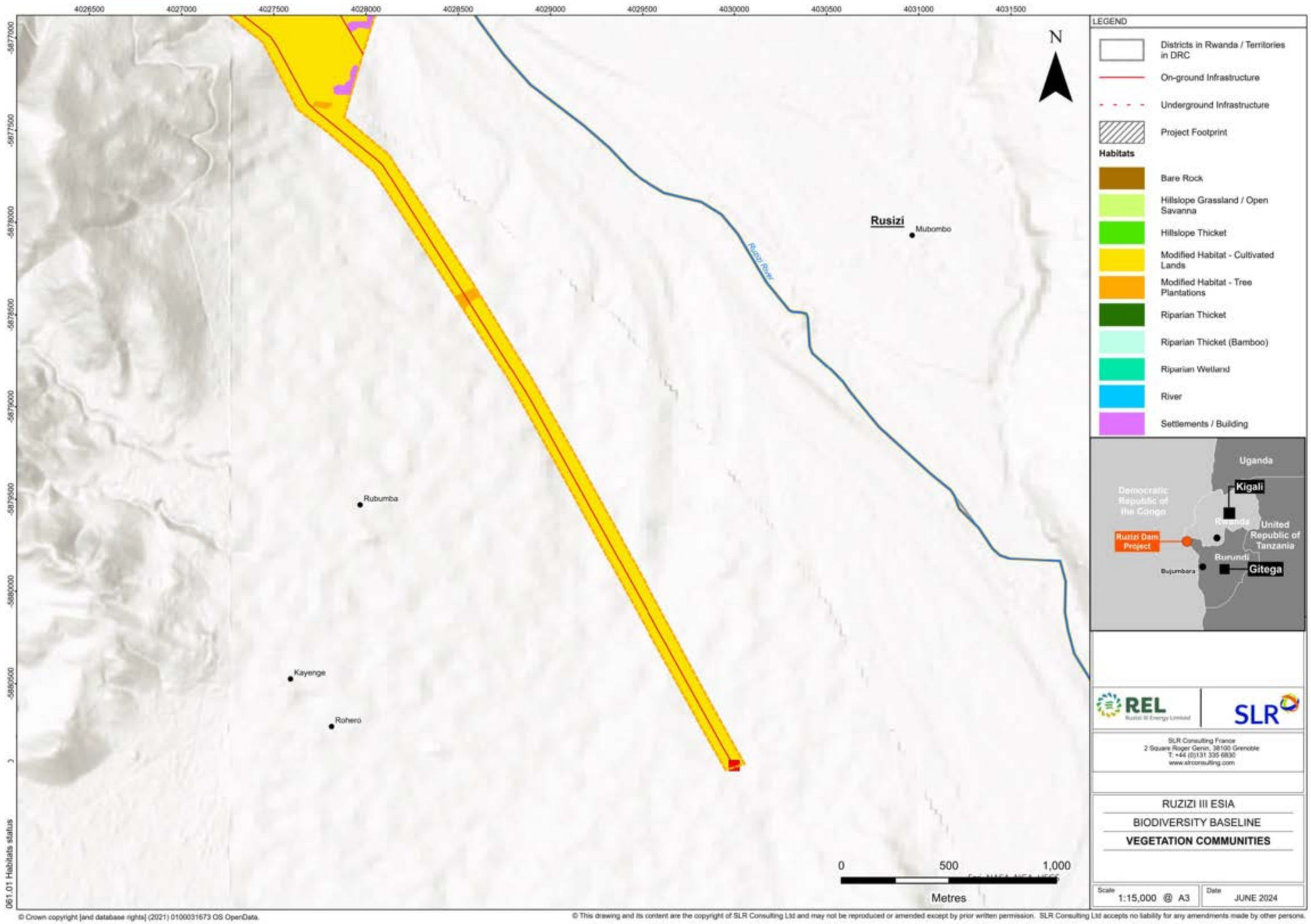


Figure 7-91d Map of Vegetation and Land Cover Types in the Project Area: Transmission Line and Access Road Corridor

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7.8.3.3 Cultivation / Secondary Shrubland Mosaic

This vegetation mosaic is the most widespread community in the project area, occurring on the hillslopes above the Ruzizi River, the riverbanks and associated floodplain, and on the plateau above the valley (Figure 7-91). The pattern of the vegetation mosaic results from some of the cultivated fields being abandoned and lying fallow, allowing varying stages of regeneration of woody shrubs and herbaceous plants. Vegetation structure varies from Tall Grassland or Low Shrubland to Tall Woodland (tree plantations).

The vegetation mosaic covers 32.1 ha of the reservoir basin and upper slopes, 15 ha along the transmission line route; 34 ha along access roads and 63 ha in other project infrastructure footprints (Table 7-29). Most of the habitat along the floodplain of the lower reaches of the Ruzizi between Bugarama and the Burundi border has been converted to agriculture and is actively cultivated. The rich floodplain soils and ease of access to water for irrigation means that these cultivated areas are not rotated as they are in the dryland cultivation system upstream of Bugarama, resulting in less fallow land with regenerating shrubland. An estimated 32.1 ha of the Cultivation / Secondary Shrubland Mosaic are likely to be lost through dam construction and inundation.

The dominant crops in the Ruzizi Valley and hillslopes are maize (*Zea mays*), cassava (*Manihot esculenta*), tree tomato (*Solanum betaceum*), sweet potato (*Ipomoea batatas*) and millet (*Sorghum* species), while tree plantations comprise mostly banana (*Musa acuminata*), avocado (*Persea americana*), mango (*Mangifera indica*) and silky oak (*Grevillea robusta*). Prominent crops on the plateau above the Ruzizi Valley include coffee (*Coffea arabica*) and tea (*Camellia senensis*), while the tree plantations are mostly *Eucalyptus* species and banana. Crops that are cultivated mostly on the floodplain downstream of Bugarama and along the Rubyiro River are sugar cane (*Saccharum officinarum*) and rice (*Oryza sativa*). Typical woody shrubs that invade fallow fields are *Lantana camara, Markhamia lutea, Tithonia diversifolia, Solanum chrysotrichum, Urena lobata, Hoslundia opposita* and *Trema orientalis*, while common herbaceous species include *Parthenium hysterophorus, Bidens pilosa, Desmodium tortuosum, Sida acuta* and *Tridax procumbens* (most of which are invasive aliens).

Species richness is relatively high, with 80 species, or 36% of the project area species list, being recorded during the January 2022 survey (Annex C). However, a high number of these (43 species) are alien species, many of which are highly invasive.

No threatened, near threatened or restricted-range species were confirmed to occur in the Cultivation / Secondary Shrubland Mosaic and none are likely to be present.

This vegetation community has Low Ecological Importance as a result of integration of Low Functional Importance (low functional diversity) and Low Biodiversity Importance (high proportion of alien species). This entire vegetation community is classified as Modified Habitat as a result of the high proportion of alien plant species and due to the extent that the primary ecological functions and species composition of the original habitats have been altered.

Regulating ecosystem services are limited within this habitat type due to its modified characteristics. Clearance of indigenous vegetation for agriculture and settlement has resulted in higher velocity rainfall impacted onto the soil surface, leading to more rapid water runoff and reduced percolation into the soil. Consequently, this effect has caused gully and sheet erosion, and in certain places have become so severe as to cause landslides.

7.8.3.4 Hillslope Thicket / Forest

Hillslope Thicket / Forest is a fragmented vegetation community mostly comprising small patches of less than 100 m^2 that are confined to areas of exposed rock or cliffs on the hillslopes, or along seasonal drainage lines high up on the slopes (Figure 7-91); thicket size is mostly dependent on level of fire protection (e.g. areas of exposed rock), with more protected areas having larger thickets.

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Vegetation structure varies from Low to Tall Thicket (sensu Edwards 1983), occasionally becoming more structurally complex on the moist upper slopes where it can be classified as Low Forest.

Hillslope Thicket / Forest covers approximately 0.5 ha of the reservoir basin and upper slopes, as well as 2.1 ha along the lower access road and 3.6 ha in other infrastructure (Table 7-29). None of this vegetation community is present on the level plains downstream of Bugarama. An estimated 0.5 ha of Hillslope Thicket / Forest are likely to be lost through dam construction and inundation, with 6.1 ha lost during construction of project infrastructure. None of the vegetation community downstream of the powerhouse is likely to be impacted by dewatering since none of the plant species are flow dependent.

The canopy is dominated by tree species such as *Sterculia tragacantha*, several *Ficus* species such as *Ficus vallis-choudae, F. sycomorus, F. oreodryadum* and *F. thonningii, Trema orientalis, Antidesma venosum*, *Sterculia quinqueloba* and *Bridelia micrantha*. Common woody shrubs include *Grewia forbesii, Hoslundia opposita, Gymnanthemum amygdalinum* and *Searsia longipes*. The herbaceous understory is usually more developed than in Riparian Thicket, with prominent species including soft shrubs such as *Acalypha* cf. *bipartita* and *A. ornata*. Geophytes are also quite common and include *Scadoxus multiflorus, Eulophia guineensis* and *Bonatea steudneri*. Grasses are sparse in the understory but do include a few shade-loving species such as *Setaria lindenbergiana* and *Oplismenus* species. Thickets on the lower hillslopes and along rocky sections above the Ruzizi River are often invaded by the alien shrubs *Lantana camara* and *Tithonia diversifolia.*

Ninety-four (94) species were recorded in Hillslope Thicket / Forest during fieldwork, which is the highest species richness for any vegetation community in the project area, representing 42% of the species list (Annex C). This is remarkably high species richness considering the small spatial coverage of the community in the project area. Floristic composition is most similar to Riparian Thicket, with which it shares 40 species.

No threatened or restricted-range species were confirmed to occur in Hillslope Thicket / Forest. One Near Threatened (NT) species (*Milicia excelsa*) was recorded at the base of a steep slope downstream of the powerhouse site and is unlikely to be directly impacted by the project. This vegetation community has relatively high functional importance (e.g. stabilisation of steep slopes and banks of seasonal drainage lines on upper slopes) and moderate Biodiversity Importance (proportion of habitat specialists, one NT species), resulting in an integrated Ecological Importance value of Moderate.

Regulating services associated with this habitat type are dependent on the density of alien plant encroachment. Soil stability is relatively high where a diversity of indigenous vegetation is present, attributed to the different root lengths and structure of the different functional growth forms. However, where monostands of alien plants are present, soil stability is weakened, with a concomitant increase in erosion. Although the habitat does support pollinators, the diversity was observed to be lower than Riparian Thicket.

This habitat is highly fragmented, comprises small discrete patches, and ecological functioning has been seriously compromised and there this habitat is assessed as Modified.

7.8.3.5 Hillslope Grassland / Savannah

Hillslope Grassland / Savannah is characteristic of the steepest hillslopes above the Ruzizi River between the upper reaches of the reservoir and the towns of Bugarama and Kamanyola (DRC), usually occurring on the highest slopes and only rarely reaching the river (Figure 7-91). Most of the accessible hillslopes have been cultivated and this vegetation community occurs in a patchwork of cultivation and regenerating low shrubland.

Hillslope Grassland / Savannah covers approximately 20 ha of the hillslopes above the Ruzizi Valley between the upper reaches of the reservoir and the towns of Bugarama and Kamanyola (Table 7-29); this includes approximately 48% of the transmission line route between the powerhouse and the Kamanyola distribution site. An estimated 1.66 ha of Hillslope Grassland / Savannah are likely to be lost through dam construction and inundation. None of the vegetation

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community downstream of the powerhouse is likely to be impacted by dewatering since none of the plant species are flow dependent. The only parts of this habitat that are likely to be impacted by erection of the transmission lines is at the location of each tower on the hillslopes.

Vegetation structure varies from Low Open to Closed Grassland (sensu Edwards 1983), becoming Open Woodland where trees and shrubs are more prominent. Very few grass species were in flower during fieldwork (making identification of non-flowering species problematic) but those that were identified included a *Cymbopogon* species, *Hyparrhenia* cf. *filipendula, Setaria sphacelata, Sporobolus* cf. *pyramidalis* and *S. africanus*. Forbs, dwarf shrubs and geophytes observed in this community included *Ocimum obovatum, Tinnea apiculatum, Bothriocline* cf. *longipes, Leonotis nepetifolia, Pentas zanzibarica* and *Habenaria* cf. *adolphii*. Low trees and woody shrubs that are characteristic of Hillslope Grassland / Savannah are *Ozoroa insignis, Vachellia hockii, Lannea* cf. *antiscorbutica, Cussonia arborea, Gymnosporia senegalensis* and *Sterculia quinqueloba*. Areas of exposed rock have a unique sub-community that is dominated by ferns such as *Adiantum incisum, Actiniopteris semiflabellata* and *Aleuritopteris farinosa*, as well as the succulent forb, *Peperomia* cf. *leptostachya*.

Fifty-nine (59) species were recorded in Hillslope Grassland / Savannah during fieldwork, which represents 26% of the project area species list (Annex C). Floristic composition is most similar to Hillslope Thicket / Forest, with which it shares 21 species, mostly woody shrubs or trees that occur in both vegetation communities.

No threatened, near-threatened or restricted-range species were confirmed to occur in Hillslope Grassland / Savannah. This vegetation community has relatively high functional importance (e.g. stabilisation of steep slopes) and moderate Biodiversity Importance (proportion of habitat specialists), resulting in an integrated Ecological Importance value of Moderate.

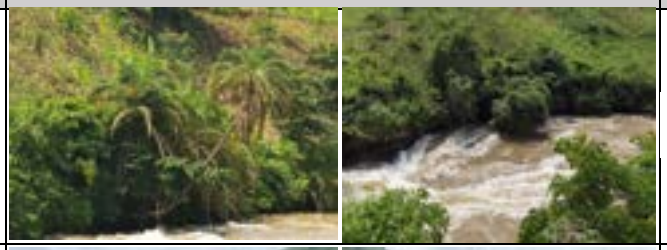
Hillslope Grassland / Savannah can be classified as largely Natural Habitat on the basis of the high proportion of indigenous species and relatively intact ecological functionality. This vegetation community has been least impacted by alien plant invasion in the project area.

Accordingly, this habitat type supports and provides important regulating services, especially soil stabilisation. This habitat type also plays a role in maintaining the hydrological characteristics of the sub-catchment. The dense graminoid growth reduces the physical impact of rainfall on the soil surface, while also reducing water velocity run-off. Notably, solitary bees were observed to be important pollinators within this habitat type.

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Table 7-28 Summary of Vegetation Communities in the Ruzizi III Project Area

Vegetation Communities	Dominant and Diagnostic Species	Photographs	Habitat Status	Ecological Importance
Riparian Thicket	*Sterculia tragacantha, Ficus vallis-choudae, F. sycomorus, Trema orientalis, Albizia gummifera, A. grandibracteata, Bridelia micrantha, Grewia forbesii*		Modified	Moderate
Riparian Wetland	*Phragmites mauritianus, Hyparrhenia sp., Pluchea ovalis, Mimosa pigra, Lipotriche scandens, Leersia hexandra, Cyperus cyperoides, Cyperus dives, Cyperus dubius, Cynodon dactylon*		Modified	Moderate
Cultivation	*Zea mays, Manihot esculenta, Solanum betaceum, Ipomoea batatas, Musa acuminata, Persea americana, Mangifera indica, Coffea arabica, Eucalyptus species, Lantana camara, Tithonia diversifolia, Parthenium hysterophorus*		Modified	Low
Hillslope Thicket / Forest	*Sterculia tragacantha, Ficus vallis-choudae, F. sycomorus, F. oreodryadum, F. thonningii, Trema orientalis, Sterculia quinqueloba, Grewia forbesii, Searsia longipes, Scadoxus multiflorus, Eulophia guineensis, Bonatea steudneri*		Modified	Moderate
Hillslope Grassland / Savanna	*Cymbopogon sp., Hyparrhenia cf. filipendula, Setaria sphacelata, Ocimum obovatum, Tinnea apiculata, Bothriocline cf. longipes, Leonotis nepetifolia, Habenaria cf. adolphii, Ozoroa insignis, Vachellia hockii, Lannea cf. antiscorbutica*		Natural	Moderate

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Table 7-29 Summary of Spatial Cover of Vegetation Communities in the Ruzizi III Project Area

Vegetation Community/ Habitat	Terrestrial Ecological Importance	Habitat Status	Reservoir (to Full Supply Level: 1150 masl)*		Dewatered Reach (only riparian wetlands, thicket) & open water)		Substation & Transmission Line RoW (30 m wide)		Access Road Corridor (20 m wide)		Access Road To Powerhouse**		Dam Site, Laydown Area, Spillway***		Other project infrastructure (powerhouse, disposal areas, laydown, camps)***		Total Footprint
			Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	ha	%	ha
Riparian Thicket	M	Modified	2.97	5.6%	5.9	15.4%	0.05	0.2%	0.45	1.%			0.35	4.8%	0.05	0.1%	**9.77**
Riparian Wetlands	M	Modified	3.04	5.7%	3.54	9.2%							0.10	1.4%			**6.68**
Hillslope Thicket / Forest	M	Largely Natural	0.45	0.8%					2.11	4.9%			0.46	6.3%	3.60	5.0%	**6.62**
Hillslope Grassland / Savannah	H	Largely Natural	1.66	3.1%			5.52	26.2%	2.84	6.6%	3.45	42.8%	0.90	12.3%	3.90	5.4%	**18.3**
Open Water	M	Modified	13.29	24.8%	28.93	75.4%			0.1	0.2%			0.95	13.0%	0..03	0.0%	**43.3**
Cultivation / Secondary Shrubland Mosaic	L	Modified	32.12	60%			15.0	71.2%	34.16	79.1%	4.52	56.0%	4.46	60.9%	63.5	87.8%	**153.8**
Towns & Villages	VL	Modified / Largely Modified					0.495	2.3%	3.24	7.5%	0.10	1.2%	0.10	1.4%	1.0	1.4%	**4.97**
Bare Rock	M	Largely Natural							0.27	0.6%					0.22	0.3%	**0.49**
Total			**53.53**	**100%**	**38.37**	**100%**	**21.06**	**100%**	**43.17**	**100%**	**8.07**	**100%**	**7.32**	**100%**	**72.34**	**100%**	**243.86**

* Note: 1150 masl was used although FSL is 1149.5masl
**Potential widening of the existing road is not included
*** These areas were based on the land acquisition areas which may be larger than the actual project footprint areas as the actual infrastructure footprint areas were not available. Therefore, these quantified areas likely represent a worst-case land loss However, note that total footprint excludes any potential quarry areas.

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7.8.3.6 Flora of Conservation Concern

Eighty-two (82) threatened plant species have distribution ranges that overlap with the project area, of which fifty are classified by the IUCN as Vulnerable (VU) and 32 as Endangered (EN) (Annex C). An additional 23 species are classified as Near Threatened (NT). However, the vast majority of these are confined to undisturbed montane habitats at much higher altitudes than that of the project area and are unlikely to occur in the project area. Six (6) species that are threatened (3 EN and 3 VU species) and one species that is classified as NT but is also a restricted-range species (i.e. has an EOO of less than 50,000 km^2) are considered to be priority Species of Conservation Concern (SCC) in this project. These species occur at altitudes represented in the project area and in habitats that would have been more widespread in the area historically and thus have a moderate likelihood of being present, even if they were not located during fieldwork (Table 7-30).

Three EN species are apparently endemic or mostly confined to the Ruzizi River Valley, either in the vicinity of the project area or on the floodplain downstream of the project area, namely *Emilia subscaposa* (Asteraceae), *Chlorophytum hirsutum* (Anthericaceae) and *Blepharis burundiensis* (Acanthaceae). Each of these species is also classified as a Restricted-range species as a result of having an EOO of less than 50,000 km^2. However, *Blepharis burundiensis* is unlikely to be present since it occurs in habitats and at altitudes not represented in the project area[17]. *Emilia subscaposa* and *Chlorophytum hirsutum* potentially occur in the fragments of natural grassland or thicket habitat that remain on the slopes above the reservoir basin although they were not located in any of the habitats surveyed. The May 2024 survey confirmed the absence of these species from the transmission line route, and they are unlikely to occur within habitats accessible to people and livestock. However, if present within very steep inaccessible slopes, neither species will be impacted by the direct loss of habitat through reservoir inundation and transmission line construction.

An additional more widespread EN species, *Bulbostylis longiradiata* (Cyperaceae), potentially occurs in the Hillslope Grassland / Savannah vegetation community in the project area. This small, easily overlooked species potentially occurs on the hillslopes above the reservoir and is thus unlikely to be impacted by the direct loss of habitat through reservoir inundation. The species was initially thought to occur on the slopes along which the transmission lines are routed and would then be impacted by construction of pylons if present. However, none of the grassland fragments that were surveyed in proximity to the transmission line, including during the May 2024 survey, contained this species and it is considered unlikely to occur within the project area.

The potentially occurring three VU species and one NT species are described in more detail in Table 7-30. An additional NT species, *Milicia excelsa* (Moraceae), was confirmed to occur at one site during fieldwork. A single mature tree was located at the edge of Hillslope Thicket at the base of a slope downstream of the powerhouse (Figure 7-92. . Since this tree is not situated within any project infrastructure it is unlikely to be impacted by the development of the project. It is also likely to be present elsewhere in the project area at sites not surveyed during fieldwork. It is a widespread species occurring throughout tropical Africa and is heavily harvested for commercial timber but is unlikely to occur in sufficient density in the project area to be harvested.

[17] This is not one of the three EN species mentioned above

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Figure 7-92. Near-Threatened *Milicia excelsa* in Hillslope Thicket near Powerhouse

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Table 7-30 Priority Plant Species that could Potentially Occur in the Ruzizi III Project Area

Scientific Name	IUCN Status	Extent of Occurrence (km^2)	Habitat	Likelihood	Rationale
Emilia subscaposa	EN	706	Prefers swamps, but has also been reported from sandy fallows, cassava fields, and dry grassland, at 775–1,030 m altitude.	Low	While much suitable present downstream of the project, this poorly known species has not been collected since 1971 and is only known from 6 specimens from the southern reaches of the Rusizi.
Chlorophytum hirsutum	EN	12,155	Grows in open forest, *Loudetia* grassland, forest margins among boulders, gallery forest, ravine with Euphorbia; at 675-1,200 m altitude.	Low	While there is suitable habitat in the project area the species is unlikely to occur within the project area due to anthropogenic influences.
Bulbostylis longiradiata	EN	111,949	Grows in grassland and open woodland at 800-1,250 m asl.	Low	While there is suitable habitat in the project area the species is unlikely to occur within the project area due to anthropogenic influences.
Vernonia melanocoma	NT	40,813	An annual herb of roadsides in wooded grassland and grassland.	Moderate	Some suitable present in the project area
Buchnera keilii	VU	578,853	Grows in grassland, light woodland at 1,300-2,000 masl.	Moderate	Some suitable present in the project area.
Ochna hackarsii	VU	83,791	Occurs in riparian forest at 750-1,470 masl.	Moderate	Some suitable present in the project area
Pauridiantha bequaertii	VU	206,231	Occurs in lowland to mid-altitude forests at 700–1,350 m elevation.	Moderate	Some suitable present in the project area

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7.8.3.7 Threats to Vegetation and Flora

The greatest current threat to vegetation in the project area is the conversion of natural habitat through to agriculture. Cultivated lands and tree plantations comprise 66% of the project area, indicating the significant habitat losses that have already taken place. This loss of natural habitat has been most severe downstream of Bugarama, where the entire floodplain and adjacent terrestrial plains have been converted to high intensity small-scaler agriculture or urban residential developments. No natural habitat was located in this part of the project area, apart from narrow strips of Riparian Wetland vegetation along the banks of the Ruzizi River. A careful scan from a high vantage point above the confluence of the Rubyiro and Ruzizi Rivers confirmed that no extensive wetland habitat remains along this stretch of the Ruzizi in either Rwanda or the DRC.

Another significant threat to vegetation is invasion of habitats by invasive alien plants. Forty-seven (47) alien plant species were recorded during fieldwork, representing 21% of the total plant list, which is a high proportion. Three species are particularly invasive and are already present in significant numbers, namely *Tithonia diversifolia*, *Lantana camara* and *Parthenium hysterophorus*. Each of these species has the potential to transform landscapes by growing in such dense infestations that few other plants can compete, resulting in transformation of habitat structure and species composition. Photos of a selection of invasive alien plant species found in the project area is presented in Figure 7-93.

Another impact on natural habitat was visible on steep slopes, namely extensive soil erosion or landslides, most of which have resulted in loss of Hillslope Grassland / Savannah vegetation. Paths along some of the steep slopes on the DRC side of the river have resulted in accelerated soil erosion in places Exacerbated and additional landslides were observed during the May 2024 survey. The hillslopes adjacent to the RN5 in the DRC are particularly susceptible to erosion as the road traverses very steep slopes with no erosion control measures.

A single active charcoal kiln and a few old kilns were located within the reservoir area, but charcoal production does not seem to be widespread, possibly because of the lack of large trees in the area (apart from tree plantations Photographs of some of these threats to vegetation are shown in Figure 7-94.

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Photo 1. *Lantana camara* (lantana)



Photo 2. Tithonia diversifolia



Photo 3. Parthenium hysterophorus



Photo 4. Desmodium tortuosum

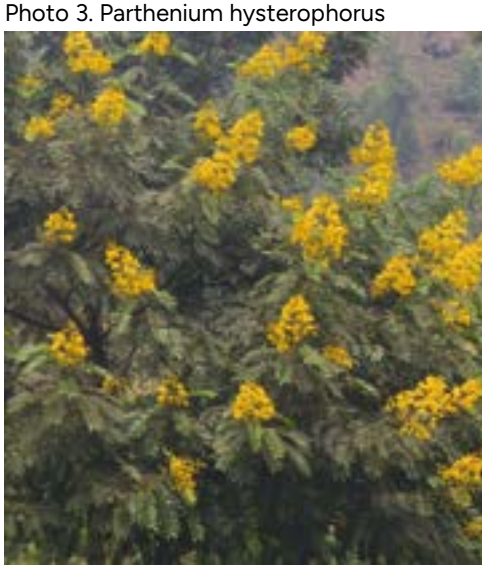


Photo 5. Senna spectabilis



Photo 6. Senna hirsuta

Figure 7-93 Photos of Selected Invasive Alien Plant Species Found in the Project Area

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Photo 1. Extensive cultivation of the Rubyiro floodplain (downstream of Ruzizi HPP)



Photo 2. Extensive cultivation of the Ruzizi Valley near Kamanyola (DRC) (downstream of Ruzizi HPP)



Photo 3. Cultivation of steep upper slopes of the Ruzizi Valley above the reservoir



Photo 4. Charcoal kiln



Photo 5. Large landslide above the Ruzizi River



Photo 6. Accelerated soil erosion along a footpath

Figure 7-94 Photographs Highlighting Threats to Vegetation Types and Flora

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7.8.3.8 Observations of Landcover Change between 2022 and 2024

Based on observations made during the 2024 survey, there were distinct, albeit minor, landcover changes from the 2022 survey, specifically within the Rwanda territory of the PAOI. The only habitat type with observed changes was the Hillslope Grassland/Open Savanna habitat which was re-delineated on imagery and found to have reduced by approximately 17 ha from 65 ha to 48 ha, which equates to a 26% loss. The loss of this habitat type was caused largely by portions being altered into agricultural areas or more heavily encroached by alien plants.

Selected areas of proposed infrastructure were visited during the supplementary survey to confirm the status of the habitats. All proposed construction sites visited were confirmed to be modified habitats possessing minimal biodiversity importance. Figure 7-95 provides photographs of the habitats within the proposed infrastructure areas.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Employer's village including disposal area</td><td>Surge shaft, Penstock, Powerhouse & Tailrace Channel</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Disposal area & access to HRT Adit</td><td>Diversion tunnel portal works, Spillway works, Damsite and Laydown areas</td></tr>
</table>

Figure 7-95 Photographs Showing Degraded Habitats in Project Construction Footprints

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7.8.4 Birds

7.8.4.1 Bird Diversity and Habitat Types

The project area is located in the southern part of the Albertine Rift Montane Forests terrestrial ecoregion, which supports an estimated 732 avifauna species, the highest avifaunal diversity of any ecoregion in Africa (Burgess *et al.,* 2004). However, this diversity is supported by a diverse range of habitats and landscape types, many of which are absent from the project area and avifaunal species richness is likely to be significantly lower. Rwanda has an exceptionally rich avifaunal diversity, with 701 species currently listed for the country (Vande weghe & Vande weghe, 2011). Distribution data for the birds of Rwanda indicate that 200 species have been recorded in the 7' x 7' mapping grids in which the project area is located (B14 and C14) (Vande weghe & Vande weghe, 2011). However, several common species recorded during fieldwork have not been recorded in these grids before and it appears that the grids have not been thoroughly surveyed. The project area does not support all the habitats represented in the two mapping grids and it is unlikely that it will support the full species list. However, species richness is still moderately high, and 115 species were recorded during the six field days during 2022 (Annex C). This is significantly higher than the avifauna list from the previous survey, i.e. 16 species (SOFRECO, 2011). The supplementary survey undertaken in May 2024 recorded an additional 13 widely distributed and non-threatened species, thereby recording a total of 128 bird species within the PAOI.

Bird families/groups that were particularly well represented were weavers and bishops (11 species), diurnal raptors (10 species), sunbirds (8 species), cuckoos and coucals (7 species), and doves and pigeons (6 species). Fish-eating birds such as kingfishers, herons and cormorants were either absent or present in remarkably lower numbers than would be expected along a large river, reflecting the low fish abundance reported by the aquatic specialist. The high daily discharge variation due to hydropeaking likely negatively influences piscivorous bird feeding capability. A species accumulation curve from the 10-species lists generated during the SLR 2022 survey is presented in Figure 7-96. Although the curve has not yet flattened, it has levelled enough to indicate that habitats within the AOI were sufficiently sampled. Tabulated data that were used to generate this curve are presented in Annex C.

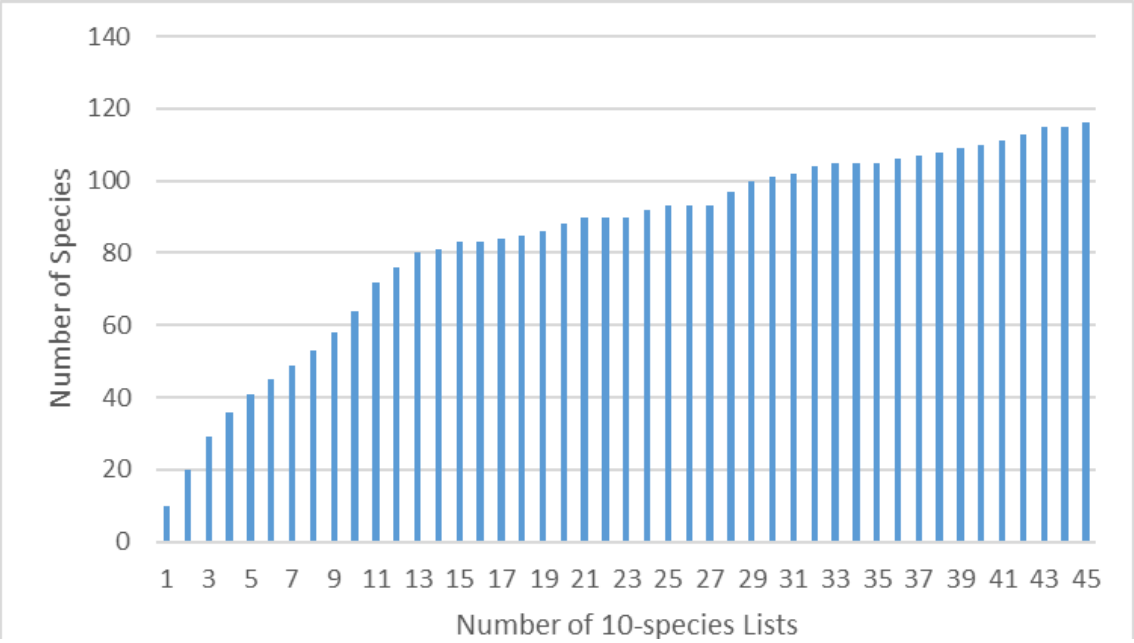


Figure 7-96 Species Accumulation Curve from 10-species List Data from 2022 Bird Survey

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Seven distinct avifaunal assemblages were recorded in the project area, corresponding to specific vegetation communities or habitats. Each of these assemblages is briefly described in Table 7-31 including mention of dominant and diagnostic species.

Table 7-31 Avifaunal Assemblages

Assemblage	Description
Hillslope Grassland / Savanna	This habitat was difficult to access and was not thoroughly sampled. However, 47 species were recorded; 41% of the project area species list. No species were noticeably dominant in this assemblage, although four species were only found in this habitat, namely African black swift, common kestrel (breeding pair), familiar chat and cinnamon-breasted bunting. No additional dominant species were observed in the May 2024 survey.
Hillslope Thicket	This is the second most diverse assemblage in the project area, with 56 species recorded, representing 49% of the project area species list. Dominant species included white-browed robin-chat, tropical boubou, red-eyed dove, speckled mousebird, African thrush, blue-spotted wood dove, grey-backed camaroptera, African paradise flycatcher and brown-throated wattle-eye. Five species were only recorded in this assemblage, namely African green pigeon, eastern olivaceous warbler, white-chinned prinia, African yellow white-eye and olive-bellied sunbird.
Riparian Thicket	Thicket habitat usually supports rich avifaunal diversity but only 26 species were recorded in the riparian thicket assemblage, which indicates the fragmented state and small size of thicket patches. Dominant species were white-browed robin-chat, tropical boubou, speckled mousebird, African thrush, blue-spotted wood dove and grey-backed camaroptera. Only one species was diagnostic for this assemblage, namely ashy flycatcher, while numerous species were shared with the Hillslope Thicket assemblage.
Riparian Wetland	This is another species-poor assemblage, with only 26 species recorded, or 23% of the project area species list. The most frequently recorded species were red-faced cisticola, village weaver, southern red bishop, bronze mannikin and tawny-flanked prinia. Only two species were apparently confined to this assemblage, namely greater swamp warbler and red-chested sunbird.
Open Water	This is the most species-poor assemblage in the project area, with only 18 species recorded. It is associated mostly with the surface water of the Ruzizi River and fishponds near the Burundi border. The only frequently occurring species in the Project footprint were reed cormorant and African pied wagtail, whereas four species were only recorded in the open water community downstream near Bugarama, namely white-faced whistling duck, western great egret, white-breasted cormorant and red-knobbed coot.
Cultivation	This is the dominant assemblage in the project area and is associated with currently cultivated lands, exotic tree plantations and secondary shrubland in fallow lands. Seventy-nine species, or 69% of the project area species list, were recorded in this assemblage. Dominant species include dark-capped bulbul, bronze mannikin, tropical boubou, red-eyed dove, northern fiscal, scarlet-chested sunbird, speckled mousebird, blue-spotted wood dove and red-faced cisticola. Three species were only found in this assemblage, i.e. are diagnostic, namely great reed warbler, spotted flycatcher and village indigobird.
Towns & Villages	This was a surprisingly diverse assemblage, with 33 species recorded. Dominant species are northern grey-headed sparrow, house sparrow, pied crow and yellow-fronted canary, while the only species confined to this assemblage were speckled pigeon, western barn owl and house sparrow.

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7.8.4.2 Priority Bird Species

Priority bird species identified in the project area are those that have been classified by the IUCN as threatened (CR, EN or VU), species classified by the IUCN as Near Threatened (NT), species restricted to Endemic Bird Areas (EBAs) such as the Albertine Rift Mountains EBA, or species restricted to biomes such as the Afrotropical Highlands or Lake Victoria Basin biomes (Kanyamibwa, 2001). A description of priority birds is summarised in the sections below.

A Threatened Species

Thirty-nine threatened and NT avifauna species have distribution ranges that broadly overlap with the project area according to distribution maps in IUCN assessments (Table 7-32).

Three of these are Critically Endangered (CR), 11 are classified as EN, 12 as VU and 13 as NT. Fine-scale distribution maps in Vande weghe & Vande weghe (2011) indicate that many of these species do not occur in western Rwanda, including a number of papyrus endemics such as papyrus gonolek (*Laniarius mufumbiri*) and papyrus yellow warbler (*Calamonastides gracilirostris*). Most of the species that do occur in western Rwanda occur in habitats or at altitudes that are not represented in the project area (especially montane forest species). Otherwise, they are species that do not tolerate the disturbance levels typical of densely settled areas such as the project area. Only one EN species (bateleur *Terathopius ecaudatus*) and one NT species (pallid harrier *Circus macrourus*) have a moderate likelihood of occurring in the project area, as described below. However, neither were seen during the 2022 or 2024 surveys.

A.1 Bateleur

Bateleur is a relatively common resident throughout sub-Saharan Africa and the Arabian Peninsula, only avoiding the heavily forested Congo Basin. It is a widespread species in East Africa, most common in open savannah, arid or semi-arid bushland, woodland and grassland (Britton, 1980). It is a common breeding resident throughout Rwanda, although there have been substantial population declines in the past 30 years (Vande weghe & Vande weghe, 2011). Foraging habitat includes a variety of grassland and savannah types, only avoiding densely wooded and forested areas. Breeding appears to be confined to Akagera National Park in the eastern part of the country, where 20-25 pairs were recorded in 1980. Breeding has been recorded from October to June. The global population is estimated to be 10,000 to 100,000 individuals (Ferguson-Lees and Christie, 2001) and it has an EOO of 23,500,000 km^2. However, the species Is suspected to have undergone moderately rapid declines during the past three generations (41 years) as a result of habitat loss and incidental poisoning and has recently been uplisted from NT to EN (BirdLife International, 2021a). No birds were recorded in the project area during fieldwork, but suitable habitat is present and it is possible that these birds may forage over the area occasionally.

A.2 Pallid harrier

This is a Palearctic non-breeding migrant to Africa, breeding mainly in the steppes of Russia, Kazakhstan and north-west China. While small numbers winter in south-east and central Europe, north Africa and the Middle East, most birds migrate to tropical Africa (BirdLife International, 2021b). Pallid Harrier is an uncommon passage migrant in Rwanda, with some birds overwintering (Vande weghe & Vande weghe, 2011). Most birds are present in the country from December to February and occur in open grassland and lightly wooded savannah, with more birds generally occurring in central and western Rwanda than the east. It has also been recorded foraging over cultivated lands in Rwanda and thus potentially occurs in the broad parts of the Ruzizi River valley downstream of Bugarama. Pallid harrier is unlikely to occur in the reservoir area or along the downstream reaches to Bugarama, and the grassland habitat along much of the transmission line route is unsuitable for this species; slopes are too steep for its foraging strategy.

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B Biome restricted Endemics

Twenty-eight (28) species that are confined to the Albertine Rift Mountains Endemic Bird Area (EBA) occur in Rwanda. Of these, only two species occur at altitudes represented in the project area (Ruwenzori nightjar *Caprimulgus ruwenzorii*, Ruwenzori hill babbler *Sylvia atriceps*), while the rest only occur at much higher altitudes, mostly in Nyungwe Forest and the Volcanoes National Park, and are unlikely to be present in the project area. More details regarding the two potentially occurring species are provided in Table 7-33.

Three biomes are represented in Rwanda (as defined by Fishpool & Evans, 2001), of which two are represented in the project area, namely the Lake Victoria Basin (11 species) and Afrotropical Highlands (60 species) biomes (Kanyamibwa, 2001). Four species endemic to the Lake Victoria Basin and ten species endemic to the Afrotropical Highlands are known to occur in south-western Rwanda and are described in Table 7-34. Eight of these species were confirmed to occur within the project area during fieldwork. The higher altitude habitats, such as the upper slopes of the Ruzizi valley, supported the most endemics, including cinnamon-chested bee-eater (*Merops oreobates*), Chubb's cisticola (*Cisticola chubbi*), black-lored babbler (*Turdoides sharpei*), bronzy sunbird (*Nectarinia kilimensis*), baglafecht weaver (*Ploceus baglafecht*) and western citril (*Dendrospiza frontalis*). The reservoir and downstream reaches to Bugarama only supported three species (baglafecht weaver, western citril & slender-billed starling *Onychognathus tenuirostris*), while the only species located along the Ruzizi River downstream of Bugarama was red-chested sunbird (*Cinnyris erythrocerca*).

However, none of the above species has a global Extent of Occurrence (EOO) of less than 50,000 km^2 and thus do not qualify as restricted-range species as defined in IFC Performance Standards (IFC 2012).

C High-Risk Species

The supplementary bird survey undertaken in May 2024 was targeted mainly at confirming bird species at risk of collision and electrocution on transmission lines. It revealed that high risk avifauna species are relatively scarce within the PAOI and proximal landscape due to the widescale level of anthropogenic activities and habitat modification. However, there are some raptor species that are at risk of electrocution due to their wingspan or streamers[18] s Nevertheless, there are raptor species occurring within the PAOI that are potentially at risk of electrocution due to their wingspan or streamers. Below is a basic description of the ecology of the species recorded.

A pair of Lanner Falcons (*Falco biarmicus*) were recorded adjacent to the clay borrow area. Lanner Falcons are generally resident although they exhibit extensive movements in arid regions, especially juveniles and non-breeding adults. The pair were exhibiting typical hunting behavior, and no nest site was located while scanning the cliffs and erosion gulleys, albeit it is expected to be in the locality of where the pair was recorded based on behavior. The activities of the borrow area are unlikely to considerably influence the behavior of the pair, as they are currently inhabiting a highly modified portion of the landscape with associated erosion and noise impacts. The species predominantly feeds on smaller birds, with rodents, bats, reptiles and insects forming a smaller component of the diet. Columbidae (doves and pigeons) likely dominate their diet within the area, and this group is tolerant to disturbance, and so borrow pit activities are unlikely to considerably influence the Lanner Falcons prey resource. The species hunts mainly by fast aerial pursuit from a perch or horizontal chase. While the species hunting behavior suggests that it is at risk of collision with the transmission line, there are no records of the species colliding with overhead lines during hunting. The species is known to nest on pylons and as such, may utilize these, posing an electrocution risk.

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A pair of Common Kestrels (*Falco tinnunculus*) were previously recorded to nest within the PAOI during the 2022 survey, and the same pair were observed during the 2024 survey proximal to the proposed transmission line (Figure 7-97). The species comprises of six subspecies, with the nominate race occurring within the region. The nominate race is migratory in N & E of breeding range but is sedentary or dispersive in the rest of the range. Based on the repeated recording of the species within the same locality, the species exhibits strong site fidelity within the PAOI. Although rodents comprise the majority of the diet within the European range, in Africa, insects, especially termites, beetles and locusts, dominate the diet, even with regards to biomass. This denotes that the species plays an important role in controlling the populations of potential pest species.

The remarkably low diversity of fish-eating birds indicates that there may be an unnaturally low fish abundance in the river, possibly as a result of the hydropeaking regime of the Ruzizi I and II HEPP



Figure 7-97 Photograph Illustrating the Pair of Common Kestrel (*Falco tinnunculus*) recorded within the Project Area of Influence

A single Long-crested Eagle (*Lophaetus occipitalis*) was recorded within the planar agricultural areas within the transmission line corridor. The species predates predominantly on small rodents which it hunts by visually scanning from a prominent perch and descending on the prey item. The species was therefore dependent on large trees within the transmission line corridor (*Mangifera indica* and *Eucalyptus* sp.) in order to hunt. In congruency with the Long-crested Eagle, a single Wahlberg's Eagle (*Hieraaetus wahlbergi*) was recorded within the planar agricultural areas within the transmission line corridor. Although the species has a more diverse diet, it hunts in a similar technique to Long-crested Eagles. Consequently, the transmission line will provide an alternative perching site for these species, posing an electrocution risk.

The only migratory species recorded during the May 2024 survey within the PAOI was a pair of Lesser Kestrels (*Falco naumanni*). The species is a non-breeding migrant, mainly trans-Saharan, although some birds winter in NW Africa and in various regions of S Europe and S Asia.

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Individuals enter and leave Africa via Gibraltar and Italy–Sicily/Malta–Tunisia in the west, via the Nile and Rift Valleys in the east, and maybe also via Iran–Saudi Arabia–Somalia/Ethiopia further east. Passage in the boreal autumn is apparently largely at high altitude, is rapid and direct, and on a broad front, but may be more concentrated, at lower altitude and more leisurely on northbound migration in the boreal spring. The species predates predominantly on Orthopterans (Locusts and Grasshoppers) and Coleopterans (Beetles) thus making them important in controlling agricultural pest species. In certain areas within southern Africa, they roost in large numbers on transmission lines. These numbers were not recorded within the PAOI, and the PAOI is unlikely to support the abundance recorded in southern Africa roosting sites, due to the lack of a hyperabundance of Orthoptera, i.e. plagues or swarms of Locusts.

Figure 7-98 illustrates the location of the high-risk avifauna species recorded within the supplementary field survey.

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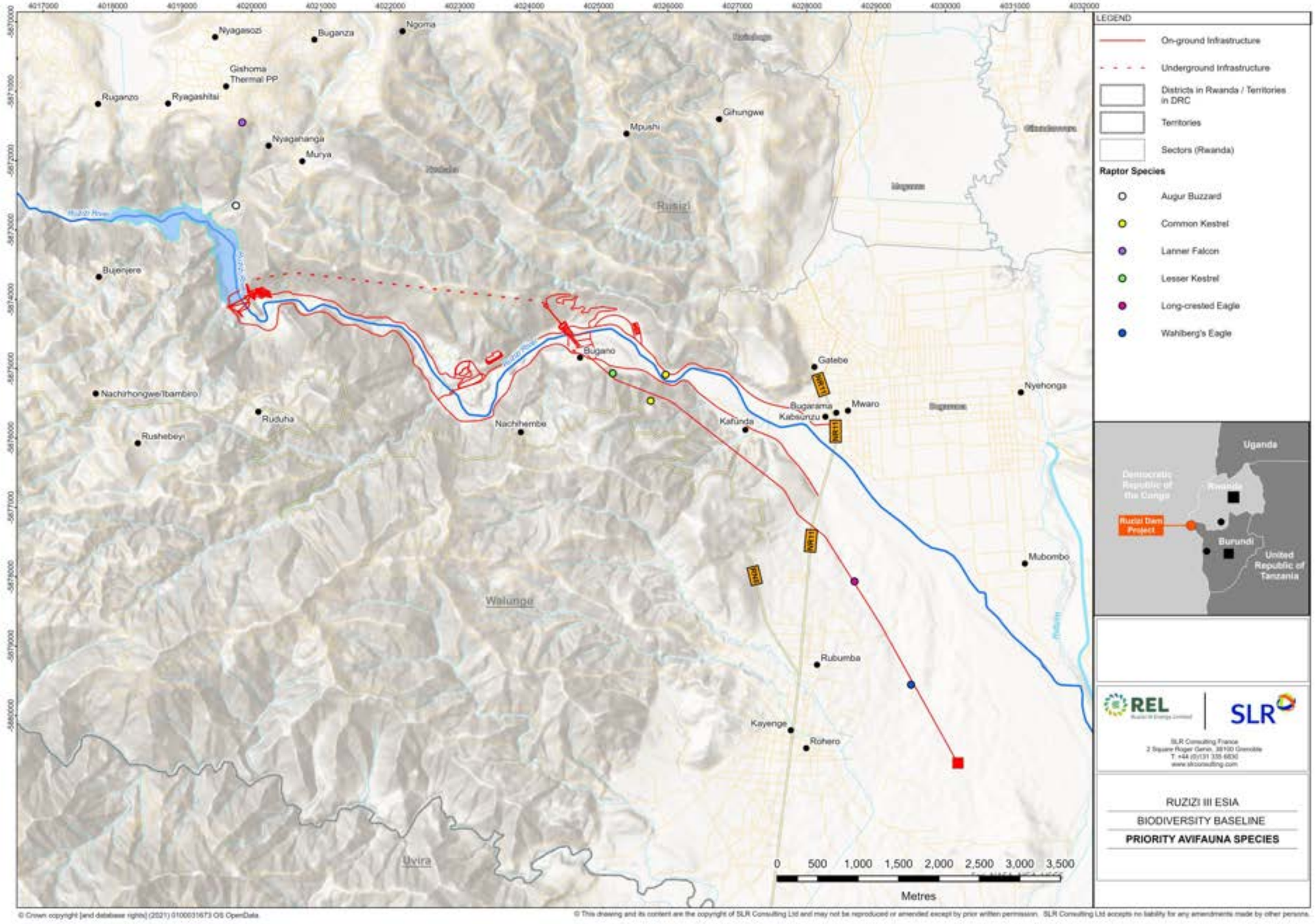


Figure 7-98 Map Illustrating the Location of High-Risk Avifauna Species Recorded during the Supplementary Field Survey

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7.8.4.3 Threats to Birds and Bird Habitats

The main current threat facing birds in the project area is loss of habitat, particularly vast areas of the floodplain that have been converted to agriculture, but even the steep slopes of the Ruzizi valley above the reservoir have been severely modified. It is possible that birds are hunted on a limited scale by local residents, but the presence of fair numbers of gamebirds, such as Red-necked Spurfowl and Scaly Francolin, is an indication that hunting is probably very limited. Very few dogs were seen and none that were unaccompanied by people, so it is unlikely that gamebirds are being hunted by dogs either. While the Endangered Grey-crowned Crane occurs in the downstream Ramsar site this area is not impacted by the flow regime from the existing hydropeaking projects (Ruzizi I and II; ~100 km upstream).

The construction of transmission lines, including for the proposed Ruzizi III HPP, is likely to introduce an additional threat to High-Risk Species. Raptor species will utilise the pylons and cables as a perching spot for hunting and possibly nesting. This is especially within the flat terrain agricultural areas, where Wahlberg's Eagle and Long-crested Eagle were recorded. These raptors were located within areas where the presence of tall mango (*Mangifera indica*) and *Eucalyptus* species provided a suitable hunting perch. These species are important in controlling pest rodent populations and the loss of these species from area due to electrocution will lead to an increase in the rodent population.

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Table 7-32 Threatened and Near Threatened Bird Species Potentially Occurring in the general vicinity of the Project Area

Common Name	Scientific Name	IUCN Status	Habitat	Likelihood	Rationale
Hooded vulture	*Necrosyrtes monachus*	CR	Occurs in open grassland, forest edge, wooded savanna and desert, often associated with human settlements north of the Equator.	Low	Absent from western Rwanda; habitats mostly degraded; high human density.
White-backed vulture	*Gyps africanus*	CR	Occurs in open wooded savanna, particularly areas of *Acacia.*	Low	Absent from western Rwanda; habitats mostly degraded; high human density.
Rüppell's vulture	*Gyps rueppelli*	CR	Prefers open landscapes such as open Acacia woodland, grassland and montane regions.	Low	Absent from western Rwanda; habitats mostly degraded; high human density.
Congo bay-owl	*Phodilus prigoginei*	EN	Occurs in a mosaic of grassland and either montane or bamboo forest, above 1,800 masl.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area.
Lappet-faced vulture	*Torgos tracheliotos*	EN	Found in dry savanna, arid plains, deserts and open mountain slopes, up to 3,500 masl.	Low	Absent from western Rwanda; habitats mostly degraded; high human density.
Secretarybird	*Sagittarius serpentarius*	EN	Prefers open landscapes, ranging from open plains and grasslands to lightly wooded savanna, but is also found in agricultural areas and semi-desert.	Low	Very rare in Rwanda and not recorded in the west; habitats mostly degraded; high human density.
Steppe eagle	*Aquila nipalensis*	EN	Occurs in open habitats such as grasslands, lightrly wooded savannah and semi-desert shrublands during passage and when overwintering.	Low	Very rare in Rwanda and not recorded in the west; habitats mostly degraded; high human density.
Madagascar pond-heron	*Ardeola idae*	EN	Prefers freshwater wetlands, particularly shallow waterbodies fringed with vegetation and adjacent trees.	Low	Absent from western Rwanda; limited suitable habitat.
Grey parrot	*Psittacus erithacus*	EN	Occurs in dense forest, including forest edges and clearings; also in gallery forest, mangroves, wooded savannah and cultivated areas close to forest.	Low	At edge of its known distribution; habitats mostly degraded; high human density.
Grey crowned crane	*Balearica regulorum*	EN	Occurs in shallow wetlands such as marshes, pans and dams with tall emergent vegetation, as well as riverbanks, shallowly flooded plains and temporary pools, sometimes foraging in adjacent grasslands, open savannas and croplands.	Low	No suitable breeding habitat present within the reservoir and downstream reaches of the Ruzizi River (at least until the Burundi border). Nearest known locality is the large Butambamo wetland to the north of the project area at 1,600 masl. Unlikely to forage in habitats in the Ruzizi valley upstream of Bugarama but may occasionally forage in cultivated lands downstream of the town.
Shelley's crimsonwing	*Cryptospiza shelleyi*	EN	Prefers the understorey of closed-canopy moist forest, often in valleys near water; also in low secondary growth at forest edges, forest clearings and glades; above 1,900 masl.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area.
Red-collared mountain-babbler	*Kupeornis rufocinctus*	EN	Confined to montane forest and bamboo at altitudes of 1,500-3,200 masl.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area.

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Common Name	Scientific Name	IUCN Status	Habitat	Likelihood	Rationale
Bateleur	*Terathopius ecaudatus*	EN	Frequents open country, including grasslands, savanna and semi-desert, often foraging over secondary vegetation near towns.	Moderate	Suitable foraging habitat present; unlikely to breed in the project area.
Martial eagle	*Polemaetus bellicosus*	EN	Occurs in open woodland, wooded savanna, grassland and open thornbush; avoids densely populated areas.	Low	Absent from western Rwanda; habitats mostly degraded; high human density.
Lesser flamingo	*Phoeniconaias minor*	NT	Occurs on large undisturbed alkaline and saline lakes and salt pans, occasionally occurring at other shallow open-water wetlands when on passage.	Low	Absent from western Rwanda; limited suitable open-water habitat present.
Black-winged pratincole	*Glareola nordmanni*	NT	Occurs in open landscapes such as grasslands or large salt pans in its overwintering grounds in southern Africa.	Low	Very rare in Rwanda and not recorded in the west.
Eurasian curlew	*Numenius arquata*	NT	Mostly coastal habitats during the austral winter, rarely occurring inland at lakes and rivers.	Low	Very rare in Rwanda and not recorded in the west, although known to occur in the lower Ruzizi floodplain in Burundi.
Pallid harrier	*Circus macrourus*	NT	Occurs in open landscapes such as grasslands or lightly wooded savannah in its overwintering grounds in southern Africa.	Moderate	Scattered records from western Rwanda; known to forage over cultivated lands, so suitable habitat present.
Black-tailed godwit	*Limosa limosa*	NT	Occurs in freshwater habitats during the austral winter, such as swampy lake shores, pools, flooded grassland and irrigated rice fields.	Low	Very rare in Rwanda and not recorded in the west.
Great snipe	*Gallinago media*	NT	Occurs in marshlands and short grass or sedges on lake edges or in flooded fields.	Low	Absent from western Rwanda; limited suitable habitat present.
White-naped pigeon	*Columba albinucha*	NT	Occurs in dense lowland forest and forested slopes, usually below 1,500 masl.	Very Low	Not yet recorded in Rwanda; no suitable habitat present.
Bedford's paradise-flycatcher	*Terpsiphone bedfordi*	NT	Occurs in lowland and transitional forest at altitudes of 980-1,500 m; prefers undisturbed primary forest.	Very Low	Not yet recorded in Rwanda; no suitable habitat present.
Papyrus gonolek	*Laniarius mufumbiri*	NT	Occurs in papyrus swamps and adjacent thicket vegetation.	Low	Absent from western Rwanda; no suitable habitat observed during fieldwork.
Crowned eagle	*Stephanoaetus coronatus*	NT	Occurs in forests and dense woodland, avoiding open habitats except where forest fragments are present; also occurs in plantations and secondary growth.	Low	Riparian forest fragments are very small and fragmented; habitats mostly degraded and prey base (monkeys) is limited; high human density.
Lagden's bush-shrike	*Malaconotus lagdeni*	NT	Inhabits montane forest up to 2,500 masl.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area.
Mountain buzzard	*Buteo oreophilus*	NT	Occurs in montane forest, exotic plantations and adjoining grassland between 2,000 m and 3,500 masl.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area.

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Common Name	Scientific Name	IUCN Status	Habitat	Likelihood	Rationale
Oberländer's ground-thrush	*Geokichla oberlaenderi*	NT	Occurs in lowland and transitional riparian forest at altitudes of 700-2,000 masl; avoids secondary or degraded forest.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area.
Albertine owlet	*Glaucidium albertinum*	VU	Found in very open montane and transitional forest, with many clearings and a dense understorey.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area.
Red-footed falcon	*Falco vespertinus*	VU	Occurs in open landscapes such as grasslands or lightly wooded savannah in its overwintering grounds in southern Africa.	Low	Occurs on passage over the project area, usually flying at great height, so unlikely to forage within the project area.
Shoebill	*Balaeniceps rex*	VU	Breeds and forages in seasonally flooded marshes that are dominated by a mixture of papyrus, reeds, cat-tails and grasses.	Very Low	Absent from central and western Rwanda; no suitable present
Southern ground-hornbill	*Bucorvus leadbeateri*	VU	Frequents woodland and savanna, as well as grassland adjoining patches of forest; avoids areas of high human density but does well in sparsely inhabited agricultural landscapes.	Low	Absent from western Rwanda; habitats mostly degraded; high human density.
Yellow-crested helmetshrike	*Prionops alberti*	VU	Occurs in mid-altitude and montane forest above 1,400 masl.	Very Low	Not yet recorded in Rwanda; no suitable habitat present.
Grauer's swamp-warbler	*Bradypterus graueri*	VU	Occurs in montane marshes, usually dominated by grass or sedge.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area.
Papyrus yellow warbler	*Calamonastides gracilirostris*	VU	Found mainly in papyrus-swamps but occasionally in other marshy habitats, especially reeds.	Very Low	Absent from central and western Rwanda; no suitable present.
Tawny eagle	*Aquila rapax*	VU	Occurs in dry open habitats across a wide elevation range, including both woodland and wooded savannah.	Low	Habitats mostly degraded; high human density.
Rockefeller's sunbird	*Cinnyris rockefelleri*	VU	Prefers thickets along streams in bamboo forest, as well as montane forest and afro-alpine moorland.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area
Grauer's broadbill	*Pseudocalyptomena graueri*	VU	Inhabits interior of primary rainforest, occasionally at edges or clearings.	Very Low	Not yet recorded in Rwanda; no suitable habitat present.
Chapin's flycatcher	*Fraseria lendu*	VU	Occurs in dense montane forest between 1,470 and 1,820 masl.	Very Low	Not yet recorded in Rwanda; no suitable habitat present.
Blue swallow	*Hirundo atrocaerulea*	VU	Preferred wintering habitat is open grassland, often with bushes and trees and marshy areas.	Low	Very rare in Rwanda with no records from the west; habitats mostly degraded; high human density.

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Table 7-33 Albertine Rift Mountains Endemic Bird Area Species Potentially Occurring in the Project Area

Common Name	Scientific Name	Distribution	Habitat	Occurrence in project area
Ruwenzori nightjar	*Caprimulgus ruwenzorii*	Distributed throughout the Albertine Rift region, with outlying populations in W Angola and NE Tanzania.	Prefers scrubby habitats, edges of montane wetlands and open clearings in montane forest.	Not recorded in the project area; potentially only occurs in the scrubby parts of the Hillslope Grassland / Savanna habitat along the highest sections of the transmission line route but this was not confirmed.
Ruwenzori hill babbler	*Sylvia atriceps*	Mostly endemic to the Albertine Rift, with a small outlying population in SE Nigeria and W Cameroon.	Occurs various montane forest types between 1,500 and 3,000 masl; prefers open forest and dense scrub at forest edges.	Not recorded in the project area; potentially only occurs in forest patches in the upper plateau areas but this was not confirmed.

Table 7-34 Biome-restricted Bird Species Confirmed to Occur or Potentially Occurring in the Project Area

Common Name	Scientific Name	Biome	Distribution[1]	Habitat[2]	Occurrence in Project Area
Cinnamon-chested bee-eater	*Merops oreobates*	Afrotropical Highlands	Occurs throughout the East African Highlands and Albertine Rift mountains; widespread in Rwanda above 1,300 masl.	Inhabits edges of montane forest, riparian forest, cultivated lands, gardens and tree plantations.	Recorded only at the highest altitudes in the project area.
Ruwenzori hill babbler	*Sylvia atriceps*	Afrotropical Highlands	Mostly endemic to the Albertine Rift, with a small outlying population in SE Nigeria and W Cameroon.	Occurs various montane forest types between 1,500 and 3,000 masl; prefers open forest and dense scrub at forest edges.	Not recorded in the project area; potentially only occurs in the forest patches in the upper plateau areas but this was not confirmed.
Carruther's cisticola	*Cisticola carruthersi*	Lake Victoria Basin	Locally in northeast and eastern DRC (northeast (Uele) and east (Ituri, Kivu)); southweast and southeast Uganda (Toro, west Ankole, Kigezi, and Sizibwa Swamp); north, central and eastern Rwanda; and central and eastern Burundi; also SW Kenya (Lake Victoria, from Yala Swamp south to Kisumu and Kendu Bay) and northern Zambia (R Luapula).	Interior of dense papyrus (Cyperus) swamps; in Rwanda, also mixed papyrus-*Miscanthidium* stands.	Not recorded in the project area; potentially occurs in riparian wetlands along the lower reaches of the Ruzizi downstream of Bugarama, but this could not be confirmed.
Chubb's cisticola	*Cisticola chubbi*	Afrotropical Highlands	Occurs throughout the Albertine Rift and western Kenya, with an isolated population in Cameroon and Nigeria; common breeding resident throughout much of Rwanda above 1,300 masl.	Prefers scrubby edges of montane forest, clearings in forest, cultivated lands and tree plantations.	Recorded only at the highest altitudes in the project area in the upper slopes of the Ruzizi valley above the reservoir.
Black-lored babbler	*Turdoides sharpei*	Lake Victoria Basin	Extreme eastern DRC, Rwanda, Burundi, Uganda (except the north), southwest Kenya and northwest and west Tanzania.	Forest-edge thickets and scrub, wooded plains and Acacia savanna, dense bushland, riverine woodland, elephant grass, gardens; where sympatric with *T. plebejus*. Appears to prefer more open areas.	Recorded mainlyat the highest altitudes in the project area, as well as at lower altitudes in the dam basin.

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Common Name	Scientific Name	Biome	Distribution[1]	Habitat[2]	Occurrence in Project Area
Slender-billed starling	*Onychognathus tenuirostris*	Afrotropical Highlands	Throughout the eastern Afrotropical Highlands from Ethiopia to Malawi; occurs mostly in e Rwanda above 1 850 masl but has been recorded wandering to lower altitudes.	Montane forests and adjacent cultivated areas, wandering widely in search of fruiting trees.	A pair seen in tall Ficus trees at the dam wall site. Potentially occurs widely throughout the reservoir and upper slopes.
White-eyed slaty flycatcher	*Melaenornis fischri*	Afrotropical Highlands	Widespread throughout the mountains of East Africa (south to Malawi) and the Albertine Rift; common breeding resident throughout much of Rwanda above 1,300 masl.	Occurs in open-canopy forest or edges of closed forest, bamboo thickets, cultivated lands, gardens and tree plantations.	A single bird observed at the edge of a cultivated field at an aquatic sampling site along the upper reaches of the Rubyiro River (1,570 masl); not observed in the project area.
Bronzy sunbird	*Nectarinia kilimensis*	Afrotropical Highlands	Widespread throughout the eastern Afrotropical Highlands (south to Zimbabwe), with an isolated population in Angola; common breeding resident throughout much of Rwanda.	Edges of forests, riparian thickets and scrub, cultivation, gardens and tree plantations.	Common at high altitudes in the project area; recorded in the upper slopes of the Ruzizi valley above the reservoir.
Northern double-collared sunbird	*Cinnyris reichenowi*	Afrotropical Highlands	Found throughout the Albertine Rift and western Kenya, with an isolated population in Cameroon and se Nigeria; confined to western Rwanda, usually above 1,500 masl.	Occurs in montane forest, riparian forest, bracken scrub and tree plantations.	Not recorded in the project area; potentially only occurs in the forest patches in the upper plateau areas but this was not confirmed.
Red-chested sunbird	*Cinnyris erythrocerca*	Lake Victoria Basin	South Sudan, eastern DRC, Rwanda, Burundi, Uganda, western Kenya and northwest & extreme western Tanzania; unrecorded from south-western Rwanda.	Edges of rivers and wetlands in savanna areas; also near water in forest, cultivations and gardens.	Recorded once in riparian wetlands along the Ruzizi River downstream of Bugarama.
Baglafecht weaver	*Ploceus baglafecht*	Afrotropical Highlands	Throughout the eastern Afrotropical Highlands from Ethiopia to Malawi; very common resident throughout most of Rwanda.	Occurs in any open habitat such as cultivated lands and gardens; also found in tree plantations, riparian thicket and scrub.	Common in the project area, occurring throughout the reservoir and upper slopes; also observed in gardens in Bugarama.
Black-billed weaver	*Ploceus melanogaster*	Afrotropical Highlands	Found throughout the Albertine Rift and western Kenya, with an isolated population in Cameroon and SE Nigeria; occurs mostly in western Rwanda, usually above 1,500 masl.	Prefers open-canopy forest, occasionally occurring in riparian forest.	A pair observed building a nest at the edge of montane forest at an aquatic sampling site along the upper reaches of the Rubyiro River (1,488 masl); not observed in the project area.
White-collared oliveback	*Nesocharis ansorgei*	Lake Victoria Basin	Albertine Rift region of E DRC, Uganda, Rwanda, Burundi and extreme NW Tanzania; scattered records from across Rwanda between 1,000 and 1,400 masl.	Marshy forest edge, streams bordered by bushes and trees, lakeshore thickets, and papyrus (*Cyperus papyrus*) swamps.	Not recorded in the project area, but potentially occurs in the small strips of riparian thicket in the reservoir area although this could not be confirmed.
Western citril	*Dendrospiza frontalis*	Afrotropical Highlands	Albertine Rift region of E DRC, Uganda, Rwanda, Burundi and extreme NW Tanzania; widespread in Rwanda, except the eastern parts.	Marshy forest edge, streams bordered by bushes and trees, lakeshore thickets, and papyrus (*Cyperus papyrus*) swamps.	Common at high altitudes in the project area; recorded in the upper slopes of the Ruzizi valley and the reservoir.
1 Birds of The World website (https://birdsoftheworld.org/bow/) for global distribution and Vande weghe and Vande weghe (2011) for Rwanda distribution					
2 Vande weghe and Vande weghe (2011)					

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7.8.5 Mammals

7.8.5.1 Diversity and Habitat Types

Mammals are poorly represented in the project area. Most large mammals have been eradicated through hunting and habitat loss and local people report that mammals such as antelope species, carnivores and elephants have not been seen in many years. Only eight mammal species were recorded in the Project AOI during the field surveys and are listed in Table 7-35. However, rodents and bats, which usually make up a large portion of mammal assemblages (especially in modified habitats), were not sampled and true mammal species richness is likely to be higher than currently reflected. No trapping of small mammals was performed due to the need to cover as much ground as possible. No motion-detecting cameras were placed as a result of the high human density and the lack of suitable habitat in which to place cameras. The previous survey for the Ruzizi III HPP (SOFRECO, 2011) recorded four mammal species during fieldwork, three of which were recorded during this study. The only species not recorded during this study was African wild cat (*Felis sylvestris lybica*).

No Chiropteran (bat) species inventory has been provided due to the lack of passive and active sampling. Nevertheless, caves and other potential roost sites were looked for within the PAOI but no caves or bat roosts were located. Insectivorous bat species were recorded feeding in Kamanyola, but it is highly likely that these species roosted in the eaves of houses rather than within the habitats of the PAOI.

Five broad mammal assemblages are likely to be present, with a Cultivation / Secondary Shrubland assemblage as the dominant one. Other minor assemblages are likely to be Riparian Thicket, Riparian Wetland, Hillslope Thicket / Forest and Hillslope Grassland / Savannah assemblages. Five species were recorded in Cultivation / Secondary Shrubland, followed by four species in Riparian Thicket and Hillslope Thicket / Forest (Table 7-35). The most frequently recorded mammal according to local people is Boehm's bush squirrel (*Paraxerus boehmi*), which most people mentioned as being a minor pest in their fields.

Two threatened (Vulnerable) mammal species were identified during fieldwork, namely (*Hippopotamus amphibius*) and Angolan Colobus (*Colobus angolensis*). The colobus was not seen but reported by local villagers as occasional visitors to a village on the DRC side of the Ruzizi River. . The occurrence of these two species in the project area is described in the following section.

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Table 7-35 Species Composition of the Mammal Assemblages in the Project Area

Common Name	Scientific Name	Data Source	IUCN Red Data	Assemblages				
				Riparian Thicket	Riparian Wetland	Hillslope Thicket	Hillslope Grassland / Savannah	Cultivation / Shrubland
ORDER: PRIMATES								
Family Cercopithecidae								
Vervet monkey	*Chlorocebus pygerythrus*	V	LC	x		x		x
Olive baboon	*Papio anubis*	V	LC	x		x	x	x
Angolan Colobus	*Colobus angolensis*	V	VU	x				x
ORDER: RODENTIA								
Family Sciuridae								
Boehm's bush squirrel	*Paraxerus boehmi*	O	LC	x		x		x
Red-legged sun squirrel	*Heliosciurus rufobrachium*	O	LC			x		
Family Nesomyidae								
Gambian rat	*Cricetomys kivuensis*	V	LC	x				x
Family Muridae								
Striped field rat	*Lemniscomys striatus*	O	LC					x
ORDER: CARNIVORA								
Family Herpestidae								
Marsh mongoose	*Atilax paludinosus*	O	LC		x			
Family Viverridae								
Genet	*Genetta maculata*	V	LC	x		x	x	
ORDER: CETARTIODACTYLA								
Family Hippopotamidae								
Hippopotamus	*Hippopotamus amphibius*	O	VU		x			
		8	**8**	**4**	**2**	**4**	**1**	**5**

LC = Least Concern; VU – Vulnerable; O = Observation; V = discussion with villagers

7.8.5.2 Priority Mammal Species

Nineteen (19) threatened and nine NT mammal species have distribution ranges that broadly overlap with the project area according to distribution maps in IUCN assessments (Table 7-36). One of these is classified as CR, five are EN and 13 as VU. Ecological information contained in IUCN assessments indicate that many of these species do not occur in habitats or at altitudes represented in the project area or are species that do not tolerate the disturbance levels typical of densely settled areas such as the project site. Four NT species have a moderate or high likelihood of occurring in the project AoI, two of which are bat species and two otter species. Two VU species has been confirmed to occur in the project area, namely hippopotamus (*Hippopotamus amphibius*) and Angolan colobus (*Colobus angolensis*). These species are described in more detail below.

7.8.5.3 Hippopotamus (Hippopotamus amphibius)

Hippopotamus occurs along rivers and lakes throughout the savanna zone of Africa, and in the main rivers of the forest zone in Central Africa (Lewison & Pluháček, 2017). The largest African populations have always been in East and Southern Africa, with an estimated East African population of about 50,000 animals (Lewison & Pluháček, 2017). The Rwandan population is estimated to be approximately 1,000 animals, although this is probably an underestimate since a 2013 census in Akagera National Park recorded 800-1,000 animals, and the species is also known from several Rwandan lakes as well as the Ruzizi River (Lewison & Pluháček, 2017). The

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largest Burundi population is in the Ruzizi Delta, where an estimated 500 animals occur (Lewison & Pluháček, 2017).

Global populations of hippopotamus experienced considerable declines in the mid-1990s and early 2000s, resulting in the species being classified as Vulnerable. It appears that populations have largely remained stable since then, although the species is still classified as VU.

Hippos generally spend the day in water and emerge at night to feed, which is when they regularly damage crops planted along rivers. Hippos typically do not eat aquatic vegetation, but forage on grass or crops close to the river, lake or wetland that they are resting in. Hippos require permanent water, particularly during the dry season, when they are likely to be concentrated along the Ruzizi River. The only population figures for the Ruzizi River are for the animals in the Ruzizi Delta, where 500 are estimated to be resident (Lewison & Pluháček, 2017). Animals or evidence of occurrence (spoor, dung) were seen at three different localities along the Ruzizi River between Bugarama and the Burundi border during January 2022 fieldwork). People were questioned throughout the project area about the presence of hippos and the consensus was that hippos generally do not occur upstream of the bridge connecting Bugarama and Kamanyola, i.e. they do not occur in the vicinity of the reservoir and associated infrastructure.

7.8.5.4 Angolan Colobus (*Colobus angolensis*)

The Angolan Colobus (*Colobus angolensis*) ranges from northeast Angola north to the Congo-Ubangui River system, eastwards (with a disjunct range) to the montane and coastal forests of Tanzania and southeastern Kenya. The species was reported within the PAOI by anecdotal evidence of observations by residents of Bugarama (Rwanda) and Kafunda village (DRC). The Angolan Colobus typically occupies forest habitats such as gallery forests, swamp forest, coastal forest, montane forest, and seasonally flooded forests, but reportedly ventures into the PAOI during extensive crop harvesting. The species is listed as VU on a global scale (de Jong *et al*., 2020). The primary threats are habitat loss and degradation, as well as poaching. Habitat loss, degradation and fragmentation is driven mainly by collection of timber and fuelwood, conversion of forest to farmland, and the expansion of human settlements (de Jong *et al*., 2020). In addition, hunting has caused several populations to be extirpated, even from suitable habitats. Within the PAOI, it was reported by locals that the species is hunted within the DRC, but not within Rwanda.

Populations within the eastern part of the range are more fragmented than populations within the Congo Basin, with species density also dependent on location (de Jong *et al*., 2020). Figure 7-100 illustrates the species distribution with respect to the PAOI. It can be noted that the species distribution does not necessarily overlap with the PAOI, but this is likely attributed to lack of data. Nevertheless, the density of Angolan colobus overlapping the PAOI is expected to be low, and the species is not regarded as a permanent resident, but rather an opportunist.

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Figure 7-99 Confirmed Occurrence of Hippopotamus in the Project Area

Clockwise from top: Map showing locations where hippos were confirmed during fieldwork; spoor of hippo; sighting of two hippo surfacing in the Ruzizi River (Source: N. Glenat (SLR); E. Sinayitutse)

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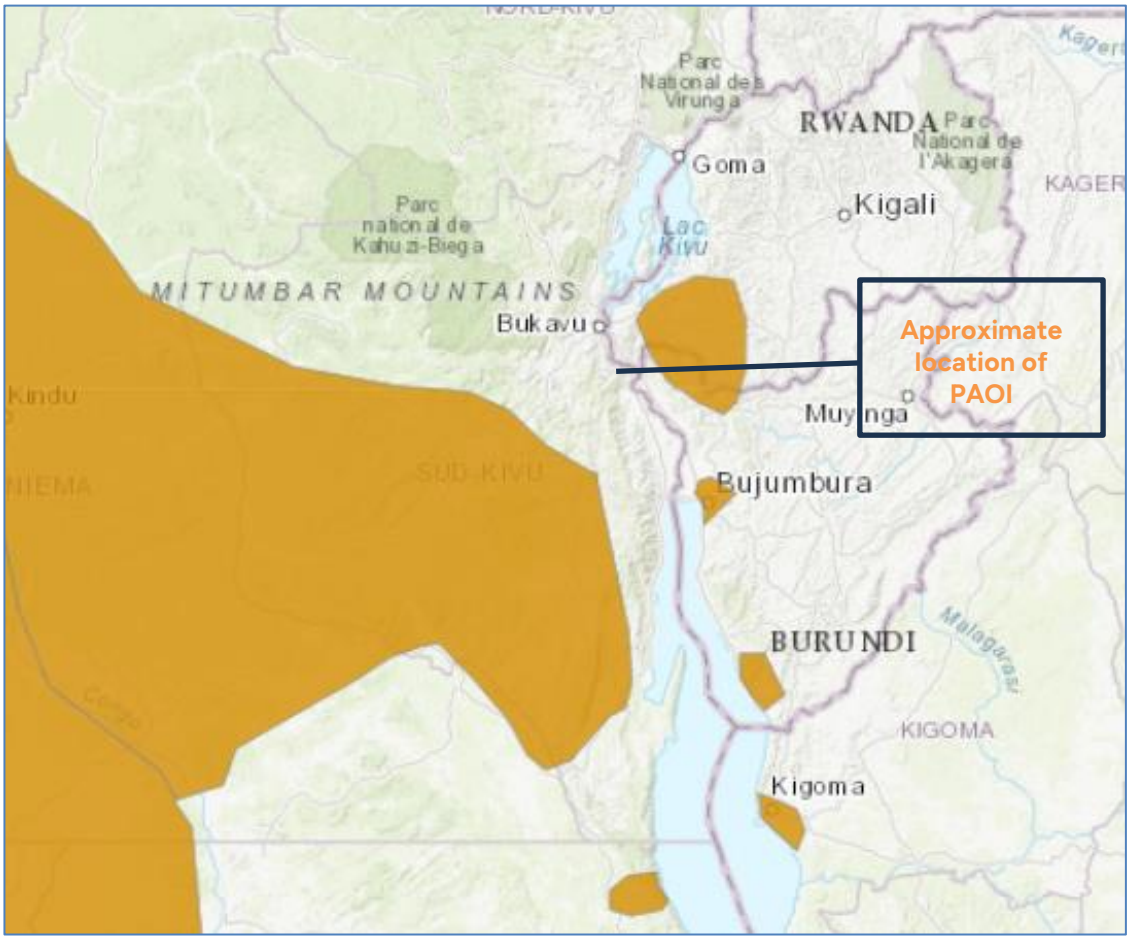


Figure 7-100 Map Illustrating the Distribution of Angolan Colobus (*Colobus angolensis*) in Relation to the Project Area of Influence. Source: (de Jong *et al.*, 2020)

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Table 7-36 Potentially occurring Threatened and Near Threatened Mammals in the Project Area

Common Name	Scientific Name	IUCN Status	Habitat	Likelihood	Rationale
African forest elephant	*Loxodonta cyclotis*	CR	Occurs in a variety of forest habitats including lowland humid forest, swamp forests, lower reaches of Afromontane forests, dry forests and forest-savanna mosaics.	Very Low	No suitable habitat present and high disturbance levels.
Chimpanzee	*Pan troglodytes*	EN	Occurs in primary and secondary moist lowland forest, swamp forest, submontane and montane forest, dry forest, forest galleries in savanna woodland, and farmland.	Low	Limited suitable habitat present, habitat degradation is severe and human density is high.
Foa's red colobus	*Piliocolobus foai*	EN	Occurs in primary montane and submontane forest from 800 to 2,270 masl.	Very Low	No suitable habitat present and high disturbance levels.
White-bellied pangolin	*Phataginus tricuspis*	EN	Occurs in moist tropical lowland forests and secondary growth, but also occurs in dense woodlands, especially along water courses; associated with abandoned oil palm plantations in some areas.	Low	Limited suitable habitat present, habitat degradation is severe and human density is high.
Ulindi River red colobus	*Piliocolobus lulindicus*	EN	Poorly known; recorded from primary lowland forest and along rivers.	Very Low	No suitable habitat present; high human density.
Giant ground pangolin	*Smutsia gigantea*	EN	Occurs in primary and secondary rainforest forest formations, gallery forests, swamp forests, forest-savannah mosaic habitats and wooded savannah.	Very Low	No suitable habitat present; high human density.
Yellow-backed duiker	*Cephalophus silvicultor*	NT	Occurs in moist lowland and montane forests (primary and secondary), forest-savanna mosaics, gallery forests, thickets; also in plantations and farmbush.	Low	Even though some suitable habitat present, habitat degradation is severe and human density is high.
Spotted-necked otter	*Hydrictis maculicollis*	NT	Prefers freshwater habitats where water is unsilted, unpolluted, and rich in small to medium sized fishes, including lakes and other shallow water habitats.	Moderate	Some suitable habitat although possibly too silted for this species.
Congo clawless otter	*Aonyx congicus*	NT	Occurs in tropical rainforests and lowland swamps of the Congo River basin.	Moderate	Some suitable habitat although habitats are degraded and human density is high.
Bay duiker	*Cephalophus dorsalis*	NT	Frequents primary and relatively unmodified lowland to mid-altitude forests; prefers primary forest but has been recorded in secondary forest and farmbush.	Low	Limited suitable habitat present, habitat degradation is severe and human density is high.
African buffalo	*Syncerus caffer*	NT	Occurs in a wide range of woodland, savannah and forest habitats.	Low	Limited suitable habitat present, habitat degradation is severe and human density is high.
Rahm's brush-furred rat	*Lophuromys rahmi*	NT	Inhabits dense primary montane forest; has been recorded in secondary forest and sparse bamboo stands covered with grass.	Very Low	No suitable habitat present.
Moon forest shrew	*Sylvisorex lunaris*	NT	Occurs in primary and secondary montane tropical moist forest and swamps above 1,700 masl.	Very Low	No suitable habitat present.
African straw-coloured fruit-bat	*Eidolon helvum*	NT	Occurs in a very wide range of habitats; can also inhabit wooded areas in large urban areas, often rossting in cities and towns	High	Suitable habitat present; can persist in degraded habitats and densely settled areas

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Common Name	Scientific Name	IUCN Status	Habitat	Likelihood	Rationale
Large-eared free-tailed bat	*Otomops martiensseni*	NT	Occurs in a very wide range of habitats; can also tolerate urban or agricultural areas.	Moderate	Some suitable habitat present; can tolerate urban and agricultural habitats.
Hippopotamus	*Hippopotamus amphibious*	VU	Occurs along rivers and lakes throughout the savanna zone of Africa, and in the main rivers of the forest zone in Central Africa.	Confirmed	Several animals were observed at one location and villagers reported the species from three other localities along the Ruzizi River downstream of Bugarama.
Leopard	*Panthera pardus*	VU	Occupies a very wide range of habitat types	Low	Limited suitable habitat present, habitat degradation is severe and human density is high.
Temminck's pangolin	*Smutsia temminckii*	VU	Occurs in savannas and woodlands in low-lying regions, as well as floodplain grassland, rocky slopes and sandveld; avoids true forest and heavily populated areas.	Very Low	No suitable habitat present and high disturbance levels.
Grey-cheeked mangabey	*Lophocebus albigena*	VU	Found in both primary and secondary forest, although it prefers undisturbed forest.	Very Low	No suitable habitat present and high disturbance levels.
L'Hoest's monkey	*Allochrocebus lhoesti*	VU	Occurs in primary lowland, submontane and montane forests, avoiding degraded habitats and densely populated areas.	Very Low	No suitable habitat present and high disturbance levels.
African golden cat	*Caracal aurata*	VU	Occurs in primary moist equatorial forest, although on the edge of its range it enters savanna regions along riverine forest.	Very Low	No suitable habitat present and high disturbance levels.
Ruwenzori shrew	*Ruwenzorisorex suncoides*	VU	Associated with damp and dense mossy vegetation in montane primary tropical moist forest.	Very Low	No suitable habitat present.
Delany's swamp mouse	*Delanymys brooksi*	VU	Confined to high altitude marshes within bamboo and montane forest.	Very Low	No suitable habitat present.
Lemara shrew	*Crocidura lanosa*	VU	Prefers primary montane forest, Cyperus swamps, and bamboo forests; has been recorded from secondary montane forest and in disturbed areas above 1,850 masl.	Very Low	No suitable habitat present.
Angolan colobus	*Colobus angolensis*	VU	Occurs in evergreen and semi-deciduous forest, including gallery forests, swamp forest, montane forest and seasonally flooded forests; avoids degraded habitats and densely settled areas.	Reported	Opportunistic visitor in PAOI as reported by local residents in Rwanda and DRC.
Owl-faced monkey	*Cercopithecus hamlyni*	VU	Occurs in lowland to mid-montane tropical moist forest and montane bamboo forest; avoids degraded forest and densely settled areas.	Very Low	No suitable habitat present; high human density.
Medium-tailed brush-furred rat	*Lophuromys medicaudatus*	VU	Inhabits montane forests and swamps, avoiding modified habitats.	Very Low	No suitable habitat present.
Kemp's thicket rat	*Thamnomys kempi*	VU	Occurs in thickets in open areas of montane secondary forests (and occasionally in primary forests).	Very Low	Project area well below the altitudinal limit for this species.

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7.8.5.5 Threats to Mammals

No evidence of hunting was seen during fieldwork with no observations of dogs or traps/snares encountered. However, evidence of hunting was reported within the DRC territory of the PAOI with pictures provided of animals used for bushmeat or skins. Interviews with the community on the Rwandan side indicated that hunting does not occur as it is well acknowledged that bushmeat is a punishable offence. The group that appears to be the most hunted are mesocarnivores such as mongooses (Herpestidae) and genets (Viverridae) (Figure 7-101A-B). Mesocarnivores are an ecologically important group and considerably influence trophic interactions, especially in landscapes where large carnivores are absent. The reduction in carnivores will likely have led to an increase in rodent populations, especially in cultivated areas where there is an abundance of food, although rodents are also targeted for food.

The loss of habitat and high human density in the project area makes it unlikely that hunting would be productive, apart from trapping of Kivu Giant pouched rats (Figure 7-101C), which does take place in the Bukavu area in the DRC (McCleland, *pers. obs.*). Farmers were observed shooting at bird pests in their fields with catapults and may do the same to mammal pests (such as squirrels and baboons) although this could not be confirmed. Existing threats to hippopotamus are not known but may include harassment and occasional hunting by local residents as they pose a safety risk to farmers along river banks and fishermen.



Figure 7-101 Photographs Illustrating Mammal Species Hunted within the DRC Territory of the Project Area of Influence. A) Marsh mongoose (*Atilax paludinosus*), B) Large-spotted genet (*Genetta maculata*) and C) Kivu Giant ouched rat (*Cricetomys kivuensis*).

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7.8.6 Herpetofauna

7.8.6.1 Diversity and Habitat Types

High herpetofauna species diversity is expected to occur within the project area of influence with a total of 66 amphibian and 89 reptile species with a Medium or higher likelihood of occurrence. The Hillslope Grassland / Savannah habitat has the highest expected species diversity for both reptiles and amphibians (Figure 7-102). Lists of potentially occurring reptiles and amphibians are provided in Annex C.

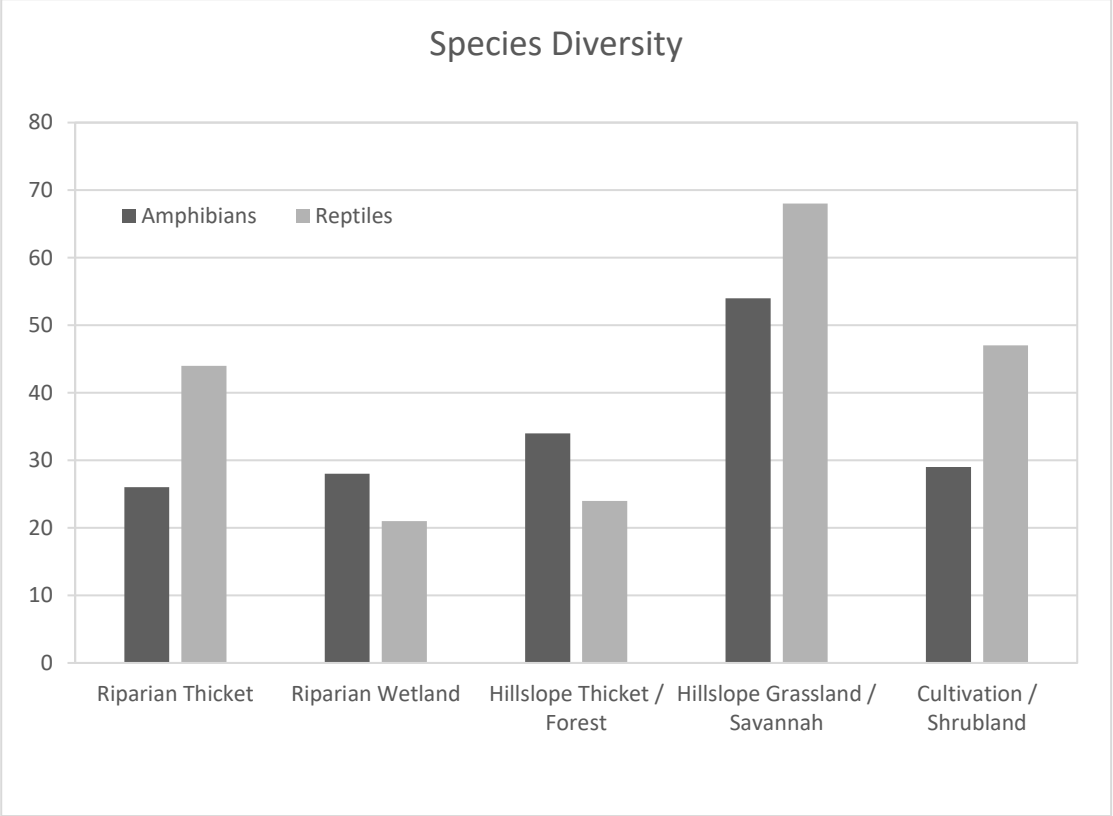


Figure 7-102 Species Diversity of Each Herpetofauna Assemblage Expected in the Project Area

7.8.6.2 Priority Herpetofauna Species

Priority herpetofauna species identified as likely to occur in the project area are those that have been classified by the IUCN as threatened (CR, EN or VU), species classified by the IUCN as Near Threatened (NT) or Data Deficient[19] (DD), species with an EOO of 50,000 km^2 or less (restricted-range species) and species restricted to the Albertine Rift Montane Forests Ecoregion (Olson *et al*., 2013) as evaluated by Ayebare *et al*. (2018). Table 7-37 provides a complete list of the priority herpetofauna expected in the project area with descriptions of the species summarised in the sections below.

[19] It is necessary to include these species as a precautionary approach because numerous DD species have in the past been evaluated as threatened once more information becomes available. Typically, DD species are those with narrow restricted geographic ranges and strong habitat requirements, making them highly susceptible to threats.

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Table 7-37 Priority Herpetofauna Species Expected in the Project Area

Family	Common Name	Scientific Name	IUCN Red Data	Endemic	Likelihood of occurrence	EOO (km^2)
Amphibians						
Arthroleptidae	Kivu screeching frog	*Arthroleptis pyrrhoscelis*	LC	X	H	34,662
Arthroleptidae	Bururi long-fingered frog	*Cardioglossa cyaneospila*	NT	X	M	24,458
Arthroleptidae	Fizi tree frog	*Leptopelis fiziensis*	DD	X	M	< 50,000
Hyperoliidae	Kivu banana frog	*Afrixalus orophilus*	LC	X	H	46,537
Hyperoliidae	Ahl's reed frog	*Hyperolius castaneus*	LC	X	M-H	73,498
Hyperoliidae		*Hyperolius diaphanus*	DD	X	M	< 50,000
Hyperoliidae		*Hyperolius discodactylus*	LC	X	M	12,383
Hyperoliidae	Bushoho reed frog	*Hyperolius frontalis*	LC	X	M-H	26,818
Pipidae		*Xenopus vestitus*	LC	X	M	>50,000
Pipidae		*Xenopus wittei*	LC	X	H	>50,000
Pyxicephalidae	De Saeger's River frog	*Amietia desaegeri*	LC	X	H	37,203
Reptiles						
Chamaeleonidae	Rugege Highlands forest chameleon	*Kinyongia rugegensis*	-	X	M	< 50,000
Chamaeleonidae	Johnston's three-horned chameleon	*Trioceros johnstoni*	LC	X	H	88,000
Chamaeleonidae	Rwenzori bearded chameleon	*Trioceros rudis*	LC	X	H	130,000
Chamaeleonidae	Schoutenden's montane dwarf chameleon	*Trioceros schoutedeni*	DD	X	M-H	14,000
Colubridae	Ruanda emerald green snake	*Philothamnus ruandae*	LC	X	H	>50,000
Gekkonidae	Sternfeld's gecko	*Cnemaspis quattuorseriata*	NT	X	M-H	>50,000
Lamprophiidae	Tanganyika water snake	*Lycodonomorphus bicolor*	LC	X	M	>50,000
Leptotyphlopidae	Uvira thread snake	*Leptotyphlops latirostris*	NT	X	M	14,000
Pythonidae	Central African rock python	*Python sebae*	NT		H	>50,000
Scincidae	Rwanda five-toed skink	*Leptosiaphos graueri*	EN	X	M	<50,000
Testudinidae	Speke's hinge-back tortoise	*Kinixys spekii*	VU		H	>50,000
Viperidae	Great Lakes bush viper	*Atheris nitschei*	LC	X	H	>50 000
Viperidae	Gaboon viper	*Bitis gabonica*	VU		H	>50 000

LC = Least Concern; DD = Data Deficient; VU = Vulnerable; NT = Near Threatened; EN = Endangered

M = Medium; M-H = Medium-High; H = High; Endemic = restricted to the Albertine Rift Montane Forests Ecoregion

Three threatened species have a medium likelihood of occurrence in the project area and one other species of importance (Nile crocodile) has been confirmed to occur downstream of the project area in the recent past. These species are dealt with in more detail below.

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A **Gaboon adder (*Bitis gabonica*)**

This species has a wide geographic range from Nigeria to East Africa (Uganda to Tanzania) and south to Angola and northern Zambia, with an isolated population in eastern South Africa and Mozambique (Luiselli et al. 2021). The species has been assessed as VU as a result of notable population declines, particularly in Nigeria and the DRC. Although this is primarily a forest-dwelling species, it does also occur in forest-plantation mosaics and agricultural areas and thus potentially occurs in the project area. However, given the extensive habitat modification and human presence it is likely targeted by local residents if encountered and likely to be scarce if present at all.

B **Speke's hinge-backed tortoise (*Kinixys spekei*)**

This tortoise has an extensive geographic range, occurring from southern Kenya southward to eSwatini (formerly Swaziland). It has been recorded from savanna, tropical bushveld, tropical savanna, sour bushveld, and the thornveld of the Lebombo Plateau but generally prefers moist savanna woodlands, although it also occurs in drier deciduous woodlands and thickets dominated by *Vachellia* and *Commiphora* in the north-eastern part of its range (Ihlow *et al.* 2019). Despite the large geographic range of this species, it has a provisional IUCN Red List evaluation of Vulnerable (VU) assigned by the IUCN SSC Tortoise and Freshwater Turtle Specialist Group in 2013 (TTWG, 2021) and is not currently globally evaluated by the IUCN (IUCN, 2022). Major threats to its survival include consumption by humans, habitat loss, susceptibility to climate change and to a lesser degree, international trade (Hailey *et al.* 2021). The project area of influence does not contain ideally suitable habitat for this species, although it has been observed in close proximity (Ihlow *et al*. 2019). The secondary shrubland associated with the cultivation and where this interfaces with the savanna habitats could provide appropriate habitat for this species, but it is only assigned a medium likelihood of occurrence.

C **Rwanda five-toed skink (*Leptosiaphos graueri*)**

The Endangered Rwanda five-toed skink (*Leptosiaphos graueri*) is an Albertine Rift Endemic with a wide altitudinal range (1,200-2,500 masl.) which occurs in wet montane forest (Wagner, 2021), flooded depression marshes (Roelke & Smith, 2016) and moss-covered rock ledges (Spawls *et al.,* 2018). It is a restricted-range species with an area of occupancy (AOO) of only 496 km^2 (Wagner, 2021). It is a fossorial species found in leaf litter. Its distribution overlaps with that of the project area of influence and consequently has a medium likelihood of occurrence. However, its preferred habitats are not extensively represented within the project area of influence and (given the high proportion of transformed habitat and mostly low altitude of the project area) it is likely that only very few individuals and/or populations will be affected by the proposed hydropower project, if at all.

D **Nile crocodile (*Crocodylus niloticus*)**

The Nile crocodile has a highly fragmented distribution, occurring in a wide diversity of water bodies in eastern, central and southern Africa (Isberg *et al.* 2019). Despite some evidence of localised population declines, Nile crocodile is still a widespread species and the population declines have not been significant enough to change its assessment of Least Concern (LC). Within Rwanda it is known to occur on the Kagera River system in the east, and a recent aerial wildlife census of the Akagera National Park counted 198 animals[20], although no information could be found regarding the presence of Nile crocodile in Lake Kivu or the upper Ruzizi River. The species is known to occur in the lower Ruzizi in Burundi, specifically in the vicinity of the Ruzizi Delta and Lake Tanganyika. All of the villagers and fishermen that were questioned within the reservoir area insisted that the species is not present. Villagers along the downstream reaches between Bugarama and the Burundi border stated that Nile Crocodiles were recorded

[20]www.africanparks.org/sites/default/files/uploads/newsroom_file_upload/2017-05/Akagera_Aerial_Census_Report_Summary_-_August_2015_%281%29.pdf

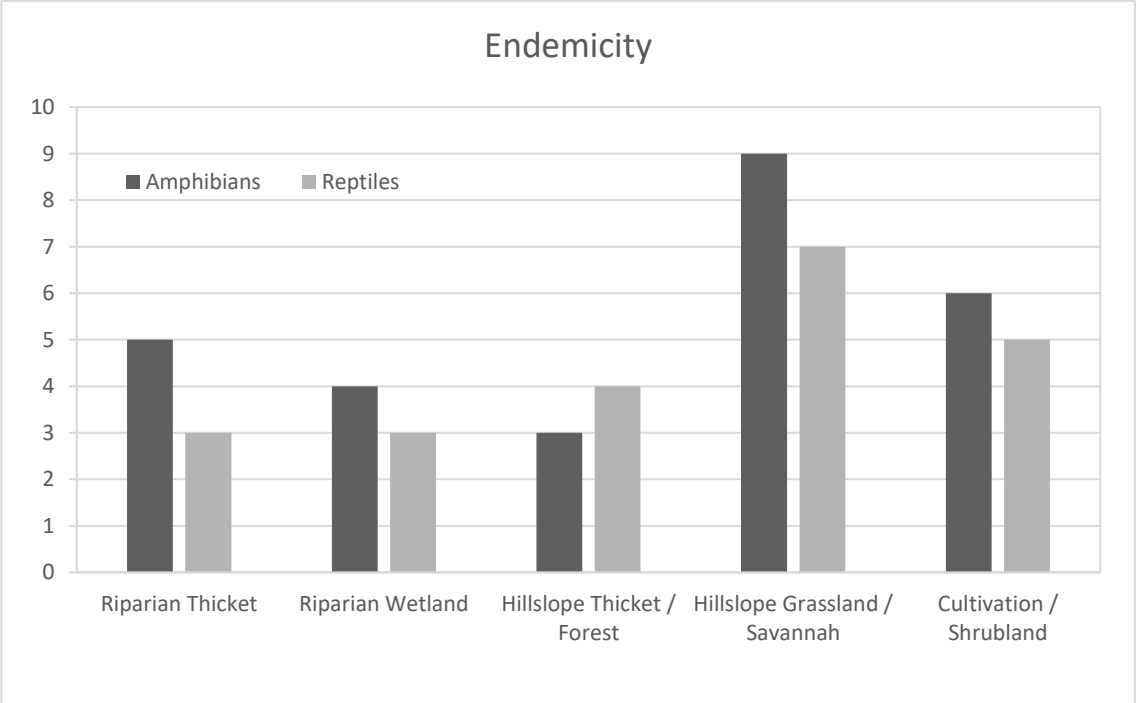
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in the past but have not been seen for several years. No evidence of this species could be found during fieldwork, and it is unlikely to be impacted by the project development.

In addition to the above species, 29 amphibian and 11 reptile species are endemic to the Albertine Rift Montane Forests Ecoregion (Ayebare *et al.* 2018). Of these, 13 amphibian and nine reptile species are expected to occur within the project area of influence with at least a Medium or higher likelihood of occurrence of which ten amphibians and three reptile species are considered to be restricted-range species, having and extent of occurrence (EOO) of less than 50,000 km^2 (Table 7-37). The highest species diversity for amphibian and reptile species endemic to the ecoregion is likely to be in the Hillslope Grassland / Savannah habitat (Figure 7-103). Such high levels of endemicity, coupled with the previously described high levels of species diversity (Figure 7-102), elevates the conservation importance of this habitat type.

Figure 7-103 Endemism of Herpetofauna Assemblages Expected in the Project Area



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7.8.7 Threats to Herpetofauna

Given the high human population density in the project area and transformed nature of most of the habitats, the major current threat to herpetofauna in the project area of influence is habitat degradation and transformation. Chance encounters of large bodied species such as larger snakes (Figure 7-104) and tortoises by people are expected to result in consumption thereof, but densities are likely to be too low for targeted hunting efforts. The major impact resulting from the proposed Ruzizi III hydropower dam would be the further loss of habitats, particularly areas of Natural Habitat (e.g. riparian thicket, riparian wetlands).



Figure 7-104 Photograph Illustrating a Puff Adder (*Bitis arietans*) killed within the DRC Territory of the Project Area of Influence

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7.8.8 Terrestrial Ecological Importance

Ecological importance of the different terrestrial habitats is assessed here. Habitat status according to ESS6 and IFC PS6 and its thresholds are assessed in the Critical Habitat Assessment in Chapter 9.

7.8.8.1 Ecological Importance

A Method for Determining Ecological Importance

The method used for assessing site-specific Ecological Importance (EI) in South Africa (SANBI, 2019) has been applied in this study. Since this method is not restricted to specific terrestrial ecosystems, it can be used in any environment. EI provides a basis to inform the assessment of impact significance that a project may have on the receiving environment.

EI is considered to be a function of the Biodiversity Importance (BI) of a particular receptor (e.g. species of conservation concern, vegetation/fauna community or habitat type) and its resilience to impacts (Receptor Resilience) as follows:

$$EI = BI + RR$$

BI is a function of Conservation Importance (CI) and the Functional Integrity (FI) of the receptor as follows:

$$BI = CI + FI$$

CI is defined as "the importance of a site for supporting biodiversity features of conservation concern present e.g. populations of IUCN Threatened and Near-Threatened species (CR, EN, VU & NT), Restricted-range species, globally significant populations of congregatory species, and areas of threatened ecosystem types, through predominantly natural processes" (SANBI, 2019). The fulfilling criteria for CI are presented in Table 7-38.

Table 7-38 Criteria for Determining Conservation Importance of a Receptor

Conservation Importance	Fulfilling Criteria
Very High	Confirmed or highly likely occurrence of CR, EN, VU or Extremely Rare or Critically Rare species that have a global Extent of Occurrence of < 10 km^2, or Any area of natural habitat of a CR ecosystem type or large area (> 0.1% of the total ecosystem type extent) of natural habitat of EN ecosystem type, or Globally significant populations of congregatory species (>10% of global population)
High	Confirmed or highly likely occurrence of CR, EN, VU species that have a global EOO of > 10 km^2. IUCN threatened species (CR, EN, VU) must be listed under any criterion other than A. If listed as threatened only under Criterion A, include if there are < 10 locations or < 10,000 mature individuals remaining; or Small area (> 0.01% but < 0.1% of the total ecosystem type extent) of natural habitat of EN ecosystem type or large area (> 0.1%) of natural habitat of VU ecosystem type; or Presence of Rare species; or Globally significant populations of congregatory species (> 1% but < 10% of global population)
Medium	Confirmed or highly likely occurrence of populations of NT species, threatened species (CR, EN, VU) listed under A criterion only and which have > 10 locations or > 10,000 mature individuals; or Any area of natural habitat of threatened ecosystem type with status of VU; or Presence of range-restricted species; or > 50% natural habitat with potential to support SCC
Low	No confirmed or highly likely populations of Species of Conservation Concern; or No confirmed or highly likely populations of range-restricted species; or < 50% of natural habitat with limited potential to support SCC

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Conservation Importance	Fulfilling Criteria
Very Low	No confirmed and highly unlikely populations of SCC; or No confirmed and highly unlikely populations of range-restricted species; or No natural habitat remaining.

FI of the receptor (e.g. the vegetation/faunal community or habitat type) is defined here as "a measure of the ecological condition of the impact receptor as determined by its remaining intact and functional area, its connectivity to other natural areas and the degree of current persistent ecological impacts". Fulfilling criteria for determining FI are given in Table 7-39.

Table 7-39 Criteria for Determining Functional Integrity of a Receptor

Functional Integrity	Fulfilling Criteria
Very High	Very large (>100 ha) intact area for any conservation status of regional vegetation type or > 5 ha for CR regional vegetation types; or High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches; or No or minimal current ecological impacts with no signs of major past disturbance (e.g. ploughing)
High	Large (> 20 ha but < 100 ha) intact area for any conservation status of regional vegetation type or > 10 ha for EN regional vegetation types; or Good habitat connectivity with potentially functional ecological corridors and a regularly used road network between intact habitat patches; or Only minor current ecological impacts (e.g. few livestock utilising area) with no signs of major past disturbance (e.g. ploughing) and good rehabilitation potential
Medium	Medium (> 5 ha but < 20 ha) semi-intact area for any conservation status of regional vegetation type or > 20 ha for VU regional vegetation types; or Only narrow corridors of good habitat connectivity or larger areas of poor habitat connectivity and a busy used road network between intact habitat patches; or Mostly minor current ecological impacts with some major impacts (e.g. established population of alien and invasive flora) and a few signs of minor past disturbance; moderate rehabilitation potential
Low	Small (> 1 ha but < 5 ha) area Almost no habitat connectivity but migrations still possible across some transformed or degraded natural habitat; a very busy used road network surrounds the area. Low rehabilitation potential Several minor and major current ecological impacts
Very Low	Very small (< 1 ha) area No habitat connectivity except for flying species or flora with wind-dispersed seeds. Several major current ecological impacts

BI can be derived from a simple matrix of CI and FI as indicated in Table 7-40.

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Table 7-40: Biodiversity Importance Two-way Matrix

Biodiversity Importance		Conservation Importance				
		Very High	High	Medium	Low	Very Low
Functional Integrity	Very High	Very High	Very High	High	Medium	Low
	High	Very High	High	Medium	Medium	Low
	Medium	High	Medium	Medium	Low	Very Low
	Low	Medium	Medium	Low	Low	Very Low
	Very Low	Medium	Low	Very Low	Very Low	Very Low

Receptor Resilience (RR) is defined as "the intrinsic capacity of the receptor to resist major damage from disturbance and/or to recover to its original state with limited or no human intervention". The fulfilling criteria for RR are presented in Table 7-41.

Table 7-41 Criteria for Determining Receptor Resilience

Receptor Resilience	Fulfilling Criteria
Very High	Habitat that can recover rapidly (~ less than 5 years) to restore > 70% of the original species composition and functionality of the receptor functionality, or species that have a very high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a very high likelihood of returning to a site once the disturbance or impact has been removed.
High	Habitat that can recover relatively quickly (~ 5-10 years) to restore > 70% of the original species composition and functionality of the receptor functionality, or species that have a high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a high likelihood of returning to a site once the disturbance or impact has been removed.
Medium	Will recover slowly (~more than 10 years) to restore > 70% of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a moderate likelihood of returning to a site once the disturbance or impact has been removed.
Low	Habitat that is unlikely to be able to recover fully after a relatively long period: > 15 years required to restore ~less than 50% of the original species composition and functionality of the receptor functionality, or species that have a low likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a low likelihood of returning to a site once the disturbance or impact has been removed.
Very Low	Habitat that is unable to recover from major impacts, or species that are unlikely to remain at a site even when a disturbance or impact is occurring, or species that are unlikely to return to a site once the disturbance or impact has been removed.

Once BI and RR have been calculated through the use of the above two matrices, EI can be determined using the matrix in Table 7-42.

Table 7-42 Ecological Importance Matrix

Ecological Importance (EI)		Biodiversity Importance (BI)				
		Very High	High	Medium	Low	Very Low
Receptor Resilience	Very Low	Very High	Very High	High	Medium	Low
	Low	Very High	High	Medium	Low	Low
	Medium	High	Medium	Medium	Low	Very Low
	High	Medium	Low	Low	Low	Very Low
	Very High	Low	Low	Very Low	Very Low	Very Low

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Guidelines for how to interpret EI of a project in terms of impact mitigation are given in Table 7-43.

Table 7-43 Guidelines for Interpreting Ecological Importance of Receptors

Ecological Importance	Interpretation in Relation to Proposed Development Activities
Very High	Avoidance mitigation - No destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e. last remaining populations of species, last remaining good condition patches of ecosystems/unique species assemblages. Destructive impacts for species/ecosystems where <persistence target remains.
High	Avoidance mitigation wherever possible. Minimization mitigation – Changes to project infrastructure design to limit the amount of habitat impacted; limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Medium	Minimization & restoration mitigation - Development activities of medium impact acceptable followed by appropriate restoration activities.
Low	Minimization & restoration mitigation - Development activities of medium to high impact acceptable followed by appropriate restoration activities.
Very Low	Minimization mitigation - Development activities of medium to high impact acceptable and restoration activities may not be required.

B Assessment of Ecological Importance

The integrated assessment of EI is presented in Table 7-44 and the spatial extent of the EI categories and habitat status are shown on the map in **Figure 7-105**. This assessment integrated the results of separate EI assessments of the five vegetation communities and seven faunal assemblages, which represented seven distinct habitats as indicated in Table 7-45. A quantification of the areal extent of each vegetation community or habitat type in the direct and indirect AOI is summarised in Table 7-29.

- One of the vegetation communities in the project area has been assessed as having a **High** Integrated EI, namely Hillslope Grassland / Savannah. Although this community occupies only ~22 ha, its high EI value is driven by High Functional Integrity and Very Low Receptor Resilience. Hillslope Grassland / Savannah is situated on extremely steep slopes with shallow, unstable soils and is an important vegetation community with regards to slope stability. It would be almost impossible for grasslands on these steep slopes to be restored to original species composition with intact ecological processes and functions if the vegetation cover was removed during infrastructure construction, hence the Very Low RR score.
- Four vegetation communities/faunal habitats have been classified as having a **Medium** Integrated EI, namely Riparian Thicket, Hillslope Thicket / Forest, Riparian Wetlands and Open Water. These communities cover 68 ha, or 28% of the project footprint (Figure 7-105). Riparian Thicket and Hillslope Thicket / Forest both have only Medium Functional Importance as a result of severe fragmentation and reduced ecological functionality and have Medium Conservation importance as a result of the potential to support SCC as well as confirmed occurrence of one NT tree species. Riparian Wetlands and Open Water both have High Conservation Importance as a result of the confirmed occurrence of hippopotamus (VU), although this is only relevant to the river downstream of Bugarama, and only Medium Functional Importance as a result of some compromised ecological functionality (e.g. as a result of invasion by alien plants) and habitat degradation.
- The Integrated EI of the Cultivation / Secondary Shrubland Mosaic community (which occupies the majority (154 ha/62%) of the project area) has been classified as **Low** and the EI for Towns & Villages as **Very Low**, mostly as a result of loss or degradation of Natural Habitat and natural ecological processes, low potential to support SCC and a high proportion of alien species present.

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Table 7-44 Summary of the Integration of Ecological Importance of Vegetation Communities and Faunal Habitats

Vegetation Community	Riparian Thicket	Hillslope Thicket / Forest	Hillslope Grassland / Savannah	Riparian Wetlands	Cultivation / Secondary Shrubland Mosaic		
	M	M	H	L	L		
Faunal Assemblage	Riparian Thicket	Hillslope Thicket / Forest	Hillslope Grassland / Savannah	Riparian Wetlands	Cultivation / Secondary Shrubland Mosaic	Open Water	Towns & Villages
	M	M	H	M	L	M	VL
Integrated Ecological Importance (EI)	M	M	H	M	L	M	VL

Table 7-45 Assessment of Ecological Importance by Habitat Type/Vegetation Community in PAOI

Vegetation Community / Habitat	Conservation Importance		Functional Importance		Biodiversity Importance	Receptor Resilience	Ecological Importance
Riparian Thicket	M	Modified Habitat with minimal SCC	M	Low habitat connectivity with diminished capacity to function as ecological corridors Visible ecological impacts with signs of forest loss in the past	M	M	M
Hillslope Thicket / Forest	M	Natural Habitat with minimal SCC Confirmed occurrence of *Milicia excelsa* (NT)	M	Low habitat connectivity with diminished capacity to function as ecological corridors Visible ecological impacts with signs of forest loss in the past	M	M	M
Hillslope Grassland / Savannah	M	Natural Habitat with potential to support SCC No SCC confirmed.	H	Good habitat connectivity with functional ecological corridors and processes Some habitat loss and fragmentation but some significant patches still present	M	VL	H
Riparian Wetlands	H	Modified Habitat with low potential to support SCC Confirmed occurrence of hippopotamus (VU)	M	Moderate to poor habitat connectivity with potentially functional ecological corridors Visible ecological impacts (e.g. established populations of alien invasive flora) and signs of minor past disturbance; moderate rehabilitation potential	M	M	M
Cultivation / Secondary Shrubland Mosaic	L	Modified Habitat with limited potential to support SCC	L	No remaining Natural Habitat	L	N/A	L

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Vegetation Community / Habitat	Conservation Importance		Functional Importance		Biodiversity Importance	Receptor Resilience	Ecological Importance
Open Water	H	Modified Habitat but with potential to support SCC Confirmed presence of hippopotamus (VU) down-stream of Bugarama	M	Flowing water sustains some fish, hippopotamus and a few waterbirds but much reduced due to hydropeaking releases.	M	H	M
Towns & Villages	L	No Natural Habitat; unlikely to support SCC	VL	No remaining Natural Habitat	VL	N/A	VL

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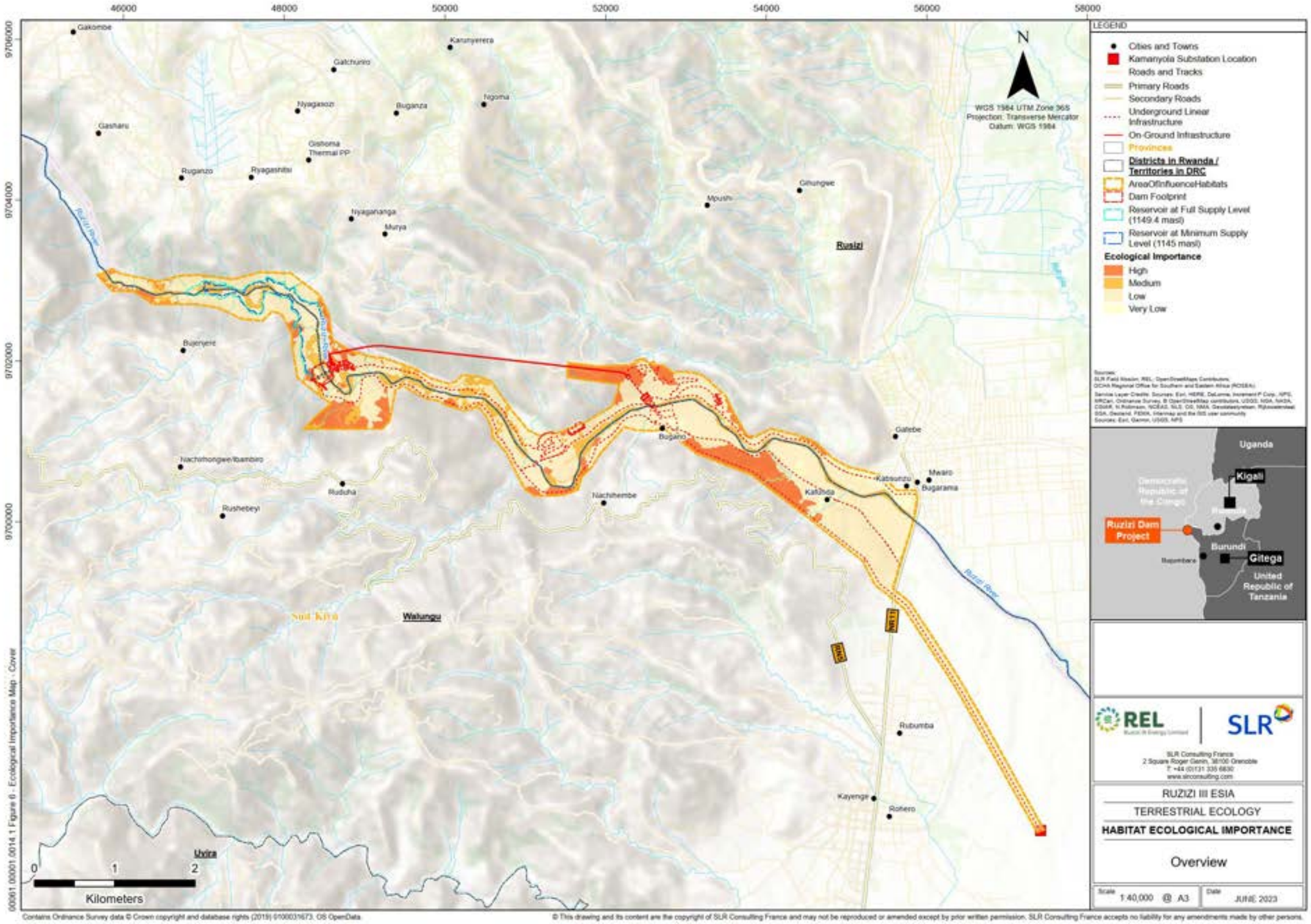


Figure 7-105a Ecological Importance of Habitats represented in the Project Area: Cover Map

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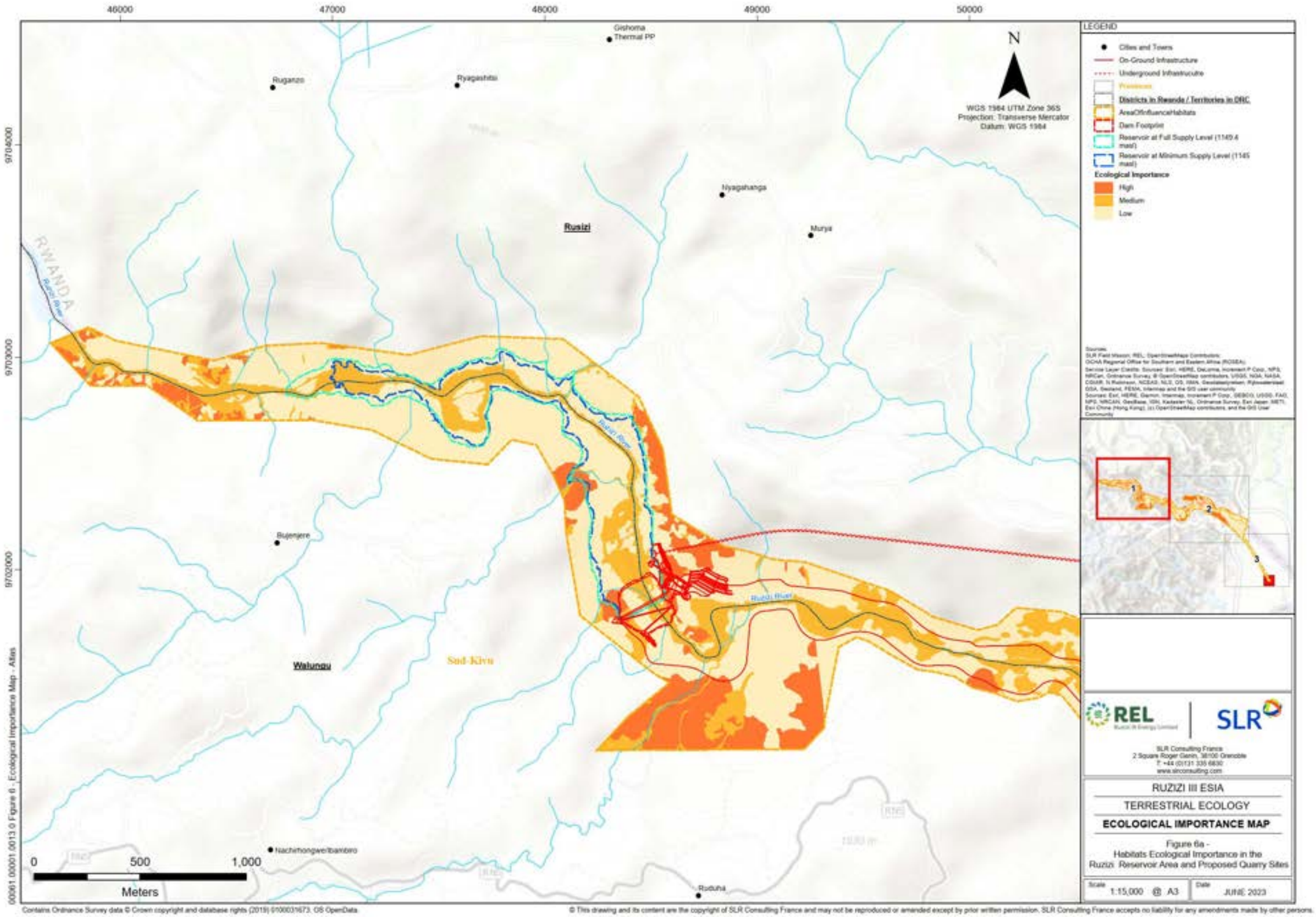


Figure 7-105b Ecological Importance of Habitats represented in the Project Area: Reservoir and Immediate Downstream Area

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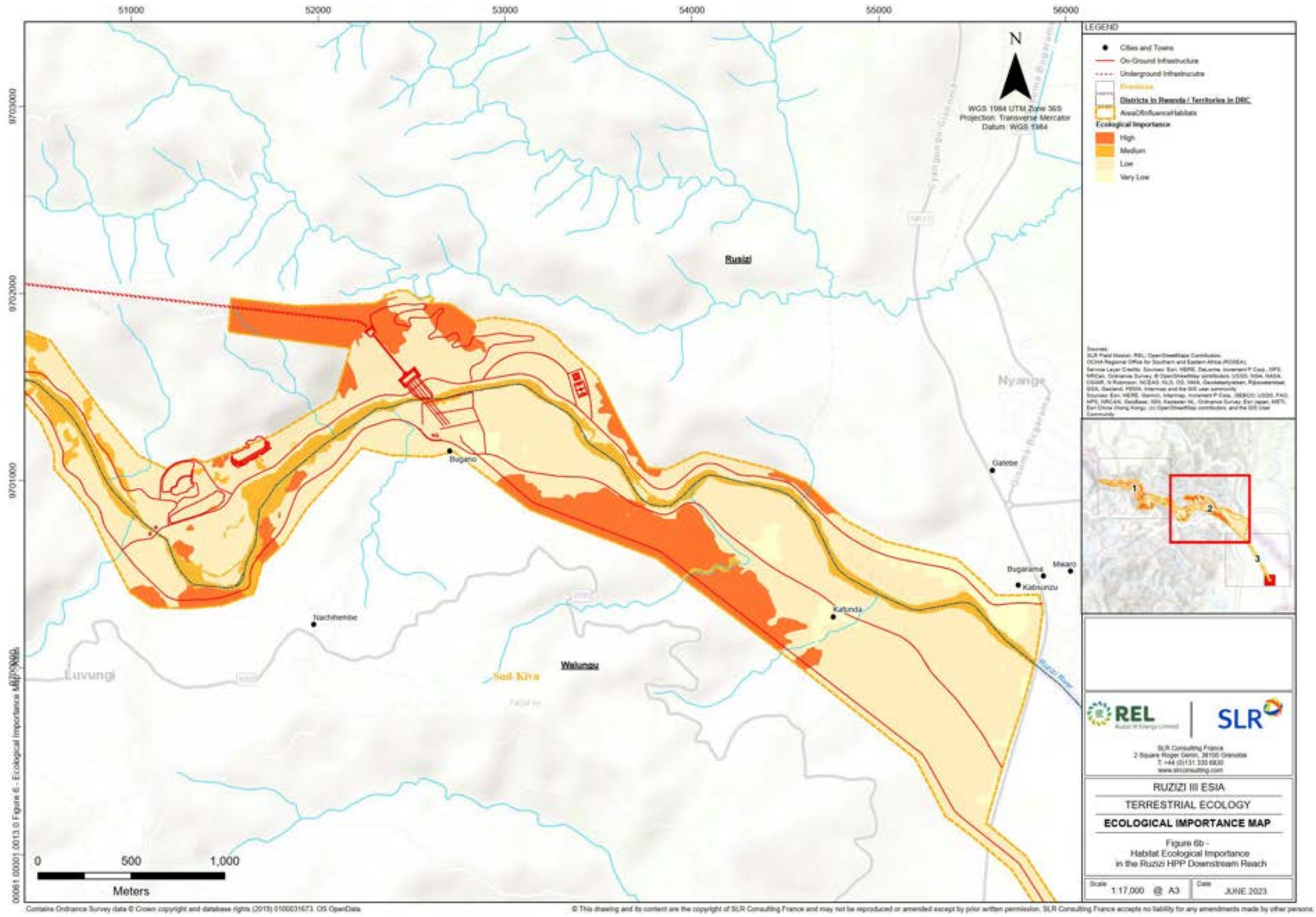


Figure 7-105c Ecological Importance of Habitats represented in the Project Area: Downstream Reaches

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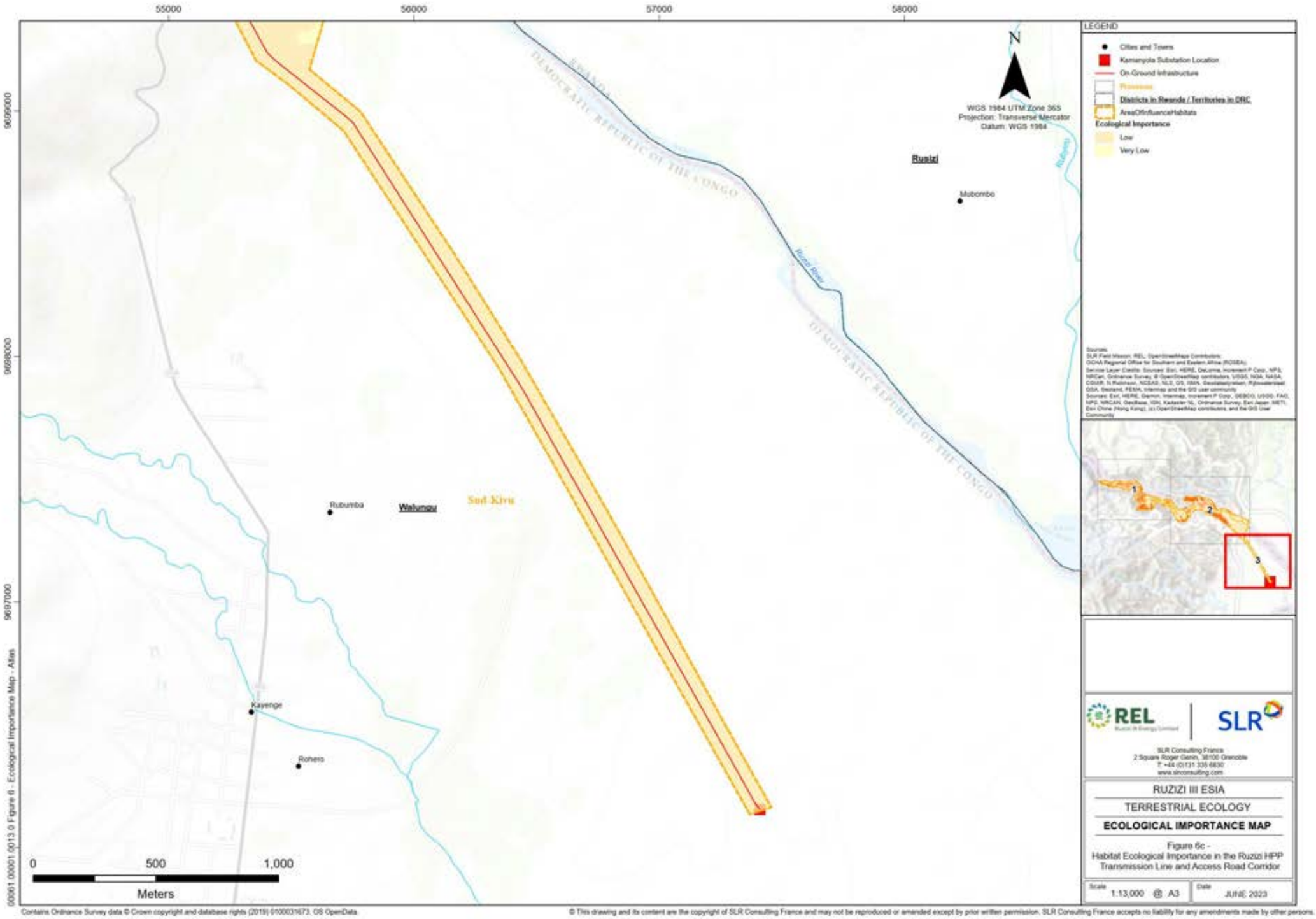


Figure 7-105d Ecological Importance of Habitats represented in the Project Area: Transmission Line and Access Road

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8 Social Baseline Situation

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Contents

8.1 Methodology 8-1

8.1.1 Study Area 8-1
8.1.2 Terminology 8-3
8.1.3 Primary Data Collection 8-4
8.1.4 Secondary Data 8-13
8.1.5 Limitations 8-13

8.2 Demography 8-14

8.2.1 Administrative Organisation 8-14
8.2.2 Settlement Patterns 8-16
8.2.3 Population 8-22
8.2.4 Education 8-25
8.2.5 Languages, Religion and Social Groups 8-26

8.3 Land Tenure 8-36

8.3.1 Rwanda 8-36
8.3.2 DRC 8-38

8.4 Land Use 8-40

8.4.1 Land Use in the Reservoir and Dewatered Reach 8-40
8.4.2 Land Use along Access Roads, at Construction Camps & Powerhouse Site 8-40
8.4.3 Land Use Along the Transmission Line Alignment 8-44
8.4.4 Land Use Along the Reach of Ruzizi River Downstream of the Project 8-44

8.5 River Uses 8-47

8.5.1 Water Supply and Domestic Activities 8-47
8.5.2 River Crossing 8-49
8.5.3 Medicinal and Spirituality Properties 8-50
8.5.4 Irrigation 8-50

8.6 Economic Activities 8-51

8.6.1 Agriculture 8-52
8.6.2 Livestock Farming 8-58
8.6.3 Hunting 8-60
8.6.4 Fishing 8-60
8.6.5 Fishfarming 8-63
8.6.6 Artisanal Activities and Small Commerce 8-66

PUBLIC DISCLOSURE AUTHORIZED

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8.6.7 Access to Banking System, Small-Scale Credit and Savings Associations 8-67
8.6.8 Development Projects and Livelihood Improvement Schemes 8-68

8.7 Community Health 8-70

8.7.1 General Community Health Context 8-70
8.7.2 Main Health Issues Treated in the Study Area 8-76

8.8 Community Infrastructure 8-80

8.8.1 Roads 8-80
8.8.2 Schools 8-81
8.8.3 Water Supply 8-83
8.8.4 Sanitation and Waste Management 8-84
8.8.5 Source of Energy for Lighting and Cooking 8-85

8.9 Gender 8-86

8.9.1 Rwanda 8-86
8.9.2 DRC 8-92
8.9.3 Gender-Based Violence in DRC 8-93

8.10 Security and Human Rights 8-95

8.10.1 Rwanda 8-95
8.10.2 DRC 8-96

8.11 Vulnerable Groups 8-97

8.11.1 Rwanda 8-97
8.11.2 DRC 8-100
8.11.3 Vulnerable Groups in the Study Area 8-100

8.12 Cultural Heritage 8-103

8.12.1 Tangible Cultural Heritage 8-103
8.12.2 Intangible Cultural Heritage 8-108

8.13 Ecosystem Services: Provisioning & Cultural Services 8-111

8.13.1 Provisioning Services 8-111
8.13.2 Cultural Services 8-118

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Tables

Table 8-1 Potential Impacts and Associated Study Areas 8-1
Table 8-2 Villages Included in the Study Area for the 2022 Studies, Rwanda 8-3
Table 8-3 Villages Included in the Study Area for the 2022 Studies, DRC 8-3
Table 8-4 List of People Interviewed in Rwanda for the Qualitative Survey (2022) 8-8
Table 8-5 List of People Interviewed in DRC for the Qualitative Survey (2022) 8-8
Table 8-6 Distribution of Households Surveyed During the Quantitative Households' Survey (2022) 8-11
Table 8-7 Estimated Population in the Study Area in 2021, According to Local Authorities (Rwanda) 8-23
Table 8-8 Population in the Study Area in 2021, According to Village Chiefs (DRC) 8-25
Table 8-9 Breakdown of Ethnic Groups Present in the Study Area, DRC (2022) 8-31
Table 8-10 Type of land tenure - Rwanda 8-37
Table 8-11 Type of land tenure, DRC 8-38
Table 8-12 Use of the Ruzizi River by surveyed Households 8-47
Table 8-13 Agricultural Cooperatives Used by Farmers in the Study Area, Rwanda (2022) 8-56
Table 8-14 Average Number of Animals Owned by Farmers (2022) 8-59
Table 8-15 Percentage of Surveyed Households Who Fish (2022) 8-61
Table 8-16 Use of Fish Caught by Surveyed Households (2022) 8-61
Table 8-17 Average Amount Made the Last Time that Households Sold Fish at the Market (2022) 8-61
Table 8-18 Surveyed Households With Access to a Bank Account or Microloan (2022) 8-68
Table 8-19 Development Actors Involved in the Study Area (2022) 8-68
Table 8-20 Frequency of Health Facility Visits by Surveyed Households in the 12 Months Preceding the Survey (2022) 8-70
Table 8-21 Main Illnesses and Affected Groups in Study Area, Rwanda (2022) 8-72
Table 8-22 Capacity of Health Centres in the Study Area, Rwanda (2022) 8-74
Table 8-23 Capacity of Health Centres in the Study Area, DRC (2022) 8-74
Table 8-24 Most Common Issues Treated in the Health Centres, DRC (2022) 8-75
Table 8-25 Number of Malaria Cases per Month (December-January), by Health Centre (2022) 8-76
Table 8-26 Number of Malaria Cases per Month (December-January) by Village, Rwanda (2022) 8-77
Table 8-27 Malaria Treatment by Surveyed Households in the two Years Preceding the Survey (2022) 8-77
Table 8-28 Number of ARI Cases Treated by Each Health Centre, DRC and Rwanda (2022) 8-78
Table 8-29 Other Illnesses Experienced by Surveyed Households in the Three Months Preceding the Survey (2022) 8-78
Table 8-30 HIV Cases Reported in Health Centres, Rwanda and DRC (2022) 8-79
Table 8-31 Schools Identified in the Study Area (2022) 8-81
Table 8-32 Main Source of Drinking Water Amongst Surveyed Households (2022) 8-83
Table 8-33 Time Necessary to Reach a Water Collection Point Amongst Surveyed Households (2022) 8-84
Table 8-34 Frequency of Water Collection Amongst Surveyed Households (2022) 8-84

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Table 8-35 Access to and Control over Resources in Rwanda, Disaggregated by Gender (2022) 8-88
Table 8-36 Estimated Household Expenses in the Study Area (2022) 8-89
Table 8-37 Distribution of Tasks by Gender, Rwanda (2022) 8-90
Table 8-38 Cases of GBV per Month, by Health Centre in Rwanda (2022) 8-91
Table 8-39 Distribution of Tasks by Gender, DRC (2022) 8-93
Table 8-40 Cases of GBV per Month, by Health Centre in DRC (2022) 8-94
Table 8-41 Percentage of Population by Category as Registered by the Ubudehe Scheme, by Village (2022) 8-99
Table 8-42 Percentage of Surveyed Households per Vulnerability Category (2022) 8-102
Table 8-43 UNESCO World Heritage Sites in DRC, Including Distance from the Project (2022) 8-103
Table 8-44 Elements of Tangible Cultural Heritage in the Study Area, by Village and Closest Project Component (2022) 8-105
Table 8-45 Intangible Cultural Heritage Practice Sites in the Study Area (2022) 8-108
Table 8-46 Frequency of Firewood Collection Near the River by Surveyed Households (2022) 8-112
Table 8-47 Percentage of Households Collecting Medicinal Plants by the River (2022) 8-115
Table 8-48 Medicinal Plants Mentioned During Interviews (2022) 8-116

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Figures

Figure 8-1 Study Area Covered by the Data Collection Activities Performed in 2022 8-2
Figure 8-2 Informal Discussion with two Female Cultivators Along Bugano's Riverside, DRC (2022) 8-5
Figure 8-3 Focus Group with the Village Committee of Nyagahanga, Rwanda (2022) 8-7
Figure 8-4 Focus Group with Men in Ryagashyitsi, Rwanda (2022) 8-7
Figure 8-5 Focus Group with Women in Nachirongwe, DRC (2022) 8-7
Figure 8-6 Focus Group with Vulnerable People in Kayenge, DRC (2022) 8-7
Figure 8-7 Interview with Ibambiro Health Centre, DRC (2022) 8-7
Figure 8-8 Interview with Bugarama's Sector Agronomist, Rwanda (2022) 8-7
Figure 8-9 Map of Qualitative Interviews (2022) 8-9
Figure 8-10 – Map of Quantitative Households' Survey (2022) 8-10
Figure 8-11 – Photographs of Interviews with Resettlement Committees in DRC and HMP in Rwanda 8-12
Figure 8-12 Map of Rwandan Administrative Divisions in the Study Area (2022) 8-15
Figure 8-13 'Umidugudu' Settlement Style in the Village of Nyagahanga, Rwanda 8-17
Figure 8-14 Example of Tree Used to Delimitate Plots, Reservoir Area 8-17
Figure 8-15 Mud House with Sheet Metal Roof in Ryagashyitsi 8-19
Figure 8-16 Brick House with Sheet Metal Roof 8-19
Figure 8-17 Wood Plank House 8-19
Figure 8-18 Cement House 8-19
Figure 8-19 Entry into a Neighbourhood of Bugano, DRC 8-20
Figure 8-20 House with Brick Wall and Straw Roof, Kafunda 8-21
Figure 8-21 Mud House with Straw Roof, Bugano 8-21
Figure 8-22 House with Brick Wall and Metal Roof, Kafunda 8-21
Figure 8-23 House with Banana Leaf Roof and Wall 8-21
Figure 8-24 Example of Fragile Housing in Bugano, DRC 8-21
Figure 8-25 Percentage Distribution of Population by Wealth Quintiles (2021) 8-22
Figure 8-26 - Population of the Rusizi District, by Age Group (2012) 8-23
Figure 8-27 Percentage Distribution of Population by Wealth Quintiles in DRC (2014) 8-24
Figure 8-28 Religion Practiced by Surveyed Households in Rwanda (2022) 8-26
Figure 8-29 Focus Group with Historically Marginalised People in Gatchuriro (Rwanda) 8-30
Figure 8-30 Historically Marginalised Person Working on a Field, Reservoir Area (Rwanda, 2022 Survey) 8-30
Figure 8-31 Ethnicity Amongst the Households Surveyed in DRC (2022) 8-32
Figure 8-32 Religious Affiliation of Surveyed Household Members in DRC (2022) 8-33
Figure 8-33 Map of Land Use Across the Study Area, DRC and Rwanda (2022) 8-41
Figure 8-34 Birdseye of the Reservoir Site 8-42
Figure 8-35 Banana Plantation in the Reservoir Area 8-42

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Figure 8-36 Manioc Drying in the Reservoir Area 8-42
Figure 8-37 Steep Slope Cultivation in the Reservoir Area 8-43
Figure 8-38 Taro Field on Riverside Slope 8-43
Figure 8-39 Patches of Cultivation Amongst Vegetation in Reservoir Area 8-43
Figure 8-40 Field of Maize in Transmission Line Station Area, Close to the Future Kamanyola Substation 8-44
Figure 8-41 Cultivation Plain in Bugarama, Rwanda, before the confluence with Ruhwa River 8-45
Figure 8-42 Bird-Eye View of Crop Cultivation and Fish farming Ponds, DRC, at the Confluence with Ruhwa River 8-45
Figure 8-43 Irrigation Canals and Fish Farming Ponds, DRC, at the Confluence with Ruhwa River 8-45
Figure 8-44 Field in Mubombo Before the Flood on 18/06/2021 8-46
Figure 8-45 Field in Mubombo At the End of the Flood on 18/06/2021 8-46
Figure 8-46 Field in Mubombo After the Flood on 18/06/2021 8-46
Figure 8-47 Collecting Water, Washing and Bathing Area in Gatebe 8-48
Figure 8-48 Manioc Drying Spot Outside of Bugarama 8-48
Figure 8-49 Hole for Manioc Fermentation in Gisheke, Rwanda 8-48
Figure 8-50 Area for Clothes Drying in DRC, downstream of Kamanyola 8-48
Figure 8-51 Manioc Drying in Gisheke, Rwanda 8-48
Figure 8-52 Manioc Drying on Slope, Reservoir Area 8-48
Figure 8-53 Sugar Smuggling Across the River, Downstream from Mwaro to Kamanyola 8-49
Figure 8-54 Irrigation Pump and Pumping Machine 8-50
Figure 8-55 Irrigation Canals, Downstream part of the Study Area in DRC 8-51
Figure 8-56 Soya Bean Drying in the Village of Mubombo, Rwanda 8-52
Figure 8-57 Coffee Plants Cultivated in Ruganzo, Rwanda 8-52
Figure 8-58 Tomatoes Packed for Market Selling, DRC, Downstream of Kamanyola 8-53
Figure 8-59 Agricultural Calendar (Rwanda and DRC) 8-54
Figure 8-60 Mango Plantation in Gombaniro, Rwanda 8-55
Figure 8-61 Small Cooperative and Processing Centre for Cassava in Kabusunzu 8-57
Figure 8-62 COCAGI Coffee Washing Station, Drying Process 8-58
Figure 8-63 Percentage of Households Owning Livestock, by Type and Province in Rwanda (EICV3, 2014) 8-58
Figure 8-64 Percentage of Households that Own Livestock (2022) 8-59
Figure 8-65 Goats Grazing on the Riverside of Gombaniro, Rwanda 8-60
Figure 8-66 Cattle Drinking from the Ruzizi Downstream of Kamanyola, DRC 8-60
Figure 8-67 Fishermen with Fishing Net, DRC and Rwanda (2022) 8-62
Figure 8-68 Fishermen with Fishing Pole, Rwanda (2022) 8-62
Figure 8-69 Fish Farming Ponds in Kayenge, DRC (2022) 8-64
Figure 8-70 Pond Used as a Water Reservoir in Kayenge, DRC (2022) 8-64
Figure 8-71 View of Fish Farming Ponds in Kayenge from Rwandan Hilltop (2022) 8-64
Figure 8-72 Location of Fish Farming Activities Within the Study Area (2022) 8-65

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Figure 8-73 Small Snack-Bar in the Village of Gombaniro, Rwanda (2022) 8-66
Figure 8-74 Shop in Kabusunzu (2022) 8-66
Figure 8-75 Percentage of Households Owning at Least a Bank Account in Rwanda, by Province (NISR, 2020) 8-67
Figure 8-76 Percentage of Households With at Least One Member Covered by Health Insurance (2021) 8-71
Figure 8-77 Rwinbogo Health Centre, Rwanda (2022) 8-71
Figure 8-78 – Health Centres and Schools in the Study Area (2022) 8-73
Figure 8-79 Road in Nyagahanga (Nzahaha), Rwanda (2022) 8-80
Figure 8-80 Road in Gatebe (Bugarama), Rwanda (2022) 8-80
Figure 8-81 Road in Bugano, DRC (2022) 8-80
Figure 8-82 Primary School in Kayenge (2022) 8-82
Figure 8-83 Primary and Secondary School in Ruduha (2022) 8-82
Figure 8-84 Primary School in Nachirongwe (2022) 8-82
Figure 8-85 CELPA Church used as School in Nachirongwe (2022) 8-82
Figure 8-86 Primary School in Nyagahanga (2022) 8-82
Figure 8-87 Public Water Point in Cement with Tap (Nyagahanga, Rwanda). 8-84
Figure 8-88 Natural Water Spring (Nyagahanga, Rwanda). 8-84
Figure 8-89 Example of an External Non-Shared Latrine in Ryagashyitsi, Rwanda (2022) 8-85
Figure 8-90 Example of an External Non-Shared Latrine in Kafunda, DRC (2022) 8-85
Figure 8-91 Owner of the Land Title Deed by Gender of Household Head, Rwanda (2022) 8-87
Figure 8-92 Location of UNESCO World Heritage Sites in DRC and Rwanda 8-104
Figure 8-93 Brahman Church in Kayenge, DRC 8-106
Figure 8-94 Church of Ryagashyitsi 8-106
Figure 8-95 Protestant Church of Bugano 8-106
Figure 8-96 Catholic Church of Ibambiro, DRC 8-106
Figure 8-97 Genocide Memorial in Muganza Sector 8-106
Figure 8-98 Genocide Memorial in Gashonga Sector 8-106
Figure 8-99 Location of Identified Site of Tangible Cultural Heritage (2022) 8-107
Figure 8-100 Baptism and Religious Chanting Spot in Gatebe (Bugarama), Rwanda (2022) 8-109
Figure 8-101 Praying Spot in Nyagahanga, Rwanda (2022) 8-109
Figure 8-102 Praying Spot in a Grotto in Nachihembe, DRC (2022) 8-109
Figure 8-103 Praying Spot in a Grotto in Bugano, DRC (2022) 8-109
Figure 8-104 Island used as a Praying site by communities from DRC, Reservoir Area (2022) 8-109
Figure 8-105 Location of Identified Site of Intangible Cultural Heritage Practices (2022) 8-110
Figure 8-106 Women Carrying Wood Branches in Gisheke, Rwanda (2022) 8-113
Figure 8-107 Plank Cutting for Housing close to the Reservoir Area, Rwanda (2022) 8-113
Figure 8-108 Scattered Trees Used for Wood Cutting in Mubombo, Rwanda (2022) 8-113
Figure 8-109 Wood Cutting Activities in the Reservoir Area (2022) 8-113
Figure 8-110 Private Timber Trees in Quarry Area, Ruganzo (2022) 8-113

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Figure 8-111 Charcoal Fabrication in the Reservoir Area (2022) 8-113
Figure 8-112 Men Carrying Straw for Livestock and Construction in Gatebe (2022) 8-114
Figure 8-113 Straw Used for Agriculture (2022) 8-114
Figure 8-114 Umuravumba Medicinal Plant, Observed in the Core Clay Borrow Area (2022) 8-117
Figure 8-115 Ikicamahirwe Medicinal Plant Observed in Ruganzo Village (2022) 8-117
Figure - Photograph Illustrating Apiculture Activities within the PAOI ..... **Error! Bookmark not defined.**

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8.1 Methodology

8.1.1 Study Area

This Social Baseline is informed by data collected in January and February 2022, through two social surveys aimed at investigating and documenting the socio-economic specificities of the communities which own, inhabit, use or are culturally tied to the natural resources affected by the Project Footprint.

A study area for the data collection has been defined based on the spatial reach of potential Project-related impacts. The impacts which have been considered to define the study area are those related to (i) loss of, or loss of access to, land and natural resources, (ii) community health and safety and (iii) water level changes downstream of the dam. The impacts considered for data collection and their associated study areas are outlined in Table 8-1. Figure 8-1 illustrates the overall area covered by the 2022 data collection activities.

Table 8-1 Potential Impacts and Associated Study Areas

Potential Impacts Considered	Spatial Area Associated with Impacts
Involuntary resettlement of individuals and communities.	> Villages impacted by land acquisition (See Table 8-2).
Loss of access to means of livelihoods and natural resources.	
Project-induced in-migration and adverse effects on community health during construction.	> Villages impacted by land acquisition (See Table 8-2). > Corridor of 1.5 km on both sides of the river, from the reservoir down to the Ruzizi's confluence with the Ruhwa.
Impacts on gender-based violence during construction works.	
Impairment or restriction of existing socio-economic activities and means of livelihoods during construction and operation.	
Labour in-flow and risks of gender-based violence during construction.	
Change in water levels and flooding risks along the floodplain downstream of the proposed dam.	> Corridor of 1.5 km on both sides of the river, from the reservoir down to the Ruzizi's confluence with the Ruhwa.
Impacts of community health around the reservoir (e.g. waterborne diseases).	> Corridor of 5 km on both sides of the river, from the reservoir down to the Ruzizi's confluence with the Ruhwa.[1]
Encroachment of the Project's footprint and activities on areas or traditions holding cultural value for local communities.	
[1] *The width of the corridor selected to assess community health and cultural heritage impacts is based on research suggesting that a dam's impact on waterborne disease cases can be felt on average within a distance of 5 km (Kibret et al, 2021). Nevertheless, it is worth noting that other researchers have suggested that carry the malaria parasite can cross hundreds of km rather than an average distance of 5 km (Wadman, 2019).*	

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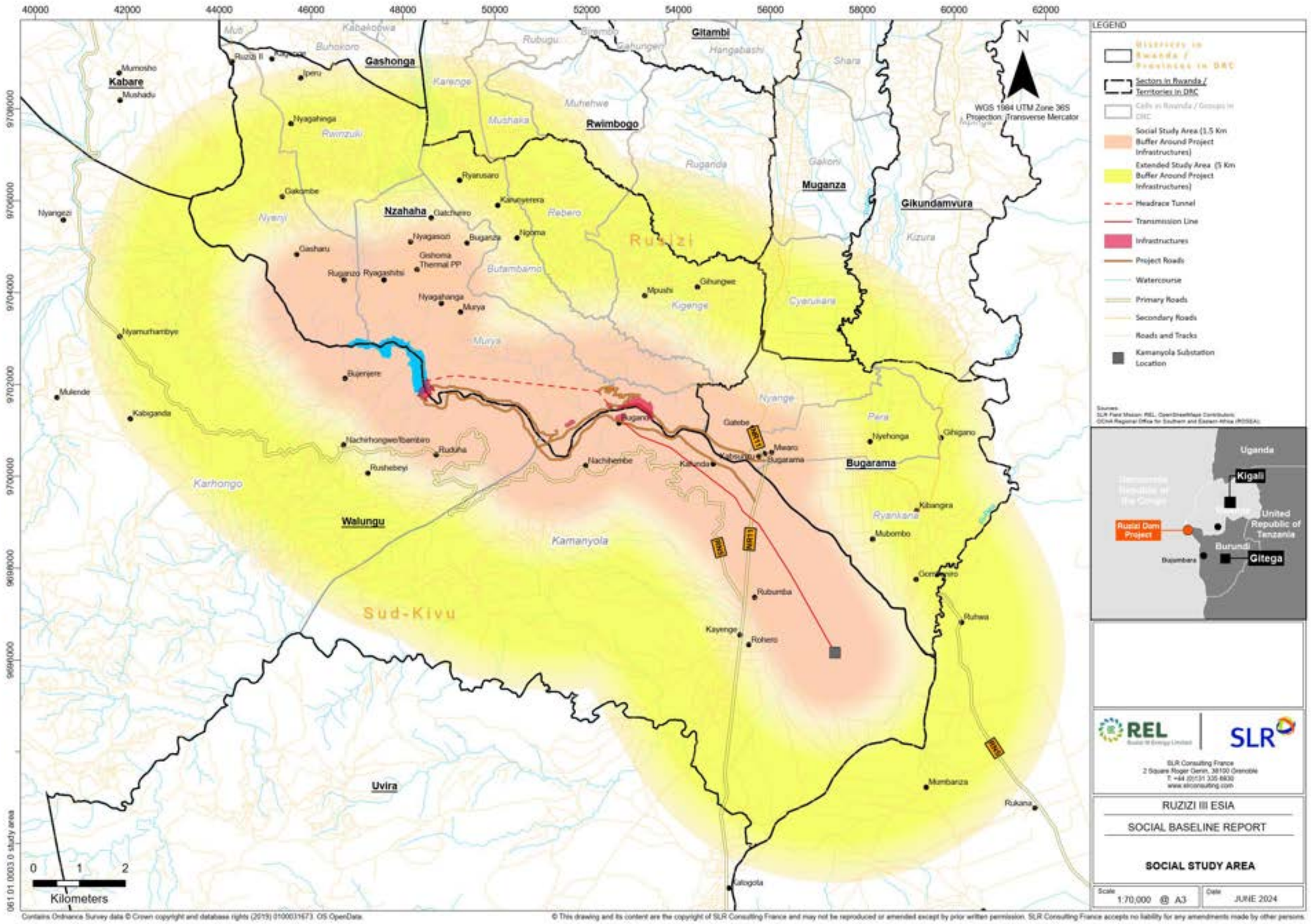


Figure 8-1 Study Area Covered by the Data Collection Activities Performed in 2022

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Table 8-2 and Table 8-3 list the villages included in the study area, respectively in Rwanda and DRC, detailing their administrative breakdown.

Table 8-2 Villages Included in the Study Area for the 2022 Studies, Rwanda

Country	Province	District	Sector	Cell	Village	Project Component
Rwanda	Western	Rusizi	Nzahaha	Murya	Nyagahanga	None
					Ryagashitsi	None
					Gatchuriro	None
				Nyenji	Rugunga	None
				Rwinzuki	Murambi	None
				Karenge	Gishoma	None
			Bugarama	Nyange	Gatebe[1]	Access Road
				Pera	Kabusunzu	
				Ryankana	Mwaro	Downstream impacts
					Mubombo	
					Gombaniro	
			Rwinbogo	Kabajoba	Mushaka	None

[1]Upstream from the village of Gatebe is officially the village of Gisheke. Although this still figures in official data and maps, it is not counted as a village in SLR's studies because Gisheke village inhabitants left this village since 1995. This village was part of a resettlement program created by the government, the details of which are explained in Section 8.2.2.1 0.

Table 8-3 Villages Included in the Study Area for the 2022 Studies, DRC

Country	Province	Territory	Groupment	Sous-Groupement	Village	Project Component
DRC	Sud-Kivu	Walungu	Kamanyola	Ngweshge	Kayange	Transmission Line
					Nachihembe	
					Kafunda	Access Road
					Bugano	Access Road + Powerhouse
			Karhongo Groupement	Ishamba	Rushebeyi	Reservoir
					Bujenjeri	
					Ibambiro	
					Nachirongwe*	
					Ruduha	

8.1.2 Terminology

The following clarifications on terminology are relevant for the whole document:

- For the sake of consistency, throughout the report the spelling 'Ruzizi' has been used for the Ruzizi River, even though in Rwanda the official orthograph is 'Rusizi'. This alternative spelling has instead been used for the 'Rusizi District', the administrative district where the Project is related in Rwanda.
- Whenever the term 'affected' or 'impacted' is used in relation to villages, communities or population, the impact refers to physical and economic displacement due to land acquisition unless stated otherwise.
- The term 'surveyed population' refers to the quantitative survey of 2022, while 'consulted population / communities / people' refers to the qualitative survey of 2022 unless stated otherwise.
- The term 'Historically Marginalised People (HMP)' has been used throughout the document to address the community known as 'Abashigajwinyuma n'Amateka' in

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Rwanda. The term 'Batwa' has been used to describe the same community in DRC. This choice of terminology has been made to reflect the fact that 'Batwa' is considered culturally and politically inappropriate term in Rwanda, although it is widely accepted in DRC.

- Whenever utilised, the term 'household' defines 'a person or a group of related or unrelated people who live together in the same dwelling unit(s), who acknowledge one adult male or female as the head of the household, who share the same housekeeping arrangements and who are considered a single unit' (NISR, 2021).

8.1.3 Primary Data Collection

Unless specified otherwise, all figures and data analysed in this report were collected through two surveys, one qualitative and one quantitative. A first survey was undertaken from 19/01/2022 to 02/02/2022 by SLR social experts, with the aim of gathering socio-economic qualitative data from communities (i) physically or economically impacted by land acquisition and (ii) inhabiting, using or being culturally tied to the natural resources affected by the Project. A second survey was conducted by Ruzizi Energy Limited (REL) from 28/01/2022 to 09/02/2022, to collect socio-economic quantitative data on a sample of households impacted by the Project's land acquisition.

8.1.3.1 Qualitative Social Survey

The qualitative social survey carried out by SLR in January 2022 was designed to achieve the following objectives:

- Map and document the settlements and communities who will be the receptors of impacts during construction and operation, namely:
  - The closest settlements to the project footprints.
  - The communities using the land and natural resources downstream of the future dam, down to the confluence with the Ruhwa River.
  - The communities benefitting from ecosystem services affected by the Project.
- Document the socio-political organisation of communities which may be the receptors of various impacts, including decision-making systems, social hierarchies and conflict resolutions mechanisms.
- Document formal and informal patterns of land tenure and land usage.
- Assess and document the impact of the loss of and loss of access to land and assets affected by the land acquisition.
- Assess and document the presence of any material and immaterial cultural heritage elements.
- Identify vulnerable groups according to local understandings and perceptions of vulnerability.
- Assess the overall public health situation in the study area, documenting the most common diseases, closest health centres, and drinking water and sanitation facilities.
- Assessing and documenting current use of provisioning or cultural ecosystem services by the communities living close the river.
- Assessing gender dynamics across the study area and identifying additional Project-related impacts on women, both due to land acquisition and worker in-flow during construction.

Socio-economic qualitative data was collected through several activities which consisted of on-site observations, focus groups, formal interviews and informal discussions. The following paragraphs describe each of these activities in detail.

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A On-Site Observations and Informal Discussions

On-site direct observations have been used to map land use characteristics in the Project Footprint and surrounding areas. Whenever possible, visual observations were enriched by informal discussions with locals performing activities and / or living around the area of interest. The subjects most frequently enquired were cultivators, fish farmers, villagers walking to or from their fields and people going to collect wood, charcoal or any other natural resource for domestic use. Whenever possible, these discussions were undertaken while the concerned activity was being performed, in order to observe social patterns and dynamics around the Project footprint (See Figure 8-2).



Figure 8-2 Informal Discussion with two Female Cultivators Along Bugano's Riverside, DRC (2022)

B Focus Groups

The focus groups undertaken as part of the qualitative survey were designed as to allow the social experts to document (i) the ecosystem services that local communities are currently benefitting from, including water and land uses, and (ii) the livelihood strategies, agricultural practices, (iii) socio-demographic profile and gender dynamics which characterise the communities exploiting and inhabiting the study area. The following focus groups were carried out in each village included in Table 8-2:

- Focus groups with the Village Committee (See Figure 8-3).
- Focus groups with male villagers (Figure 8-4).
- Focus groups with female villagers (Figure 8-5).
- Focus groups with vulnerable people (Figure 8-6).

The sampling for the latter three groups was realised through a gatekeeper methodology.[1] The sample was developed with the help of the Village Head, who was instructed to select three to six people for each focus group. Whenever possible, the focus groups with women were led by a female social expert and translator, while the focus groups with men were led by a male social expert and translator. Complete separation of the two groups allowed the social experts to ensure that sensitive issues surrounding gender-based violence or discrimination could be discussed openly. All focus groups included a final informal discussion where interviewed people

[1] In qualitative social research, gatekeeper sampling describes a sampling strategy whereby the researcher utilises a community's insider as a representative and mediator to access meaningful information on the society which is being studied (Andoh-Arthur, 2019).

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were asked to pose any question or concerns, they may have in regards to the Project and the study.

In DRC, the four focus groups were carried out in all villages without any modification. In Rwanda, the following changes were implemented to adapt to the local context:

- Instead of undertaking separate vulnerability focus groups, vulnerable people were included in the gender-separate focus groups. This allowed the social experts to avoid reinforcing the existing sense of marginalisation experienced by vulnerable groups and open up the discussion on vulnerability to non-vulnerable perspectives, which contributed to a richer analysis.
- One additional mixed focus group was undertaken in Gatchuriro, in order to discuss exclusively with members of the Historically Marginalised community living in the Study Area, with the aim of better understanding their vulnerability and their dependency on the natural resources within and surrounding the Project. The findings of the consultation with this community are found in section 8.2.5.1B. In DRC, information on the Batwa community was collected during informal interviews: the findings of this analysis are found in section 8.2.5.2E. A stand-alone study was produced by Anthropolinks in 2023 to investigate the socioeconomic and cultural characteristics of the two communities. The findings of this report have been included in sections 8.2.5.1B and 8.2.5.2E.
- In Mubombo and Gombaniro, two mixed (rather than gender-separate) focus groups were undertaken to explore the impact that changes in water levels have previously had on communities downstream. Gender-based roles were still investigated and women were engaged actively to ensure their voices were represented. Finally, focus groups with Village Committee were also undertaken in each of the villages in the Study Area. These groups aimed to collect demographic and socio-economic data at the village level and enquire about any potential vulnerability or existing issues affecting the community.

The findings of the consultations carried out with women in both DRC and Rwanda are found in section 8.9, while the results of the vulnerability analysis are outlined in section 8.11.

C Formal Interviews

Formal one-on-one interviews with institutional stakeholders were carried out with Sector Agronomist (see Figure 8-8), Cell Executives and Health Centre Directors in Rwanda, and with Health Centre Directors only in DRC (see Figure 8-7).

Overall, 168 women and 227 men, for a total of 395 people, were engaged as part of the qualitative social survey. An anonymised list of all the interviews carried out as part of the qualitative social survey is presented in Annex E-1. Figure 8-9 shows the geographic distribution of the localities where interviews were carried out in DRC and in Rwanda. This information is further detailed in Table 8-4 for Rwanda and Table 8-5 for DRC, which disaggregate the data by interview type and gender.

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Figure 8-3 Focus Group with the Village Committee of Nyagahanga, Rwanda (2022)



Figure 8-4 Focus Group with Men in Ryagashyitsi, Rwanda (2022)



Figure 8-5 Focus Group with Women in Nachirongwe, DRC (2022)



Figure 8-6 Focus Group with Vulnerable People in Kayenge, DRC (2022)



Figure 8-7 Interview with Ibambiro Health Centre, DRC (2022)



Figure 8-8 Interview with Bugarama's Sector Agronomist, Rwanda (2022)

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Table 8-4 List of People Interviewed in Rwanda for the Qualitative Survey (2022)

Sector	Cell	Village	Total no. of people interviewed	No. of women interviewed	No. of men Interviewed	Interview Type
Nzahaha	Murya	Nyagahanga	13	4	9	Focus groups
		Ryagashitsi	9	4	5	Focus groups
		Gatchuriro	20	1	1	Murya Cell Office
				9	9	Focus group with HMP
		Stretch from reservoir to powerhouse	6	3	3	Informal discussions
	Nyenji	Ruganzo	14	6	8	Focus groups
		Rugunga	1	0	1	Cell Executive Interview
	Rwinzuki	Murambi	2	0	1	Sector Agronomist
				0	1	Health Centre Interview
	Karenge	Gishoma	1	0	1	Head of cooperative interview
Bugarama	Nyange	Nyange Cell Riverside	6	4	2	Informal discussion
		Gatebe	11	5	6	Focus groups
	Pera	Kabsunzu	10	4	6	Focus groups
		Bugarama	5	0	1	Executive of Pera Cell
				0	1	Director of health centre
				0	1	Executive of Nyange Cell
				0	1	Sector Agronomist
				0	1	Director of Rice Cooperative
	Ryankana	Mwaro	10	5	5	Focus groups
		Ryankana Cell riverside	10	5	5	Informal discussion
		Mubombo	22	6	15	Focus group
				0	1	Head of Ryankana Cell
		Gombaniro	29	15	14	Focus group
Rwinbogo	Kabajoba	Mushaka	1	1	0	Health centre interview
Total			**180**	**78**	**102**	

Table 8-5 List of People Interviewed in DRC for the Qualitative Survey (2022)

Groupement	Village	Total no. of people interviewed	No. of women interviewed	No. of men Interviewed	Interview Type
Kamanyola	Bugano	24	2	0	Informal discussion
			9	13	Focus groups
	Kayenge	23	9	11	Focus groups
			0	3	Health Centre
	Kafunda	22	11	9	Focus groups
			2	0	Informal discussion
	Nachihembe	20	10	10	Focus groups
	Rubumba	5	4	1	Health Centre
	Downstream riverside	6	2	4	Informal discussion
Karhongo	Rushebeyi	19	6	13	Focus groups
	Ibambiro	29	10	14	Focus groups
			0	5	Health Centre
	Nachirongwe	23	9	14	Focus groups
	Bujenjeri	22	10	12	Focus groups
	Ruduha	22	0	3	Health Centre
			6	13	Focus groups
Total		**215**	**90**	**125**	

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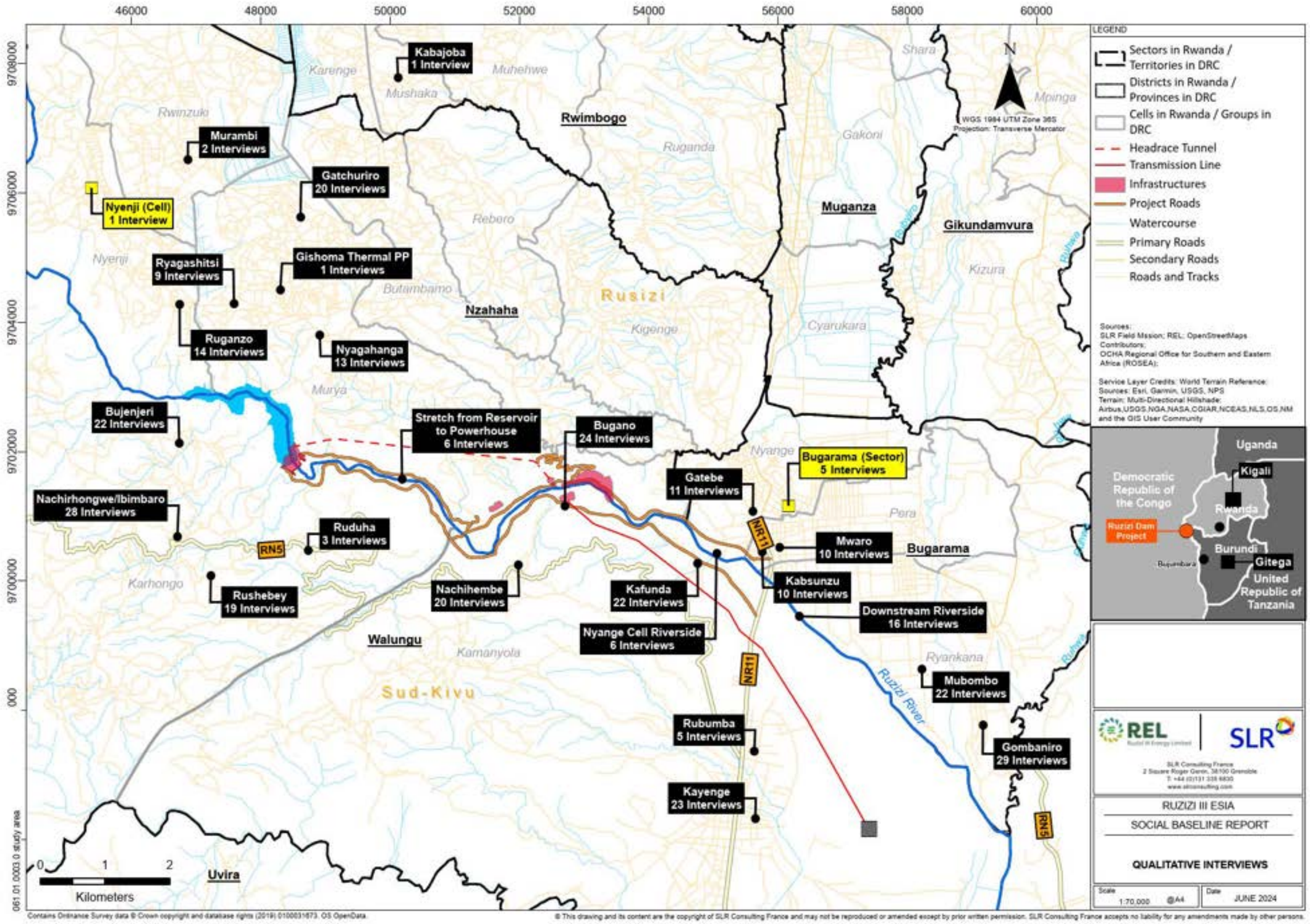


Figure 8-9 Map of Qualitative Interviews (2022)

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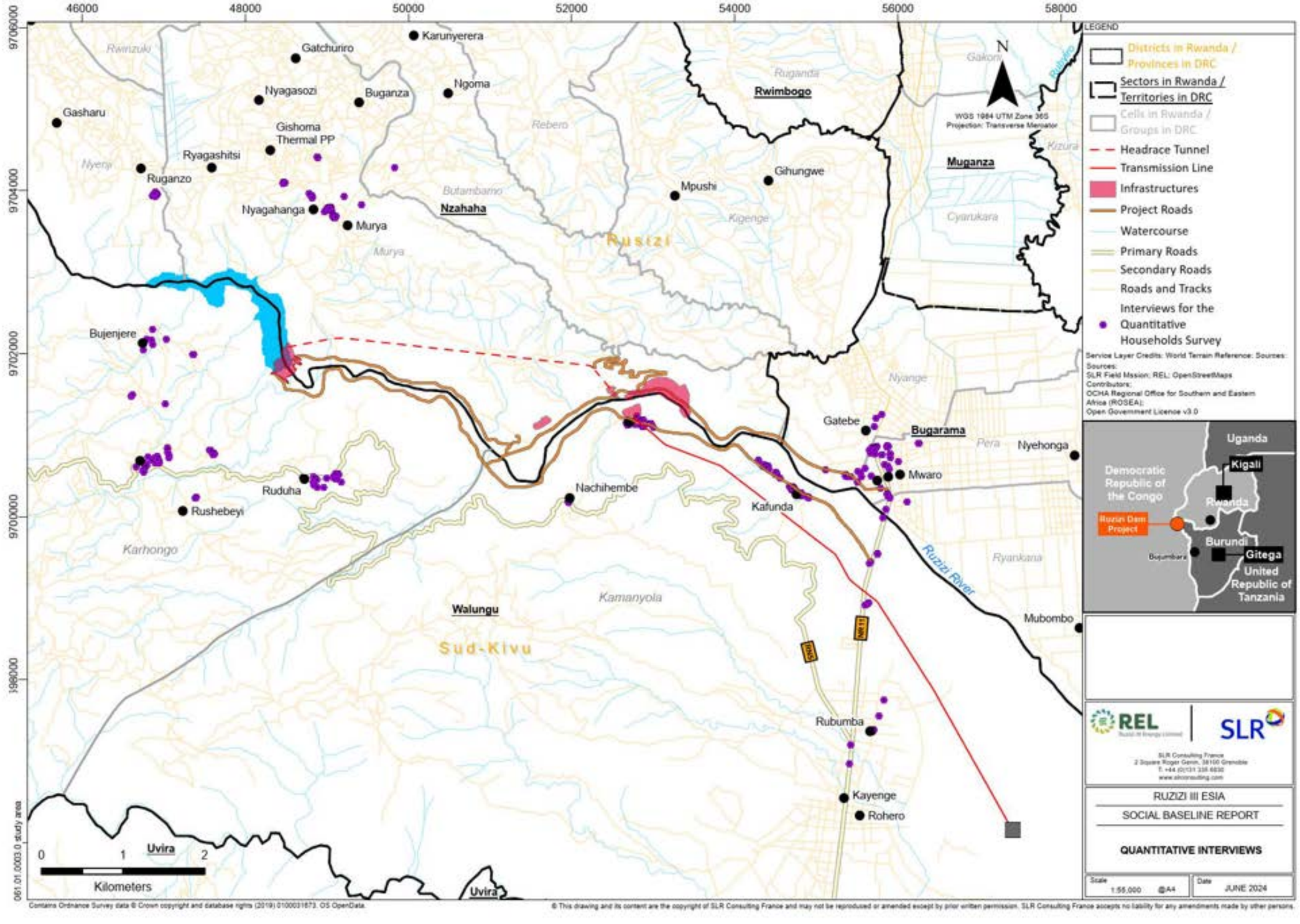


Figure 8-10 – Map of Quantitative Households' Survey (2022)

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8.1.3.2 Quantitative Socioeconomic Survey

A quantitative socio-economic survey of households affected by the Project's land take was carried out from 28/01/2022 to 02/09/2022 as part of the resettlement process. The socioeconomic survey consisted of a socio-economic questionnaire administrated using electronic forms on smartphones. The objective of the socio-economic questionnaire (See ANNEX E-2) was to collect socio-economic information on the physically and economically displaced households in DRC and Rwanda, which were identified in 2022 through a preliminary census. The information collected as part of the quantitative survey was related to:

- The demographic profile of the surveyed population, including nationality, ethnicity (in the case of DRC only), language, education, religion, age and gender.
- Current livelihood strategies, types of income generating activities, levels of cash circulating in the economy and existing financial management institutions.
- Land owning and renting trends.
- Access to and use of natural resources.

Six hundred and one (601) households were surveyed. This represents a sample of 27% of the affected households, as indicated in the table below. All physically displaced households were purposely included in the survey, the remaining economically displaced households were randomly selected from the census's database. Figure 8-10 shows the geographical distribution of households enquired during the quantitative socio-economic survey.

Table 8-6 Distribution of Households Surveyed During the Quantitative Households' Survey (2022)

Groupement (DRC) / Sector (Rwanda)	Number of Affected Households	Number of Surveyed Households	Sample Size
DRC			
Kamanyola	599	190	32%
Karhongo	947	208	22%
Total	1,546	398	26%
Rwanda			
Bugarama	367	60	16%
Nzahah	336	143	43%
Total	703	203	29%
DRC and Rwanda Total			
Total	2,249	601	27%

8.1.3.3 Historically Marginalized People Studies

An assessment of the situation of the Historically Marginalized People (HMP) in Rwanda impacted by the Project was undertaken by REL. An interview was conducted with the only historically marginalized family impacted by the project in Rwanda. The interview took place on 9 February 2022 in the Ryagashyitsi village, Murya Cell, Nzahaha Sector. with the participation of the Social Economic Development Officer of the Cell.

An assessment based on interviews conducted in DRC by REL; 9 heads of Batwa households in Bujenjere and 8 heads of Batwa households in Ruduha (both in Nyangezi cluster) were interviewed. Focus groups discussions were undertaken on 7 and 12 October 2022 in Kamanyola, Ruduha, and Bujenjere Nyangezi. The interviews gathered additional information on the socio-economic life of the HMP.

A specialist study was undertaken by Anthropolinks in 2023 to investigate the socioeconomic and cultural characteristics of the two communities. Three indigenous people experts

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conducted (i) a data desk documentation review, (ii) a 7-day fieldtrip to the Project area (in DRC and Rwanda), and (iii) interviews with two local HMP experts and local leaders.

During the fieldwork, the experts visited Batwa's communities including individuals and households. Data was collected through intensive Interviews and focus group discussions, conducted in Swahili in DRC and in Kinyarwanda in Rwanda. Interviews were conducted with local authority and civil society to collect their view on the subject and to cross-check information. A total of 17 interviews were conducted (7 in DRC and 8 in Rwanda). In addition, the expert's team interviewed HMP leaders and NGOs focusing on protecting the rights of the HMP.



Resettlement committee of Kafunda in the groupement of Kamanyola in DRC



Interview of HMP from Nyange cell in Rwanda

Figure 8-11 – Photographs of Interviews with Resettlement Committees in DRC and HMP in Rwanda

The findings of this report have been included in sections 8.2.5.1B and 8.2.5.2E.

8.1.3.4 Gender

Gender dynamics in the study area were investigated as part of the qualitative survey. SLR investigated the strategies through which men and women access, control and benefit from different livelihoods and resources, and explored attitudes towards and instances of gender-based violence across the Study Area. Data on gender dynamics was collected through four types of interviews:

- Female-led focus groups with women.[2]
- Gender-based questions to male-led focus groups with men.
- Questions on gender violence and women's access to resources to village committees.
- Informal discussions with female farmers and villagers along the Ruzizi River.

As shown in Table 8-4 and Table 8-5, 42% of interviewed people during the qualitative survey were female.

8.1.3.5 Cultural Heritage

According to the World Bank's Environmental and Social Framework (ESF), the term cultural heritage is defined as encompassing elements of tangible and intangible heritage which may be recognized and valued at a local, regional, national or global level, as follows:

- Tangible cultural heritage includes movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance.

[2] All questions posed to women about the distribution of tasks, control of resources and the roles and responsibilities expected of them in their society were also posed to men. The only set of questions which were exclusively posed to women revolved around verbal, physical and sexual violence against women and young girls, both at the domestic and village level.

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Tangible cultural heritage may be located in urban or rural settings and may be above or below land or under the water.

- Intangible cultural heritage includes practices, representations, expressions, knowledge, skills - as well as the instruments, objects, artifacts and cultural spaces associated therewith - that communities and groups recognize as part of their cultural heritage, as transmitted from generation to generation and constantly recreated by them in response to their environment, their interaction with nature and their history.

Traces of Ruzizi's 'iron age civilization' have been found to the South-West of Kamanyola and to the South of Bugarama. Additionally, archaeological sites have been reported in Kinanira (Nyakabuye Sector), Ruhamandyarya (Nyakabuye Sector), Kabosa (Gitambi Sector) and Mibirizi (Gashonga Sector). However, previous environmental and social studies concluded that no archaeological artefact would be affected by the Project. Officials from the Institute of National Museums of DRC, in Kinshasa, and the Institute of National Museums of Butare, in Rwanda, confirmed that there are no cultural or archaeological sites in the area directly concerned by the Project.[3]

Based on this premise, no archaeological survey was performed by SLR in 2022. However, all focus groups and interviews with local authorities included targeted questions to locate, describe and document (i) physical sites holding cultural, spiritual or religious importance for groups or individuals within the village and (ii) customs or practices which may be unique or peculiar to any groups within the village or to the village itself. The result of this exercise was the creation of a geographical inventory of all elements of tangible and intangible cultural heritage. The details of the findings on cultural heritage and the inventory of all discovered elements are outlined in Section 8.12.

8.1.4 Secondary Data

Official data on the demographic and socio-economic conditions of the study area has been extracted exclusively from governmental statistics and reports. For Rwanda, secondary data on the study area's societies and economies was available at the national, provincial and district level. For the national and provincial level, all population data has been retrieved by the 2012 Census Database and the 2021 Demographic and Health Survey, which draws from data collected in 2019-2020. For DRC, statistical data was mostly available at national level, through the 2014 Demographic and Health Survey and the 2014 Employment, Informal Sector and Consumption Report, which draw from data dating back to 2012-2013. Data was unavailable at the Sector Level (Rwanda) or Groupement Level (DRC).

8.1.5 Limitations

- The boundaries of the villages are not always well defined. Some villages have been created recently and others have been moved. When GIS data was partial or insufficient, administrative delineations has relied on informants' knowledge and on field observations.
- While the social team in Rwanda included one female expert and one female translator, the team in DRC was exclusively composed by males due to an unplanned logistical constraint. The lack of a female interviewer during the women-only focus groups may have constrained women from providing honest answers on sensitive topics, especially on gender-based violence (GBV). Nevertheless, all of the questions asked by the interviewers in DRC had been designed by a female gender expert and the male interviewers worked in close contact with the female gender expert in Rwanda to ensure consistency in the findings and methodology.
- Given that the use of ethnic labels is legally punishable in Rwanda (see section 8.2.5), it has been deemed most culturally appropriate not to enquire about ethnic differences or

[3] source: (African Development Bank, 2015)

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tensions in any of the interviews and focus groups carried out in Rwanda. Nevertheless, questions about social exclusion and marginalisation have been posed.

8.2 Demography

8.2.1 Administrative Organisation

Figure 8-12 shows the administrative divisions in the study area.

8.2.1.1 Rwanda

Since 2001, Rwanda's administrative structure has been based on two layers of government – central and local. This decentralised system spans across six administrative entities: provinces, districts, sectors, cells and villages. The country is composed of 4 provinces and the City of Kigali, 30 districts, 416 sectors, 2,148 cells and 14,837 villages.[4] The province acts as a coordinating organ, ensuring the planning, execution and supervision of the decentralised services. Each province is headed by a government which is elected by the presidential decree. The Western province, which is concerned by the Project, is divided into 7 districts: Karongi, Ngororero, Nyabihu, Nyamasheke, Rubavu, Rutsiru and Rusizi. The Project and all the villages thereby affected are located in the latter.

The district is an autonomous administrative entity responsible for the promotion of democracy and solidarity and represents a basis for development services. Districts are headed by a mayor elected and administered by a district council, through which policies are formulated and adopted. The Rusizi district, concerned by the Project, is divided into 18 sectors: of these, the sectors of Bugarama and Nzahaha are concerned by the Project.

The sector is responsible for the implementation of development programs, the delivery of services and the promotion of social welfare and good governance. The policy organ of the Cell is the Sector Council, which is in charge of approving Sector-level action plans and programs and following up on their implementation. The people who make up the council are (i) Cell representatives, (ii) members of the National Youth Bureau, (iii) members of the National women bureau, (iv) representatives of people with disabilities, women, schools, non-governmental organisations (NGOs), cooperatives and health.

The cell is an entity in charge of providing basic services through a council, an executive secretariat and development consultative committee. Cells are constituted by a council, an executive secretary and an executive committee. The cells concerned by the Project are those of Murya and Nianjyi in the Nzahaha Sector, and Ryankana, Bugarama and Nyange in the Bugarama Sector. The village is the lowest administrative unit, based on the direct participation of citizens and headed by a council and executive committee. The council is made up of all residents aged 18 years old and above and meets once a month. The executive committee is constituted by a village head, an in-charge of security, an in-charge of immigration and emigration, an in-charge of information and training and an in-charge of development. All of these leaders have a mandate of 5 years, and they are elected through a direct universal suffrage.

[4] Republic of Rwanda – Government of Rwanda: Administrative structure (www.gov.rw), accessed on 28/01/2022.

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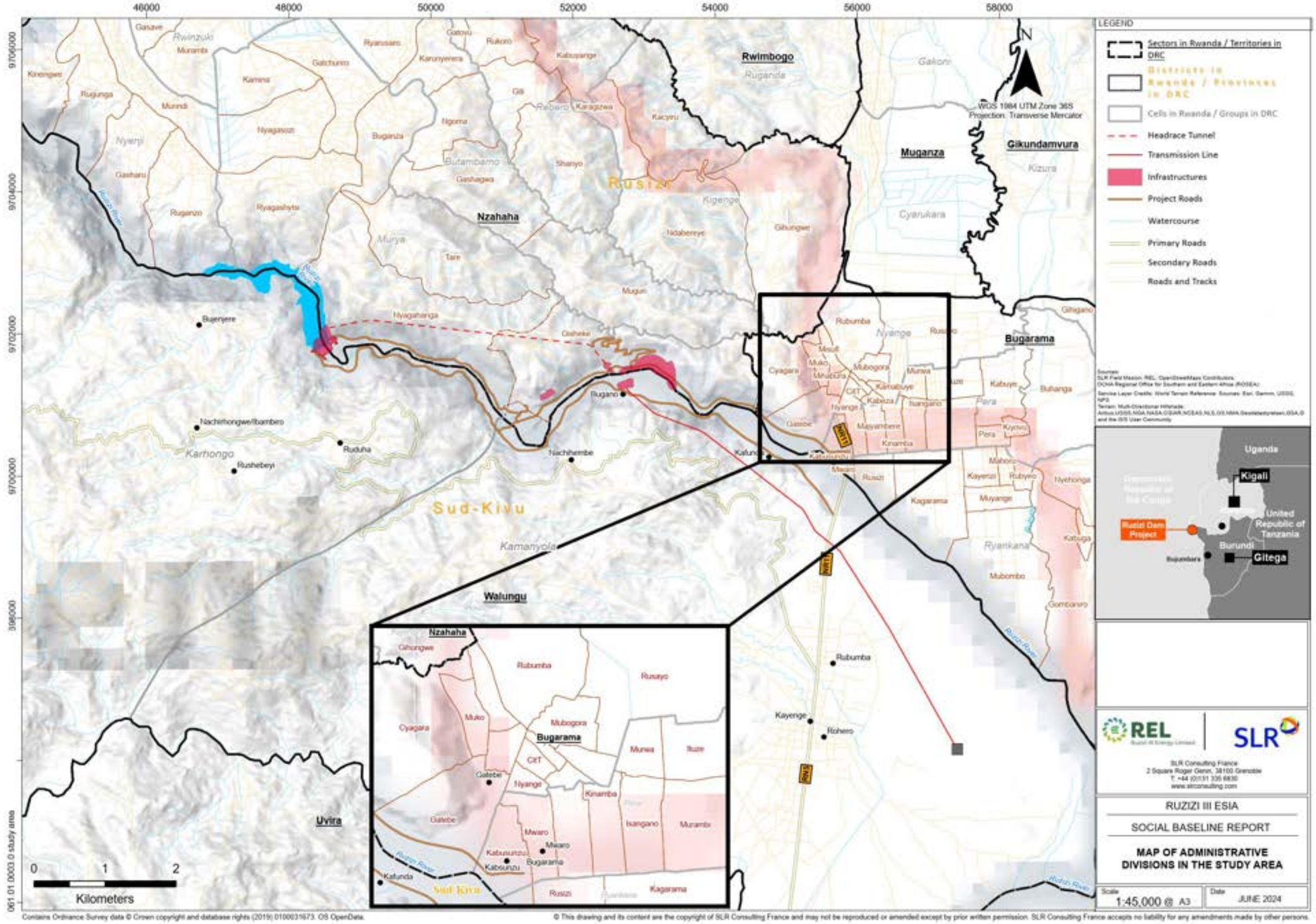


Figure 8-12 Map of Rwandan Administrative Divisions in the Study Area (2022)

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8.2.1.2 DRC

Since June 2015, DRC has been divided in 26 Provinces, split into 145 Territories and 35 Cities. The cities are divided into 137 urban townships, whereas the territories are divided into 174 rural townships, 471 sectors and 264 chieftainships. Sectors and Chieftainships are then split into 5,908 Groupements (UNHCR, 2015). The province of Sud Kivu, which is concerned by the Project, is divided in 8 Territories and 3 Townships: Bagira, Ibanda, Kadutu, Fizi, Idjwi, Kabare, Kalehe, Mwenga, Shabunda, Uvira, Walungu. The Territory concerned by the Project is Walungu, which is divided into the Chieftainship of Ngweshe and Kaziba. The two Groupements concerned by the Project are Kamanyola and Karhongo: both Groupements are located in the Chieftainship of Ngweshe.

Hierarchically, after the head of Province stands a Territory Administrator and two Territory Administration Assistants. In each Groupement, there is a Chief who nominates the Village Heads. In Sud-Kivu, the customary authorities are the most decentralised political and administrative authorities, as formalised in the law N°08/016 of 7/10/2008. Village Chiefs are empowered to ensure, in accordance with law 15/015 of the 25th of August 2015, the protection of land and traditional identity. Village Chiefs head a village committee, which is elected by the population and whose mission is to encourage the development of the village, settle disputes and report to the Groupement Chief. The number of committee members is proportional to the number of neighbourhoods and citizens in each village.

8.2.2 Settlement Patterns

8.2.2.1 Rwanda

A Settlement Types in the Study Area

In Rwanda, there are four 4 types of habitat or settlements:

- Clustered or grouped rural settlements, also referred to as *imidugudu*.
- Dispersed or isolated housing, also referred to as scattered settlements.
- Planned urban housing.
- Squatter housing or informal settlements also referred to as *akajagari*.

At national level, about 49% of the Rwandan households are in clustered rural settlements (*Imidugudu*), 34% are in dispersed areas, 14% are in *akajagari* or squatter housing and only 2% are in planned urban housing (NISR, 2021).

The study area is overwhelmingly characterised by organised grouped settlements surrounded by vast areas of cultivable land (see Figure 8-13), which is cultivated by different owners and renters. Plots are often delimited by small trees and ranging in size from 0.01 to 1 hectare for most of the population (See Figure 8-14). The main different between settlements in Bugarama and Nzahaha lies in the higher population density of the villages in Bugarama, which are semi-urban. Additionally, the villages in Nyange, Pera and Ryankana Cells are all surrounded by rice cultivation plots, which take up a high proportion of land surrounding the residential settlements (See Section 8.6.1.3A). Figure 8-33 in section 0 presents the land use in the study area and illustrates the geographical distribution of settlements.

The *umudugudu*, or village, aims to regroup residential buildings and share plotted spaces of surrounding cultivable areas, in order to provide improved infrastructure and access to basic facilities (International Alert, 2015). Ministerial order No. 001/07.05 of 19 May 2009 relating to the implementation of the national program on regrouped settlement defines *umudugudu* as 'a mode of planned settlement of between 100 and 200 houses in an area from 10 to 20 hectares with a possibility of capacity of extension and as far as possible a space provided for various non-agricultural activities.' This settlement style was strongly promoted by a series of governmental policies aimed at solving the land scarcity exacerbated by the influx of returning

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refugees after 1994 (Hilhorst and Leeuwen, 1999). The Human Settlement Policy (HSP) was created in 1996 and updated in 2004 and 2009, highlighting the need for planning rural settlements in a centralised and organised way. As part of the HSP, the Government started encouraging residents of scattered housing to move into *imidugudu* (Dale, 2021). Other policies, such as the National Urbanisation Policy of 2015 and the National Strategy for Transformation of 2018, sought to further facilitate the development of connected and well-serviced rural settlements. These policies are grounded in a wider vision, exemplified by three political frameworks: Vision 2020, Vision 2050 and Economic Development and Poverty Reduction Strategy (EDPRS) 2. These three documents advocate for organised urbanisation as one of the driving factors for economic growth and for infrastructure development.

B Residential Building Types in the Study Area

Houses are usually regrouped in small conglomerations of around 20 families called '*Amasibo*', or neighbourhoods. The types of housing observed in the study area is of three main types:

- House made of mud with sheet metal roof (See Figure 8-15).
- House made of bricks with sheet metal roof (See Figure 8-16).
- House made of wood planks (See Figure 8-17).
- House made of cement (See Figure 8-18).



Figure 8-13 'Umidugudu' Settlement Style in the Village of Nyagahanga, Rwanda



Figure 8-14 Example of Tree Used to Delimitate Plots, Reservoir Area

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C Past Resettlement Processes in Rwanda

The villages in the study area on the Rwandan side have been undergoing several planned population movements, organised by the Ministry of Disaster Management and Refugees Affairs (MIDIMAR) to resettle communities away from hazardous areas. According to the National Risk Atlas, the Rusizi District is susceptible to high risks of erosion and landslide (MIDIMAR, 2014). During the interviews and focus groups, the following resettlement movements have been mentioned by the local communities:

- In 1995, the residents of Gisheke village moved away due to landslides and erosion risks. Most of these people are now living in Gatebe, Kabusunzu, Mwaro, Mubombo and Gombaniro, although they kept their lands in Gisheke, since these are considered largely the most fertile in the area.[5] Most people moved over time, especially between 2000 and 2011.
- In the early 2000s, several households living in the slopes of Nyagahanga and Ryaghyitsi have been moved away due to landslide risks.
- In the village of Gombaniro, land has been bought by the Government for the construction of houses for people coming from various high-risk zones. There are currently a few plots which are inhabited, and more are awaiting construction. Many of these people have resettled in Ruganzo. SLR has been told that out of 30 families resettled in this village, 20 currently have no land and are renting everything, including land for their house. More families are also being moved into Gombaniro due to the creation of the cement industry CIMERWA: so far, 17 families have been moved so far and more are preparing to settle. The government found them land by buying it off of owners in Gombaniro and gave them land titles.
- The creation of Ruganzo in 2005 came from the movement of 150 families who moved from the slopes close to Gatchuriro. In Ruganzo, only 1 family is originary of the place, and the rest has resettled for different reasons.

[5] These schemes have added themselves to existing internal population movements after the genocide. For example, people in Mwaro reported that Gisheke was the worst hit village in the area. This led a lot of families to start moving into Mwaro from Gisheke even before the start of official resettlement projects.

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Figure 8-15 Mud House with Sheet Metal Roof in Ryagashyitsi



Figure 8-16 Brick House with Sheet Metal Roof



Figure 8-17 Wood Plank House



Figure 8-18 Cement House

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8.2.2.2 DRC

In the study area on the DRC side, settlements are less centralised than in Rwanda. Instead, villages are characterised by scattered neighbourhoods quite close to each other, regrouping people from the same family or clan (See Figure 8-19). The neighbourhoods in the village are defined according to the number of inhabitants, which range from 10 to 30 families under the supervision of a village chief called *Nyumba kumi* (in Mashi language).

All of the villages in the study area were created either by population settlement or by natural extension of an existing neighbourhood. Some of the neighbourhoods, like Kayenge in Kamanyola, are so large and densely populated that they are considered to be a village. Some plots are located around the houses, while the riverside plots are all quite far from the residential villages: on the riverside close to Bugano's village, SLR met two female farmers who reported walking over 2 hours from Kamanyola just to work on a rented field on the riverside.



Figure 8-19 Entry into a Neighbourhood of Bugano, DRC

The types of housing observed in the study area are:

- House made of mud with straw roof (See Figure 8-20).
- House made of bricks with straw roof (See Figure 8-21).
- House made of bricks with sheet metal roof (Figure 8-22).
- House made of banana leaves (Figure 8-23).
- Fragile house made of mud and wood (Figure 8-24).

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Figure 8-20 House with Brick Wall and Straw Roof, Kafunda



Figure 8-21 Mud House with Straw Roof, Bugano



Figure 8-22 House with Brick Wall and Metal Roof, Kafunda



Figure 8-23 House with Banana Leaf Roof and Wall



Figure 8-24 Example of Fragile Housing in Bugano, DRC

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8.2.3 Population

8.2.3.1 Rwanda

Most statistical data on Rwandan demographics is available at the provincial (NISR, 2021) or district level (NISR, 2011). National data on wider population characteristics can be retrieved from the 2012 Census Database.[6]

The 2012 census counted a population of 10,515,973, although it is estimated that in 2022 the national population has reached 13,483,964.[7] According to Rwanda's Demographic and Health Survey (2021), the population is relatively young. In rural areas, 42% of the population under 14 and 54% aging 15 to 64. Women head 31% of households in rural Rwanda, with an average household size of 4.3 people. Overall, 22% of households at national level include children who are orphans or not living with their biological parents. As described in Section 8.1.1, the Project is located in the Western Province, which has a population of 2,471,439.

Figure 8-25 shows the distribution of population across the wealth quintiles in the province: it is important to note that the percentage of people in the lowest quintile is the second highest of the country after the South Province.

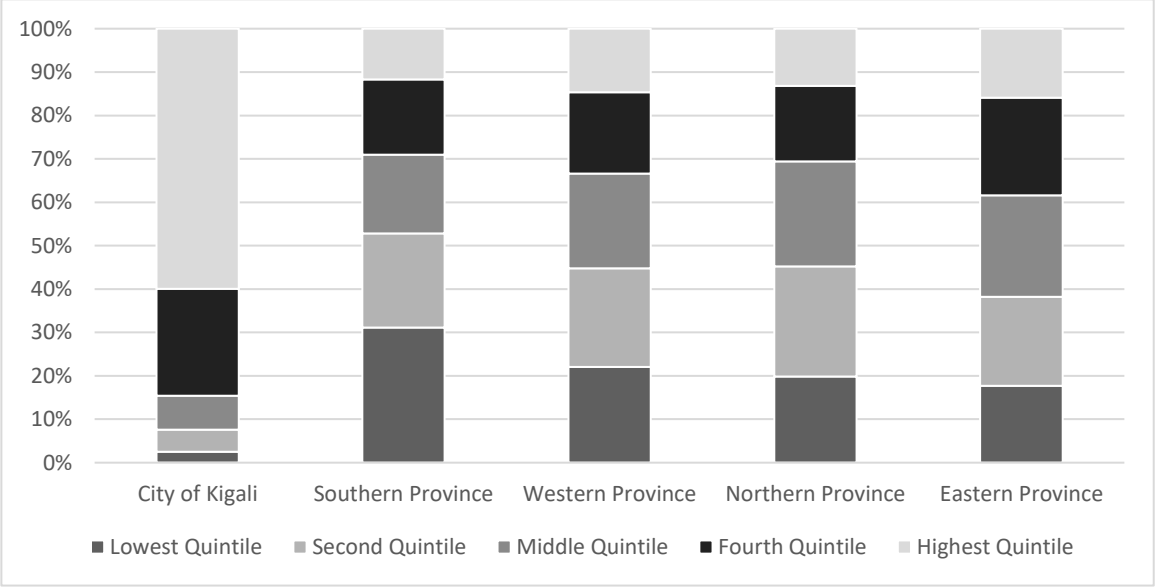


Figure 8-25 Percentage Distribution of Population by Wealth Quintiles (2021)

The Western Province has the highest illiteracy rate for women (18%) and second highest for men (14%) in the country. Additionally, 14% of household members aged 5 have one mild disability, while 6% a more serious disability impacting more than one domain (NISR, 2021).

The Rusizi District is one of the seven districts within the Western Province. The latest statistics on the Rusizi district date back to the last census in 2012. In 2012, the population in Rusizi District amounted to 400,858 people and 83,756 households, with a population density of 418 people per square kilometre. The mean number of children ever born to women 15-49 years old is 4.8, just below the national average of 5.

Although the majority of the district's population is rural, the urban population went from 63,868 in 2012 to an estimated 137,315 in 2020 (National Urbanisation Strategy, 2015), which would bring the urban population from 15.8% to 34.2%. The population is overwhelmingly of Rwandan nationality (99.80%) with a slight majority of females (52%) over males (48%). The breakdown

[6] Rwanda Data Potal, Socio-Economic Database Census (2012), https://rwanda.opendataforafrica.org/pxiuvud/socio-economic-database-census.
[7] Worldlometer, Rwanda Population (2022) - Worldometer (worldometers.info), accessed on 01/03/2022

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of the population by age is respectively provided in Figure 8-26. In the Rusizi District, 45% if the population was considered poor and extremely poor in 2011, ranking the district third within the Western Province in terms of poverty levels.

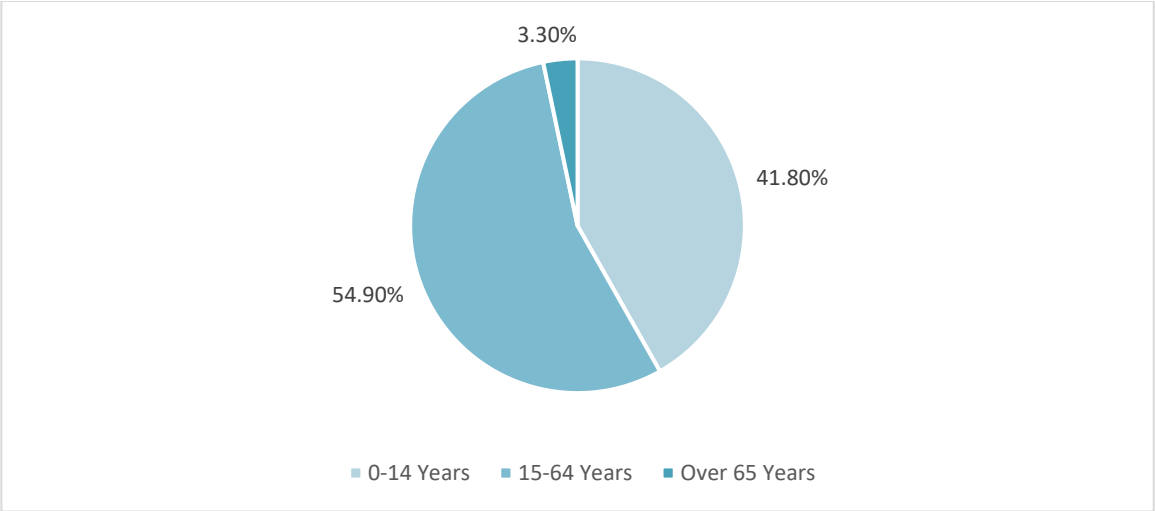


Figure 8-26 - Population of the Rusizi District, by Age Group (2012)

Where possible, the social experts on field gathered data on current population numbers from local authorities. Table 8-7 shows the population data collected on field in the study area, disaggregated by cell and village level. The authorities enquired about these numbers were Cell Executive Secretaries, Sector Agronomists and Village Committees. Whenever possible, they provided exact data on the population. When data was only available at the household level, this was multiplied by the average number of members per household, which was 7 people according to the interviews carried out across villages.

Table 8-7 Estimated Population in the Study Area in 2021, According to Local Authorities (Rwanda)

Sector	Cell	Village	Total Population in 2021
Nzahaha	Total Nzahaha Sector		27,714
	Murya	Total Murya Cell	7,013
		Ryagashyitsi	668
		Nyagahanga	648
	Nyenji	Total Nyenji Cell	4,886
		Ruganzo	820
	Pera	Total Pera Cell	13,000
		Gatebe	920
	Nyange	Total Nyange Cell	11,000
		Kabusunzu	1,117
	Ryankana	Total Ryankana Cell	16, 656
		Gombaniro	1,930
		Mubombo	605
		Mwaro	1,989
Bugarama	Pera	Total Pera Cell	13,000
		Gatebe	920
	Nyange	Total Nyange Cell	11,000
		Kabusunzu	1,117

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8.2.3.2 DRC

Most statistical data on Congolese demographics is available at provincial level, through the Demographic and Health Survey of 2013-2014 and the Household Living Conditions Survey of 2014. The last population census dates back to 1984, although a new census has been planned since 2012. However, the national population in January 2022 is estimated to be at around 94,260,417 people, making DRC one of the most fast-growing countries in the world with a growth rate of 3.19% (World Population, 2019). The proportion of people under 15 years old is estimated at 51% of the total population. In rural areas, 25.2% of households are woman-headed and 21.8% of children are orphans.

The project is located in the province of Sud Kivu, which had a population of 4,944,662 in 2015.[8] This province is divided between the eight territories of Fizi, Idjwi, Kabare, Kalehe, Mwenga, Shabunda, Uvira, Walungu and Bukavu Town. Aside from Kinshasa, the province of Sud-Kivu follows Bas-Congo as the second richest province in terms of wealth quintiles, as shown in Figure 8-27 below.

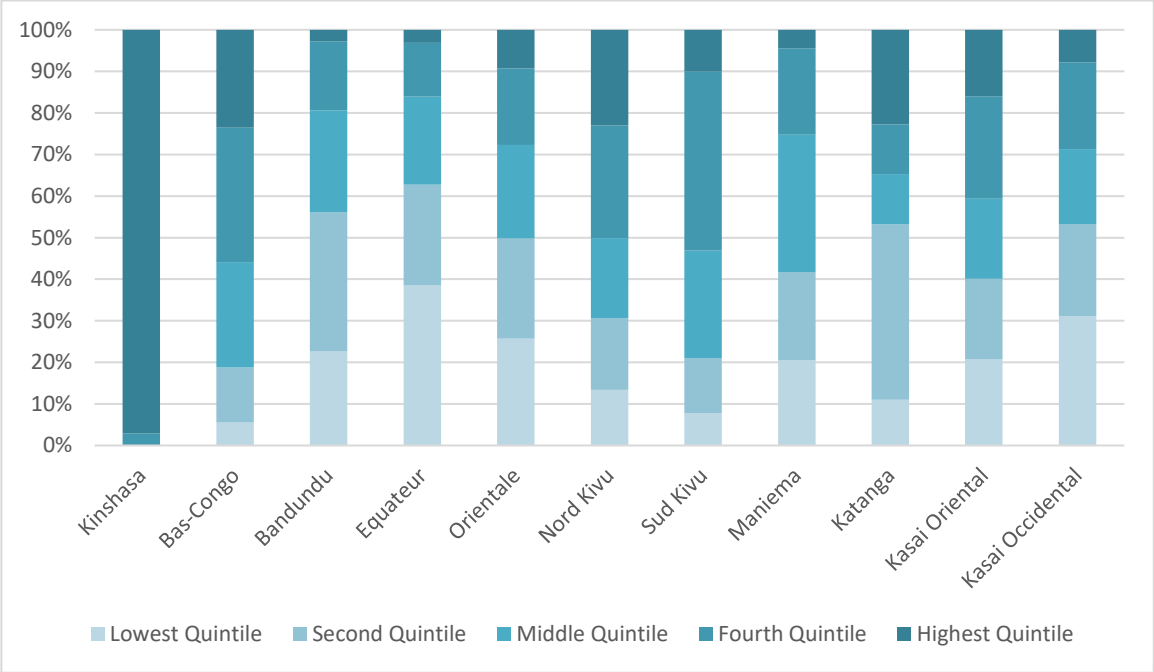


Figure 8-27 Percentage Distribution of Population by Wealth Quintiles in DRC (2014)

Where possible, the social experts on field gathered data on current population numbers from local authorities. Table 8-8 shows the data collected in each of the surveyed villages. The authorities enquired about the number of people and households in each village were the village heads. The average household size is of about 5.7 people (Ministry of Health, 2014).

[8]https://monusco.unmissions.org/sites/default/files/south_kivu_factsheet._eng.pdf#:~:text=South-Kivu%20province%20Population%3A%204944662%20%2876%20persons%2Fkm2%29%20Surface%3A%2065%2C070,Kalehe%2C%20Mwenga%2C%20Shabunda%2C%20Uvira%2C%20Walungu%20%28and%20Bukavu%20Town%29

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Table 8-8 Population in the Study Area in 2021, According to Village Chiefs (DRC)

Groupement	Village	Estimated Total No. of People in 2021	Estimated Total No. of Households in 2021	No. of Neighbourhoods
Kamanyola	Kafunda	300	61	4
	Bugano	230	46	2
	Kayenge	10,000	2,000	4[1]
	Nachihembe	900	180	1[2]
Karhongo	Nachirongwe	495	99	-
	Ibambiro	500	100	-
	Rushebeyi	1,140	228	-
	Bujenjeri	1,225	~245	-
	Ruduha	1,500	~300	-

[1] *According to the focus groups, Kayenge is registered not as a village but as the largest neighbourhood of the city of Kamanyola. The 3 neighbourhoods that surround it (Irohero, Kaboya and Rugenge) are also considered as neighbourhoods of Kamanyola but were developed around Kayenge due to the population movements caused by the socio-political insecurity in 1994.*

[2] *According to the focus groups, Nachihembe is officially considered a neighbourhood of the village of Bugano rather than a separate village. For the purpose of this study, it has been considered as separate due to its numerous inhabitants and its considerable distance from Bugano.*

8.2.4 Education

8.2.4.1 Rwanda

At national level, 50% of females and 55% of males aged 6 and over have some primary education, and 15% and 11% have no education at all. The average number of years of completed education is 3.8 among women and 3.7 among men. Rural residents are twice as likely as urban ones to have no education, 16% of women and 12% of men have none. For the Western Province, the school attendance rate 90.6% for males and 90.7% for females for primary school, but 33.8% and 36.5% respectively for secondary school (NISR, 2021).

The national data confirms the information collected on field. Most of the schools observed in the villages offer basic primary education. The number of kids who do not go to primary school is not very high, as families often use micro-credit associations to pay for school fees. However, secondary school fees are often too expensive, with a fee gap ranging from primary school fees around 12,000 Rwandan francs to secondary school fees of around 50,000 Rwandan francs. A more serious deterrent is the house-to-school distance. Out of 8 villages included in the study, 3 had no schools at all. For some villages, there are several primary school options within a 1.30-hour walk: for example, people in Ryagashyitsi send their children to school in Nygahanga, Murya and Gatchuriro. For other villages schools can be hard to reach. In the village of Ruganzo, most children do not go to school or arrive late, not only because of high poverty levels but mostly because the schools are all over a 2-hour walk, which it makes it very dangerous for small children. Another problem encountered by most schools are related to the few numbers of teachers available. For example, the primary school of Nygahanga has 20 teachers and 15 rooms (of which some were still in construction at the time of the interview) for around 225 children. For a breakdown of the school infrastructure present in the study area, refer to Section 8.8.2.

8.2.4.2 DRC

According to the Demographic and Health Survey in 2014, at national level 19% of women and 8% of men are illiterate. In rural areas, 77% of people go to school, as opposed to 87% in urban areas. In the Sud-Kivu region, 20% of females have had no education as opposed to 6.4% of male adults, while 48.1% of women and 43.9% of men have had incomplete primary education. The data collected in the study area reflects the national situation. The main constraints encountered to school attendance are (i) lack of equipment and basic infrastructure and (ii) walking distance to the closest school. Out of 9 villages included in the study, 4 do not have any

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schools. The village of Kayenge has 4 primary schools: due to the small capacity of schools in the other villages of the study area, a lot of children have no option but to walk from 1 to 2 hours to reach the schools in Kayenge. For a breakdown of the school infrastructure present in the study area, refer to Section 8.8.3.

8.2.5 Languages, Religion and Social Groups

8.2.5.1 Rwanda

A Language, Religion and Social Groups in the Study Area

The main religions in the Rusizi district are Catholic (48.5%) and Protestant (43.7%), with a minority of Pentecostal, Methodist and Evangelist Christians. The types of Christianity most frequently observed in the study area are indeed Catholics, Protestants, Pentecostals following the Association des Eglises de Pentecôte au Rwanda (ADEPR), Adventists and Free Methodists in Nzahaha. In addition to these groups, in Bugarama Muslims are also represented around the Bugarama Mosque in Kabusunzu. In Nyange Cell, there is also a small minority of Jews, grouped around the village of Morumba where their church is located, and Jeovah Witnesses. Figure 8-27 gives the distribution of the religions practiced amongst the households surveyed during the quantitative survey in Rwanda.

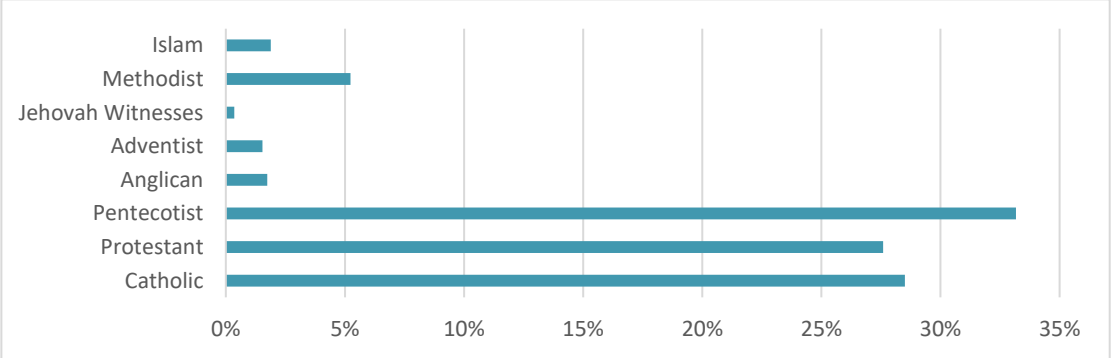


Figure 8-28 Religion Practiced by Surveyed Households in Rwanda (2022)

In terms of language, all people of Rwandese nationality speak Kinyarwanda, while a minority of people also speak Swahili or Mashi, especially on the villages in Bugarama Sector close to the border with DRC. Most of these people are Congolese who crossed the border and now live in Rwanda. The relationship between immigrants and Rwandan national is harmonious, with people frequently sharing families across the border. Pera Cell is the area where most Congolese and Burundians are found within the study area, due to the vicinity of both countries. Their numbers are still, however, extremely low. According to the Pera Cell executive, Congolese and Burundians would represent less than 1.5% of the Cell population. There are seemingly no types of conflict or exclusions with these people: although the process for them to register their land is more complex, SLR met one Burundian that managed to obtain a land title and one Congolese who was in the process of obtaining it.

Speaking of ethnicity has been made illegal by the Government of Rwanda since the 1994 genocide, in an attempt to promote a peaceful recovery from the ethnic tensions that motivated the violence. Laws against ethnic divisionism were passed in 2001 (Law n°47/2001 of 18 December 2001 on the Prevention, Suppression and Punishment of the Crime of Discrimination and Sectarism) and are enshrined in the 2003 constitution through various articles outlawing forms of discrimination and divisionism. Punishment for breaking these laws include lengthy prison sentences and hefty fines. Instead of recognising different communities or special categories of people, the state promotes the paradigm of '*ndi umunyarwanda*' ("I am Rwandan") or Rwandan nationality as the only acceptable identity and asserts that tightly managed political and identity-based discourse is necessary for security. Therefore, it has been deemed most culturally appropriate not to enquire about ethnic differences or tensions in any

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of the interviews and focus groups. Nevertheless, questions have been posed about social exclusion and marginalisation. During the interviews, one specific community emerged as more vulnerable and marginalised than others: this community is officially named by the Rwandan Government as '*Abasigajwinyuma Nam*atekas', or 'Historically Marginalised People'. The following Section describes their characteristics and livelihoods.

B The *Abasigajwinyuma Namatekas*, or Historically Marginalised People, in the Study Area

The presence of Historically Marginalised People (HMP) in the study area was identified during the 2022 qualitative survey, during which a focus group was carried out with 18 HMP, 9 women and 9 men (see Figure 8-29). A stand-alone study was produced by Anthropolinks in 2023 to investigate the socioeconomic and cultural characteristics of HMP. Unless otherwise specified, the information presented in the paragraphs below has been retrieved from this anthropological study.

B.1 Demographic Characteristics

The *Abasigajwinyuma Namatekas, or Historically Marginalised People (HMP),* make up around 0.4% of the population of Rwanda and are historically known as the original inhabitants of the country's forests.[9] Part of the wider Pygmies ethnic group, this community was historically composed of hunter-gatherer forest dwellers whose livelihoods was largely dependent on natural resources. Throughout the 20th century, the marginalisation of the community, historically perceived as at the bottom of the social ladder, was accentuated by land grabbing and commercial expansion into forests due to demographic pressure. In the 1960s, a series of government policies to redistribute land contributed to the dispersal of the HMP. By the end of the 1980s, the last communities living in the forests were expelled from the Volcanoes National Park, the Gishwati Forest or the Nyungwe Forest Reserve. It is estimated that about 1/3 of the community was killed during the genocide, leaving the population at an estimated 33,000 people (CAURWA, 2004).

B.2 Legal Status

Since the Rwandan genocide, the country has adopted a policy of national reconciliation which prohibits ethnic identification. Laws against ethnic divisionism were passed in 2001 (Law n°47/2001 of 18 december 2001 on the Prevention, Suppression and Punishment of the Crime of Discrimination and Sectarism) and are enshrined in the 2003 Constitutions. However, Article 80 of the Constitution recognises HMP as an umbrella term covering different vulnerable groups, including communities of pygmies which have been dispossessed from their ancestral lands and have since been living as a marginalised community in mainstream society.

B.3 Terminology and Self-Identification

The community in Rwanda accept being referred to as Abasigajwinyuma namateka, or HMP. This is considered less discriminatory than the term 'Batwa', which is both culturally discriminatory and politically inappropriate, since the use of ethnic labels is legally punishable and self-identification with the Batwa label is perceived as auto discriminatory by the Rwandan administration.

Another term which is frequently used is *Basangwa Butaka* (literally 'the ones who own their lands'). This term is rejected by some people within the community as it does not reflect their contemporary reality, since they are generally landless and working for others.

Interviews also confirmed the historical existence of discriminatory naming practices towards HMP, the members of which can be negatively addressed with Kinyarwanda terms which emphasises false beliefs that the community is uneducated, immoral or uncivilised.

[9] Batwa People, https://kwekudee-tripdownmemorylane.blogspot.com/2013/03/batwa-people-one-of-first-people-on.html, accessed on 23/02/2022.

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B.4 Geographical Distribution and Settlement

In the Project area, HMP are present in the Bugarama and Nzahaha sectors. The origins of Batwa settlements in Bugarama were not clearly stated during interviews. The community moved to this area after being evicted by government-induced schemes, including forced evacuation from high-risk landslide and flooding area and by Bye Bye Nyakatsi Policy in 2011.[10] According to the Social Affairs Officer, the HM population of Nzahaha is estimated at 9 households, for a total of 57 people (6 households in Murya and 3 households in Butambamo).

B.5 Lifestyle

The HMP communities of Bugarama and Nzahaha live together, sometimes in separate neighbourhoods and sometimes in family units mixed with the rest of the community. The practice of social distancing called *ukunena*[11] was used to discriminate against HMP before the 1990s and 2000s. While the government has outlawed the practice, during interviews some HMP mentioned that it still exists today.

HMP are generally identified as a separate group by neighbouring communities. Intermarriage is sometimes practiced, although it is constrained by the levels of poverty and stigma associated with the community. The only type of relationship between HMP and non-HMP is related to the labour they provide for other Rwandans. Some of the HMP interviewed reported feeling that other villagers ignore and exclude them from positive development and employment opportunities. Interviewees reported a sense of transborder solidarity with Batwas in DRC, as well as in between other HMP families within the Project area.

Due to financial instability and marginalisation, HMP children are more likely to drop out of school. HMP are also more likely to rely on traditional medicine rather than health centres, although they do have subsidised health insurance through the Rwandan *Ubudehe* Scheme.[12]

B.6 Governance, Language and Culture

Although some exceptions exist, HMP are generally absent from local government structures and administration, mainly due poverty, low levels of education and the absence of social connections. Interviews carried out as part of the qualitative survey in 2022 suggested that HMP are organised around a community leader, who represents a group of families residing in numerous Cells.

Most of the cultural specificity of HMP has been lost after their displacement from ancestral lands. However, in the Project area HMP are still known to be musicians, performers, singers and dancers. The dances practiced by the community include *Mundi, Rugenyo, Mdagirante, Imiyoborere Myiza Ibereye Abanyarwanda, Ubutabera, Ubumwe, M'amahoro, Izamare Maremare.*

Although it was reported that HMP have a particular intonation, they do not have a traditional language other than Kinyarwanda.

B.7 Livelihoods

Poverty, landlessness and discrimination after their forced displacement from ancestral lands, in the Project area HMP are landless, living as tenants or squatters on others' lands (see Box 8-1), and known for not owning any cattle, which is widely perceived as a sign of poverty and low status. They engage in limited agricultural activities during the rainy season, such as *nyiragabura* farming or maintaining small gardens near their houses or on others' fields, which allow them to

[10] The Bye Bye Nyakatsi Policy was a government initiative implemented in Rwanda in 2011. "Nyakatsi" refers to traditional thatched-roof houses commonly found in rural areas. The policy aimed to improve housing conditions and promote modernization by replacing traditional houses with more durable and weather-resistant structures.

[11] The practice consists of not sharing the same plate and serving food and drink separately to protect others from the 'impurity' of HMP.

[12] Rwanda's Ubudehe Program is a national approach for poverty reduction that categorizes households to facilitate interventions.

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occasionally sell bananas. However, their primary source of income in the project area is occasional daily labor for smallholders (see Box 8-2 and Figure 8-30). These workers got a pay of around 1,000 Francs per day, and some of them get a Vision Umurenge Program allowance of 1,000-1,200 francs per day doing public works, although they don't receive this money regularly.

Historically, the community was known as potters in Rwanda. However, as clay marshes were converted into farmland in the 1980s and pottery making became economically unviable in the 1990s, the practice declined. In the project area, the community used to access clay quarries on the banks of the Ruzizi River, but they were evicted ten years ago as part of the Bye Bye Nyakatsi program and the resettlement of people from high-risk areas. Interviews conducted in 2022 revealed that the families in Murya Cell used to make pottery to exchange for food, but since a cooperative in Rwingbogo took over the land where they obtained clay, they have been unable to continue this activity. Currently, the clay quarries are located 2 to 3 hours away from the homes of the community, and access is sometimes restricted by landlords. The Anthropolinks report mentions that the NGO Caritas purchased a piece of land with a clay quarry to ensure that Batwa have access to it, although the specific location is not provided. Pots are only sold during the dry season for an average price of 200 RWF, making it challenging to generate a sustainable income, especially considering competition from modern materials.

Gathering activities, such as collecting wild plants for personal consumption, are rarely practiced by the community. When they do gather, it is usually on the fields of the farmers they work for.

Box 8-1 Story of a Historically Marginalised Person Living in Ryagashyitsi (from 2022 qualitative survey)

This Historically Marginalised Person with serious mental disabilities. His family was displaced from some land that they used to live in Ryagashyitsi up to 2015, as this area was officially classified as high risk due to landslides. In 2021 his brother managed to buy land off another owner in Ryagashyitsi, making them the only Historically Marginalised family of in area to own land. However, they have been struggling to prove their status as owners of the land and still have not received titles. This man started living on his brother's plot, he sleeps under a banana tree with no bed or house. According to the interviewee, since he is too mentally unstable to work on a field, he goes around begging and depends on his brother's harvest and stealing food from fields for a living.

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Figure 8-29 Focus Group with Historically Marginalised People in Gatchuriro (Rwanda)



Figure 8-30 Historically Marginalised Person Working on a Field, Reservoir Area (Rwanda, 2022 Survey)

Box 8-2 Livelihood of a Young Male Historically Marginalised Person (from 2022 qualitative survey)

This young 'Historically Marginalised Person in his 20s lives in Gatchuriro. His family does not own any land and they do not regularly rent out any fields. They also do not own any cattle or goats and never sell to the market as they do not cultivate for themselves. They usually wake up in the morning and go look for work. Most of them time, work is only available for one day, but occasionally they can find it for more than two days. It is almost never for longer than a week. He gets paid 1,000 francs per day cultivating bananas. He does not self-identify as a 'Historically Marginalised People'.

B.8 Cultural Heritage

The project takes place in an area where the HMP communities have been affected by forced population movements over the last 20-30 years and massive deforestation that has led loss of forest areas. While hunting, gathering and pottery are still considered essential to their identity and constitute knowledge and skills their immaterial cultural heritage, those practices have been permanently affected by the effects of political events and violence in the region. The interviews conducted in the study area have not reveal the presence of any tangible cultural heritage.

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8.2.5.2 Languages, Religion and Ethnicity in the Study Area – DRC

A Ethnic Groups in the Study Area

The population of DRC is highly diverse, counting 40 ethnic groups and more than 400 tribes. There are four national languages, in addition to French: Kikongo (west), Lingala (Kinshasa and north-west), Swahili (east) and Tshiluba (south). In Sud-Kivu, 13 ethnic groups are represented: Babembe, Babuyu, Babwari, Bafuliru, Bahavu, Balega, Bamasanze, Bahavu, Balega, Banyindu, Barundi, Bashi, Batembo and Bavira and Bajoba. In the territory of Walungo, the main ethnic group present is the Bashi, which represents 80% of the population.

According to the interviews carried out during the qualitative survey, the study area is dominated culturally and demographically by the Bashi. The Bashi are the original landowners and traditional decision-makers, but the other ethnic groups in the village who are minorities have bought the land and are included into the socio-economic and political life of the village. The main minority ethnic groups represented in the study area are the Bafuliru, Banyarwanda, Murega and Barega, with even smaller minorities Barundu, Bayaindu and Babembe. In addition to these ethnic groups, there are two marginalised minority groups: the Batwa and the Banyamulenge. Sections D and E below describe these two groups in greater detail.

The local society is structured around the tribe. Each tribe is tied to land and to a traditional chief. After that, the extended family or clan represents the centre of production, consumption and social solidarity. Clans regroup different families sharing a common ancestor and creating powerful solidarity networks. The two main ethnic groups, the Bashi and Bafuliru, are constituted respectively of 8 and 13 clans.

A considerable number of Banyarwanda (Rwandese) people have installed themselves in various villages after the conflict in 1994. In particular, the village of Kayenge has three new neighbourhoods called Irohero, Kaboya and Rugenge, which have been created to host Rwandan refugees. According to the focus groups, the Banyarwanda community is well integrated with Congolese villagers.

Table 8-9 shows the ethnic group breakdown in each village, according to the data collected during the qualitative survey. Figure 8-31 gives the distribution of households surveyed during the quantitative survey by ethnicity and village.

Table 8-9 Breakdown of Ethnic Groups Present in the Study Area, DRC (2022)

Village	Main ethnic group	Minority ethnic groups	Extreme Minority / Secluded Groups
Kafunda	Bashi	Barega, Banyarwanda, Babembe	None
Bugano			
Nachihembe			
Nachirongwe			
Ibambiro			
Rushebeyi			
Bujenjeri	Bashi	Barega, Banyarwanda, Bafuliro	Batwa
Kayenge		Burundese, Barega, Banyarwanda, Bafuliru	Batwa, Banyamulenge
Ruduha		Barega, Bafuliro, Babembe	Banyamulenge

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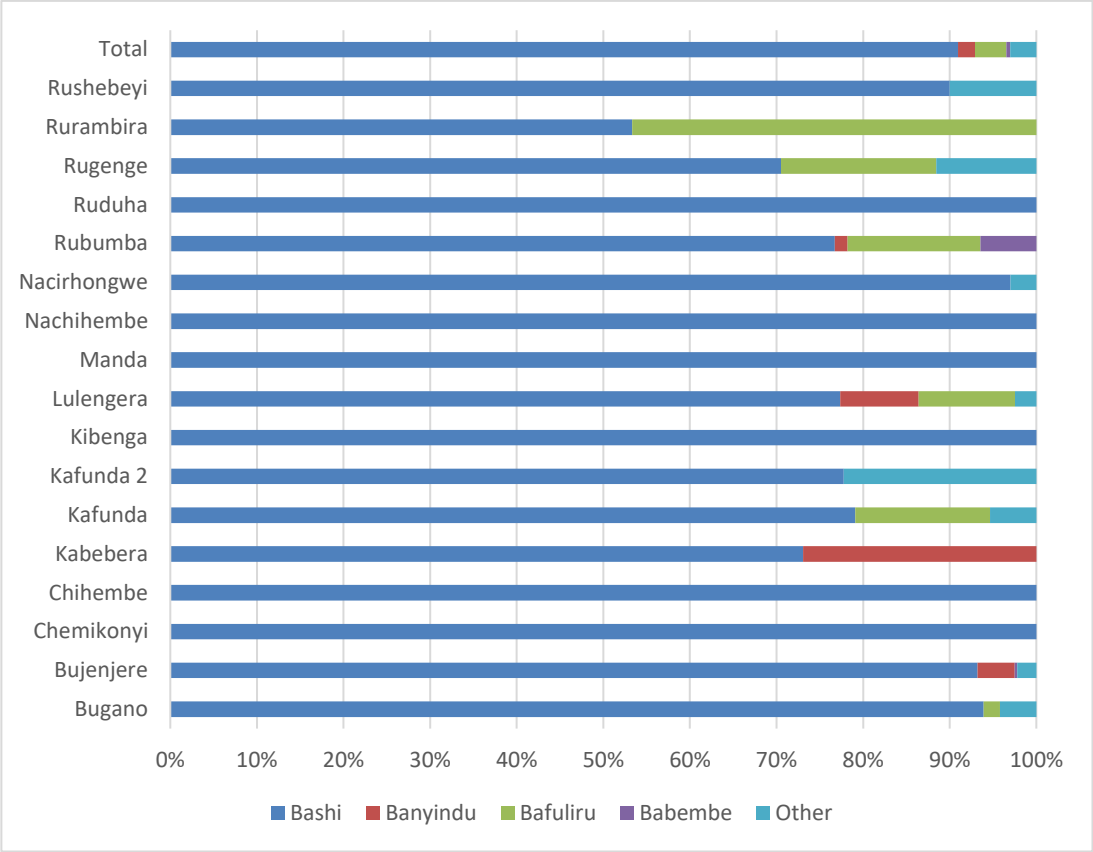


Figure 8-31 Ethnicity Amongst the Households Surveyed in DRC (2022)

B **Languages in the Study Area**

The two main languages in the study are Mashi and Swahili, with the former being more frequently spoken that the latter. Minority languages spoken alongside Swahili are the languages of the minority ethnic groups, the most frequently spoken of which is the fuliru, the language of the Bafuliru group.

C **Religions in the Study Area**

The religions of these groups are the same for all ethnic groups apart from the Banyamulenge, with the main two churches being Catholic and Protestant. A large amount of people, other common religions are:

- Communautés des églises libres pentecôtistes en Afrique (CELPA).
- Communautés des églises pentecôtistes au Congo (CEPAC).
- Communautés des églises chrétiennes en Afrique (CECA).

The only other religions found in the Study Area are exclusively practiced by the Batwa and Banyamulenge community. These two groups have their own religious practices meeting in their homes rather than joining public praying groups or utilising natural spaces for prayer.

Figure 8-32 below gives the distribution of the religions practiced amongst the households surveyed during the quantitative survey in DRC.

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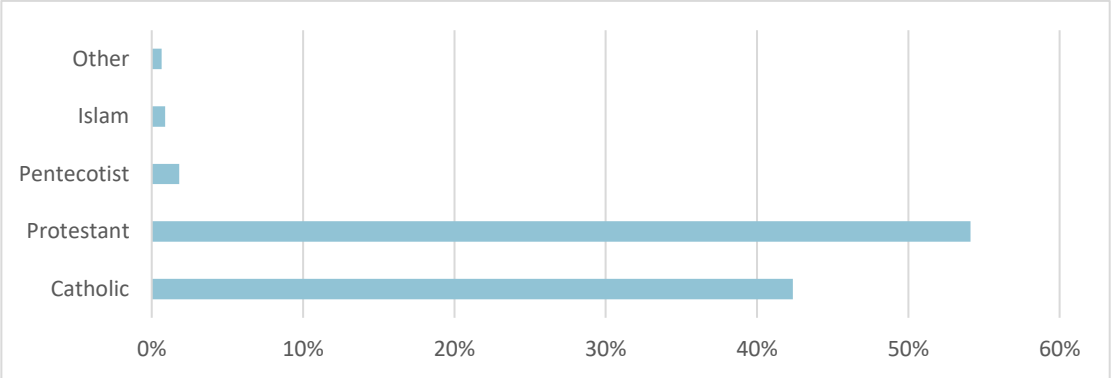


Figure 8-32 Religious Affiliation of Surveyed Household Members in DRC (2022)

D Banyamulenge Community in the Study Area

The Banyamulenge are a group of cattle herders of Rwandan origins. They are often perceived as outsiders and live separately from other groups. The only village where they are present in the study area is Kayenge. The Banyamulenge work as livestock herders rather than agriculturalists and they consider themselves superior to other local ethnic groups, which is why they do not intermix or intermarry. Like the Batwa , they are minoritarian and can be recognised by their looks ad accent. They live in separate neighbourhoods and join prayer groups within their homes with different names, including Brahman, Elpag, Cev, Cada and Neno. However, according to interviews and focus groups the Banyamulenge do not appear to be considered as HMP.

E Batwa Community in the Study Area

The presence of Batwa in the study area was identified during the 2022 qualitative survey. A stand-alone study was produced by Anthropolinks in 2023 to investigate the socioeconomic and cultural characteristics of these communities. Unless otherwise specified, the information presented in the paragraphs below has been retrieved from this anthropological study.

E.1 Demographic Characteristics

The Batwa are part of the larger Pygmy Ethnic Group and represent almost 1% of the population in DRC. According to the DGPA Atlas of Indigenous Pygmy Peoples (2012), the Batwa are present in 18 of the 23 'collectivités' in South Kivu, representing around 10% of the national Batwa population[13]. The Batwa of South Kivu were historically known as hunter-gatherer indigenous communities living in the mountainous forests of the region. The community was displaced from their ancestral habitat due to demographic expansion as well as forced expulsion for the creation of national protected areas, most importantly the Kahuzi-Biega National Park. Political conflict and violence caused further displacements in the Ruzizi Plain, where the Batwa are amongst the most exposed to forced enrolment in armed groups and to violence, especially sexual violence against women.

E.2 Legal Status

The Batwa are legally protected under organic Law No. 22/030 of 19/06/2022 on the Promotion and Protection of Indigenous Pygmy People, which aims to fill the legislative gap in the protection and promotion of the rights of indigenous Pygmy peoples in the DRC. Key provisions of the law include the recognition of Pygmy customs, access to justice and social services, full enjoyment of land and resources, participation in decision-making processes, the right to free, prior, and informed consent, and the promotion of socio-economic development plans and the rights of Pygmy women and children.

[13]Batwa People, https://kwekudee-tripdownmemorylane.blogspot.com/2013/03/batwa-people-one-of-first-people-on.html, accessed on 23/02/2022

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E.3 Terminology and Self-Identification

The term Batwa is not considered offensive in DRC. However, other naming practices are equally common in the Project area. The community living in Kamanyola refers to themselves as Bambuti, a Swahili term, while communities that have historically lived with their Bashi neighbours prefer the term Bahrwa, a Mashi term. The terms '*autochtone*' (French for indigenous people) and Pygmies are also used by non-batwa neighbours.

E.4 Geographical Distribution and Settlement

In the Project area, the Batwa have been identified in Kamanyola and in Karhongo. In Kamanyola, most Batwa live grouped in the village of Ruguengue, south of Kamanyola town. Some Batwa also live scattered around Kamanyola town, although they tend to no longer identify with the batwa community due to their long-standing integration in the Bashi or the Banyamoubira clans. The Batwa settlement of Ruguengue has an estimated population of 300 people. It was established in 2002 by the NGO PIDP, by Kapupu Diwa Mutimanwa, a well-known indigenous people activist who bought the land for a few batwa families to settle here. These families settled alongside other batwa families that had previously settled in the area, including:

- Families who came from the Ruzizi area in Rwanda and Burundi to exploit the honey-rich forests in the 1970s and settled in the area.
- Families who fled the genocide in Rwanda in 1994-1995.
- Families who came from the Ruzizi area in 1996-1997 to flee conflict in neighbouring areas. They had first settled around the city of Bugano (Kamanyola), which they left in the early 2000s due to insecurity and conflict in the area.

In the Karhongo groupment, Batwa are scattered in Nyangezi, Ruduha, Nachirongwe and Bujenjere. Karhongo is not a structured community but rather consists of isolated individuals with a batwa identity who have integrated into inter-ethnic marriages through various population movements over the past 30 years. In these villages, Batwa identity tends to be concealed due to its association with past discrimination. The qualitative survey carried out in 2022 identified an estimated 15 Batwa households living in Bujenjere village, as well as an estimated 2 households living in Ruduha and Nachirongwe.

E.5 Lifestyle

The Batwa communities of Bugarama and Nzahaha live together, sometimes in separate neighbourhoods and sometimes in family units mix with the rest of the community. They are identified as a specific group by neighbouring communities. Intermarriage is sometimes practiced, although it is constrained by the levels of poverty and stigma associated with them. Interviewees reported a sense of transborder solidarity between Rwanda and DRC, as well as inbetween families in the two countries, within the Project area. The only type of relationship between Batwa and non- Batwa related to labour.

Although primary education is free for children, it is reported that Batwa children are regularly turned away because they do not have appropriate clothing, and many are discouraged from attending due to bullying and discrimination. Access to health services is also a challenge for some Batwa.

E.6 Governance, Language and Culture

Although some exceptions exist, Batwa are generally absent from local government structures and administration, mainly due poverty, low levels of education and the absence of social connections. No evidence was found of an internal decision-making structure during the survey. Most of the cultural specificity of Batwa has been lost after their displacement from ancestral lands. However, in the Project area the Batwa are still known to be musicians, performers,

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singers and dancers. In Kamanyola, the main dance practiced by the Batwa is the Kubina, or Kushisa.

Although it was reported that the Batwa have a particular intornation, they do not have a traditional language other than Kinyarwanda.

E.7 Livelihoods

Since their forced displacement from ancestral lands, the Batwa in the Project area are facing a continuous depletion of forest resources. Most Batwa are landless, residing as tenants or squatters on others' lands. Even for those who own land, it is often limited to the area their house occupies. In the Karhongo groupement (DRC), some Batwa families still own land individually, but they no longer identify themselves as part of an indigenous Batwa community due to intermarriage and integration into mainstream society.

Currently, the Batwa's main source of income is occasional labour in agriculture in the rainy season, while gathering activities are practiced in the dry seasons. However, gathering activities still take place in farming fields as well as further away in fallow lands. Men predominantly engage in harvesting wild honey, while women collect medicinal and edible plants (Sogho, Moubolé, Mologuo, Bihama), and straw for roofing, which they sell in the local market. The collection of wild resources can be time-consuming and requires permission from landowners. The straw is mainly collected along the riverbanks or near the Ruzizi River. Wild resource collections can be time consuming and require long travel times as well as permission from landowners. It was reported that amongst other areas (*Kirira*, *Kaboya*, *Tchapagna*), the surroundings of the city of Bugano (Kamanyola) are used for wild plant collection activities.

The Batwa households in Karhongo practice agriculture on smaller plots compared to non-Batwa communities. On the other hand, the Batwa in Kamanyola do not own any land and depend on non-Batwa landowners for low-income daily work. Some women in Kamanyola have access to small plots through concessions from Bantu landowners, but it is precarious and insufficient. Although some Batwa have small gardens for occasional sales of bananas, they do not meet the households' consumption needs, leading to frequent experiences of hunger.

Pottery, which holds cultural significance for the Batwa, has declined rapidly in the Kamanyola area. Access to clay is mainly ensured through a clay quarry on land purchased by Kapupu Diwa to resettle a Batwa family in 2002. However, the market for pottery has dwindled, and the activity is no longer widely practiced.

While some Batwa own poultry, they do not have livestock due to their lack of land ownership. This absence of livestock is considered an obstacle to intermarriage and is seen as a form of discrimination, as cattle ownership carries social status and economic opportunities.

E.8 Cultural Heritage

The cultural heritage features of the Batwa community of DRC are similar to those described for the HMP communities of Rwanda in section 8.2.5.1B.8.

Likewise, the interviews conducted in the study area have not reveal the presence of any tangible cultural heritage.

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8.3 Land Tenure

8.3.1 Rwanda

8.3.1.1 Land Ownership

In Rwanda, the 2003 Constitution revised in 2015 recognises private land ownership. Law no.43/2013 provides equal access to land without discrimination based on sex and origin, providing leases of 99 years for most agricultural land and of up to 49 years for foreigners. Unwritten customary law is recognised by article 201(3), but only when it has not been replaced by a written law.

Land is formally registered through land titles. The management of these is centralised at the Cell level, where a land committee is in charge of registering land, through a process of land titling which has been systematised in 2011. All the villages in the study area are currently in the process of giving out land titles in mass. SLR's social experts have observed a very high number of people queuing to get their land titles in all of the administrative buildings where interviews took place. Nevertheless, land ownership without title still exists. The Executive Secretary of Pera Cell estimated that around 3,000 people (around 23% of the total population) are still without title. In Nzahaha Sector, it was estimated by local authorities that around 30% of people are still without titles. A land title can hold the name of one individual or two individuals in the case of legally wedded couples. It can be bought at the office of the Cell Administration for 40,000 francs and then name on it can be exchanged for 33,000 francs or for 45.000 for each person if the land is divided into different parts. The first question that gets asked is whether land was bought or whether it comes from heritage: in both instances, witnesses are required to confirm this. Once his/her land is approved for a title, the person needs to pay online through a service called IREMBO: it is with proof of that payment that the title is issued at the level of the Sector.

At national level, about 90% of Rwandan households cultivate at least one parcel of land, but 84% of them farm on less than 0.9 hectares (NISR, 2021). When they own any land, most people owning an average of 1/2 hectare of land per family due to the extremely high pressure on land. According to informants, 0.75 hectare is the minimum acceptable size for a plot to feed an average-size family, while 1 is considered comfortable. Nevertheless, land speculation is often a cause of inequality and reinforces the poverty of those that own the least land. As reported in Nyagahanga, there are often owners that own more than a majority and often resell their plots at high prices when others need them: for example, in this village there is one man that owns 10 hectares, while the rest of the village owns less than 1. In both DRC and Rwanda, interviews revealed that the price of 1 hectare on the riverside is currently between 1 and 5 million Rwandan francs according to the exact area, requiring an amount of cash which is unattainable for most households.

8.3.1.2 Land Renting and Nyiragabura

According to focus groups across the study area, renting is the most common way of acquiring cultivable land. Whilst owning a piece of land is seen as normal for those who decide to settle in the villages with their family, renting is seen as the mainstream way of acquiring for (i) those that either live somewhere else and are looking to expand their cultivation activities, (ii) those who sold their land for cash but cannot afford to re-buy it and (iii) those that settle into the village but cannot afford buying a plot. During the focus groups in Nyagahanga, it was estimated that around 20% of people only rent and do not own any land. The importance of renting is further demonstrated by the fact that local definitions of vulnerabilities often revolve around people's ability to afford renting a land plot or a house (See Box 8-3 Access to Land for a Vulnerable Person).

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Box 8-3 Access to Land for a Vulnerable Person

One vulnerable man in Ruganzo village does not own a house. He is paying 2,000 francs a month for a hen's cage which he is using as a house. He irregularly finds work on people's fields for a wage, but this contributes very little to his income and in a month he earns only around 1,000 francs from this activity. Since he cannot afford his rent, he is also doing on nyiragabura on someone else's land. He maintains another person's lands and takes care of the harvest during the appropriate season. Once the produce has been harvested, he takes 50% for himself and leaves the rest to the landowner.

Table 8-8 shows the type of tenure type amongst the Rwandan population surveyed in 2022: this reflects the fact that most households in Rwanda have a title but also rent some land, confirming the popularity of this type of land access mechanism.

Table 8-10 Type of land tenure - Rwanda

Land Tenure Type	Man-headed Households (%)	Woman-headed Households (%)	All Households (%)
Households who have a legal landholding title	61%	58%	61%
Households who are renting land	62%	54%	61%
Households who are cultivating through the nyiragabura system	27%	27%	27%

8.3.1.3 Land Conflicts

According to the interviews and focus groups carried out by SLR, conflicts related to land ownership in Rwanda are rare. Nonetheless, a recognised issue throughout the study area is women's difficulty ensuring land tenure security: for a deeper analysis of this issue, refer to Section 8.9.1.1.

The main types of conflict which are observed in the study area related to hereditary rights, plot separations and control of untitled land. In case of a conflict, the main institutions in charge of resolution at village level are the following:

- Inama y'umuryango is an informal family meeting.
- Inshuti z'umuryango (or 'friends of family') is a local committee which meets at village level to resolve small scale conflicts at the domestic level, especially between husband and wife.
- The umudugudu, or village Head, is the third authority in charge of resolving conflicts, especially when they involve more than one family.
- Land committees at cell level and a land manager at sector level have the role of facilitating the work of land registration units.
- Imyangamugayo are community members who contribute to dispute resolution in an informal way, literally 'loyal people'.
- If the conflict still is not resolved, the *Abunzi* committees[14], created by Organic law No. 31/2006 of 14/08/2006 on Organisation, Jurisdiction, Competence and Functioning of the Mediation Committee, deal with all disputes before they can be submitted to the Primary Court in the formal judicial system.

[14] Abunzi committees there are seven in each cell and seven in each sector.

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8.3.2 DRC

8.3.2.1 Land Ownership

Historically, in DRC small chiefdoms defined by boundaries of clans or ethnic communities, which were headed by the Mwami (the customary chief) and broken down into smaller units, each with their own customary leader. Viewed as the supreme leader, the Mwami held the power to grant inalienable property rights for some form of payment or tribute. With the advent of colonialism in 1885, the Belgian administration declared all land as a personal estate of Leopold II of Belgium, mixed with concessions reserved to Europeans only. After seizing control in 1965, Mobutu passed the 'Bakajika Law', which reclaimed state ownership on all and. Subsequently, the law of 1073 nationalised all lands fully, turning all property into concessions.

Nonetheless, land tenure in Sud Kivu is still mostly reliant on customary rights. According to these, all land belongs to the family of the chief, which has the power to give out the lands to who may want to use them, for the price of a bull or goat. Nowadays, all available land plots have been transferred: consequently, they are all individually owned and transmitted through patrilineal heritage, sale or sharecropping. Titles are not popular throughout the study area. Customary rights are either monetarised or in-cash, through a contract called *Bugule*: this consists of a cash or in-kind payment called *Kalinzi*, which results effectively in a sale. Although the size of land plots varies substantially, the average plot size owned by one household is around 0.5 hectares.

8.3.2.2 Informal Land Use and Sharecropping

Because the land market is increasingly monetarised, a high number of people do not own any land and rely on (i) usage rights given by the family (for example, for wives who have access to the husband's lands, (ii) sharecropping arrangements and (iii) cash renting. Sharecropping, through a traditional system called *Bwasa,* consists of a short-term agreement where one person agrees to work on one's land in exchange for 50% of their harvest.

As Table 8-11 shows, amongst the Congolese population surveyed in 2022, it is a lot more common to rent land or have a customary right rather than having a title.

Table 8-11 Type of land tenure, DRC

Land Tenure Type	Man-headed Households (%)	Woman-headed Households (%)	All Households (%)
Households who have a legal landholding title	6%	2%	5%
Households who have a customary property right (Bugule)	41%	22%	35%
Households who have a customary usage right	34%	23%	31%
Households who are renting land	40%	48%	42%
Households who are cultivating through the Bwasa system	41%	39%	40%

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8.3.2.3 Land Conflicts

Land conflicts are common throughout the study area. The preponderance of land disputes results mainly from the following issues:

- Incoherence between legal and regulatory texts and customary rules recognized by the Constitution.[15] The most common situations which can arise are that (i) land is given to two different people by the same authority, (ii) land is given to two different people by two different authorities and (iii) land is owned customarily by one person but legally by another.
- Constant reselling and fragmentation of land caused by natural population increase and refugee movements, leading to food insecurity landlessness of vulnerable households.
- Exclusion of women from secure land tenure rights (See 8.9.1.1).
- Interpersonal conflicts relating to contract terms and conditions, land ownership and delimitations and land division within the family or clan.
- Tension between Congolese people and people of Rwandan descent, due to land tensions caused by the migration of Rwandans to Sud-Kivu after the Rwandan Genocide of 1994.

When conflicts arise, the most common ways to resolve them is through the village committee. If the conflict is particularly complicated, it can be brought to the land conflict resolution committee, or Groupe de Réflexion sur les Conflits Fonciers (GRF). The Land Brigades, located in each municipality, acts as technical advisor to the village authority in case of more complex conflicts on land control and real estate.

[15] Ramanantsoa, T.S. (2019) 'Analyse du Régime Foncier et Social Dans les Provinces du Nord Kivu, du Sud Kivu et de l'Ituri en République Démocratique du Congo'.

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8.4 Land Use

Figure 8-33 shows an overview of the different land use types observed across the study area.

8.4.1 Land Use in the Reservoir and Dewatered Reach

Figure 8-34 shows a view of the reservoir area from the top. The reservoir and dam site are characterised by a dominance of steep slope cultivation, especially of maize and cassava (Figure 8-37), alongside a minority of flat riverside areas where maize, cassava, fruit trees and bananas are cultivated (Figure 8-35). Where the riverside plots are not flat, it is still common to find small fields of cassava and taro (Figure 8-38). In between different plantations, areas have been observed where manioc is dried on the riverside and where wood is cut for firewood selling. Cultivated areas are mixed with smaller patches of vegetation, as can be seen in Figure 8-39. No house or residential building has been observed in the reservoir and dam site area.

8.4.2 Land Use along Access Roads, at Construction Camps & Powerhouse Site

On the Rwanda side of the Ruzizi River, the current access road from Bugarama to the powerhouse is currently a hotspot of activities which connect the residential villages of Bugarama Sector to the surrounding fields, natural resources and to the Ruzizi River. The existing road is busy with people walking towards and back from water, wood and straw collection, or making their way back and to their fields. At the entrance of the village of Kabusunzu, a large opening onto the Ruzizi with an area for easy crossing to DRC makes it a particularly propitious place for the population to meet at the river for socialisation, water collection, object cleaning, fishing, clothes washing and bathing activities.

On the DRC side, the access road will physically displace some grouped houses, which are part of the riverside villages. For example, Figure 8-22 shows a house in the village of Kafunda, which will be directly impacted by the access road. The village of Bugano is located where the powerhouse will be located (Figure 8-19). The exact number of households displaced by this component is available in the RAP.

Where the access road touches the river, riverside crops have been observed alongside areas of firewood tree growing, charcoal making and fishing.

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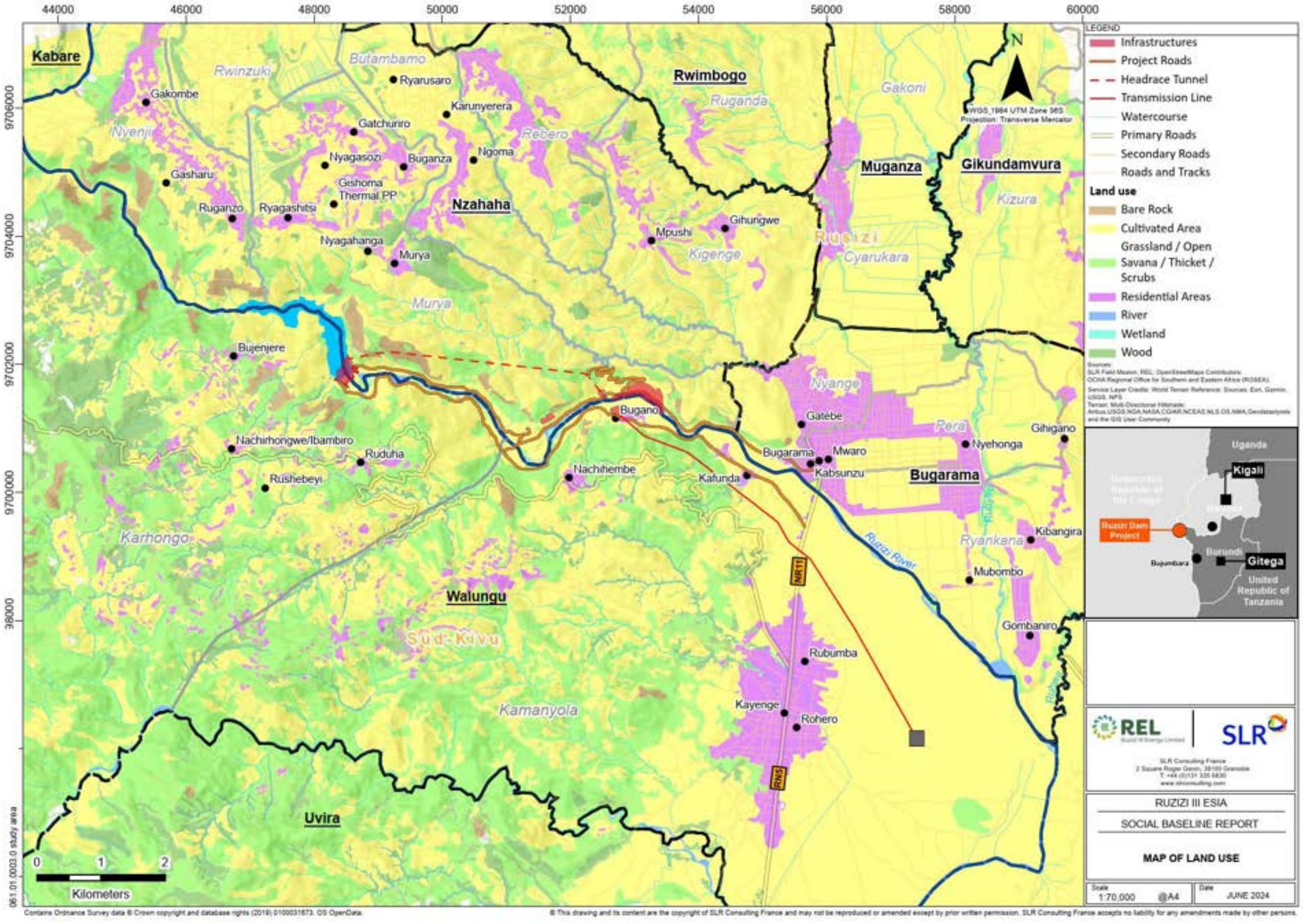


Figure 8-33 Map of Land Use Across the Study Area, DRC and Rwanda (2022)

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Figure 8-34 Birdseye of the Reservoir Site



Figure 8-35 Banana Plantation in the Reservoir Area



Figure 8-36 Manioc Drying in the Reservoir Area

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Figure 8-37 Steep Slope Cultivation in the Reservoir Area



Figure 8-38 Taro Field on Riverside Slope



Figure 8-39 Patches of Cultivation Amongst Vegetation in Reservoir Area

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8.4.3 Land Use Along the Transmission Line Alignment

The Transmission Line crosses inhabited and cultivated areas for its 200 metres after leaving the switchyard area. It then goes up the hills during approximately 3 km, crossing areas sparsely cultivated. It then joins the outskirts of Kamanyola town, going through maize fields. It crosses the RN5 road, without affecting any building, and then continues through cultivated areas (maize fields) down to the site of the future Kamanyola Substation (see Figure 8-40).



Figure 8-40 Field of Maize in Transmission Line Station Area, Close to the Future Kamanyola Substation

8.4.4 Land Use Along the Reach of Ruzizi River Downstream of the Project

The areas on the banks of the Ruzizi River downstream of the Project access roads are slightly different on the Rwandese and Congolese sides. In Rwanda, the downstream reach of the Ruzizi is characterised by a riverside plain cultivated predominantly with vegetables, of which tomatoes is the most widely farmed, and with rice.

Figure 8-41 shows a bird-eye view of the crop cultivation plain in Bugarama, with the rice fields showing up at the back of the city. Section D describes rice farming downstream of the Ruzizi in additional detail.

In DRC, the downstream reach of the Ruzizi is characterised by a mixture of riverside banana and maize cultivation, fish farming and irrigated vegetable cultivation. Figure 8-42 shows a bird-eye view of the fish farming ponds and cultivated plots from a hilltop in Rwanda. Figure 8-43 illustrates the irrigation canals which irrigate the plain as they meet with the farming ponds. Section 8.6.5 describes fish farming practices in the downstream reach of the Ruzizi in more detail.

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Figure 8-41 Cultivation Plain in Bugarama, Rwanda, before the confluence with Ruhwa River



Figure 8-42 Bird-Eye View of Crop Cultivation and Fish farming Ponds, DRC, at the Confluence with Ruhwa River



Figure 8-43 Irrigation Canals and Fish Farming Ponds, DRC, at the Confluence with Ruhwa River

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The people interviewed in the villages downstream on the Rwanda side have all reported some experiences of flooding. This is a problem throughout the Bugarama Sector, but it hits hardest the villages of Gatebe, Kagarama, Rusizi Mubombo and Gombaniro, which are heavily dependent on vegetable cultivation along the river. In 2021, there were three floodings, one in May-April and two in June, on the 4th and on the 18th. The one on June 18th was the worst, as it destroyed 25 hectares of land (Figures Figure 8-44, Figure 8-45 and Figure 8-46). In the village of Gombaniro, farmers reported that during the June floods 5,000 lemon trees were destroyed. One person's land, the closest to the river, was so badly affected that he hasn't been able to cultivate on it since. According to all the people affected, water stayed on land for around 4 months. These villages are also affected by water rises and floods from the Ruhwa, which causes floods lasting around 1 month, around March-April.

According to the focus group carried out with the people who lost their whole harvest due to these floods, they estimated a loss of 3 to 4 million francs for the year.



Figure 8-44 Field in Mubombo Before the Flood on 18/06/2021



Figure 8-45 Field in Mubombo At the End of the Flood on 18/06/2021



Figure 8-46 Field in Mubombo After the Flood on 18/06/2021

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8.5 River Uses

All across the study area, the Ruzizi River is perceived as a cultural and economic resource. The following sections reveal how water is used in the villages where the focus groups and interviews were carried out. According to the information collected from farmers and residents in the area, the Ruzizi is mainly used in the following ways:

- Source of domestic water supply.
- River crossing.
- Medicinal and Spiritual Use.
- Irrigation.

The quantitative households survey revealed that households regularly use the Ruzizi River for drinking, bathing, collecting cooking water, preparing manioc on the riverside, washing clothes and praying on the riverbanks, as shown in Table 8-12 below.

Table 8-12 Use of the Ruzizi River by surveyed Households

	Rwanda			DRC		
	Man-headed Households	Woman-headed Households	All Households	Man-headed Households	Woman-headed Households	All Households
Take water for drinking	42%	42%	42%	56%	68%	60%
Bathing	63%	69%	64%	74%	84%	77%
Take water to cook	70%	73%	70%	42%	57%	47%
Preparation of manioc	73%	73%	73%	21%	35%	26%
Washing clothes	75%	77%	75%	58%	77%	64%
Baptism / Praying	36%	19%	34%	22%	28%	24%
Other (medicinal use & watering crops)	12%	8%	12%	34%	26%	31%

8.5.1 Water Supply and Domestic Activities

Across the study areas, all villages use the Ruzizi as a source of domestic water supply. Domestic uses of the riverside water include drinking, cooking, bathing, playing, cleaning objects and washing clothes. During one of the focus groups in DRC, women explained that even when people have taps, they prefer using water from the Ruzizi to drink, because it is deemed to improve health, and to cook, as it is believed to have special properties that make the water boil faster. Additionally, all across the study area it has been observed that the riverside is used for manioc fermentation, manioc drying and manioc grinding for flour making: this is done all season long by women, who dig holes next to the river and fill them with water to let the manioc ferment, and then leave it overnight for a couple of days in order for it to dry (Figure 8-49). There are no specific areas for this activity, which is either practiced by individuals in isolated spots (Figure 8-49) or in groups by multiple people (Figure 8-48). This can be practiced either on flat surfaces or on slopes on flat wooden structures built for this purpose (Figure 8-52). While there are no specific points where water is collected, people tend to perform activities of clothes washing and bathing in open areas where the river offers space to dry the clothes on the grass (Figure 8-50) or to socialise while washing and/or playing in the water (Figure 8-47). It is women who perform these activities with children. Men usually bathe in the river during the day or night, while women themselves shower in buckets at home to avoid attracting unwanted attention. Although this has been mentioned more rarely in Rwanda, in DRC the water is frequently used to facilitate livestock activities. In case of retained placenta of the cow, water from the Ruzizi River is given and the placenta is released within 30 minutes. There is also a belief that the animals (goats and cows) that drink water from the Ruzizi produce a lot of milk and are in good health.

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Figure 8-47 Collecting Water, Washing and Bathing Area in Gatebe



Figure 8-48 Manioc Drying Spot Outside of Bugarama



Figure 8-49 Hole for Manioc Fermentation in Gisheke, Rwanda



Figure 8-50 Area for Clothes Drying in DRC, downstream of Kamanyola



Figure 8-51 Manioc Drying in Gisheke, Rwanda



Figure 8-52 Manioc Drying on Slope, Reservoir Area

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8.5.2 River Crossing

According to the interviews across the study area, people cross the border regularly by swimming across the river, from Rwanda to DRC and the other way round. The three main reasons why people cross are (i) employment, (ii) commerce and (iii) visiting family.

As for employment, people have mentioned the fact that in DRC, Rwandan workers are paid more than double what they are paid in Rwanda. The average price for paid agricultural work in the study area is 700 francs per day, but in DRC they can get around 2,000 francs. According to Pera Cell Executive, crossing to look for employment is the number one reason for illegal crossings. Before COVID, he estimated that around 3,000 people regularly went to DRC from Pera Cell to look for work on fields. Both men and women cross for paid work, although women do it a lot less frequently, either waiting for a time where the crossing is less physically demanding or looking for areas where the water is low.

In addition to paid work, some men cross the river regularly for produce smuggling. In some areas, there can be small pirogues for crossing, although the most used method is simply swimming with large containers or sacks (Figure 8-53 Figure 8-53). Smuggling of rice, maize and sugar is particularly popular from Rwanda to DRC, while DRC often sends cooking oil over to the Rwandan side. The people employed for this type of work are often young men between 20 and 35 years old. They swim across in dangerous conditions, even when the current is high, and do around 10 trips a day every day on most days in a week. On the downstream stretch of the riverside, informants declared that accidents are frequent when the water is released by Ruzizi II which is unpredictable.

Finally, children, women and men all cross frequently to see family members or socialise with acquaintances on the other side of the river. A family downstream on the DRC side reported that there are around 7 families in the village that have family members they visit regularly across the border. Pera Cell Executive explained that around 27 Congolese families moved into Rwanda from the 1970s and have since then been in close contact with other family members across the border.



Figure 8-53 Sugar Smuggling Across the River, Downstream from Mwaro to Kamanyola

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8.5.3 Medicinal and Spirituality Properties

In Rwanda, the Ruzizi water per se is not used for any specific spiritual purposes, with the exception of baptisms which are practiced on the riverside in small points where people gather for praying and religious singing. However, in DRC the healing and spiritual use of water from the Ruzizi has been mentioned throughout all the study area. Overall, the river is seen as a source of protein and livelihood through fishing. It is believed to have healing properties for health and nutrition. The interviewees generally explained the Ruzizi which can cure several illnesses, help with anaemia and malnutrition and increase the quantity and quality of milk for nursing women. Most frequently, people are immersed into the water to cure scabies and all types of wounds, while for more serious illnesses medicine is taken with or mixed with the water from the Ruzizi to increase the beneficial effects. Additionally, women believe that the Ruzizi water has special minerals which help women recover right after giving birth. The water from the Ruzizi is also used for baptisms and for spiritual practices, most notably casting out demons or evil spirits from people's bodies and houses. Baptism ceremonies are done at some places of the Ruzizi River and even prayer sessions are organized at the Ruzizi River and in caves near the river (See Section 8.12.2).

8.5.4 Irrigation

According to the interviews and focus groups carried out, most irrigation takes place from May to September. The different methods used for the irrigation of crops are (i) by hand with buckets, (ii) with a water pump (Figure 8-54) and (iii) through irrigation canals (Figure 8-55).

Irrigating by hand with buckets is by far the most common way of irrigating crops, especially small plants such as tomatoes or peppers.

The irrigation canals are mostly used during May and September, according to the information given by the farmers on the DRC side. These canals usually flood once a year during the rainy season. Even people that live close to irrigational canals seem to prefer using buckets for the smaller plants, whilst they tend to use the canals for bigger plants such as maize and manioc. The existing water canals are perceived by the enquired families as not very effective.

Water pumps get to 300 or 400m, based on information gained on the riverside of Gombaniro They are mainly used in the summer months.



Figure 8-54 Irrigation Pump and Pumping Machine

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Figure 8-55 Irrigation Canals, Downstream part of the Study Area in DRC

8.6 Economic Activities

The villages in the study area are predominantly dependent on subsistence agriculture. Nonetheless, cash cropping and agricultural wage labour are important sources of livelihood which households resort to when money is required for basic expenses such as security taxes, medical fees or schooling payments.

In Rwanda, in the Western Province 70% of rural women and 87.5% of men are currently employed: respectively, 46% women and 40% men work in agriculture, 34% women and 31% men in unskilled manual labour. Around 15% of women also engage in commercial activities, as opposed to 12% of men. Although women declared being employed more frequently than their male counterparts, they are generally more likely to perform agricultural labour without being paid, either as a sharecropping agreement in exchange for food or due to the owner refusing to pay them at the end of the work: around 23% of employed women in Rwanda report not being paid for their agricultural work (NISR, 2021). While the Nzahaha Sector is dominated by agricultural activities, Bugarama Sector has a semi-urban economy characterised by a growing proportion of the population which is involved in small businesses and artisanal commerce. According to the Pera Cell Executive, 70% of people cultivate while the remaining 30%

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depending on small shops. In Kabusunzu, just under half of the population is dependent on small shops rather than cultivation.

In DRC, at the national level 74% of women report working. Sud Kivu is the region with the highest female employment at 77,4%, followed by Bas-Congo at 77.2% Out of these, 70% work in agriculture 75% of men report working. Activities conducted by men are also more diversified with only 45% in agriculture and 36.3% in small commerce. In the study area, small commerce is less frequently found than in Rwanda. Instead, households are almost entirely dependent on livestock and agriculture, with an economy mostly directed towards subsistence.

8.6.1 Agriculture

A Subsistence Crops

Agriculture is amongst the major livelihood strategies both in DRC and Rwanda. Countrywide, in Rwanda the share of land area per major crop are as follows: Pulses (29.5%), Roots and Tubers (25%), Cereals (22.5%), and Banana (18%), fruits (3%) and vegetables (2%) (MINAGRI, 2014). In the study area, subsistence agriculture tends to be centred around cereals, tubers and vegetables. The crops cultivated on the project footprint and around the villages in the study area are maize, manioc, bananas, beans, vegetables, fruit trees. In DRC, Maize in predominant cop cultivated in the plain around Kamanyola. In Rwanda, in terms of crops, coffee is almost exclusively grown at higher altitudes. In the Nzahaha sector, coffee trees have been seen more frequently (See Figure 8-57Figure 8-57), whilst downstream of the Bugarama sector the cultivation of soja beans has been observed (See Figure 8-56Figure 8-56).

All across the study area, bananas are suffering from an illness called *kirabiragna*, which has been around since 2015. Although bananas are still cultivated in the reservoir area and along the river, they are almost not at all present on the riverside in the Bugarama sector in Rwanda, due not only to the illness but also to the less appropriate soil.



Figure 8-56 Soya Bean Drying in the Village of Mubombo, Rwanda



Figure 8-57 Coffee Plants Cultivated in Ruganzo, Rwanda

According to farmers, the soil is a lot more fertilise on the riverside compared to the slopes. The area of Gisheke is believed to be the most fertile strip of land in Rwanda, while Bujenjeri has the same reputation in DRC. Instead, the slopes are dry and unsuitable for most crops, due to the lack of rain, difficulty in irrigating and the effect of erosion and deforestation. In Rwanda, erosion control holes on the slopes are used to recuperate fertilisers that are taken down into the plain

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by rain during rainy season, but often this is not enough, and it is difficult to properly fertilise that soil. On the riverside, market gardening is practiced all year round, especially tomatoes and aubergines are cultivated and then easily sold for a higher amount of money than most other crops (See Figure 8-58Figure 8-14). Bugarama's tomatoes are particularly well known in other regions, and they are an important source of livelihoods for local communities.



Figure 8-58 Tomatoes Packed for Market Selling, DRC, Downstream of Kamanyola

8.6.1.2 Agricultural Calendar

Figure 8-59 shows the agricultural calendar of the main crops observed in the study area, for Rwanda and for DRC. This calendar has been developed based on the information collected from the focus groups with cultivators, and from interviews with the sector agronomists of Bugarama and Nzahaha Sectors in the case of Rwanda. It is important to note that in both Rwanda and DRC farmers emphasised that the quality of the soil on the riverside plots makes it possible to cultivate all-year-round. According to the Bugarama and Nzahaha Agronomists, the quietest time in the year in August, where no crops are generally cultivated. Apart from these two, the calendar can change slightly during all other months, depending on the type of soil and meteorological conditions.

Coffee is cultivated by some households in Rwanda, where some coffee cooperatives exist. Coffee is not cultivated in DRC. Once planted, a coffee tree takes about 4 years to become productive. Then, coffee beans can be harvested between February and May each year.

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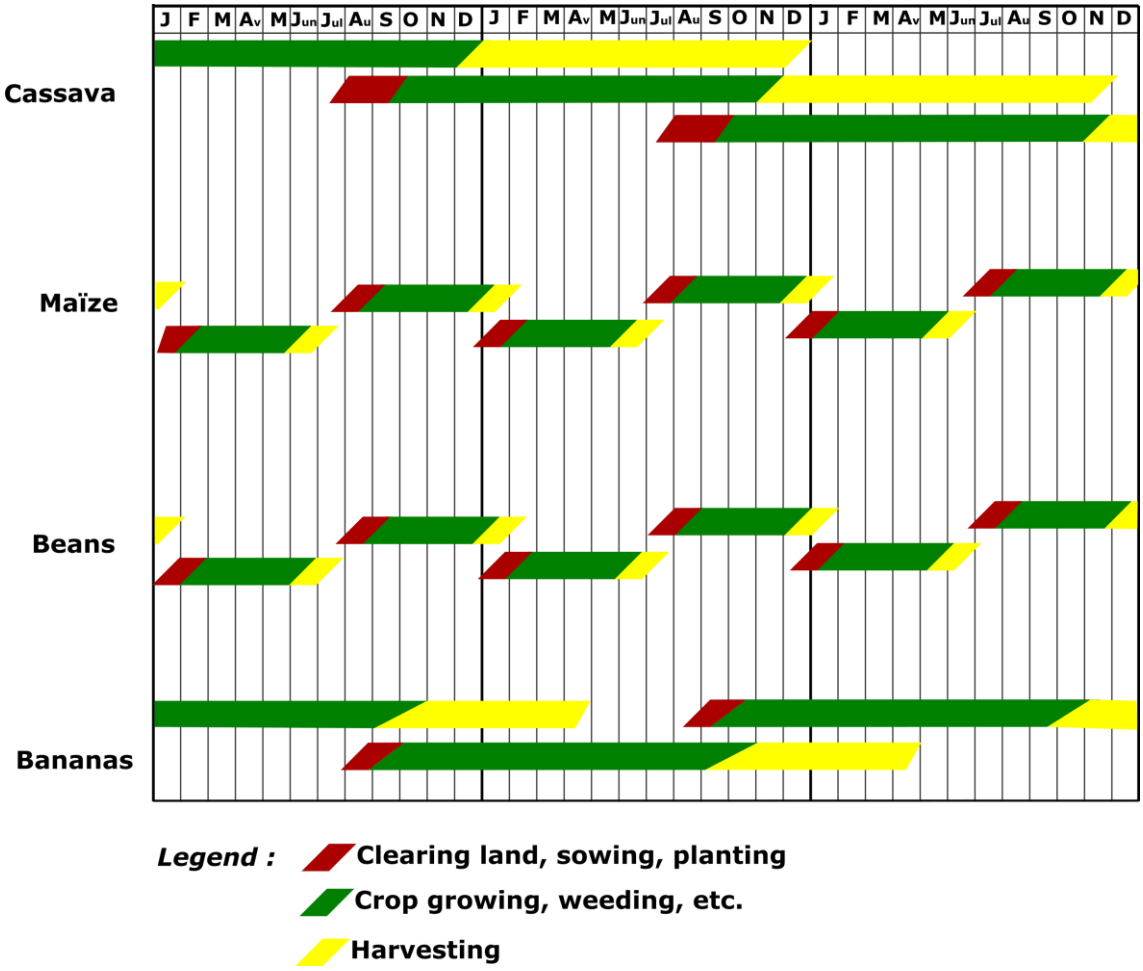


Figure 8-59 Agricultural Calendar (Rwanda and DRC)

8.6.1.3 Commercial Agriculture

A Plantations

According to the interviews carried out across the study area, the only large-scale commercial activities related to agriculture are of two kinds: a mango plantation in Gombaniro and a rice cultivation plain in the Bugarama sector.

On the confluence with the Ruhwa River, after the village of Gombaniro, lies a 15-hectare mango plantation (Figure 8-60). This plantation is part of a programme aimed at supporting deserted army men. The land plots in the plantation are owned by ex-soldiers who were given the plots by the Rwanda Demobilisation and Reintegration Commission, or RDRC, in order to support their reintegration in their respective communities. In practice, local farmers explained that the ex-soldiers pay wage workers to harves the mangos, which are then processed by a mango processing cooperative in Nyanji Cell.

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Figure 8-60 Mango Plantation in Gombaniro, Rwanda

Rice cultivation has only been observed in Bugarama, where the cooperatives Khem, Coimugna, Coprorici, Nibra and Nyankanyuke have a total of 14,000 hectares encompassing 4 Sectors. Out of these, Khem takes water from the Ruhwa and partly from the Ruzizi alongside Coimugna and Coprorici, while Nibra and Nyankanyuke take water from the Ruhwa. Due to a zoning policy implemented by the government in 2016, plots were divided in equal ways and they were put under the control of 4 cooperatives, one per sector. The maximum amount is one block, which is the equivalent of 0.4 hectares. In Bugarama, there are 130 hectares of rice cultivation, when people own between 0.2 and 0.5 hectares each. According to the focus group in Mwaro, people cultivate plots of around 0.125 hectares. On such a plot, 1.5 tonnes of rice are produced in a season. The taxes and customs taken by the cooperative take up quite a lot of the income: on 1.5 tonnes of rice, around 155.000 francs are taken away for tax.

Although seasonal, income from rice cultivation is an important source of livelihood. According to focus groups, in the villages downstream of the study area, the 60% of people that's dependent on agriculture is divided between a 40% in rice and a 20% in other crops, especially vegetables on the riverside. The way in which the cooperatives are organised is that they own the land and the government has been regulating since 2011 the size of lands cultivated by each person, who on average can only own between 1 and 4 plots. They then take the harvest, paying each person around 270 francs per kilogram. One of the main issues that workers complain of is that they have to then pay 1,200 francs per kg in a shop to buy rice to feed their families.

B Market Selling

The most common type of commercial agriculture across the study area consists of small-scale selling of agricultural produce. Selling produce to markets is more frequent in Bugarama, where the presence of markets makes it easier for people to sell regularly. However, in Nzahaha Sector it is a lot harder to find markets, which makes it rare for people to sell: according to the interviews had here, people have almost no cash revenue and they infrequently sell some produce only when they are in imminent need of cash.

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C Cooperative Selling

In the project area, the only cooperatives which were observed where in Rwanda. According to the interviews and focus groups in DRC, there are no cooperatives or agricultural associations in the villages concerned, which only rely on the support of small-scale NGO schemes for the improvement of their livelihood.

In DRC, small-scale cooperatives have been mentioned for maize and beans. In Rwanda, cooperatives are larger and more frequently used. However, it is important to note that farmers often avoid becoming members of the cooperative due to the high costs of joining. Instead, they may use the cooperative when needed to sell their produce. Table 8-13 shows the cooperatives which were observed in the study area. While this list is not comprehensive, the cooperatives mentioned here are the ones that were flagged to the social survey team as the most famous one and largest in the zone. Smaller and more disperse cooperatives and processing centres exist for cassava and were often observed in Bugarama (See Figure 8-61).

Table 8-13 Agricultural Cooperatives Used by Farmers in the Study Area, Rwanda (2022)

Sector	Cooperative Name	Cooperative Type
Gashonga	Gashonga Coffee Cooperative	Coffee
Nyakabuye	Rotukanya	
Giheke	Gisuma Coffee	
Gahogo	Turengere Ikawa	
Gashonga	Kinyaga Coffee	
Gahara	Tuzamurane	
Nzahaha	-	Mango
Bugarama	Khem	Rice
	Nyibura	
	Nyankanyuwe	
	COPORICI	
	Coimugna	
	-	Maize
	-	Handicrafts and small craftsmanship

Out of the cooperatives mentioned above, there was one that was mentioned by all the villages producing coffee in Nzahaha: Ruganzo, Ryagashyitsi and Nyagahanga. The director of the cooperative to gather data on coffee production in the region was interviewed. COCAGI Cooperative was founded in 2004 by the current director, without any reliance on NGO funding (See Figure 8-62). Out of 1,114 members, 298 are women and 69 reside in villages in the study area. More specifically, 14 members are from Nyagahanga, 32 are from Ruganzo and 23 are from Ryagashyitsi. In order to be a member, people need to have at least 50 'pieds' of coffee. The cooperative can only accept a maximum of 3 tonnes of coffee per person.

Additionally, people come selling from the villages of Murya, Nzahaha, Rugunga, Gashar, Kinengui, Kabugabo, Gassave, Murambi, Chuberezi and Chiranga.

COCAGI is certified Fair Trade, Rainforest Alliance and UTZ. The cost of joining the cooperative is 46,000 francs for life. With this, members get the following benefits:

- Premium payment to the cooperative transferred either in cash amount or development project.
- Fixed price higher than AEIP national standards.
- Health insurance every year for up to three family members.
- Loans are given without interest to pay for school fees, excess medical expenses and clothes.
- One cow can be given to each family.
- Small-scale loans are given under request to pay for electricity.

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The cooperative can process up to 1,500 tonnes of coffee, although it has a larger capacity, has it has to respect the coffee zoning policy created by the Rwandan government in 2016. The cooperative has 23 staff and up to 180 people working on the washing station on a good season. It sells at national level and then mainly to Italy and the United Kingdom.

It is important to note that people have explained that the largest problem with the cooperative is that the membership price or the selling price they get is often lower or the same as their cost to get to the cooperative. Box 8-4 illustrates the experience of a woman selling coffee to a coffee cooperative.

Box 8-4 Story of a Woman from Ruganzo Selling to a Coffee Cooperative

This woman sells coffee to Cocagi cooperative. When she wants to sell, she needs to pay someone for a bike where she is limited in the number of baskets of coffee beans that she can bring up, which are onlten only two buckets. She then needs to leave the bike and catch a bus. When she gets to the cooperative, she is paid a lower price for the beans that are of bad quality. Last time she sold coffee to a coffee cooperative she was paid 120 francs per kilogram in March 2021. After spending money for transport and loosing beans with the quality check, out of 120 she was left with a gain of 40-60 francs.



Figure 8-61 Small Cooperative and Processing Centre for Cassava in Kabusunzu

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Figure 8-62 COCAGI Coffee Washing Station, Drying Process

8.6.2 Livestock Farming

Livestock is an important source of revenues for Rwandese and Congolese households alike. However, in Rwanda it is a lot less frequently observed than in DRC. According to the Integrated Housing Living Conditions Survey (EICV3), after the City of Kigali, the western province has the lowest number of cattle-owning households. Figure 8-63 shows the percentage of households owning livestock, disaggregated by province and by type.

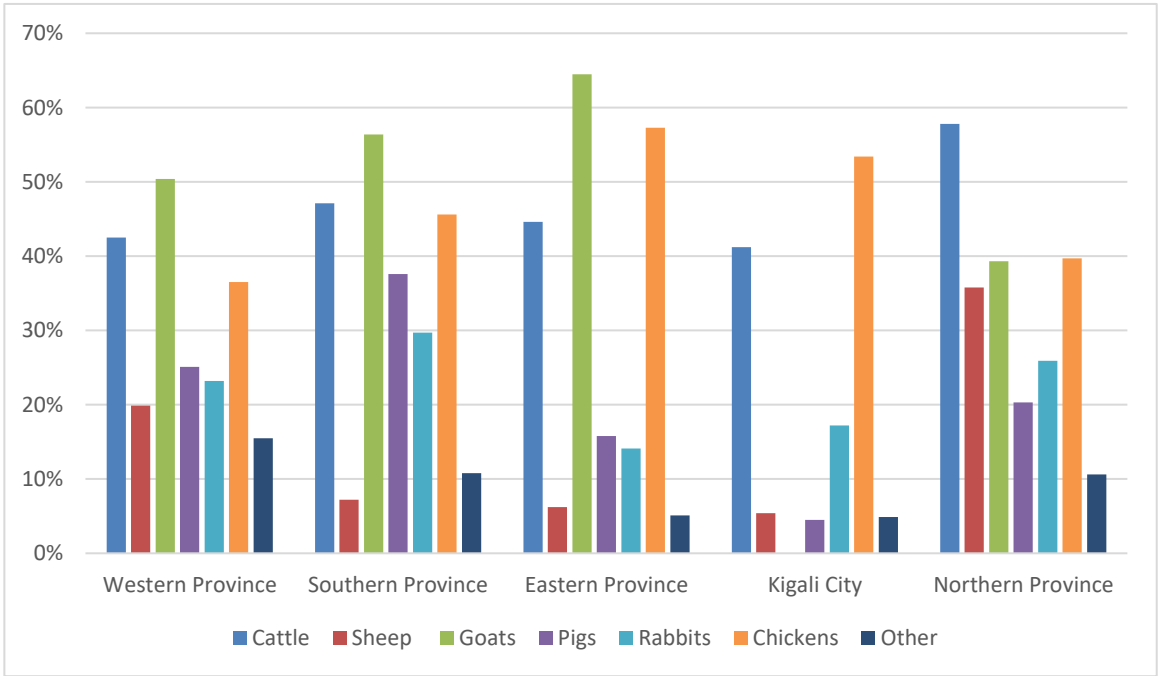


Figure 8-63 Percentage of Households Owning Livestock, by Type and Province in Rwanda (EICV3, 2014)

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In DRC, livestock data on a national level is not available. However, amongst the households surveyed during the quantitative survey, livestock farming is more frequently practiced in DRC than it is in Rwanda, as illustrated in Figure 8-64. Just under 70% of surveyed households in DRC own chickens and goats, around 20% and 30% respectively own cows and pigs and 40% own other animals, including rabbits, sheep, ducks, turkeys, guinea pigs, pigeons, cats and dogs. In Rwanda, only around 30% of surveyed households own goats, chickens and pigs and a smaller 20% owns cows.

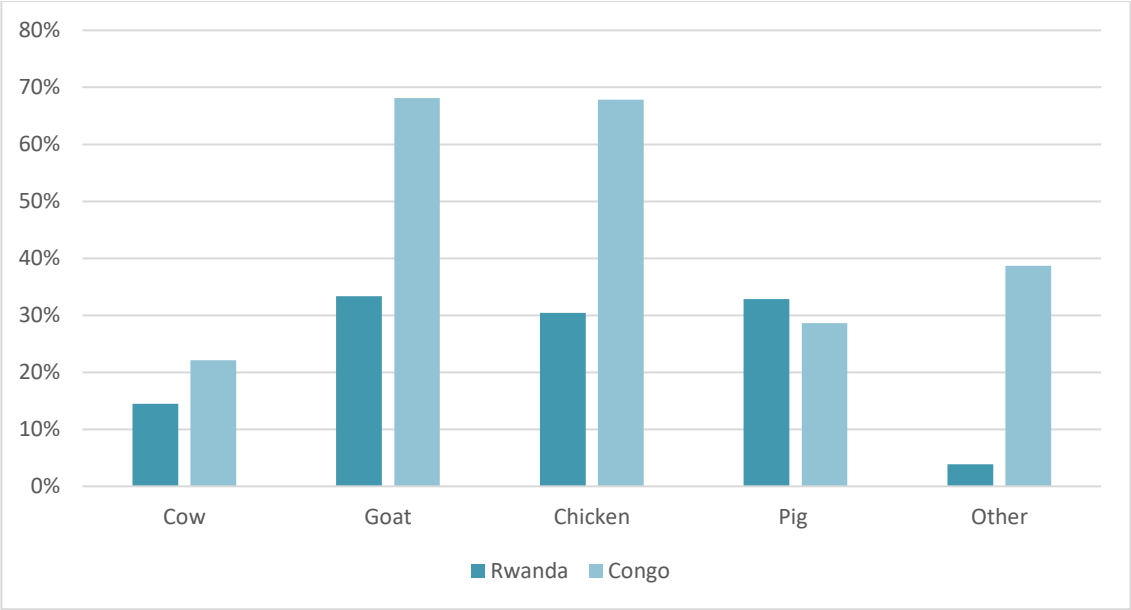


Figure 8-64 Percentage of Households that Own Livestock (2022)

The average number of animals owned is also much higher in DRC than it is in Rwanda (See Table 8-14).

Table 8-14 Average Number of Animals Owned by Farmers (2022)

Number of animals owned		Rwanda			DRC		
		Man-headed Households	Woman-headed Households	All Households	Man-headed Households	Woman-headed households	All Households
Cow	Average	2	1	2	5	5	5
	Max	4	1	4	30	18	30
	Min	1	1	1	1	1	1
Goat	Average	4	3	3	6	5	6
	Max	40	6	40	35	15	35
	Min	1	1	1	1	1	1
Chicken	Average	5	4	5	9	9	9
	Max	35	10	35	45	50	50
	Min	1	1	1	1	1	1
Pig	Average	2	2	2	3	2	2
	Max	7	2	7	16	7	16
	Min	1	1	1	1	1	1

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Figure 8-65 Goats Grazing on the Riverside of Gombaniro, Rwanda



Figure 8-66 Cattle Drinking from the Ruzizi Downstream of Kamanyola, DRC

8.6.3 Hunting

According to the social surveys, no households in Rwanda hunt. In the DRC, during the quantitative households' survey, only 34 households (9%) declared having at least one member hunting. Few households hunt monkeys and antelope (only 4 households), while the majority of the hunters are hunting small game.

8.6.4 Fishing

Fishing is practiced all throughout the study area, although it is not a primary activity for any of the households engaged according to the social surveys. The common trends which came out of the interviews are the fact that fishing is an activity exclusively practiced by men and is not an important economic activity. All fishermen said they fish on average 2 to 4 times a week. However, it is important to note that despite the frequency of fishing activities, fishing does not represent an important source of livelihood compared to agriculture. During the focus group in Kabusunzu, men reported that even by fishing multiple times a week, you might only get fish 5 times a month during the wet season, because the depth of the water makes it difficult to find fish. One of the men interviewed reported that he can go 5 days of continuously fishing without finding any fish. Interviews seemed to point to an income of around 1,500 Rwandan francs for 1 kg of fish sold at the market. September to June is considered to be the best season for fishing and the main two types of fishing are with a fishing net (Figure 8-67) or with a fishing pole (Figure 8-68). The frequency of fish buying changes significantly depending on the cash availability of each household. In Nyagahanga, one man reported buying 2 or 3 fish every Saturday from fishermen who come to sell at the village, while another reported buying around 3kg of fish every two weeks to feed 9 people in the family.

Amongst the surveyed population, fishing was reported considerably more frequently in DRC than in Rwanda, by 39% of households as opposed to 13% in Rwanda (See Table 8-15). Equally in DRC and Rwanda, the people who do fish do so multiple times a week. Once that fish is caught, it is utilised mostly for eating and selling alike, as illustrated in

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Table 8-16. Of the households that reported selling fish, over 85% stated that they did so in the last month.

Table 8-17 shows the average amount of money made by selling, in Rwandese Francs for Rwanda and Congolese Francs for DRC. Of the households that reported selling fish, over 85% stated that they did so in the last month. On average, Rwandan surveyed households reported having earned around 10,000 RWF last time they sold fish at the market. Similarly, in DRC they reported earning the equivalent of 11,000 RWF. While these numbers are confirmed by the information collected during the qualitative survey, is important to note that due to the low number of people that provided an answer to this question, the data may be inconclusive.

Table 8-15 Percentage of Surveyed Households Who Fish (2022)

	DRC	Rwanda
Man-headed Households	42%	14%
Woman-headed Households	33%	8%
All Households	39%	13%

Table 8-16 Use of Fish Caught by Surveyed Households (2022)

		Mainly Sell	Mainly Eat	Sell and Eat	Total
Rwanda	Man-headed Households	4%	24%	72%	100%
	Woman-headed Households	0%	50%	50%	100%
	All Households	4%	26%	70%	100%
DRC	Man-headed Households	4%	39%	56%	100%
	Woman-headed Households	0%	34%	66%	100%
	All Households	3%	38%	59%	100%

Table 8-17 Average Amount Made the Last Time that Households Sold Fish at the Market (2022)

	DRC	Rwanda
Man-headed Households	44,212	9,000
Woman-headed Households	43,648	-
All Households	44,053	9,000

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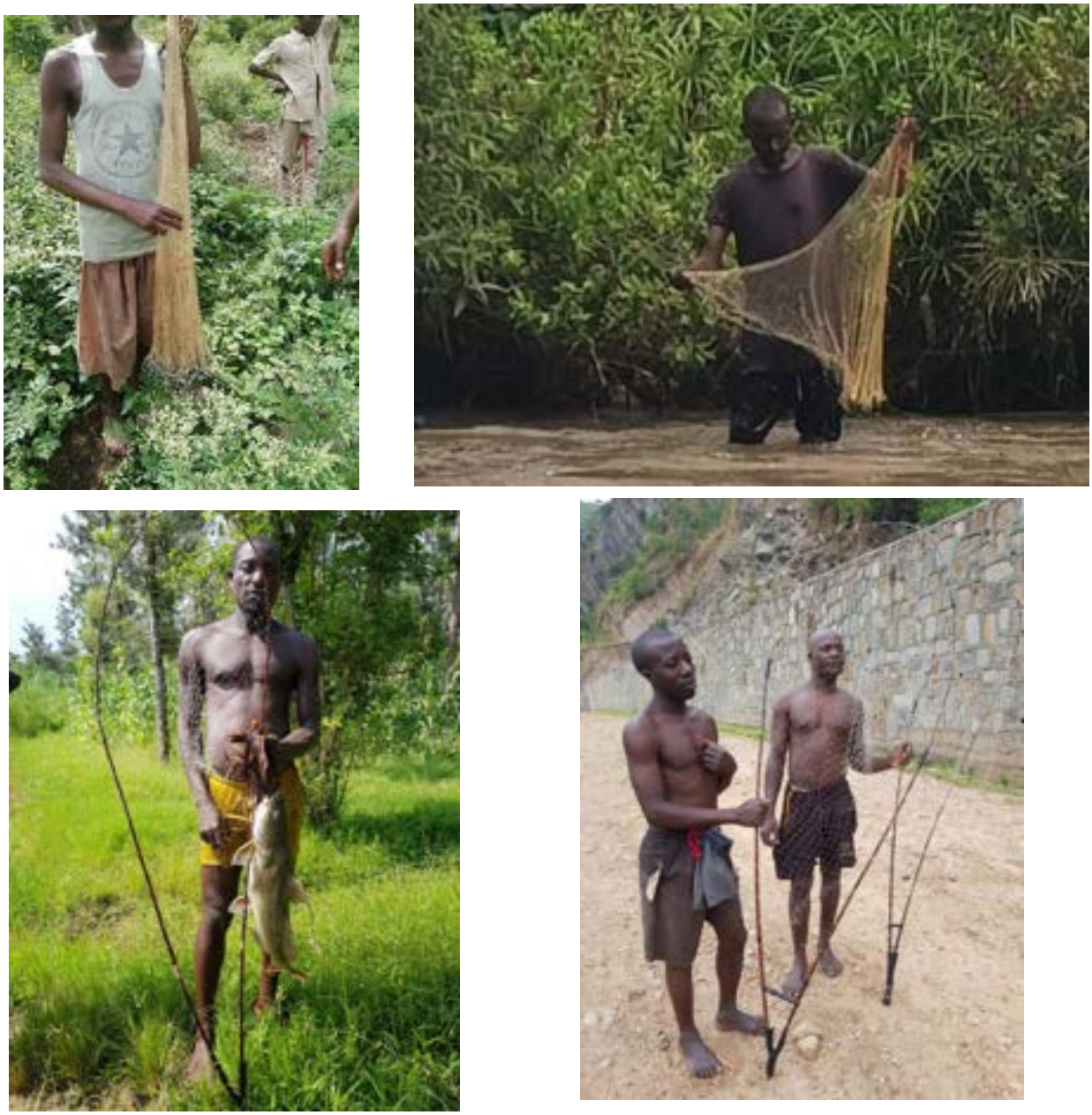


Figure 8-67 Fishermen with Fishing Net, DRC and Rwanda (2022)



Figure 8-68 Fishermen with Fishing Pole, Rwanda (2022)

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8.6.5 Fishfarming

The economic importance of fishfarming in the study area is generally low. Only two areas where commercial fish farming activities are carried out have been identified in 2022 (See Figure 8-72). In Rwanda, in the village of Gatebe (Bugarama Sector), one fishfarming company is farming tilapias for the local market on a small scale, with one pond only. In DRC, on the riverside of Kayenge, close to the confluence with the Ruhwa River, there are several fish farming ponds directly alimented by the Ruzizi (See Figure 8-69). Fish farming ponds in Kayenge are sponsored by a FAO program, in collaboration with Biologie ISP Bukavu, with the aim of distributing juveniles to fish farmers to increase fishing activities and fish commercialisation. Some of these ponds are not always used for fish farming and can be used as water reservoirs to water fields during the dry season, as was explained by interviewed people in Kayenge (See Figure 8-70). Figure 8-71 shows a bird-eye view of the fish farming ponds from a hilltop in Rwanda.

About 28 small ponds are also located in the reservoir area. They are used by local farmers to do some small-scale fish farming.

Although interviewed fish farmers did not provide any quantitative information on the volume of fish produced, they generally saw fishfarming as a secondary commercial activity practiced only alongside agriculture.

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Figure 8-69 Fish Farming Ponds in Kayenge, DRC (2022)



Figure 8-70 Pond Used as a Water Reservoir in Kayenge, DRC (2022)



Figure 8-71 View of Fish Farming Ponds in Kayenge from Rwandan Hilltop (2022)

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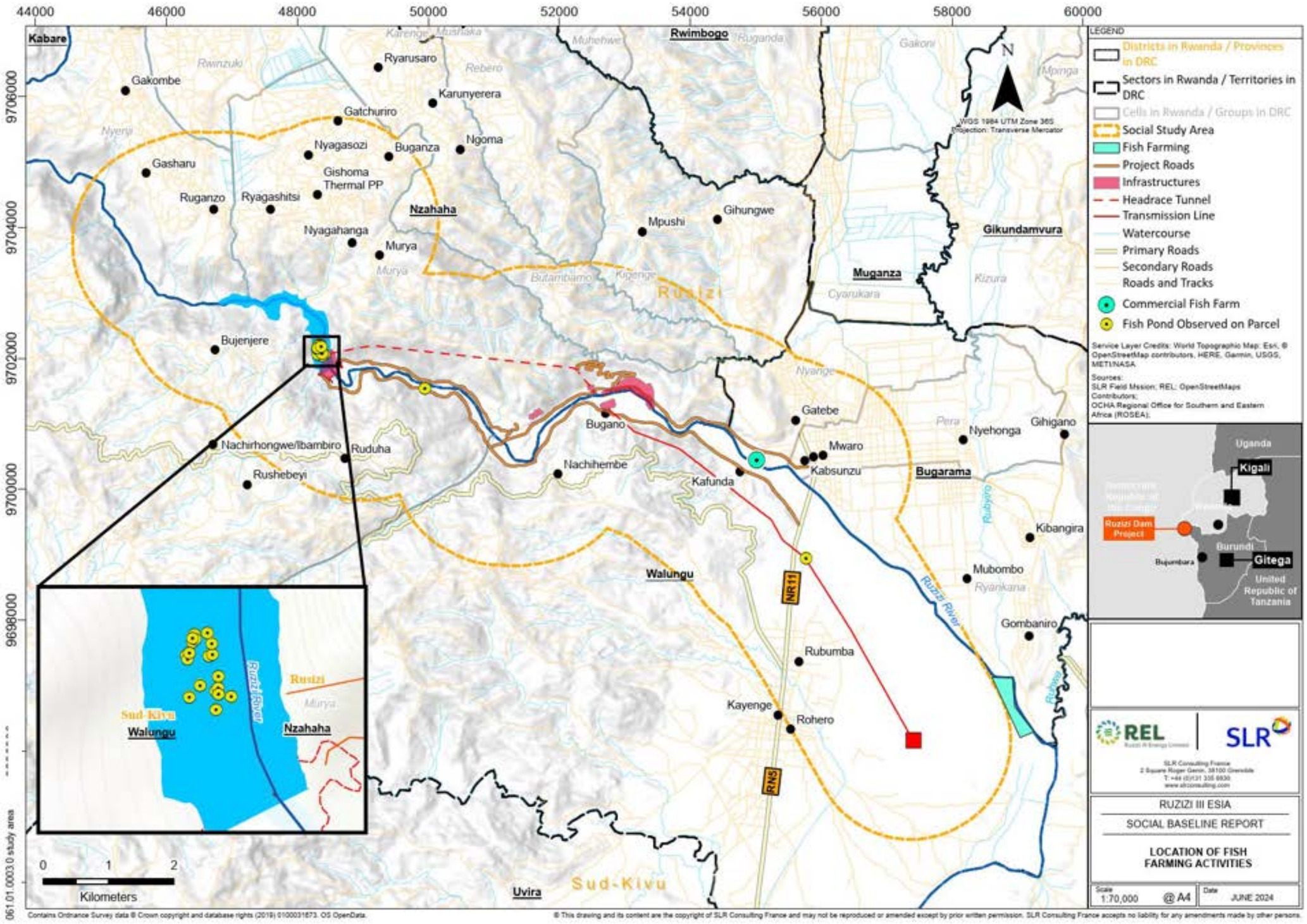


Figure 8-72 Location of Fish Farming Activities Within the Study Area (2022)

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8.6.6 Artisanal Activities and Small Commerce

Across the study area, small commerce is limited. Apart from the village of Kabusunzu in Rwanda and the town of Kamanyola in DRC, where some small shops and agricultural processing activities have been identified, very small artisanal activities are infrequently taking place within the villages. These activities usually consist of small kiosks selling produce (Figure 8-73) or small shops (Figure 8-74).

In Rwanda, according to the Nyange Cell executive Secretary, just over half of the Cell's population is entirely or significantly dependent on small trade and artisanal activities. He estimates that 80-90% of women are sewing for a salary, whilst nearly all men (90-100%) are practicing carpentry for a salary. People from surrounding cells often come to Bugarama sector to purchase these services. In Kabusunzu, the people who own a shop or gain a salary are seen as the wealthiest. Men during the focus groups reported that some have very beautiful houses that they rent out, they have workers to take care of their activities and they either move to Kamembe or own a second home for living. The urban jobs which are seen to be providing the best livelihoods are the following:

- Owning a clothes shop.
- Owning a general boutique.
- Owning a bar / restaurant.
- Working in a gas station.
- Working in construction.

There is a general perception that social mobility is not easy in the area, as poor people who still rely on agriculture find it difficult to find the funds to open an activity. Unless they get help by NGO, they often get involved in smaller cash-producing activities of market selling, carpentry of sewing. People in the focus groups reported that they thought that those who own store are often wealthier people who migrated here to open an activity.



Figure 8-73 Small Snack-Bar in the Village of Gombaniro, Rwanda (2022)



Figure 8-74 Shop in Kabusunzu (2022)

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8.6.7 Access to Banking System, Small-Scale Credit and Savings Associations

All across the study area, in both DRC and Rwanda, banking institutions are not very frequent. For DRC, no national data is available on bank ownership, but the focus groups have revealed that apart from the bigger cities of Kamanyola and Bukavu, people do not rely on banks for their savings. In Rwanda, Ruzizidistrict has one of the lowest rates of bank account ownership, as shown in Figure 8-74.

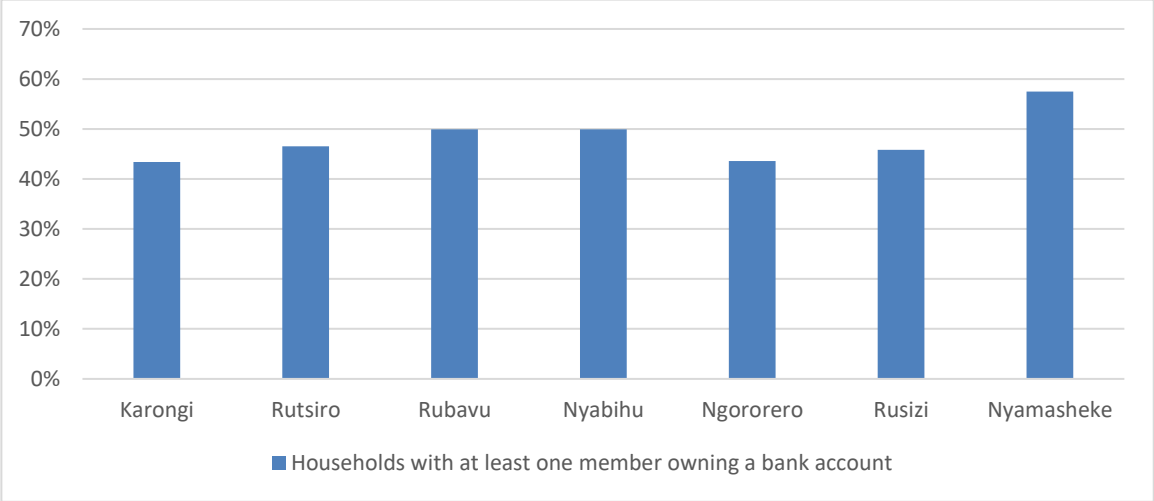


Figure 8-75 Percentage of Households Owning at Least a Bank Account in Rwanda, by Province (NISR, 2020)

In all of the villages in the study area, small saving groups have often been mentioned as the most effective way for people to build savings and obtain small loans. In Rwanda, for those that own land with an official title, property can be used as collateral to gain access to SACCOs (Savings and Credit Cooperative Organization), microfinance organisations based in each sector. The SACCOs in the study area are situated in Bugarama (Uruyange SACCO), Rwinbogo (Balio SACCO) and in Nzahaha (Intsinzi SACCO).

These credit groups are present in both DRC and Rwanda but they tend to change exorbitant interest rates or require land ownership to access the system. In villages, people use more frequently small scale saving and credit groups. These groups are called *Twoyobake* in Rwanda, whilst in DRC they are known with the French term Association Villageoise D'épargne et De Credit (AVEC) or with other local names, such as *Likirimba*, *Umoja ni nguvu*, MUSO and Solidarity Among Men. In DRC there is usually one committee per village, with a treasurer taken from the village committee. Instead, in Rwanda they can often group a few people with similar financial capacities. Although officially these groups are open to men as well, the number of men part of these groups is extremely low in Rwanda: women often use these when money is needed to pay for health and school fees. Some of the women reported that these groups have helped them to gain some control over their own money and to make decisions about how it is spent. In DRC, these groups seem to be equally used by men and women.

As part of the quantitative households surveyed, questions were asked about access to banking system. Table 8-18 shows that owning a bank account is more common in Rwanda than it is DRC, with very similar rates for woman-headed and man-headed households. Instead, having loans with micro-credit organisation is a lot less frequent, especially for woman-headed households, in both countries but in particular in DRC.

Amongst the households surveyed in 2022, in Rwanda 57% of households have joint bank accounts between the husband and wife. In the DRC very few households have bank accounts but of those that do, 58% of those bank accounts are owned by the husband. In Rwanda, of the households that indicated that they have a microloan, 69% of those loans are held jointly by the

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husband and wife, while in the DRC most of the microloans (44%) are in the wife's name and 26% in the husband's name and 26% held jointly.

Table 8-18 Surveyed Households With Access to a Bank Account or Microloan (2022)

		Households with at least one member having a bank account (%)	Households with at least one member having a loan with a micro credit organisation (%)
Rwanda	Man-headed Households	96%	18%
	Woman-headed Households	96%	4%
	All Households	96%	16%
DRC	Man-headed Households	4%	9%
	Woman-headed Households	3%	3%
	All Households	4%	7%

8.6.8 Development Projects and Livelihood Improvement Schemes

The authorities interviewed in the study area mentioned several NGOs which are currently helping vulnerable people and improving livelihoods in the study area. Table 8-19 summarises the organisation currently involved in the study area, alongside their main activities.

Table 8-19 Development Actors Involved in the Study Area (2022)

Country	Village(s)	Project Name	Purpose
Rwanda	Kabusunzu	Caritas	Supporting people in extreme poverty and providing housing for those who are homeless
	Rwinbogo and Rwinzuki Health Centres	Global funding	Paying health worker salaries
	Kabusunzu	Profam	Promoting women's empowerment
		ARCT Rumuka	Promoting women's independence through loans for small shops
		Benevolencia	Supporting vulnerable people
		Mukopaka Shambalet	Supporting women's empowerment
	Whole study area	One Acre Found	Helping people to find land, supporting people with the right seeds, fertilisers and pesticides (program called TUBURA)
	Gatebe	World Vision	Provision on seed sand fertilisers and support of people in category 1 of the Ubudehe Scheme with small-scale loans
		Care International	Helping vulnerable people with small-scale loans and financial management support
	Ryagashyitsi	Compassion Internationale	Helps children paying for school
DRC	Kafunda	GIZ	Gave the village a mill to transform maize and cassava into flour
	Kayenge		Distribution of farming tools, seeds for agricultural processing units
	Kafunda	Foundation Chokola	Supports the population with pig breeding
	Nachihembe		
	Kayenge	FUMU	Management of fish farming activities
		GIPI	
		ASDECEM	Provides agricultural support
		Femme lève-toi	Supports women
		Umoja Wetu	ASK
		Vijana Kazini	ASK
		Terra Renaissance	Construction of schools, latrines and bridges

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Country	Village(s)	Project Name	Purpose
		Swaf	Distribution of seeds, animals and poultry to the *Abasigajwinyuma Namatekas* (Rwanda) or Batwa (DRC) community
		Ami du Kivu	Reforestation
	Nachirongwe	DRISHA	Rural development activities at sous-groupement level
	Ibambiro		
	Rushebeyi		
	Nachirongwe	GEREF	Reforestation
	Ibambiro	IADEL	Supports the population with the development of rabbit breeding
	Rushebeyi	ACEDP	Supports the population with breeding, reforestation and general development works
		Rhukole Kuguma	Supports the population with agriculture, breeding and reforestation

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8.7 Community Health

8.7.1 General Community Health Context

Overall, the study area has little access to basic health facilities. Although in Rwanda the health worker system allows people to have access to medicine and medical advice when needed, the health centres are still badly equipped and suffering from various infrastructural and human resources constraints. In DRC, the health centres have extremely low capacity for hospitalisation and treatment. Nevertheless, according to the quantitative survey, 40% of Rwandan and 65% of Congolese surveyed households visited a healthcare facility in the past 12 months, as can be seen in Table 8-20.

Table 8-20 Frequency of Health Facility Visits by Surveyed Households in the 12 Months Preceding the Survey (2022)

		Never been	1 time	2 times	3 times	more than 3 times	Total
Rwanda	Man-headed households	14%	12%	18%	17%	39%	100%
	Woman-headed households	12%	19%	15%	8%	46%	100%
	Total all households	14%	13%	17%	15%	40%	100%
DRC	Men-headed households	7%	7%	11%	9%	66%	100%
	Women-headed households	10%	6%	11%	10%	64%	100%
	Total all households	8%	7%	11%	9%	65%	100%

8.7.1.1 Rwanda

Rwanda's health system is organised from village to province level. Overall, there are 11 provincial hospitals, 36 district hospitals, 499 health centres and several health posts and health workers located in villages. The 2012 data on the ratio of public health workers to the population shows that the ratio is very high. The ratio of doctor to population is 1:15428. The dentist per population ratio is much higher at 1:91628. There is one nurse for 1,200 people and one midwife for about 23.364 people (NISR, 2021). The western Province has 12 hospitals, two of which are located in the Rusizi district. For the villages in the study area, the only district hospital is Kamembe Hospital.

Hospitals are usually accessed through a referral from health centres. The Rusizi district comprises 15 health centres, with a mean walking distance to health centre in Ruzizi is 56.2 minutes and 44% of households walking under an hour to reach a health centre (NISR, 2021). Health centres are available through an insurance system, where 3,000 Rwandan francs per person provide access to basic health services. In Rusizi District, 91% of women and 92% of men in the highest wealth quintile have insurance coverage, compared to 67% of women and 63% of men in the lowest quintile (NISR, 2021). According to focus groups and interviews in the health centres, the fee to access health insurance is considered quite high and is often difficult to pay for most residents. As shown by Figure 8-76, Rusizi is one of the districts with the lowest percentage of people owning health insurance.

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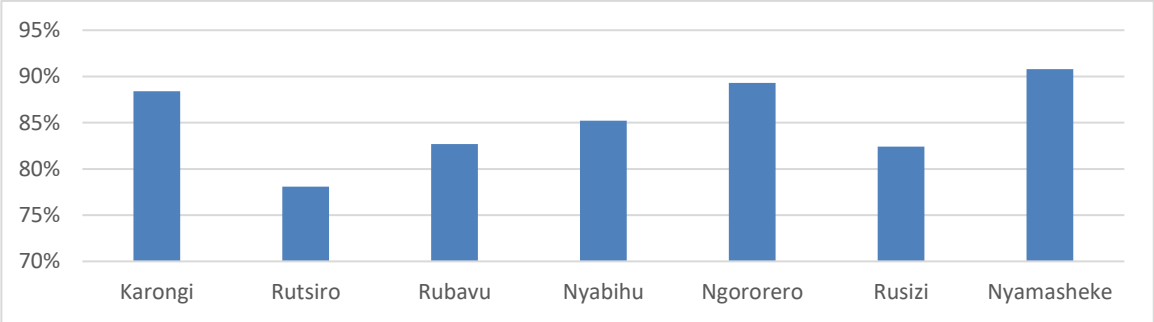


Figure 8-76 Percentage of Households With at Least One Member Covered by Health Insurance (2021)

Health posts are more numerous than health centres and should work as a first contact point for small issues and basic types of treatment. However, the system is not effective across the study area, as no health posts are currently running.

At the bottom of the health pyramid are the health workers, four of which (two men and two women) exist in all of the villages in the study area. The role of health workers is that of diagnosing, referring and supporting residents with the provision of family planning and basic medicine for issues such as fever or dhiarrea. For infectious illnesses such as malaria and COVID-19, health workers are provided with testing kits.



Figure 8-77 Rwinbogo Health Centre, Rwanda (2022)

Figure 8-78 shows all of the health centres identified in the study area, such as the Rwinbogo health centre in Figure 8-77. Table 8-22 summarises the characteristics of the centres visited in the study area in Rwanda, according to the interviews had with the centres' directors in January 2022.

The main challenges encountered by the health centres were the same in all of the places surveyed. In particular, the centres' directors flagged the following issues as pivotal in the capacity and efficiency challenges experienced:

- Lack of personnel and extremely long waiting times due to limited human resources.
- Lacking equipment and bad infrastructure (old structures, lacking laboratory equipment and capacity, electricity problems).
- Lack of an ambulance (all centres refer to Kamembe District Hospital's ambulance, which means that their service is overexploited).

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- Late or limited drug delivery (all centres depend on the delivery of medicine by one pharmacy in Kamembe, deliveries are so late that all centres reported being almost out of stock of essential drugs since the last delivery in December).
- Bad road, causing late arrivals and worsening of complicated for pregnant women.

Table 8-21 shows the main illnesses observed in the study area and the most affected groups.

Table 8-22 gives an overview of the capacity of health centres located in the study area in Rwanda.

Table 8-21 Main Illnesses and Affected Groups in Study Area, Rwanda (2022)

Illness	Most affected group	Reported in
Acute Respiratory Infections (ARI)[16]	Whole population, with particularly high cases for adults	Whole Study Area
Malaria	Whole population, with particularly high cases for children under 5 and pregnant women	
Diarrhea	Whole population	
Pneumonia	Whole population	
Rheumatisms and Articulation Problems	Adults, with particularly high cases for the elderly	
Gastritis	Adults	
Diabetes	Adults	
Hypertension	Adults	
Cold and Fever	Children	
Urinary Infections	People aged 15 and over	
Sexually Transmitted Diseases (STDs)	Adults	
Anaemia and Malnutrition	Women, Children aged 6-10 and People with HIV	
Bilharzia	Whole population	Bugarama

[16] The health institutions visited during the qualitative interviews were not gathering data specifically on COVID-19 specifically. However, COVID-19 cases were included in the category of respiratory diseases.

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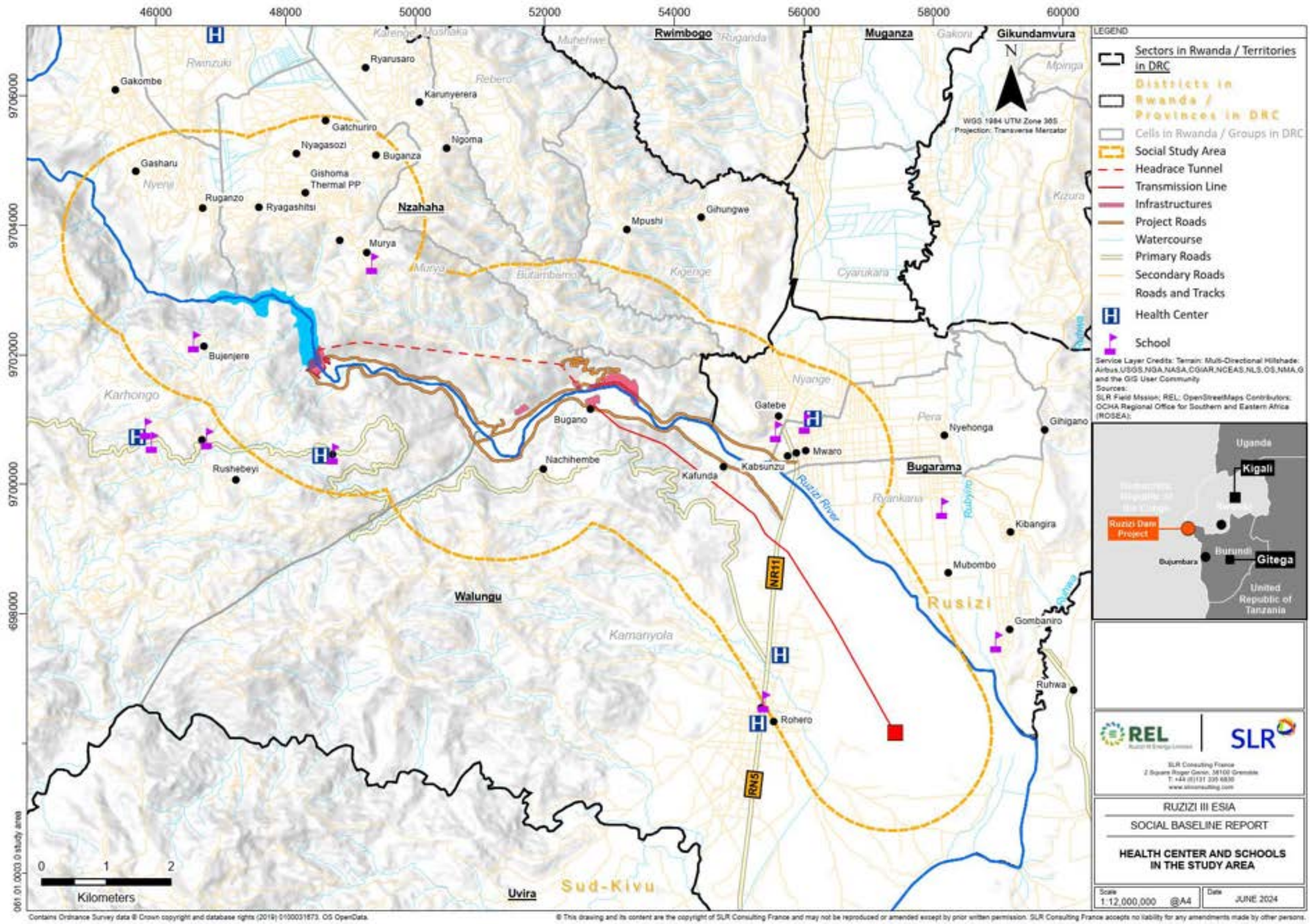


Figure 8-78 – Health Centres and Schools in the Study Area (2022)

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Table 8-22 Capacity of Health Centres in the Study Area, Rwanda (2022)

Sector	Hospital Name	Hospital Type	Founded in	Financing	NGOs involved	Origin of patients	Number of patients per day	Number of beds	Ambulance	Total Staff	Number of nurses		Nurse to patient ratio (day)
											Day	Night	
Rwinbogo [RA]	Rwinbogo Health Centre	Catholic Health Centre	1968	Local diocese exclusively	None	Rwinbogo, Nzahaha, Bugarama	120	30	No	22	6	5	1/20
Nzahaha [RB]	Rwinzuki Health Centre	Catholic Health Centre	2013	Local diocese + Government + NGO	Global Fund and Dynamic[17]	Nzahaha, Gashonga, Rwinbogo	120	20	No	24	5	5	1/24
Bugarama [RC]	Bugarama Health Centre	Islamic Health Centre	2010	Islamic centre + Government	-	Bugarama, Muganza	350	29	No	29	7	2	1/50

Table 8-23 Capacity of Health Centres in the Study Area, DRC (2022)

Village	Hospital Type	Founded in	Financing	NGOs involved	Origin of patients	Average Number of patients per week	Ambulance	Total Staff	Number of nurses	Nurse to patient ratio (day)
Ibambiro [CA]	Catholic health centre	1982	Diocese of Bukavu	Caritas, Conopro and PAM (malnutrition)	Covers 15 villages	62	No	7	4	1/9
Kayenge [CB]	Confessional health centre	1949	Self-financing through payments	GIZ (financial support and performance review)	Covers 6 villages	65	No	18	12	1/5
Rubumba [CC]	CEPAC Church Health Centre	2002	CEPAC	Life Net International (equipment), Prosanu (malaria), Panzi (sexual violence), Caritas (malnutrition), Coodilusi (HIV)	Covers 9 villages	40	No	13	7	1/6
Ruduha [CD]	CECA	2005	CECA	None	Ruduha village mainly	40	No	2	1	1/20

[17] The Director of the health centre reported that Dynamic is an NGO which provides services to support children from their birth to their 15th year, whilst Global Fund helps by paying the salary of a few nurses.

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8.7.1.2 DRC

In DRC, out of 9 villages in the study area, only two have one health centre and one has two, for a total of four health centres. These health centres also cover several other villages outside the project area for primary health care. In the past, these health centres were owned by religious denominations and were subsidized and staffed by these denominations. Currently, the Congolese state manages these health centres. These centres no longer receive subsidies. The functioning of these centres is currently based on the monetisation of care.

The main issues encountered by the health centres were the same in all of the places surveyed. The main challenges included:

- Lack of funds to finance the purchase of medicines, due to the low financial capacity of patients who cannot afford treatment.[18]
- Lacking equipment and bad infrastructure (old structures, lacking laboratory equipment and capacity, lack of electricity and water, no separation between the houses and the centre).
- Lack of appropriate beds. Health centres in the study area have between one or two rooms for hospitalisation, with a maximum of 4 beds. In the centre of Kayenge, the social experts on field found that two mothers were sharing a bed and the new borne babies were sleeping on the floor.
- Lack of an ambulance or any appropriate transportation to the hospital. The only public hospital is found in Nyangezi, more than 30 km away from Kamanyola Groupement on a bad quality road. The only ambulance which this hospital owns cannot meet the high needs of the region and is never available to transport those who need to be taken to hospital, according to the interviews with the health centres.

The village of Nachirongwe also has an association called Groupe de Relais Communautaire, or Community Relay Group, which is concerned with increasing community health sensibilisation.

Table 8-23 illustrates the capacity of the health centres observed in the study area. Table 8-24 shows the most common issues treated in the health centres in the study area, alongside their most affected group.

Table 8-24 Most Common Issues Treated in the Health Centres, DRC (2022)

Illness	Most affected group	Reported in
Malaria	Children under 5 and pregnant women	Whole Study Area
Typhoid	Whole population	
Acute Respiratory Infection	Children under 5	
Malnutrition	Children under 10	
STDs	15 to 40-year-old, women and men	
Intestinal Worms	Whole population	
Diarrhoea	Children under 5	
Gastritis	Adults	
Rheumatism	Adults	
Bilharzia	Whole population	
Cholera	Adults	Bujenjeri
Hepatitis B	Adults	Kayenge
Ankylostoma	Whole population	Ibambiro
Amoebiasis	Whole population	
Taenia	Whole population	

[18] These centres is that they all require a payment for treatment. Due to widespread poverty, most people are treated under a credit scheme but are unable to repay the hospital which prevents them from seeking treatment again or causes high debts.

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8.7.2 Main Health Issues Treated in the Study Area

8.7.2.1 Vector-Borne Diseases

A Malaria

Across the study area and at national level, malaria remains one of the greatest threats to public health, taking its greatest toll on children under 5 and pregnant women. Health centres reported that the months with the highest malaria cases are during the rainy season, from September to April. Malaria is mostly frequent affecting children younger than 5 years old, pregnant and nursing women.

In Rwanda, malaria is endemic in 11 districts, including Rusizi. In the western province, 64% households have at least one insecticide-treated net (ITN), but only 27% have more than 1. The percentage of positive malaria testing is 3.1% for children aged 6-59 months and 1.7% for women aged 15-49. Both rates are slightly higher than national average for rural areas, respectively of 2.9% and 1.3%. Hospital referral rates for malaria are low: in December 2019, Bugarama health centre hospitalised 33 people, of which 24 adults and 9 children, out of 1,176 malaria diagnosis. In DRC, Sud-Kivu is the region with the highest hospitalisation rate for malaria in the country, with around 49% of hospitalisation being caused by severe malaria cases (Ministry of Health, 2014).

Health centres reported that the months with the highest malaria cases are during the rainy season, mostly from November to February. Table 8-25 shows the number of cases reported by each centre for the months of December-January, which are considered two of the months where exposure to malaria is highest.

Table 8-25 Number of Malaria Cases per Month (December-January), by Health Centre (2022)

Country	Health centre	Number of cases per month (Dec-Jan)	Malaria Case to Total Patient Ratio (monthly)
Rwanda	Rwinbogo	33	1/87
	Rwinzuki	120	1/24
	Bugarama	1,176	1/7
DRC	Ibambiro	200	1/2
	Kayenge	160	1/2
	Rubumba	162	1/2[1]
	Ruduha	80	1/2

[1] *For the health centres of Rubumba and Kayenge, the calculation is based on the data provided by the health centres on the average number of patients per week suggested that around 100% of patients visiting the centre was diagnosed with malaria. Since this is not considered realistic, it has been assumed that during rainy season the numbers of patients would have been higher: the rate of ½ has been selected based on this assumption.*

In DRFC, malaria is only treated in health centres, aside from traditional herbal remedies. In Rwanda, malaria rapid diagnostic tests are taken by health workers before treatment with artemisinin-based combination therapy (ACT). Most malaria cases can be treated at the level of the village, although some of the more serious cases, especially those affecting children and pregnant women, are sent to the closest health centre. Table 8-26 shows the number of cases by village, based on data collected by health workers in each village.[19]

[19] This data was not collected for the villages of Mubombo and Gombaniro. Due to time constraints, this interview focused solely on downstream flooding and did not collect any data on health.

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Table 8-26 Estimated number of malaria cases reported between December and January by village, Rwanda (2022)

Village	Number of cases per month (Dec-Jan)	Cases to total population ratio	Distance from the river
Nyagahanga	30	1/22	1.2 km
Ryagashytsi	30	1/22	2.9 km
Ruganzo	30	1/27	1.4 km
Gatebe	50	1/18	Riverside
Kabusunzu	50	1/22	Riverside
Mwaro	60	1/33	Riverside

According to the quantitative survey, in DRC 93% of surveyed households have had malaria in the last 3 months, as opposed to 69% in Rwanda. In Rwanda, more people reported treating malaria by going to the hospital, while in DRC more people have gone to a health worker (See Table 8-27).

Table 8-27 Malaria Treatment by Surveyed Households in the two Years Preceding the Survey (2022)

		Never treated	Health worker	Hospital	With Medicinal Herbs or Plants
Rwanda	Man-headed Households	1%	12%	2%	1%
	Woman-headed Households	-	8%	-	4%
	All Households	-	11%	1%	1%
DRC	Man-headed Households	2%	2%	28%	9%
	Woman-headed Households	6%	5%	27%	14%
	All Households	3%	3%	28%	11%

B Bhilarzia and Onchocerchiasis

In Rwanda, the only health centre that mentioned Bhilarzia cases is Bugarama health centre. They reported getting around 20-30 cases mostly in the month of September. However, the health centres do not differentiate between intestinal and urinary bhilarzia. Consequently, it is assumed that data on the illness encompasses the two types. In DRC, bhilarzia has been mentioned as a rare illness, infrequently experienced by people living on the Ruzizi plain, around the areas of Bufuliru and Nyangezi. The health centres interviewed support around 1-3 patients a year from this area.

No cases of Onchocerchiasis have been mentioned by any of the health centres.

8.7.2.2 Diarrhea, Acute Respiratory Infections and Fever

Aside from vector-borne diseases, the most frequently treated illnesses in the health centred surveyed are acute respiratory diseases (ARI) and diarrhea. ARIs are one of the leading causes of childhood morbidity and mortality, especially due to pneumonia. Diarrhea is particularly frequent in children, for whom it is still a major cause of death even though the condition can be treated with oral rehydration therapy (ORT). This illness is mostly caused by the consumption of contaminated water and to unhygienic practices in food preparation and disposal of excreta.

In Rwanda, health workers in the interviewed villages explained that drinking water from the Ruzizi river is often what causes cases of dhiarrea. The RDHS (2014) revealed that 18.4% of children under age 5 in the western province had had diarrhea in the 2 weeks preceding the survey, while 28% had had a fever: this makes the western province the one with the highest diarrhea and fever cases in the country.

In DRC, the National Health Survey (2021) found that more than one in five children suffer from diarrhea in the weeks prior to the interview and that 8.2% of children under 5 had symptoms of ARI. This data makes the region the one with the highest number of cases for both illnesses. Table 8-28 shows the number of cases of ARI treated by each of the health centres in the study area.

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Table 8-28 Number of ARI Cases Treated by Each Health Centre, DRC and Rwanda (2022)

	Health centre	Number of cases per month
Rwanda	Rwinzuki	1,314
	Rwinbogo	-
	Bugarama	2,500
DRC	Ibambiro	30
	Kayenge	70
	Rubumba	10
	Ruduha	80

According to the quantitative survey, 40% of surveyed households had at least one member who had diarrhoea and 28% had ARI in the three months weeks preceding the survey. In DRC, the reported numbers were respectively 32% and 36% (See Table 8-29).

Table 8-29 Other Illnesses Experienced by Surveyed Households in the Three Months Preceding the Survey (2022)

		Diarrhoea	Respiratory infection
Rwanda	Man-headed Households	40%	27%
	Woman-headed Households	42%	35%
	All Households	40%	28%
DRC	Man-headed Households	31%	35%
	Woman-headed Households	32%	40%
	All Households	32%	36%

8.7.2.3 HIV/AIDS and Other Sexually Transmitted Diseases (STDs)

In both DRC and Rwanda, all the health centres interviewed mentioned STDs and HIV as major challenges, as can be seen in Table 8-30.

Although health centres in both countries are used to treating STDs, in DRC the health centres have reported that it is still considered more common to treat STDs with herbal remedies and village-level treatments rather than seek medical support. People who tend to come in with HIV cases are either young men in the military or young men and women between 20 and 25 years old. The most frequent STDs are syphilis, gonorrhoea, gonococcal disease. Based on national statistics, women seem slightly more likely to seek treatment for STDs more frequently than men, although men are often more exposed than women. In Rwanda, in the western province, 64% of women and 62% of men reported going to a clinic to receive treatment, although only 0.9% of women reported having more than 2 partners in the past 12 months, as opposed to 6.2% of men. Awareness and education about sexual health is still low: in the Rusizi District, only around 4.9% of people use condoms (NISR, 2021).

Acquired immunodeficiency syndrome (AIDS), which is caused by the human immunodeficiency virus (HIV), is one of the most serious public health challenges facing Rwanda and DRC. However, since 2005 HIV prevalence in Rwanda has remained stable at 3%, and new HIV infections have declined from 27 to 8 per 10,000 people (Health Sector Performance Report 2019-2020). The only village in the study area that reported HIV cases is Ruganzo, where there are 10 people who have been diagnosed with HIV in Rwinbogo Health Centre.

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Table 8-30 HIV Cases Reported in Health Centres, Rwanda and DRC (2022)

Health Centre	Number of STD Cases per Month	Number of People Under HIV Treatment
Rwinbogo	-	-
Rwinzuki	75	85
Bugarama	-	540
Ibambiro	-	2
Kayenge	-	24
Ruduha	10	-
Rubumba	-	6

8.7.2.4 Malnutrition

Malnutrition was mentioned by all health centres as a major issue. In DRC, Sud-Kivu is the province with the highest level of malnutrition in the country, with a rate of 53% for the province's population (Ministry of Health, 2014). All villages in the DRC side of the study areahave more than 10 people suffering from malnutrition, most of which are children under 10. In Ibambiro, around 20 children and 10 pregnant women per month are treated for malnutrition. In Rwanda, according to the DHRS (2014) 33% of Rwandan children aged 6-59 months are stunted, 1% are wasted, 8% are underweight, and 6% are overweight. In the western province, only 18% of children aged 6-23 months were fed a minimum acceptable diet and 41% of children age 6-59 months are anaemic.

In Rwanda, all villages in the study area reported that no more than 10 children are suffering from malnutrition. Ruganzo and Ryagashyitsi have reported malnutrition as a particularly serious issue for women and children. The Bugarama health centre is the one with the largest capacity for malnutrition support, which can be provided for free for people within the categories 1 and 2 of the Ubuduhehe Scheme: currently, 145 people are under a malnutrition support scheme: of these, 40 are children while 105 are adults suffering from HIV.

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8.8 Community Infrastructure

8.8.1 Roads

The condition of roads is bad throughout the whole study area. In Rwanda, the only roads in better condition are the ones in the semi-urban Bugarama Sector: here, the village of Kabusunzu presents some asphalted roads, whilst Gatebe, Mwaro, Gombaniro and Mubombo do not (See Figure 8-79 and Figure 8-80). In DRC, the condition of roads across the study area is equally bad in all villages (See Figure 8-81).



Figure 8-79 Road in Nyagahanga (Nzahaha), Rwanda (2022)



Figure 8-80 Road in Gatebe (Bugarama), Rwanda (2022)



Figure 8-81 Road in Bugano, DRC (2022)

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8.8.2 Schools

In Rwanda, in the study area all observed schools are built in bricks with windows (See Figure 8-86), but the study area is equally lacking in terms of number of schools. Out of 8 villages, only 5 are covered by one school, of which only one is secondary.

In DRC, most of the study area is not covered by schools. Out of 9 villages, only 5 are covered by one or two schools with Kayenge having 4 schools, for a total of 9 schools. Most of these schools are primary only (See Figure 8-82 and Figure 8-83) and only 2 offer secondary education as well (See Figure 8-83) According to observations carried out on field, all of the schools are badly equipped and have insufficient infrastructure. In particular, the primary school of Nachirongwe only has 6 classes to accommodate children from various villages in Ishamba. Two more classes have been created to study in the CELPA Sinai Church, which has offered its premises for learning (See Figure 8-84 and Figure 8-85).

Table 8-31 summarises the schools observed in the study area, by country, village and school type and Figure 8-78 shows the location of the schools.

Table 8-31 Schools Identified in the Study Area (2022)

Country	Village	School Type	Origin of Students
Rwanda	Nyagahanga	[R1] Primary School	Nyagahanga, Ryagashyitsi, Ruganzo
	Gatebe	[R2] Primary School	Gatebe
	Kabusunzu	[R3] Primary and Secondary School	Mwaro, Gatebe
	Mubombo	[R4] Primary School	Mubombo
	Gombaniro	[R5] Primary School	Gombaniro
DRC	Kayenge	[C1] Two Primary Schools	Kayenge, Kansheyi, Kaboya
		[C2] Kayenge Primary and Secondary School	
	Ruduha	[C3] Primary and Secondary School Ngomo Ruduha	Ruduha
	Nachirongwe	[C4] Primary School	All Ishamba
	Ibambiro	[C5] Primary School	
		[C6] Secondary School	All Ishamba
	Bujenjeri	[C7] Primary School (in construction)	Planned for Bujenjere, Nachirongwe, Mubumbano

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Figure 8-82 Primary School in Kayenge (2022)



Figure 8-83 Primary and Secondary School in Ruduha (2022)



Figure 8-84 Primary School in Nachirongwe (2022)



Figure 8-85 CELPA Church used as School in Nachirongwe (2022)



Figure 8-86 Primary School in Nyagahanga (2022)

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8.8.3 Water Supply

According to the Rwanda Demographic Health Survey 2020, in Rwanda 80% of households nation-wide have access to an improved water source, with urban households having a much better access (96%) than rural (77%). The most common sources of drinking water in urban households are water piped into the household's dwelling, yard, plot, or neighbour yard (50%) and public taps or standpipes (26%). Rural households obtain their drinking water mainly from protected wells or springs (36%) and public taps or standpipes (31%).

In the Rusizi District, in 2014 27% of people still used an unimproved source of drinking water, making the district lag behind national targets by 12 percentage point (NISR, 2014). Although this aspect may have improved since 2011, interviews across the study area indicated that drinking unimproved water from the river is still a widespread practice. According to the RDHS, 41% of rural households reported having to travel more than 30 minutes (round trip) to obtain drinking water. In the western province, only 54.8% have an improved drinking water facility within a 30-minute walk. In DRC, the proportion of households using safe drinking water increased from 46% in 2007 to 49% in 2013. In rural areas, this proportion went from 24% to 32%, while in urban areas it went from 80% to 85% (Ministry of Health, 2014).

In the study area, a minority of the households interviewed as part of the quantitative households' survey use the Ruzizi River as their main drinking water source, as shown in Table 8-32 below. The Ruzizi River is more used in the downstream areas of the study area, where settlements are closer to the river than in the reservoir area, where they are located at the top of the slopes. Some of the water supply systems observed across the study area were not functioning, while others are either private faucets or paid points: the later were only observed in the Rwandan village of Ruganzo. Out of the functioning water points, almost all were built out of cement or mud with a tap (See Figure 8-87), while only one was a natural spring (Figure 8-88). In Nyange and Pera Cells, wealthier people have taps that do not work very efficiently and often can go on without working for 2 days. Those that cannot afford a tap use the water from the river for all drinking and domestic purposes. In the village of Ryagashyitsi, water has not been working since September and people have to walk an hour to get to a different source. In the study area, only Nyagahanga had a working water point within the village premises. All of the other villages walk until another point, apart from the villages in Bugarama Sector, where it is more common to drink from the riverside for families who cannot afford faucets or bottled water.

As shown in Table 8-33, surveyed households declared the time needed to collect drinking was most frequently less than 30 minutes in Rwanda, and up to one hour in DRC. The majority of households reported taking water several times a day, both in Rwanda (86%) and in DRC (76%), as illustrated in Table 8-34.

Table 8-32 Main Source of Drinking Water Amongst Surveyed Households (2022)

Country / Groupement or Cell	Ruzizi River	Tap / water point	Another river closeby	A spring	Total
DRC	36%	27%	11%	25%	100%
Kamanyola	70%	26%	2%	3%	100%
Karhongo	6%	29%	20%	45%	100%
Rwanda	5%	71%	23%	-	100%
Bugarama	13%	83%	3%	-	100%
Nzahaha	2%	66%	31%	1%	100%
Total	25%	42%	15%	17%	100%

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Table 8-33 Time Necessary to Reach a Water Collection Point Amongst Surveyed Households (2022)

	Rwanda			DRC		
	Man-headed Households	Woman-headed Households	All Households	Man-headed Households	Woman-headed Households	All Households
Less than 30 minutes	78%	73%	77%	36%	45%	39%
Between 30 and 1 hour	18%	23%	19%	38%	44%	39%
Between 1 and 2 hours	3%	4%	3%	16%	5%	13%
More than 2 hours	1%	-	-	10%	4%	8%
Total	100%	100%	100%	100%	100%	100%

Table 8-34 Frequency of Water Collection Amongst Surveyed Households (2022)

		Several times a day	Once a day	Once every 2 days	Total
Rwanda	Man-headed Households	86%	13%	1%	100%
	Woman-headed Households	85%	15%	-	100%
	All households	86%	13%	1%	100%
DRC	Man-headed Households	78%	19%	3%	100%
	Woman-headed Households	73%	25%	2%	100%
	All households	76%	21%	3%	100%



Figure 8-87 Public Water Point in Cement with Tap (Nyagahanga, Rwanda).



Figure 8-88 Natural Water Spring (Nyagahanga, Rwanda).

8.8.4 Sanitation and Waste Management

In Rwanda, only 69% of rural households nationwide have access to improved sanitation facilities, of which 69% in rural areas (RDHS, 2015). In western province, 74.6% of people use an improved sanitation facility, whilst 2.5% of people practices open defecation. In DRC, the proportion of households that use an improved sanitary installation is lower, at 17% of rural households overall (Ministry of Health, 2014).

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In the study area of both countries, most households had an external latrine, which can be either individual or more frequently shared between multiple houses (See Figure 8-89 and Figure 8-90)



Figure 8-89 Example of an External Non-Shared Latrine in Ryagashyitsi, Rwanda (2022)



Figure 8-90 Example of an External Non-Shared Latrine in Kafunda, DRC (2022)

8.8.5 Source of Energy for Lighting and Cooking

Across the study area, most people reported cooking with firewood due to the high cost of charcoal, while no one reported cooking with gas. When collected, charcoal is often sold, rather than used for cooking. As for lighting, lack of electricity or bad electrification is a widespread issue.

In Rwanda, In the Pera Cell, the Executive Secretary reported that 8 in 12 villages have almost no electricity. All of the other villages also reported having very bad electricity in some houses and no electricity at all in most houses. On the national level, only around 46% of households have electricity on average, with 37% in rural areas and 86% in urban areas (NISR, 2021). Amongst the households interviewed during the quantitative survey, 70% declared they had access to electricity (87% in Bugarama Sector and 63% in Nzahaha Sector).

In DRC, only 14% of households have electricity in their residence. Although 42% of urban areas are electrified, 99.6% of rural areas are not (Ministry of Health, 2014). None of the villages in the study area in DRC are electrified. Amongst the households interviewed during the quantitative survey, 11% declared they had access to electricity (18% in Kamanyola Groupement and 4% in Karhongo Groupement).

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8.9 Gender

Rwanda and DRC present a significantly different picture when it comes to gender empowerment and discrimination as observed on a national level. In 2021, Rwanda ranked 66th in the world on the Women Peace and Security Index, despite its 160th position on the Human Development Index, revealing important achievements for women despite low levels of income, health and education (GIWPS, 2021). In 2020, Rwanda was also listed 9th in the world by the Global Gender Gap Index of 2020. However, the gender-based policies developed by the Rwandan government have often been result-oriented and quantitative in nature, failing instead to address deeply ingrained societal norms and power structures within which gender inequalities are embedded (Debusscher, P. and Ansoms, A., 2013).

In DRC, gender discrimination and gender-based violence are major issues. DRC scored 163rd out of 170 countries on the Women Peace and Security (WPS) Index of 2021, gaining the worst score for gender-based violence (GIWPS, 2021). DRC was also listed 149th out of 153 countries in the Global Gender Gap Index of 2020. In particular, the Sud-Kivu province suffered from heightened gender-based violence due to influx of refugees after the 1994 genocide in Rwanda, the following conflicts from 1996 to 2002, and the continuing instances of assaults and isolated violence in the area.

Across the study area, women are not only suffering from a limited access to secure land tenure and having to balance domestic tasks with the work on the fields, but they are also struggling to gain control over their income and develop bargaining power in domestic decisions and economic transactions. While women may officially have access to the same opportunities and resources as men, gender-based focus groups have revealed that women are constrained in their ability to control their access to and use of tools and resources to improve their livelihoods.

The following sections explore the four main elements of gender-based inequality observed in the study area: (i) land tenure insecurity, (ii) little control over resources, (iii) gender-biased distribution of tasks and (iv) gender-based violence.[20]

8.9.1 Rwanda

8.9.1.1 Land Tenure Insecurity

The majority of females in Rusizi district are small-scale farmers 69.5%, which emphasises women's needs to secure access to a cultivable field for their livelihood (NISR, 2021).

When it comes to land, in Rwanda women can officially inherit land, but they often do not due to the low availability of land. Since men in Rwanda are expected to pay or provide resources for their bride, male children are often prioritised when land is given off to them at the time of their marriage. Land inheritance in Kinyarwanda is defined as a system of 'gift' giving from parents to children. Once families decide to split their land, they need to call neighbours and family on site to act as witnesses to the transaction. When a man gets married, he is given two plots, one for the house and one for cultivation. When a woman gets married, she is given, if available, a plot for cultivation only alongside a material dowry made of objects for the house.

According to focus groups with men and women, the most common way for women to obtain a land title is through an official marriage. When women are legally married, their name will appear on the husband's title once the marriage has been officialised at the Cell. Shared land

[20] Gender-Based Violence (GBV) is an umbrella term for any harmful act that is perpetrated against a person's will and that is based on socially ascribed gender differences (World Bank, 2018). The term GBV stems from the 1993 United Nations Declaration on the Elimination of Violence against Women, which defined violence against women as 'any act of gender-based violence that results in, or is likely to result in, physical, sexual or psychological harm or suffering to women'. While GBV disproportionately affects women and girls across the globe, men and boys can also experience GBV and these acts are highly stigmatized and often stay hidden and unreported.

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titles for married couples are common: as shown in Figure 8-91, 70% of male-headed households surveyed in 2022 have a land title with the name of the wife alongside the name of the husband. In case of divorce, the property should be legally shared between the husband and the wife.

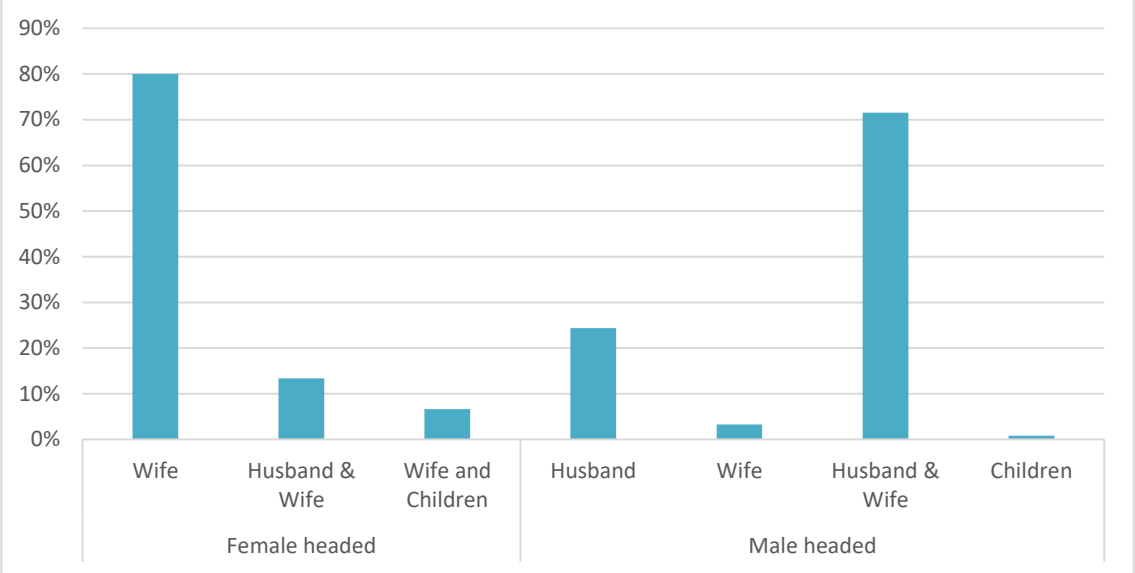


Figure 8-91 Owner of the Land Title Deed by Gender of Household Head, Rwanda (2022)

While the shared titling system is advantageous for legal wives, this poses a problem for the high number of women engaging in a polygamous relationship as non-legal partners. Polygyny is defined by the Government as a practice according to which women report that their partner has one or several other wives. In the Western Province, 7.4% of women report having co-wives, close to the national average of 8% (NISR, 2014). Women interviewed in Mwaro explained that men often avoid marrying a woman in order to keep the land. Culturally polygamy is widely normalised. 'Unofficial wives' do not get any legal or financial benefits out of the relationships, and they are often locked in landless conditions working on a plot of land which belongs to the husband and will be taken away at the termination of the relationship. Unofficial wives are seen by Rwandan women as the most vulnerable women in villages. In the Rusizi District, 26.2% of households are headed by females and 6.4% are 'de facto female-headed households', i.e. those headed by females in the absence of a male head who is ordinarily present. Due to the higher difficulty in security land without a husband or inheriting property as a widow, these households are more likely to remain landless or homeless (NISR, 2021).

Additionally, it may be more difficult for a woman to buy land. If land is sold within a family, husband and wife will discuss their options and share ideas but it is men who then go and look for buyers/sellers, negotiate the price and carry out the transaction. This has been conformed throughout all interviews during the social surveys. The Box 8-5 below presents the story of a widow losing her 1 hectare of land due to the Project and has expressed her fears regarding her ability to find and negotiate prices for a new plot.

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Box 8-5 Story of a Widow with Seven Children in Ruganzo Village

This woman is a widow with seven children, who has been living all her life in the village of Ruganzo. Her kids go from a few months to the age of 19 and they all live in her house. Since she lost her husband, she has been left with the land plot that she inherited through the marriage. She owns 1 hectare and is thanks to this considered to be one of the people with the largest land resources in the village, although this is not enough to feed all of her children. This woman's field will be taken fully by land acquisition. She has already enquired around the village to plan for the land that she will need to buy and she estimates that the price due to speculation will be around 10 million Rwandan francs. She is very worried that compensation will not cover these high costs and that she will need to sell her house and send some children to work to be able to pay for new land. Additionally, she feels that being a woman will make it harder for her to negotiate a fair price, because usually the negotiation phase of land buying is left to men.

8.9.1.2 Access to and Control over Resources

In addition to the issues related to land tenure security, women usually have less control than men their own or the family's income. Out of the 84% of married women who are employed in Rusizi District, 23% were not paid, in contrast with 8% of men. For those that did earn cash, 23% report that they themselves mainly decide how their cash earnings are used and 67% report that they make such decisions jointly with their husbands. Regarding their husband's earnings, 24% said that their husband makes these decisions alone and 70% said that the decisions are made jointly (NISR, 2021). Overall, in the Western Province 61.5% of married women reported feeling that they participate in decisions regarding health, purchases and visits to their family, as opposed 91.6% of men (NISR, 2021).

Table 8-35 shows a breakdown of women's access to and control of resources and the benefits arising from these, according to the focus groups carried out across the study area.

Table 8-35 Access to and Control over Resources in Rwanda, Disaggregated by Gender (2022)

Resource	Access to the resource	Control of the resource	Control of the benefits obtained from the resource
Land	Mostly men	Mostly men	Mostly men
Natural Resources	Equally men and women	Mostly women	Mostly women
Paid Work	Equally men and women	Mostly men	Mostly men
Financial Services (ex. Micro-Credit)	Mostly women	Mostly men	Mostly men
Education	Equally men and women	Mostly men	Mostly men
Domestic Decision-Making	Equally men and women	Mostly men	Mostly men
Village-Level Decision-Making	Equally men and women	Equally men and women	Equally men and women
Healthcare	Equally men and women	Mostly men	Equally men and women

In the Study Area, women reported participating actively to the life of the village and feeling represented by all collective institutions. However, women explained that men often take control of their income, which often results in domestic disagreements because women prioritise health and education expenses whilst men are more likely to spend money less wisely on alcohol, transport or investments which may not bring benefits to the wives. According to NISR (2021), nearly half of women in Rwanda report at least one problem associated with accessing health care for themselves. The least and most common problems women face in accessing health care are getting permission to go for treatment (4%) and getting money for treatment (52%) and distance problems (25%). Lack of the husband's permission or support in finding transportation to a health centre can result in different types of complications: for example, Rwinbogo Health Centre reported that 50 to 70 children die on site each month due to complications caused by late hospital arrivals or attempts at giving birth in the village.

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During the focus groups with men and women, the social experts mapped all of the cash expenses of the average household in the study area. Men and women were asked who was in charge of physically making the payment, whose money went into the payment and who decided whether the payment had to be made. Table 8-36 summarises the findings.

Table 8-36 Estimated Household Expenses in the Study Area (2022)

Expense	Amount	Frequency of payment	In-charge of deciding whether to pay	In charge of making the payment	In charge of finding money for the payment
Security Fee (paid to the village security volunteers)	1,000 francs	Monthly	Compulsory	Husband	Husband and wife
Primary School Fees	12,000	Yearly	Husband	Wife	Husband and wife
Secondary School Fee	50,000	Yearly	Husband	Wife	Husband and wife
Health Insurance	3,000	Yearly	Husband	Husband	Husband and wife
Feeding School Program	3,500	Each trimester	Husband	Wife	Husband and wife
Financial Services (ex. Micro-Credit)	500-10,000*	Weekly	Husband	Mostly wife	Husband and wife
Rent	Variable	Variable	Husband	Mostly husband	Husband and wife

**Focus groups in Mwaro revealed that micro-credit associations at the village level are fixed at 500 francs a week, but some wealthier people can pay up to 10,000. The amount of money that can be loaned is proportional to the contribution.*

Micro-credit organisations at village level are often used by women as a way of gaining control over financial resources. In Mwaro, out of 60 members 50 are women and in Gatebe out of 40 members are 30 are women. Unless they own a shop or small activity, women feel that they do not have a valid reason to open a separate bank from their husband. Box 8-6 presents an insight on women's financial lives according to three women in Kabusunzu.

Box 8-6 Story of Three Women's Financial Constraints in Kabusunzu, Rwanda

These three women are married with children. They have irregular access to cash from selling at the market, which is an activity exclusively practiced by women whenever the family is left with agricultural surplus. When women sell, they take the money back home to give it to their husband. In their opinion, it is rare for women to own bank accounts or manage their own shops. The majority of men have multiple women and often mistreat them, some of them may fall in love with a man that already has a wife but does not tell them until they are already pregnant or living together. Before taking any money from the family's resources, wives have to ask for permission: this is a problem in their view, because men have multiple children and try to avoid these expenses to spend money instead on drinking with friends or travelling to other villages to find new wives.

8.9.1.3 Gender-Based Distribution of Tasks

Table 8-37 shows the gender-based separation of tasks at the domestic level. On the basis of the information provided by the focus groups carried out all across the study area, each activity was categorised as practiced exclusively by men / women, practiced mostly by men / women, practiced equally by men and women and practiced by neither. In the case of equal participation, if different activities are practiced by men and women within the same task, this has been specified.

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Table 8-37 Distribution of Tasks by Gender, Rwanda (2022)

Activity Type		Nzahaha Sector		Bugarama Sector	
		Practiced by men	Practiced by women	Practiced by men	Practiced by women
Productive Activities	Formal Employment	N /A [21]			
	Informal Employment	x	x	x	x
	Commerce / Business			x	x
	Subsistence Agriculture	x	x	x	x
	Cash Cropping	x	x	x	x
	Market Selling		x		x
Reproductive Activities	Health of Children and the Elderly		x		x
	Water Collection		x		x
	Firewood Collection		x		x
	Charcoal Collection	x		x	
	Sand Collection	x		x	
	Cooking		x		x
	Washing Clothes and Bathing Children		x		x
	Cleaning / Washing Dishes		x		x
Communitarian Activities	Village-level Associations	x	x	x	x
	Religious Associations	x	x	x	x
	Decision-Making	x	x	x	x
	Micro-credit Associations		x		x

8.9.1.4 Gender-Based Violence

Domestic violence is widespread across the study area. According to provincial-level data, in the Western Province 39% of women aged 15-49 have experienced physical violence and 33% have ever experienced sexual violence, the highest rate in the country (NISR, 2021). The health centres visited during the qualitative survey were all aware of the high numbers of cases of physical and sexual violence against women. They reported that most women deal with these issues at village level, often using committees that can help solve domestic problems or simply seeking help with friends and family. Most health centres, however, reported having been in the situation where someone came as a victim of violence: in this case, they can provide assistance and consultation, and refer the case to the District hospital is the victim is in need of urgent help. Table 8-38 shows the estimated number of women that can turn up with medical issues due to sexual or physical violence.[22]

[21] None of the people interviewed as part of the qualitative survey reported being engaged in formal employment.
[22] It is important to note that this figure may be a very rough estimation. The social expert asked the interviewee to think of the months in the past year where this issue was identified most frequently and come up with an estimate of this kind. However, these trends are by no means repeated every month.

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Table 8-38 Cases of GBV per Month, by Health Centre in Rwanda (2022)

Health Centre	Average number of cases per month
Rwinbogo	2
Rwinzuki	3
Bugarama	2

During the gender-based focus groups, women have discussed two different types of GBV: domestic and worker-related.

As for the first type, provincial data (NISR, 2021) shows that 32.5%, 38.1 % and 16.8% of women respectively experienced emotional, physical and sexual violence by their husbands. In the western province of Rwanda, 74% of women and 47% of men agree that a husband is justified in beating his wife in at least one of seven circumstances, including if the woman burns the food, argues with him, goes out without telling him, neglects the children, refuses to have intercourse, has sex with someone else or looks in his phone. Women in the study area reported that it is common for women to be shouted at or badly treated by a husband: physical violence is rare, but when it takes place women gather together to support each other and can appeal to the village committee to denounce the bad behaviour. In most of the villages in the Study Area, women reported that issues of sexual violence are frequent, especially between young girls and married men. At domestic level, both verbal and physical violence are recognised by the women as issues that are commonly discussed amongst wives. Extra-marital rape and violence is reported as the most common way in which this plays out. As for worker-related GBV, instances of sexual violence have been found in regard to two previous projects: the Gishoma Geothermal Power Plants in Ryagashitsi and the construction of the Bugarama-to-Gisheke road in Gatebe, Kabusunzu and Mwaro.

A Gishoma Geothermal Power Plant

The Gishoma project is located at the beginning of the village of Ryagashitsi. During a focus group, women reported an experience of gender-based violence during the operation of the plant. The information is summarised in Box 8-7 below.

Box 8-7 Insight on GBV by Women in Ryagashytsi

The interviewed women pointed out a fair-skinned child and explained that he was born out of one of three pregnancies caused by Chinese workers from the Power Plant close to the village. They explained that several workers 'took advantage' of young unmarried girls, promising them wealth and a marriage only to get them pregnant and before disappearing. They explained that the unwanted pregnancies were difficult for these women, who were rejected by their families and whose children were perceived as outsiders. The Chinese worker community comes every summer since 2013, they do not live in the village or mix with the villagers in any other way apart from taking advantage of women. In addition to this impact, women also explained that they have been suffering from vibration and wastewater which is thrown into the village during the phases of operation.

B Bugarama-to-Gisheke Road Project for RuziziIII

This project was initiated in 2011 to build the access road that would lead to the RuziziIII dam. According to interviews, works lasted about 2 years and mobilised around 200 workers who resided in Kabusunzu and Gatebe. According to the women in both of these villages, these men were very undisciplined and started dating young women in the village. Many of these girls were not educated on how to protect themselves and unwanted pregnancies occurred. According to the women interviewed during the focus groups, most of these women were 'tricked into' having sexual relations with the workers, who in exchange offered them a marriage or relationship. According to the women in Kabusunzu, around 30 girls under 25 years old got pregnant, and a third of these got abortions through natural remedies, which resulted in serious complications for a few women that had to be transferred to the health centre. Additionally, a big problem that was experienced due to this wave of sexual activity was a rise in HIV cases

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amongst these young women, who had to go to the Bugarama health centre to get treated but were stigmatised by their family after this. None of the workers in the village actually got married to these girls and they all left the area at the end of the works. Some of them 'took away' some young girls who did not keep in touch with the family and never came back. Women in Mwaro, although far from the road, also reported cases of gender-based discrimination, as many of them were employed by the project to carry out jobs such as moving away the grasses before construction. Not only were women paid around 500 francs per day, which is lower than the average 700-1,000 they could get in agriculture, but they declared they were often fired without any apparent reason.

8.9.2 DRC

8.9.2.1 Land Tenure Insecurity

According to national law, land can be owned by any person, including women and regardless of ethnicity. However, according to traditional customary right, women are unable to own or control land, which they can only access through fathers, brothers or husbands. Under customary rules, female children do not inherit land from their parents. Women leave their father's household when they get married. The groom pays the father of the bride dot, or a bride price, and she becomes part of the household of her husband. Generally, women reported being able to access her husband's land, but restrictions on usage were common, especially in the village. For example, despite being the primary workers on agricultural land, women often cannot control what was planted or how those profits were used. After the husband dies, what happens to women depends on individual cases, but there is no customary law that assures them ownership of the land which her husband's family may try to take. Whether they can use the land or not, the name of women is often not put on the land title.

Polygamy is also a constraint to women's access to land. Despite the predominance of monogamous unions in the DRC, polygamy remains a practice affecting 24% of women in Sud-Kivu (Ministry of Health, 2014). Not owning land can result in a series of complications especially for woman-headed households. In fact, land titles are often necessary as a form of equity for accessing loans, credit and agricultural productive assets. Box 8-8 shows the story of a woman in Bugano riverside who works on a piece of land for her husband.

Box 8-8 Story of a Female Land Renter in Bugano, DRC

This woman is 55 years old, married and has been living in Kamanyola all of her life. Every morning she walks around 2 hours all the way to the riverside right after the village of Bugano. Here, she is renting a square plot of around 25 square meters for the monetary value of 100,000 Congolese francs per year: although she works here alone, it is her husband that decides what to do with the harvest and tells her to go sell produce when necessary. There are 8 more people, all women, working on this field and each person has been given 25 square meters for the harvest. She explained that women are allowed to buy land with cash, but it is considered strange for a woman to do so because she will either already have her family home or she will be married, in which case the husband will be in charge of buying shared lands. She believes that women who live alone as widows will struggle the most due to the difficulty of finding land to buy as a woman. Her husband has a plot that he works on and her work on this rented plot.

8.9.2.2 Access to and Control over Resources

According to the focus groups carried out across the study area, access to and control over resources and their benefits are shared between men and women. As opposed to Rwanda, women reported feeling like they had access to and control over all resources. However, their responses are likely to have been influenced by the fact that the surveyors in DRC were males. The lack of women's awareness regarding their limitations in accessing and using resources may

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also be due to lower levels of education, urbanisation and gender empowerment observed in the Congolese side of the study area, in comparison to the Rwandan side.

In addition to discrimination in land, women are discriminated in their access to decision-making and financial empowerment. Out of 40 villages in the territory of Walungu, there are no female chiefs or female committee members. This lack of representation in political power is reflected in a lack of control over productive resources. In the Walungu territory, women involved in a study by Women for Women International reported that men controlled 91% of all household decisions, from the purchase of the house and land to schooling decisions and expenditure of income and sales.[23]

8.9.2.3 Distribution of Tasks

Table 8-39 shows the distribution of domestic and village-level tasks disaggregated by gender, based on the information collected during focus groups. Compared to the findings in Rwanda, the division of tasks seems to be more equal in terms of gender. However, the information provided on the gender division of activities may have been influenced by the fact that all of the interviewers in DRC were male.

Table 8-39 Distribution of Tasks by Gender, DRC (2022)

Activity Type		Practiced by men	Practiced by women
Productive Activities	Formal Employment	N / A[24]	
	Informal Employment	x	x
	Commerce	x	x
	Subsistence Agriculture	x	x
	Commercial Agriculture	x	x
	Market Selling	x	x
Reproductive Activities	Health of Children and the Elderly	x	x
	Water Collection		x
	Firewood Collection	x	x
	Charcoal Collection	x	x
	Sand Collection	x	x
	Cooking	x	x
	Washing Clothes and Bathing Children		x
	Cleaning / Washing Dishes		x
Communitarian Activities	Village-level Associations	x	x
	Religious Associations	x	x
	Decision-Making	x	x
	Micro-credit Associations	x	x

8.9.3 Gender-Based Violence in DRC

Like in Rwanda, cases of GBV have been mentioned all across the study area. In particular, the Sud-Kivu province suffered from heightened gender-based violence due to influx of refugees after the 1994 genocide in Rwanda, the following conflicts from 1996 to 2002 and the continuing instances of assaults and isolated violence in the area. While gender-based violence was not

[23] WFWI (2021), 'A Place to Call Her Own: Land Titling and Gender-Based Violence in South Kivu, DRC, https://www.iucn.org/news/gender/202104/a-place-call-her-own-land-titling-and-gender-based-violence-south-kivu-drc, accessed on 08/03/2022.

[24] None of the people interviewed as part of the qualitative survey reported being engaged in formal employment.

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openly discussed, health centres mentioned dealing with women who report medical problems due to sexual and physical violence, as shown in Table 8-40.

Table 8-40 Cases of GBV per Month, by Health Centre in DRC (2022)

Health Centre	Average number of cases per month
Ibambiro	Rarely
Kayenge	3
Rubumba	2
Ruduha	Rarely

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8.10 Security and Human Rights

8.10.1 Rwanda

8.10.1.1 Security

Rwanda currently enjoys high levels of political stability and general security. However, there have been cross-border incursions and armed clashes along the border with DRC and Burundi. Vigilant security forces are limiting raids to brief cross-border attacks in the northwest (particularly Rubavu and Musanze districts) and along the southern border (particularly Rusizi, Nyaruguru, and Nyamagabe districts)[25]. Several military camps are established on the Rwanda side of the Ruzizi River. In July 2016, Burundi banned public transport vehicles from crossing the border with Rwanda. The border remains closed currently.

8.10.1.2 Human Rights Record

Rwanda ratified Convention No. 87 on Freedom of Association and Protection of the Right to Organise (1948) in 1988 and Convention No. 98 on the Right to Organise and Collective Bargaining (1949) in 1988. The law provides for the right to form and join unions and employer associations, bargain collectively, and strike, but it places restrictions on these rights. The International Trade Union Confederation (ITUC) global rights index reports violation of workers' rights in Rwanda[26].

The law prohibits all of the worst forms of child labor. The minimum age for full-time employment is 16, but children ages 13 to 15 are allowed to perform light work in the context of an apprenticeship. The law prohibits children younger than age 18 from participating in physically harmful work, including work underground, under water, at dangerous heights, or in confined spaces; work with dangerous machinery, equipment, and tools, or which involves the manual handling or transport of heavy loads; work that exposes the child to unsafe temperatures or noise levels; and work for long hours or during the night. The 2018 labour law determines the nature of other prohibited forms of work for a child.

The Ministry of Public Service and Labour conducted labour inspections of sectors of the economy known to employ children, focusing on domestic work and the agriculture sector. Observers note considerable political will to address child labour within the Ministry of Education, Ministry of Gender and Family Promotion, but the labour inspectorate remained underfunded and understaffed. The majority of child laborers are working in the agricultural sector and as household domestics. Child labour also exists in isolated instances in cross-border transportation and in the mining industry[27].

8.10.1.3 Rule of Law

The Rule of Law in Rwanda is a contentious topic. As many issues in Rwanda, the debate on the Rule of Law is highly polarised. The general picture that emerges is that of a government that builds institutions, such as the Public Procurement Authority, the Office of the Auditor General, the Ombudsman's Office, the Anti-Corruption Unit in the Rwanda Revenue Authority, Maisons d'Accès à la Justice, Commercial Courts, among others. These institutions' tasks and responsibilities are well defined by the law[28]. At the same time, the government is hesitant to

[25] https://crisis24.garda.com/insights-intelligence/intelligence/country-reports/rwanda
[26] https://survey.ituc-csi.org/Rwanda.html#tabs-2
[27] Human Rights report from the U.S. Department of Stats Bureau of Democraty, Human Rights and Labor.
[28] Rule of Law Quick Scan Rwanda. Prospects and Challenges. Roelof H. Haverman. 2012, HiiL, The Hague, The Netherlands.

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open up political space and freedom of expression. International and national NGOs report human right abuses by the police force, including arbitrary detention or ill-treatment[29].

8.10.2 DRC

8.10.2.1 Security

Since the 1990s, the security situation in the eastern area of DRC, and in Sud-Kivu, has been characterized by a succession of armed conflicts. After more than two decades of ongoing violent conflict, armed groups have become an integral feature of the eastern DRC's social-political order. The situation in Sud-Kivu is described by some as a "stable instability"[30]. Despite a decrease in there number in the recent years, there would still be more than 60 armed groups in Sud-Kivu[31]. The Walungu territory, where the Project is located, would be the territory of sud-Kivu with the lowest presence of armed groups (only 2 or 3, at its borders with other territories). In 2021, 17 incidents with armed groups (with 22 victims) have been recorded in the Walungu territory (3 near Kamanyola and 2 on the road between Kamanyola and Bukavu), out of a total of 593 incidents with 1,052 victims recorded in Sud-Kivu[32].

8.10.2.2 Human Rights Records

The Democratic Republic of the DRC ratified Convention No. 87 on Freedom of Association and Protection of the Right to Organise (1948) in 2001 and Convention No. 98 on the Right to Organise and Collective Bargaining (1949) in 1969. Although the freedom of association and collective bargaining is defined by the Labour Code and is enshrined in the Constitution, the International Trade Union Confederation (ITUC) global rights index reports violation of workers' rights in DRC[33].

The government prohibits all of the worst forms of child labour. The law sets the minimum age for work at 16, and a ministerial order sets the minimum age for hazardous work at 18. The law also stipulates children may not work for more than four hours per day and restricts all minors from transporting heavy items. The Ministry of Labour has responsibility for investigating child labour abuses but had no dedicated child labour inspection service. In 2016 the National Labour Committee adopted an action plan to fight the worst forms of child labour, slated for implementation during the year; however, it has not been implemented. Child labour, including forced child labour, has been reported throughout the country[34]. Child labour is most common in the informal sector, including in artisanal mining and subsistence agriculture. According to the Ministry of Labour, children are working in mines and stone quarries and as child soldiers, water sellers, domestic workers, and entertainers in bars and restaurants. The commercial sexual exploitation of children also occurred.

8.10.2.3 Rule of Law

Serious human rights issues have been reported about law enforcement and public order bodies in DRC[35], including restrictions on free expression and the press, freedom of association,

[29] Human Rights report from the U.S. Department of Stats Bureau of Democraty, Human Rights and Labor, and Human Right Watch, https://www.hrw.org/africa/rwanda

[30] Judith Verweijen. 2016, "Stable Instability. Political settlements and armed groups in the Congo". RIFT VALLEY INSTITUTE - USALAMA PROJECT: GOVERNANCE IN CONFLICT

[31] Kivu Security Tracker, Feb. 2021, The Landscape of Armed Groups in Eastern Congo. Congo Research Group, NYU-Center on International Cooperation. https://kivusecurity.nyc3.digitaloceanspaces.com/reports/39/2021%20KST%20report%20EN.pdf

[32] Baromètre sécuritaire du Kivu, https://kivusecurity.org/

[33] https://survey.ituc-csi.org/Congo-44-Democratic-Republic-of.html#tabs-1

[34] see for instance the Human Rights report from the U.S. Department of Stats Bureau of Democraty, Human Rights and Labor.

[35] idem

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corruption, arbitrary detention, or even abduction or unlawful physical punishment. Human rights abuses from DRC security and police forces have been mostly reported in the eastern part of the country, including South-Kivu. Although the government convicted some officials and punished some security force official who committed abuses, it is reported that authorities do not always investigate, prosecute, or punish the official committing human rights abuses.

8.11 Vulnerable Groups

According to the World Bank Environmental and Social Standard (ESS) N°1, disadvantaged or vulnerable refers to 'those who may be more likely to be adversely affected by the project impacts and/or more limited than others in their ability to take advantage of a project's benefits'. Such individuals and groups are more likely to be excluded from, or unable to participate fully in the consultation process.

According to the European Investment Bank Standard 7, vulnerable groups are those that (a) are usually exposed to several risks and adverse impacts at once; (b) are more sensitive to those risks and impacts, often having been subject to pre-existing discriminations; and (c) have a weaker adaptative capacity for coping with those risks and recovering from those impacts, due to limited access or rights to required assets and/or resources. As a result, they can be disproportionately affected by project-related risks and impacts.

This section describes the vulnerability criteria in Rwanda and in DRC, both from the institutional framework and from the views of the local communities, documented during the social field surveys. The vulnerability criteria considered for the ESIA are then defined.

8.11.1 Rwanda

8.11.1.1 Official Vulnerability Criteria

The Constitution of Rwanda identifies five categories of vulnerable people:

- Survivors of genocide
- Disabled people
- Poor people
- The elderly
- Vulnerable children.[36]

The national social protection policy presents a more detailed list, including older people, those living with disabilities, young children, female-headed households, genocide survivors, young people and the historically marginalised. As part of this policy, the government delivers a core set of social protection programmes through the Ministry of Local Government (MINALOC), supported by several complementary initiatives delivered by other ministries (MINALOC, 2011). The following section describes all of the main schemes which are currently supporting Rwanda's vulnerable population.

8.11.1.2 Social Policies for Vulnerable People

A Vision Umurenge Program (VUP)

The Vision 2020 *Umurenge* Program (VUP) was introduced in 2008 to link donor support with poverty reduction and public works; by 2014, that program had reached 13% of the poorest Rwandans through wages for public works (Dale, 2021).

[36] The Constitution of Republican Rwanda with Amendments (2015), Chapter 5, Article 51, p. 5

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The main programme run by MINALOC, and a flagship of the EDPRS 2008–2012, is the Vision 2020 Umurenge Programme (VUP), which contains three pillars: VUP public works, VUP direct support, and VUP financial services. The three pillars represent public works for the poor who are able to work, cash transfers for very poor households without labour capacity, and financial services.

The people interviewed in the study area, reported two types of transfers which are more for people in the villages. These transfers are made into one bank account per family, which is owned by the husband unless the woman lives alone. They are not easy to get as the conditions are strict.

- For elder-headed households (over 65 years old, 7500 francs per person per month (condition is that no one else is present to take care of the old person(s).
- For vulnerable people, public works such as cleaning roads are given in addition to 30,000 francs per month per person.

B Ingoboka Scheme

The *Ingoboka* is a governmental social policy system where a number of people proportional to the amount of people living in the village is picked randomly by the village head for a special cash loan. People need to voluntarily apply for this, and they are then chosen randomly. In the village of Kabusunzu, 4 people are chosen each year. The loan is 100,000 francs, but it needs to be repaid in each agricultural trimester for a total of 25,000 francs each time. This money is usually used to buy clothes, pay school fees or health insurance, but the scheme is not very population due to the strict repayment requirements.

C Ubudehe Scheme

Awarded the United Nations Public Service Award in 2008, Rwanda's *Ubudehe* Program is a national approach for poverty reduction that categorizes households to facilitate interventions. The poorest households, defined as landless and consistently food insecure, are eligible for extra support through social protection programs (Dale, 2021).

The Ubudehe is a social support scheme reliant on four core categories of social class or needs:

- Category 1: people who have a hard time find food to eat, that cannot pay school fees, that do not have clothes and whose health insurance is paid by the state
- Category 2: people who can find food to eat, can pay health insurance and school fees and can find clothes for their families, but have a hard time finding work
- Category 3: people who can pay secondary school fees, they cultivate enough to be able to sell some surplus and they can pay workers to help on their fields.
- Category 4: people who have an income between 60,000 and 600,000 francs

In the villages studied as part of the SLR mission, no one was identified as part of Category 4.

The breakdown of people for categories 1, 2 and 3, in total number and as a percentage of the total population, is outlined for each of the Cell in the study area, as per Table 8-41.

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Table 8-41 Percentage of Population by Category as Registered by the Ubudehe Scheme, by Village (2022)

Sector	Cell	Total Population	% of population in Category 1	% of population in Category 2	% of population in Category 3	% of population in Category 4
Nzahaha	Murya	7,013 people (1302 households)	15.36%	7.52%	69.96%	0%
	Nyenji	4,886 people (999 households)	11.31%	45.54%	43.14%	0%
Bugarama	Pera	12,177 people (2435)[37]	14.01%	53.13%	32.85%	0%
	Nyange	11,000 people (2778 households)	14.75%	52.62%	39.20%	0.03%
	Ryankana	13,880 people[38] (2776 households)	12.53%	40.59%	46.86%	0%

D Rwanda Demobilisation and Reintegration Commission

The Rwanda Demobilisation and Reintegration Commission, or RDRC, has been founded in 1997 by a Cabinet decision and approved by a Presidential Decree No.37/01 of 09/04/2002 with the aim of supporting successful demobilization, social and economic reintegration of ex-combatants in their respective communities, with a particular focus on the provision of such support to female, child and disabled ex-combatants.[39]

E Girinka 'One Cow Per Poor Family' Program

One of the most popular forms of social protection allocated through ubudehe is the Girinka Program, where poor families are given a cow, seen as a way to provide not just nutritional benefits from milk consumption, but financial stability and a sense of personal dignity (Dale, 2021). In the village of Ruganzo, there is one person on this program. People explained during the interview that, although they see cows as one of the most useful solutions to poverty and dependency from agriculture, this program is too limited as only five cows per cell can be provided.

F Genocide Survivors Support and Assistance Fund

The Genocide Survivors Support and Assistance Fund was created in 2008 with the aim of providing vulnerable genocide survivors with support in education, health, shelter, social assistance and income generation. The FARG assistance package comprises the following social policies:

- Social Assistance Cash Transfer Payments of Rw 5,000 per month.
- Education Scholarships.
- Payment of Health Insurance.
- Access to Income Generating Projects.
- Building houses for those which were orphaned, mentally damaged or physically handicapped due to the genocide.

[37] Due to the lack of data disaggregated by person, this number has been calculated based on the average number of household members estimated by the executive secretary of the cell (5 people per household)
[38] Due to the lack of data disaggregated by person, this number has been calculated based on the average number of household members estimated by the executive secretary of the cell (5 people per household)
[39] http://www.demobrwanda.gov.rw/, accessed on 04/03/2022.

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8.11.1.3 Vulnerability Criteria Identified during the Surveys

The focus groups performed in Rwanda highlighted that the local perception of vulnerability is linked with landlessness and with the physical ability to work. These two elements make people unable to sustain themselves.

8.11.2 DRC

In DRC, the focus groups revealed that the most vulnerable groups are the following:

- Old people.
- Widows and orphans.
- Landless people.
- Disabled people.
- People suffering from chronic illness.
- Extremely poor people.
- Women independently practicing a small agricultural or commercial activity with no or little support.

Differently from Rwanda, in DRC there is no official system to deal with vulnerable people. However, these are known, and the village often helps them with financial support or food. Most of these people are landless.

8.11.3 Vulnerable Groups in the Study Area

8.11.3.1 Vulnerability Criteria Identified during the Social Surveys

On the basis of the discussions had with both vulnerable and non-vulnerable people during the social surveys in January and February 2022, five criteria of vulnerability have been selected on the basis of local definitions and perceptions to identify vulnerable households.

- Woman-headed households, defined as any household headed by a woman.
- Elder-headed households, defined as any household headed by a person over 65 years old living without any 18–64-year-old non-disabled household member.
- Disabled-headed households, defined as any household headed by a mentally or physically disabled person living without any 18–64-year-old non-disabled household member.
- Landless households, defined as any household without any land title, customary ownership right or customary usage right over the land plots cultivated by household members. These households can access land to cultivate only through renting or *nyiragabura* (in Rwanda) or *bwaso* (in DRC) systems.
- Historically Marginalised Households, defined as households including at least one person from the *Abasigajwinyuma Namatekas* (Rwanda) / Batwa (DRC) Community.

These criteria are defined and characterised in the following paragraphs.

A Woman-headed Households

Woman-headed households where the proclaimed head of the household is female. Woman-headed households are vulnerable due to the difficulties that women experience in securing land tenure, to the time and resources necessary to taking care of children and to the fewer opportunities for income available to women.

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B Elder-headed Households

Elder-headed households are defined as households with one or more people over 65 years of age without one or more caretaker(s) without disabilities and of an age equal or superior to 18 years old. All of the focus groups and interviews confirm that older people struggle to gain a cash income and even cultivate to feed themselves, due to their physical condition.

C Disabled-headed Households

Disabled-headed households are defined as households with one or more people who declared having any disability, without one or more over 18 caretaker(s) without disabilities. Disabled-headed households are not only more vulnerable because they have a lower income and more limited opportunities to gain wealth, but also because they often have higher expenses due to their disability.

D Landless Households

Landless households are defined as households who reported owning no land (whether in customary or legal ways) and only reported renting or sharecropping instead. All across the study areas, a common theme in all focus groups was that landless people are seen as poor, as they may rent different plots temporarily and struggle at times to find anywhere to cultivate. These people are often reduced to sharecropping arrangements or wage labour on other people's fields. According to the interviews, being landless is the number one indicator of poverty and vulnerability. The story of one landless person is shown in Box 8-9.

Box 8-9 Story of a Homeless Person in Pera Cell, Rwanda

This woman is a homeless elderly Historically Marginalised Person who has been living in Pera Cell all of her life, denying her identity as part of the *Abasigajwinyuma Namatekas* community. She has been put on a list to provide support for homeless people, because her whole family doesn't own any land and has been living in precarious ways in different places. She currently lives in a house rented out by Caritas. When the government managed to give her a land plot and title, her son took ownership of it and sold it for some cash before disappearing with the money. She has now been abandoned by her son and is left begging on the streets with no land or significant source of income. The Pera Cell Executive has put her on an *Umurenge* program, a type of community work scheme that seeks to support vulnerable people.

E *Abasigajwinyuma Namatekas* (Rwanda) / Batwa (DRC) Households

Historically Marginalised / Batwa Households are defined as households including at least one person from the Historically Marginalised Community in Rwanda or the Batwa community in DRC. Section 8.2.5.1B and 8.2.5.2E. describes the vulnerability of people from the Historically Marginalised Community in Rwanda, and the Batwa community in DRC.

8.11.3.2 Vulnerable Groups in the Surveyed Population

On the basis of the 5 criteria defined above, 38% of the 601 households surveyed during the quantitative household survey are vulnerable (see Table 8-42). Additionally, 8% of all surveyed households (11% in DRC and 2% in Rwanda) fall into more than one category of vulnerability. The two categories that tend to overlap the most and woman-headed households and landless households: Table 8-42 breaks the total vulnerable households down by category. As can be observed, the majority of the vulnerable population consists of woman-headed households, the percentage of which is considerably higher in DRC than it is in Rwanda, and landless people.

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Table 8-42 Percentage of Surveyed Households per Vulnerability Category (2022)

Vulnerability Type	% of all surveyed households		
	Rwanda	DRC	Total households
Total Vulnerable households	22%	47%	38%
Woman-headed households	13%	31%	25%
Elder-headed households	1%	1%	1%
Disabled-headed households	9%	3%	5%
Landless households[4]	-	22%	15%
Historically Marginalised / Batwa Households	2%	1%	1%

Aside from these criteria, it is important to note that the surveyed population is struggling with widespread poverty and lack of cash-producing mechanisms. Overall, 32% of interviewed households (35% in DRC and 27% in Rwanda) reported experiencing days where the household could not eat in the month preceding the survey. In Rwanda, people with low incomes are classified by the government as vulnerable through a social assistance and cash-transfer scheme known as *Ubuduhehe* Scheme, which is popular in the Project area alongside various other small-scale government scheme to support low-income households. Out of the surveyed population, 12% of Rwandan and 4% of DRC households declared receiving some kind of social assistance, revealing that governmental support is much lower in DRC than in Rwanda.

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8.12 Cultural Heritage

For the World Bank ESS 8, "*cultural heritage provides continuity in tangible and intangible forms between the past, present and future People identify with cultural heritage as a reflection and expression of their constantly evolving values, beliefs, knowledge and traditions. Cultural heritage, in its many manifestations, is important as a source of valuable scientific and historical information, as an economic and social asset for development, and as an integral part of people's cultural identity and practice*."

Cultural heritage is defined by the European Investment Bank Standard 10 as "*all the various aspects of a community's past and present that are identified as a reflection and expression of its constantly evolving values, beliefs, knowledge and traditions and which the community considers valuable, and desires to sustain and transmit to future generations*."

The following paragraphs outline the tangible and intangible cultural heritage elements identified within the Study Area.

8.12.1 Tangible Cultural Heritage

The World Bank Environmental and Social Standard (ESS) n°8 describes tangible cultural heritage elements as '*movable or immovable objects, sites, structures, groups of structures, natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance*'. The European Investment Bank Standard 10 states that tangible cultural heritage elements can be monuments, individual buildings, groups of buildings and sites.

8.12.1.1 Nationally and Internationally Recognised Elements of Tangible Cultural Heritage

In DRC there are five natural parks on the UNESCO World Heritage List, and 3 sites on the UNESCO Tentative List. Rwanda has 5 sites inscribed in the UNESCO World Heritage Tentative List. Figure 8-92 shows the location of these sites and Table 8-43 lists them and indicated their distance from the Project footprint.

Table 8-43 UNESCO World Heritage Sites in DRC, Including Distance from the Project (2022)

Country	Site	Status	Distance from the Project
Rwanda	Nyungwe Forest National Park	UNESCO World Heritage Tentative List (2021)	25km
	Gisozi Memorial	UNESCO World Heritage Tentative List (2012)	150km
	Bisesero Memorial	UNESCO World Heritage Tentative List (2012)	70km
	Murambi Memorial	UNESCO World Heritage Tentative List (2012)	75km
	Nyamata Memorial	UNESCO World Heritage Tentative List (2012)	140km
DRC	Garamba National Park	UNESCO World Heritage List (1980)	750km
	Kahuzi-Biega National Park	UNESCO World Heritage List (1980)	100km
	Okapi Wildlife Reserve	UNESCO World Heritage List (1996)	500km
	Salonga National Park	UNESCO World Heritage List (1984)	850km
	Virunga National Park	UNESCO World Heritage List (1979)	400km
	Maputi Cave	UNESCO World Heritage Tentative List (1997)	450km
	Dimba and Ngovo caves	UNESCO World Heritage Tentative List (1997)	1,500km
	Upemba depression	UNESCO World Heritage Tentative List (1997)	700km

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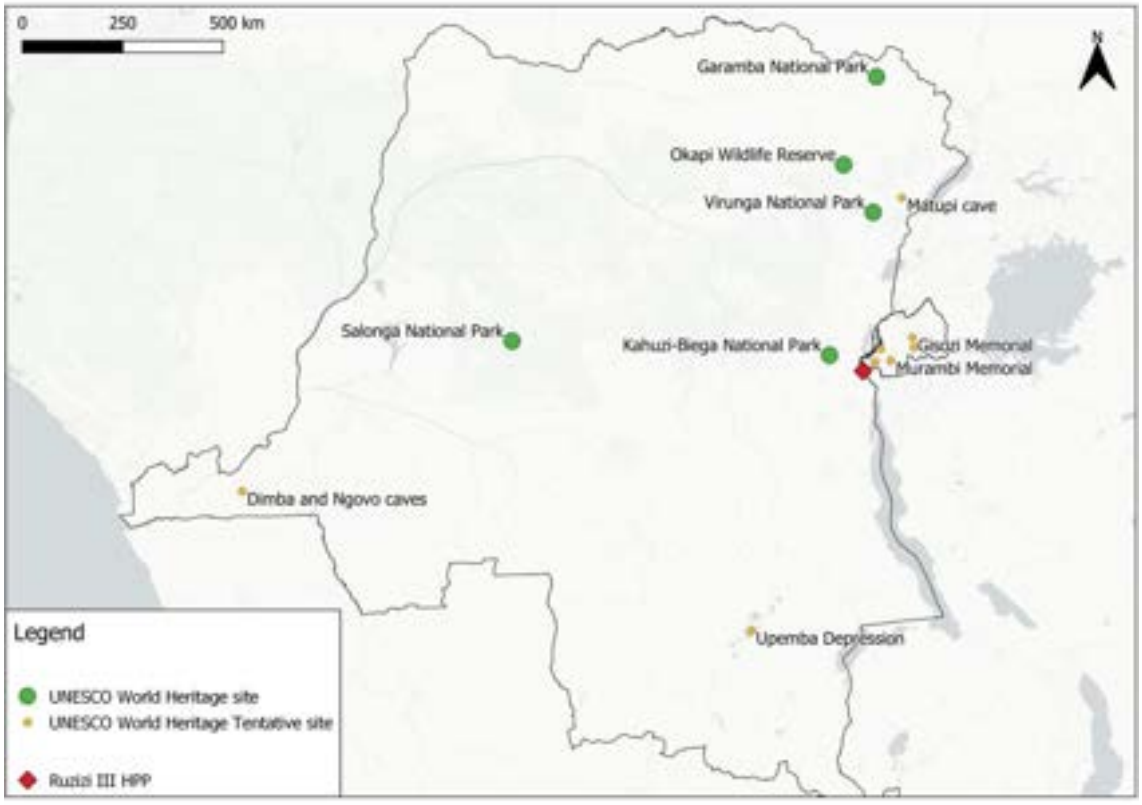


Figure 8-92 Location of UNESCO World Heritage Sites in DRC and Rwanda

8.12.1.2 Elements of Tangible Cultural Heritage of Importance to Local Communities

According to the interviews and focus groups, there are no elements of cultural heritage located in the Project's footprint. The elements of cultural heritage and collective cultural value which were observed in the study area are several churches and two genocide memorials. As for cemeteries, we were informed by all focus groups that most families cannot afford the costs of burying in cemeteries, which are often spare and not numerous due to the intense land pressure. Due to the cost of arranging travel to the cemetery, buying the place and coffin and organising the funeral, most poor families choose to bury around their houses, in their yards or close to the fields where they cultivate. Although each cell has a cemetery, the only village that reported using a cemetery is Nyagahanga, who said that some people go to Nyagasozi, and Gatebe which uses the one in Nyange Cell. In DRC, 7 individual graves are located in the land plots which will be acquired by the Project.

Figure 8-99 shows the geographical distribution of elements of tangible cultural heritage indicated by the inhabitants of villages within the study area. Table 8-44 summarises their location and their distance from the closest project component.

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Table 8-44 Elements of Tangible Cultural Heritage in the Study Area, by Village and Closest Project Component (2022)

Country	Locality	Cultural Heritage Element	Distance from Closest Project Component
Rwanda	Nyagahanga	[R1] Church	130m from access road to core clay borrow area
	Ryagashytsi	[R2] Church	50m from access road to Prospective Basalt Quarry site
	Kabusunzu	[R3] Church	1,250m from the access road
	Ruganzo	[R4] Pentecost Church	500m from the Prospective Basalt Quarry site
	Mwaro	[R5] Adventist Church	250m from the access road
	Mubombo	[R6] Church	2,750m from the access road, 600m from the Ruzizi River
	Gombaniro	[R7] Church	4,500m from the access road, 250m from the Ruzizi River
	Gatebe	[R8] Church	550m from the access road
	Gashonga Sector	[R9] Genocide Memorial (Figure 8-97)	9km north of the Prospective Basalt Quarry site
	Muganza Sector	[R10] Genocide Memorial (Figure 8-98)	6.5 km north of the access road, 6km north of the Powerhouse site
DRC	Kayenge	[C1] Protestant Church	1,500m south-west of the transmission line
		[C2] Brahman Church (Figure 8-93)	1,500m south-west of the transmission line
	Bugano	[C3] Protestant Church (Figure 8-95)	50m from the access road
		[C4] CEV Catholic Church	In the footprint of the access road
		1 grave	In the footprint of the access road
	Nachihembe	[C5] Church	500m from the access road
	Ruduha	[C6] CEPAC Church	1,000m from the landslide protection work and disposal area site
		[C7] CECA Church	900m from the landslide protection work and disposal area site
		1 grave	In the footprint of the access road
	Nachirongwe	[C8] Catholic Church	1,500m from the dam site
		[C9] CELPA Church	1,800m from the dam site
	Rushebeyi	[C10] Catholic Church	2,000m from the dam site
	Ibambiro	[C11] Catholic Church (Figure 8-96)	2,500m from the reservoir
	Bujenjere	[C12] CECA Church	700m from the reservoir
		[C13] CELPA Church	700m from the reservoir
	Kafunda	[C14] Village's Praying Space	20m from the access road
		5 graves	In the footprint of the access road

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Figure 8-93 Brahman Church in Kayenge, DRC



Figure 8-94 Church of Ryagashyitsi



Figure 8-95 Protestant Church of Bugano



Figure 8-96 Catholic Church of Ibambiro, DRC



Figure 8-97 Genocide Memorial in Muganza Sector



Figure 8-98 Genocide Memorial in Gashonga Sector

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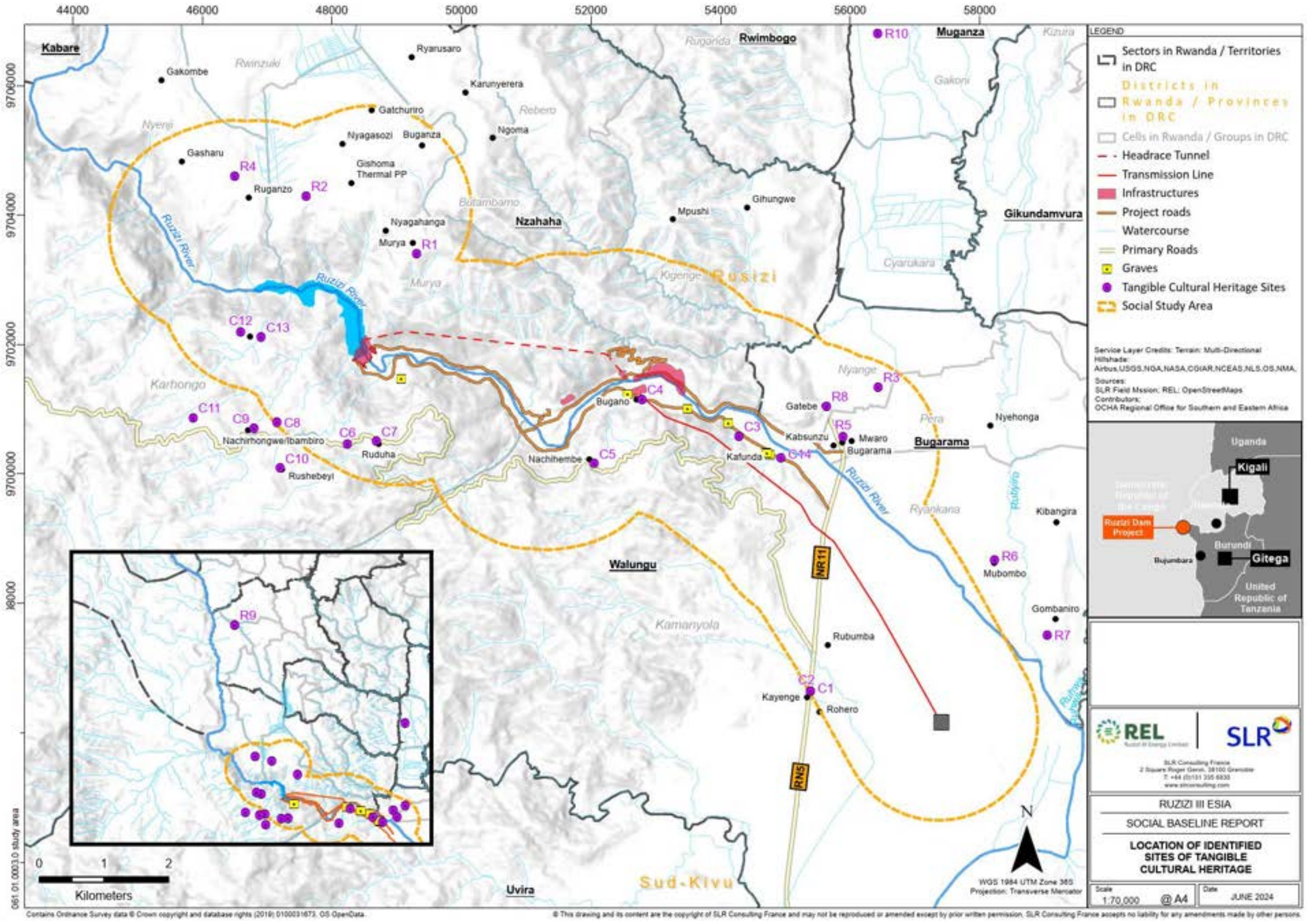


Figure 8-99 Location of Identified Site of Tangible Cultural Heritage (2022)

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8.12.2 Intangible Cultural Heritage

The World Bank Environmental and Social Standard (ESS) n°8 and the European Investment Bank Standard 10 both define intangible cultural heritage as '*practices, representations, expressions, knowledge, skills as well as the instruments, objects, artefacts and cultural spaces associated therewith that communities and groups recognize as part of their cultural heritage, as transmitted from generation to generation*'.

In DRC, one element was inscribed in 2021 on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity: the Congolese Rumba. Rwanda does not have any intangible cultural heritage elements inscribed on this list.

Across the whole study area, all villages reported that there was nothing specific or peculiar about any customs, practices or way of being of communities living in or around the village. The only source of intangible cultural heritage observed on field and reported by the informants is the practice of praying and chanting in small natural spots considered to be sacred. It is important to note that these places are not considered sacred per se or worshipped for their natural qualities. Instead, they are made sacred by the very act of religious chanting and individual prayer: as such, they are selected based on their secluded nature. These practices are associated with both Christian believers.

It is important to note that, according to informants, the Ruzizi River itself is not considered having a cultural or spiritual value, both in Rwanda and in DRC. In both countries, in the study area, no element of the landscape or natural feature was identified as having any cultural or spiritual significance for the local communities. Table 8-45 lists the sites of intangible cultural heritage practices identified during the social field survey in the study area and Figure 8-105 localises these elements on the map.

Table 8-45 Intangible Cultural Heritage Practice Sites in the Study Area (2022)

Country	Village	Cultural Heritage Element	Distance from Closest Project Component
Rwanda	Nyagahanga	[R1] Praying spot hidden in vegetation *Ubutayu Domuriya* (Figure 8-101)	~100 to 150m from the access road to the core clay borrow area
		[R2] Baptism Spot	~10m from the access road and ~30m from a disposal area
	Gatebe	[R3] Praying and Baptism Spot (Figure 8-100Figure 8-99)Figure 8-100	~150m from the access road
	Ruganzo	[R4] Praying spot hidden in vegetation[1]	~600m from the prospective basalt quarry site
DRC	Bugano	[C1] Protestant Baptism Spot Figure 8-101	~20m from the access road
		[C2] Praying spot in a grotto (Figure 8-102Figure 8-103)	In the Transmission Line Right of Way
	Nachihembe	[C3] Protestant baptism spot in a grotto (Figure 8-103Figure 8-102)[2]	~200m from the access road and ~150 from the possible border post
	in the Ruzizi river, downstream of the future dam	[C4] Sacred Island for Praying (Figure 8-104Figure 8-104)[3]	~50 m from the access road

[1] The Social team was unable to go take a picture and GPS point of this particular spot. However, the village committee and villagers explained that its location is in the opposite direction of where the land acquisition and project will take place, to the north of Nzahaha.

[2] According to the focus groups in Nachihembe, this spot is particularly well known by Christians in the region, many of whom come from Rwanda, Bukavu and Uvira just to pray.

[3] A local informant explained that this site is fairly recent, as it has been used for praying for around 5 months. It has allegedly been chosen because of the strength of the current, since it is believed that the difficulty accessing it makes the prayers more powerful.

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Figure 8-100 Baptism and Religious Chanting Spot in Gatebe (Bugarama), Rwanda (2022)



Figure 8-101 Praying Spot in Nyagahanga, Rwanda (2022)



Figure 8-102 Praying Spot in a Grotto in Nachihembe, DRC (2022)



Figure 8-103 Praying Spot in a Grotto in Bugano, DRC (2022)



Figure 8-104 Island used as a Praying site by communities from DRC, Reservoir Area (2022)

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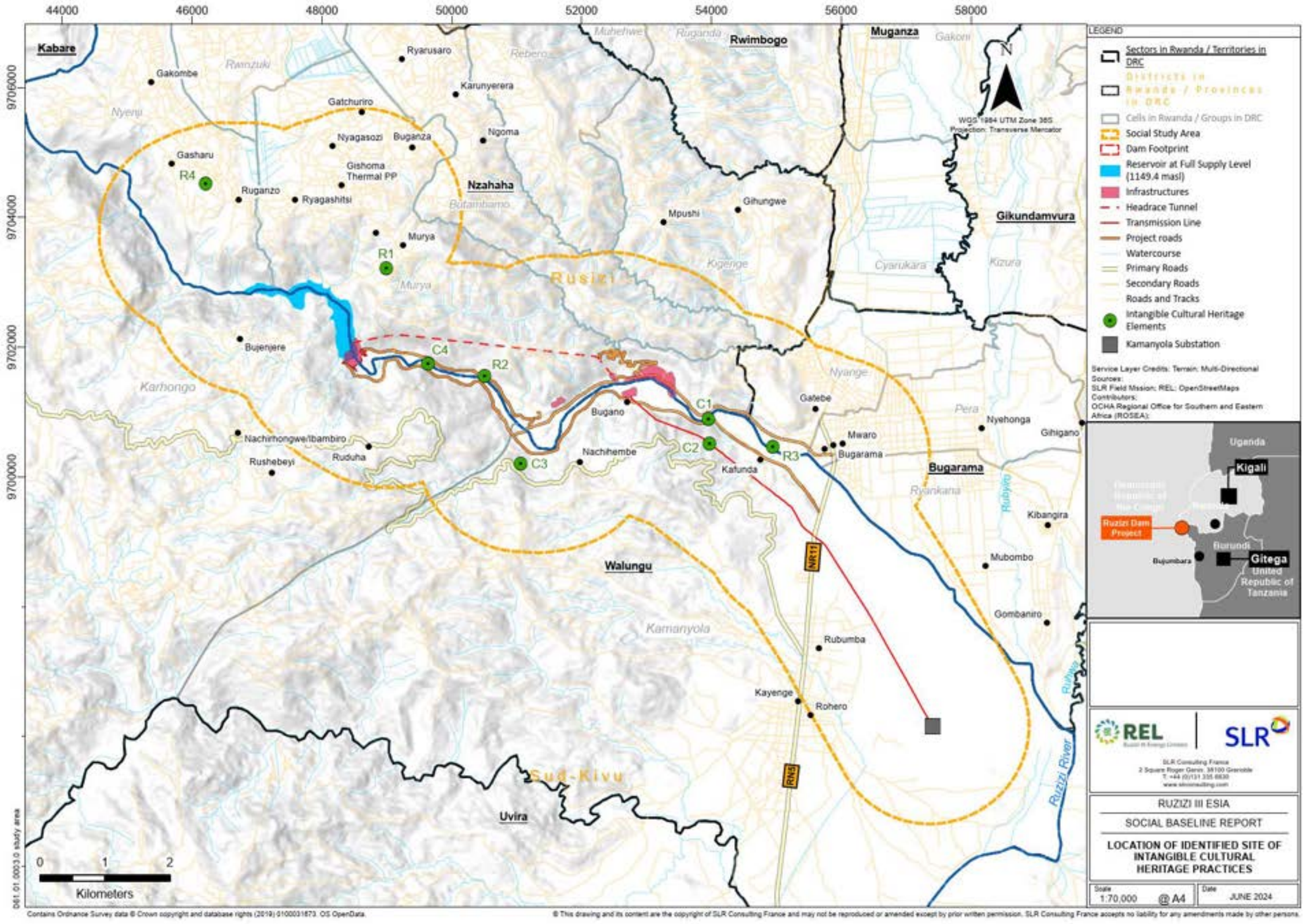


Figure 8-105 Location of Identified Site of Intangible Cultural Heritage Practices (2022)

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8.13 Ecosystem Services: Provisioning & Cultural Services

According to the World Bank Environmental and Social Standard (ESS) n°1, ecosystem services are the benefits that people derive from ecosystems. They are organized into four types:

- Provisioning services are the products people obtain from ecosystems and which may include, but is not limited to, food, freshwater, timbers, fibres, and medicinal plants.
- Regulating services are the benefits people obtain from the regulation of ecosystem processes and which may include surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards.
- Cultural services are the non-material benefits people obtain from ecosystems and which may include natural areas that are sacred sites and areas of importance for recreations and aesthetic enjoyment.
- Supporting services are the natural processes that maintain the other services, and which may include soil formation, nutrient cycling and primary production.

Ecosystem services valued by humans are often underpinned by biodiversity and impacts on biodiversity can often adversely affect the delivery of ecosystem services. Therefore, the identification of ecosystem services requires both social and environmental expertise and stakeholder consultation. While ecosystem services should be considered across multiple topic areas, with an emphasis on interlinkages between social and environmental aspects, the provisioning and cultural services are more related to social components of the environment.

This section is part of the social baseline chapter. Therefore, it presents solely baseline information for provisioning and cultural services.

8.13.1 Provisioning Services

Provisioning services such as provision of food (game meat, cultivated crops, livestock farming, wild-caught fish and aquaculture) have been covered in Section 8.6. The services provided by the Ruzizi River itself have been described in Section 8.5.

8.13.1.1 Collection of Timber Products and Charcoal

A Firewood

According to the interviews and focus groups in the study area, collecting wood is a routine activity for all families in both DRC and Rwanda. This activity is mostly practiced by women according to the interviews in Rwanda, although in DRC it was reported that men collect wood as well (See Figure 8-106).[40] On average, families need to collect firewood every three days, although people with larger families might even have to go every day or every two days. According to the quantitative survey, 89% of affected households in DRC and 76% of affected households in Rwanda are currently collecting wood near the river multiple times a week (See Table 8-46).

[40] The different response in Congo may be due to the lack of female surveyors amongst the team working in Congo, which may have influenced the validity of the answers provided by women on gender-related questions.

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Table 8-46 Frequency of Firewood Collection Near the River by Surveyed Households (2022)

	DRC	Rwanda
Never	4%	15%
Multiple times a week	89%	76%
Once per week	6%	7%
Once a month	1%	2%
Total	100%	100%

In Rwanda, women explained that men carry wood in two instances only: if women are ill and if they are not married and their mother instructs them to help with wood collection. The trees used for wood cutting are mainly eucalyptus, gravillea and mango. Due to the intense deforestation of the whole study area, the interviews and focus groups carried out have demonstrated that there are no forests left for wood cutting. For most people, the average walk to get wood can go from two to seven hours, depending on where scattered available trees are found. When this can be afforded, to make up for the extremely low availability of natural trees, people may plant certain trees on their own land with the purpose of exploiting them for wood branch collection. The only two instances in which this has been observed on a large scale is in the villages of Ruganzo and Mubombo in Rwanda, where a few families own and can rent out land plots specifically for wood cutting close to the village (See Figure 8-110 and Figure 8-108). In all of the other villages, according to focus groups planting one's own firewood is a very common practice for those who can afford it, but plots for these are often found away from the villages and closer to the river. Generally, people start walking towards the river and stop wherever they can find trees, sometimes on the riverside but not necessarily. Wood taking can be a time-consuming activity, as described in Box 8-10.

While there is no internal market on wood branches for domestic use, wood is also collected for the fabrication of planks which are used domestically as well as sold for construction purposes. Areas of wood cutting (See Figure 8-109) and fabrication of wood planks have been observed frequently along the riverside (See Figure 8-107).

Box 8-10 Insight on Wood Collection by Three Young Women in Ryagashyitsi

These women explain that wood collection can be an extremely time-consuming activity, whose weight falls exclusively on women. Around their village, wood is so scarce that they have to walk all the way to the Ruzizi around three times a week. They usually leave in the morning around 7 in the morning and come back with some wood around 3 in the afternoon. After this, they are left with more work to do in the fields for the rest of the day. Unless the kids are old enough to go to school, they are obliged to carry them along.

B Charcoal

The fabrication of charcoal is an activity that is solely practiced by men. According to information gathered during the focus groups, it is fabricated at the feet of slopes, close to the river (See Figure 8-111). Usually, it is made by using the trees which are planted and owned by the fabricator in his own plot, or wood is bought to fabricate charcoal at home. Although a minority of households mentioned selling charcoal on some occasions, it was generally reported during interviews that charcoal tends to be produced for domestic use rather than sale.

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Figure 8-106 Women Carrying Wood Branches in Gisheke, Rwanda (2022)



Figure 8-107 Plank Cutting for Housing close to the Reservoir Area, Rwanda (2022)



Figure 8-108 Scattered Trees Used for Wood Cutting in Mubombo, Rwanda (2022)



Figure 8-109 Wood Cutting Activities in the Reservoir Area (2022)



Figure 8-110 Private Timber Trees in Quarry Area, Ruganzo (2022)



Figure 8-111 Charcoal Fabrication in the Reservoir Area (2022)

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8.13.1.2 Collection of Sand, Straw and Clay

Collection of sand for construction has been mentioned infrequently during the interviews and focus groups. Since sand is difficult to collect in the study area, men tend to go to Kamembe to buy it from shops. However, some have mentioned that men can often go to search for sand further away from the villages: there is no specific place for this type of activity. However, in DRC people reported going to the Ruzizi to search for sand.

Collection of clay has also been infrequently mentioned. This material is associated with the HMP / Batwa communities in Rwanda and DRC (see sections 8.2.5.1B.7 and 8.2.5.2E.7). In Rwanda, HMP reported that they used to collect clay from one specific area in *Rwingbogo* Sector. However, for a few years now a cooperative has been installed on top of this collection point. Since then, they have been making pottery a lot less frequently. The use of clay or earth to make bricks/pottery is done on the banks of the Ruzizi by men and women, according to interviews in DRC. While clay is still collected around the banks of the Ruzizi in the DRC as well as in Rwanda, the specific location of collection points was not provided.

Finally, collection of straw is a popular activity throughout the study area. In DRC, this is one of the most common materials for housing building. In Rwanda, two different types of straw are frequently used, one in cultivation (See Figure 8-113) and one in livestock feeding and construction. Since straw is particularly bulky, the focus groups revealed that it is mostly men that carry out this activity (See Figure 8-112). Straw is generally collected in waiting areas, along the riverbanks or near the Ruzizi River.



Figure 8-112 Men Carrying Straw for Livestock and Construction in Gatebe (2022)



Figure 8-113 Straw Used for Agriculture (2022)

8.13.1.3 Collection of Medicinal Plants and Other Non-Timber Forest Products

According to the interviews and focus groups in the study area, villagers collect various plants for medicinal purposes. The same plants have been mentioned by all villages visited: collecting medicinal plants is not a regular activity and varies depending on necessity, it is usually practiced by women who often go close to the river or around the village to find these plants.

According to the interviews and focus groups in the study area, villagers collect various plants for medicinal purposes. According to the socio-economic quantitative survey, 60% of affected

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households in DRC and 56% of affected households in Rwanda collect plants on the riverside, as seen in Table 8-47.

Table 8-47 Percentage of Households Collecting Medicinal Plants by the River (2022)

	DRC	Rwanda
Man-headed households	88%	64%
Woman-headed households	80%	58%
Total all households	60%	56%

As outlined in sections 8.2.5.1B.7 and 8.2.5.2E.7, HMP in Rwanda and the Batwa in DRC still practice some gathering activities, including harvesting wild honey and collecting wild plants for personal consumption. In Rwanda, this is rarely practiced on the fields of the farmers HMP work for. In DRC, gathering activities still take place in farming fields as well as further away in fallow lands. Men predominantly engage in harvesting wild honey, while women collect medicinal and edible plants (Sogho, Moubolé, Mologuo, Bihama), which they sell in the local market. It was reported that amongst other areas (*Kirira*, *Kaboya*, *Tchapagna*), the surroundings of the city of Bugano (Kamanyola) are used for wild plant collection activities (see section 8.2.5.2E.7)Communication with residents of the Bugano and Kafunda Villages in the DRC during the May 2024 supplementary survey revealed that traditional medicine is important due to the lack of a clinic.

The focus of this survey was primarily on the impacts on plants collected on hilllslope grassland habitats that would arise from the development of the transmission line. Medicinal plants associated with this habitat type comprise of Umuravumba (*Tetradenia riparia*), Umuburizi (*Gymnanthemum amygdalinum*), *Lantana ukambensis*, *Ziziphus mucronata* and *Gymnosporia* sp.

Additional indigenous medicinal plants associated with other habitat types include *Erythrina abyssinica, Markhamia lutea, Markhamia platycalyx* and *Mitragyna rubrostipulata*.Table 8-48 shows plants which have been cited as most often collected and used by the local population during the interviews. The local names are cited in Kinyarwanda, but the same plants are found on both sides of the river.

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Table 8-48 Medicinal Plants Mentioned During Interviews (2022)

Plant Name (in Kinyarwanda)	Medicinal Usage
Umuravumba (See Figure 8-114)	Coughs and fevers, nose haemorrageas and protective powers for children and women walking alone
Umubirizi Ikicamahirwe (See Figure 8-115) Aloe Vera	Intestinal problems and injuries
Akabyeri	Diarrhea
Issogo	
Urubuhu	Vomit and nausea
Ikivuraninda	Bleeding
Umweza	Poisoning
Inyabarasanya	
Igituntu Y'ikiryano	
Umusange	
Umutuku	
Imbonakerakure	Skin
Aloe Vera	Injuries and Int
Igikakarubamba	Intestinal worms
Inzoko	
Umukugutu	
Makasia	
Rugozi	
Kamirampanga	
Muvura	
Umuzibaziba	ifumbi, a common mouth bleeding issue
Umunkamba	
Icyuma	
Igipapayi	Fainting and fever, hepatisis
Umuvemba	Hepatitis
Moringa	Any small illness, such as fever or fatigue
Kabashnkuru	
Kabayeri	
Dodo	Malnutrition
Kankina	Malaria
Itusi y'ikarata	
Urubuhu	Iryaka illness of young babies
Kabayeri	
Umuko	
Kaba	
Shankunu	
Mazi-mbeho	

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Figure 8-114 Umuravumba Medicinal Plant, Observed in the Core Clay Borrow Area (2022)



Figure 8-115 Ikicamahirwe Medicinal Plant Observed in Ruganzo Village (2022)

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8.13.2 Cultural Services

In the study area no specific use of natural spaces and resources for tourism and recreation has been noted. The only recreation activity observed is children swimming and playing in the river.

During both the focus groups in villages and the informal discussions carried out along the river in Rwanda and DRC, none of the interviewed farmers and authorities reported any perception of the river as holding a particular aesthetic, spiritual, religious or cultural value for the population. However, especially in DRC the water from the river is perceived as carrying a particular cultural and spiritual value. This has been described in Section 0.

The productive value of land seems to be the element that ties local communities to the riverside: interviewed people overwhelmingly agreed that the lands closest to the river are perceived as irreplaceable due to their high fertility and better quality of soil.

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9 Critical Habitat Assessment

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Contents

9.1 Introduction 9-1

9.1.1 Approach and Relevant Lender Standards 9-1
9.1.2 Definitions of Habitat Status and Requirements 9-2
9.1.3 Definition of Terms 9-6
9.1.4 Methodology 9-6
9.1.5 Approach to Critical Habitat Assessment 9-12
9.1.6 Assumptions and Limitations 9-12

9.2 Assessment of Natural and Modified Habitats 9-14

9.2.1 Habitat Types, Status and Extent 9-14
9.2.2 Protected Area and Internationally Recognised Areas 9-17

9.3 Critical Habitat Assessment 9-20

9.3.1 Objectives and Approach 9-20
9.3.2 Screening of Potential CH-Qualifying Species 9-20
9.3.3 Critical Habitat Assessment for Fish 9-34
9.3.4 Summary of Critical Habitat Assessment 9-49

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Tables

Table 9-1 Critical Habitat Criteria (ESS6 & IFC PS6) and Thresholds (as per IFC PS6/GN6) 9-4

Table 9-2 Assumptions and Limitations 9-12

Table 9-3 Habitat Status of Vegetation Communities/Faunal Habitats Represented in the Study Area 9-14

Table 9-4 Summary Quantification of Spatial Extent of Habitat Status in the Project Area of Influence 9-17

Table 9-5 Potential Critical Habitat Qualifying Protected Areas in the Project Area of Influence 9-18

Table 9-6. Initial Screening of CH-qualifying Species Confirmed or Likely to Occur in the Ruzizi Basin and Project Area 9-21

Table 9-7 Application of ESS6 Criteria 1, 2 and 3 and IFC PS6 Thresholds for Critical Habitat to the Ruzizi III HPP CHA 9-38

Table 9-8 Fish Species Screened in for CHA in Table 9-6 9-41

Table 9-9 Ecological Processes Required to Sustain CH-Qualifying Fish Species 9-49

Table 9-10 Implications of CHA Findings for Project 9-52

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Figures

Figure 9-1 SLR 2022 Terrestrial Survey Sites Near Ruzizi III HPP within Rwanda and DRC Portion of Ruzizi Basin 9-8
Figure 9-2 SLR May 2024 Terrestrial Survey Sites Near Ruzizi III HPP within Rwanda and DRC 9-9
Figure 9-3 SLR 2022 Aquatic Survey Sites Near Ruzizi III HPP within Ruzizi Basin 9-10
Figure 9-4 CRBEC/CRSNE 2015-2022 Fish Survey Sites in Ruzizi Basin 9-11
Figure 9-5 Habitat Status of the Ruzizi III HPP Project Area: Entire Terrestrial Area of Influence 9-16
Figure 9-6 Protected Areas in Proximity to the Ruzizi River Basin 9-19
Figure 9-7 Project EAAA for Migratory Fish (1,059 km^2) and Non-Migratory Fish (113 km^2) 9-36
Figure 9-8 Distribution of *Acapoeta tanganicae* in the Ruzizi Basin 9-44
Figure 9-9 Distribution of *Labeobarbus caudovittatus* in the Ruzizi Basin 9-45
Figure 9-10 Distribution of *Labeobarbus leleupanus* in the Ruzizi Basin 9-46
Figure 9-11 Distribution of *Chiloglanis asymetricaudalis* (Endangered) in the Ruzizi Basin 9-47
Figure 9-12 Distribution of *Chiloglanis ruziziensis* (Critically Endangered) in the Ruzizi Basin 9-48

PUBLIC DISCLOSURE AUTHORIZED

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9.1 Introduction

9.1.1 Approach and Relevant Lender Standards

The approach to this CHA followed the requirements of the World Bank and the International Finance Corporation (IFC), as set out in their Environmental and Social Safeguards (ESS 2018) and IFC guidance notes: (IFC GN6, 2019): Biodiversity Conservation and Sustainable Management of Living Natural Resources. The IFC PS6 / GN6 (2019) thresholds for determination of critical habitat were applied. The approach followed is also aligned with African Development Bank (AfDB) requirements as set out in their Operational Safeguard 3 (OS3) - Biodiversity, Renewable Resources and Ecosystem Services.

9.1.1.1 World Bank Standard for Biodiversity

The World Bank's ESS6 requires a differentiated risk management approach to habitats based on their sensitivity and values and address all habitats, categorized as 'Modified Habitat', 'Natural Habitat', and 'Critical Habitat', (as defined in Section 9.1.2) along with 'legally protected and internationally and regionally recognized areas of biodiversity value' which may encompass habitat in any or all of these categories.

Categorising habitats as Natural or Modified based on their condition needs to recognise that in practice, Natural and Modified Habitats exist on a continuum ranging from largely untouched, 'pristine' Natural Habitats to intensively managed Modified Habitats. It is important to note that land which has been or is used for shifting agriculture, hunting, grazing or selective timber harvesting may still be classified as Natural Habitat depending on the degree of transformation or degradation, or the degree of restoration if the drivers of degradation are no longer active (e.g. abandoned cultivated lands). Critical Habitats can be represented by Modified or Natural habitats depending on whether biodiversity features are present that meet the relevant criteria and the thresholds for Critical Habitat. This categorisation of habitats provides an indication of the level of risk a project poses to biodiversity and then provides a basis for determining the level of mitigation required to compensate for impacts on habitats of different conservation value e.g. loss or fragmentation. Both ESS6 and the IFC's PS6 requires an ultimate outcome of no net loss of biodiversity for Natural Habitat and net gain for Critical Habitat.

Projects with significant risks and adverse impacts on biodiversity require a Biodiversity Management Plan. Where there is a lack of scientific certainty or where impacts on biodiversity are uncertain, a precautionary approach is required, including implementation of the mitigation hierarchy, application of cost-effective mitigation measures and adaptive management.

ESS6 (in summary) states that projects can only be undertaken in Critical Habitat if a number of criteria are satisfied e.g. there are no other viable alternatives for the project in habitats of lesser biodiversity value; all national laws and international obligations of the host country's approval for the project in or adjacent to the Critical Habitat has been complied with; there is no likelihood of measurable adverse impacts on the biodiversity values for which the Critical Habitat was designated; there is no anticipated net reduction in a population of any Critically Endangered, Endangered or restricted range species over a reasonable time period; the project will be designed to achieve a net gain of those biodiversity values for which the Critical Habitat was designated, and that a robust appropriately designed long term biodiversity monitoring and evaluation program is integrated in to the Borrower's management program.

9.1.1.2 African Development Bank (AfDB)

The AfDB adopted an Integrated Safeguards System in 2013 with supporting guidance materials produced in 2015. Operational Safeguard 3 (OS3) - Biodiversity, Renewable Resources and Ecosystem Services adopts similar language to that of IFC PS6. Specific objectives of OS3 are to "endeavour to reinstate or restore biodiversity, including, where some impacts are

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unavoidable, through implementing biodiversity offsets to achieve 'no net loss but net gain' of biodiversity" (AfDB 2013). In addition, OS3 states that '*for projects that are being developed in natural habitats, modified habitats with significant conservation value, critical habitats or legally protected areas, the borrower or client incorporates the best available science and engages internationally recognised biodiversity experts in conducting the impact assessment and in developing and implementing mitigation and management strategies*' (ADB 2013).

The AfDB requirements of projects in Critical Habitat (AfDB 2015) are aligned with IFC requirements and also require a net gain of biodiversity for projects impacting biodiversity values that contribute to Critical Habitat. The AfDB safeguard for biodiversity specifically states the following:

'Projects may be permitted within Natural or Critical Habitats, with implementation of appropriate biodiversity offsets, if the borrower or client can demonstrate that:

- All other elements of the mitigation hierarchy have been implemented to the extent feasible before an offset program was developed.
- The project-related activities will not have adverse effects on the criteria for which the Critical Habitat was designated.
- The borrower or client can demonstrate that the project will not have negative effects on Critically Endangered or Endangered species.

A biodiversity monitoring program has been established, with results feeding into adaptive management of biodiversity impacts, and into the offsets program.

Under circumstances where development of biodiversity offsets is permitted by the Bank, this should be done in accordance with the principles of the Business and Biodiversity Offsets Program (BBOP) and with reference to offset design guidance which should be used by borrowers or clients to inform the design of biodiversity offsets' (ADB, 2015).

The AfDB recognises that projects impacting on Critical Habitat may require an extended process of identifying an offset and developing and implementing an offset programme. It specifies that such process requires engagement of partners, lenders and implementers.

9.1.2 Definitions of Habitat Status and Requirements

9.1.2.1 Natural Habitat

Natural Habitats are defined by ESS6 as "areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition". ESS6 indicates that habitats affected by human activities are still considered Natural Habitats if they: "(a) have limited impact on the species composition or ecological function of the habitat; (b) form part of a long-term pattern of traditional use, to which native species assemblages have adapted; (c) are no longer prevalent, and the habitat supports a mature and diverse community of predominantly native species; or (d) have not profoundly affected the habitats ability to recover its former ecological characteristics". It recognises that expert inputs may be required to determine whether the character and functions of the habitat remain essentially natural.

Under ESS6, if Natural Habitats are identified as part of the assessment, the Project will seek to avoid adverse impacts, in accordance with the mitigation hierarchy. Where Natural Habitats have the potential to be adversely affected by the project, the Project will not implement any project related activities unless:

a) There are no technically and financially feasible alternatives; and
b) Appropriate mitigation measures are put in place, in accordance with the mitigation hierarchy, to achieve no net loss and, where feasible, preferably a net gain of biodiversity over the long term. When residual impacts remain despite best efforts to avoid, minimize and mitigate impacts, and where appropriate and supported by relevant stakeholders,

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mitigation measures may include biodiversity offsets adhering to the principle of "like-for-like or better."

9.1.2.2 Modified Habitat

Modified Habitats are "areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition"[1]. Modified Habitats may include areas managed for agriculture, forest plantations, reclaimed[2] coastal zones, and reclaimed wetlands. Examples of modified aquatic habitats include dams, river diversions, canals and dramatically altered flow regimes (World Bank 2021)[3].

ESS6 applies to those areas of Modified Habitat that include significant biodiversity value, as determined by the risks and impacts identification process required in ESS1. The Project should minimize impacts on such biodiversity and implement mitigation measures as appropriate.

9.1.2.3 Critical Habitat

A Criteria

Critical Habitat is a description of the most significant and highest priority areas for biodiversity conservation. It considers both global and national priority setting systems and builds on the conservation biology principles of 'vulnerability' (degree of threat) and 'irreplaceability' (rarity or uniqueness). Determination of Critical Habitat is based on quantitative thresholds of biodiversity priority, which are largely based on globally accepted precedents such as the International Union for Conservation of Nature (IUCN) Red List criteria and Key Biodiversity Area (KBA) thresholds.

As per ESS6, Critical Habitats are areas with high biodiversity importance or value, and include the following categories:

a) Habitat of significant importance to Critically Endangered and/or Endangered[4] species,
b) Habitat of significant importance to Endemic and/or Restricted-Range species,
c) Habitat supporting globally significant concentrations of migratory species and/or congregatory species,
d) Highly threatened and/or unique ecosystems, and/or
e) Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)5.

The AfDB's OS3, follows the five criteria specified by the IFC PS6 (as above but where Criterion 5 is "*Areas that are associated with key evolutionary processes*" rather than that specified by ESS6 (as per (e) above): "*Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d).* AfDB OS3 criteria for Critical

[1] This excludes habitat that has been converted in anticipation of the project.

[2] Reclamation as used in this context is the process of creating new land from sea or other aquatic areas for productive use.

[3] World Bank 2021. ESS6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources: Technical Support Manual. Version 5.1 (April 2021).

[4] As listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. The determination of Critical Habitat based on other listings is as follows: (i) If the species is listed nationally / regionally as critically endangered or endangered, in countries that have adhered to IUCN guidance, the Critical Habitat determination will be made on a project by project basis in consultation with competent professionals; and (ii) in instances where nationally or regionally listed species' categorizations do not correspond well to those of the IUCN (e.g., some countries more generally list species as "protected" or "restricted"), an assessment will be conducted to determine the rationale and purpose of the listing. In this case, the Critical Habitat determination will be based on such an assessment.

[5] Note: The IFC PS6/GN6 and the AFD's fifth criterion for determining critical habitats refers to Key Evolutionary Processes rather than Key Ecological Processes.

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Habitat also includes i) *Areas that are important to species that are vital to ecosystems, such as keystone species*; and ii) *Areas that supply ecological networks.*

The World Bank's ESS6 and the African Development Bank OS3 does not provide specific guidance or thresholds for the determination of Critical Habitats. Therefore, Critical Habitats were assessed using the thresholds specified in the IFC Guidance Note 6 (IFC, 2019) which underpins the IFC PS6 (IFC, 2012) for the first four criteria.

ESS6 (in summary) states that projects can only be undertaken in Critical Habitat if a number of criteria are satisfied e.g. there are no other viable alternatives for the project in habitats of lesser biodiversity value; all national laws and international obligations of the host country's approval for the project in or adjacent to the Critical Habitat has been complied with; there is no likelihood of measurable adverse impacts on the biodiversity values for which the Critical Habitat was designated; there is no anticipated net reduction in a population of any Critically Endangered, Endangered or restricted range species over a reasonable time period; the project will be designed to achieve a net gain of those biodiversity values for which the Critical Habitat was designated, and that a robust appropriately designed long term biodiversity monitoring and evaluation program is integrated in to the Borrower's management program.

See Section 9.3 for further details on the Critical Habitat thresholds, approach used, and results of the CHA.

B Critical Habitat Thresholds

Thresholds used in this CHA are described and defined based on the IFC Guidance Note 6 (IFC 2019) (see Table 9-1) except for Criterion 5 (Key Ecological Processes) which is the fifth criterion of ESS6 and which replaces the IFC's fifth criterion: Key Evolutionary Processes.

Table 9-1 Critical Habitat Criteria (ESS6 & IFC PS6) and Thresholds (as per IFC PS6/GN6)

ESS6 Criteria (2018; clause 23)	IFC PS6 Criteria	Description	IFC PS6 Threshold(s)
(a) Habitat of significant importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches	**Criterion 1** (a) Critically Endangered and/or Endangered Species	Species threatened with global extinction and listed as CR and EN on the IUCN Red List of Threatened Species or on national or regional Red Lists shall be considered under Criterion 1. Critically Endangered species face an extremely high risk of extinction in the wild. Endangered species face a very high risk of extinction in the wild. The inclusion of species in Criterion 1 that are listed nationally/regionally as CR or EN in countries that have adhered to IUCN guidance, shall be determined on a project-by-project basis in consultation with competent professionals. This criterion may also apply to Vulnerable (VU) species where they are borderline and could be up-listed to EN or CR with further loss. Subspecies can be included in this criterion where such subspecies are formally recognised and assessed by IUCN.	(a) Areas that support globally-important concentrations of an IUCN Red-listed EN or CR species (> 0.5% of the global population AND > 5 reproductive units of a CR or EN species). (b) Areas that support globally-important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in Criterion 1. (c) As appropriate, areas containing important concentrations of a nationally or regionally-listed EN or CR species.
(b) Habitat of significant importance to endemic or restricted-range species	**Criterion 2** (b) Endemic and/or restricted-range species	The term endemic is defined as restricted-range. In terms of IFC GN6, restricted range refers to a limited extent of occurrence (EOO). For terrestrial vertebrates and plants, a restricted-range species is defined as those species that have an EOO less than 50,000 square kilometres (km^2). For coastal, riverine, and other aquatic species in habitats that do not exceed 200 km width at any point (for example, rivers), restricted range is defined as having a global range of less than or equal to 500 km linear geographic span (i.e., the	Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.

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ESS6 Criteria (2018; clause 23)	IFC PS6 Criteria	Description	IFC PS6 Threshold(s)
		distance between occupied locations furthest apart).	
(c) Habitat supporting globally or nationally significant concentrations of migratory or congregatory species	**Criterion 3** (c) Migratory and congregatory species	Migratory species are defined as any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem). Congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis.	(a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle. (b) Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.
(d) Highly threatened or unique ecosystems	**Criterion 4** (d) Highly-threatened and/or unique ecosystems	The IUCN is developing a Red List of Ecosystems, following an approach similar to the Red List for Threatened Species. The client should use the Red List of Ecosystems where formal IUCN assessments have been performed. Where formal IUCN assessments have not been performed, the client may use assessments using systematic methods at the national/regional level, carried out by governmental bodies, recognized academic institutions and/or other relevant qualified organizations (including internationally-recognized NGOs).	a) Areas representing ≥5% of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN. b) Other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.
(e) Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d).	**Criterion 5** (e) Key evolutionary processes	This criterion is linked to any of the four criteria above and is therefore not a standalone criterion for assessing critical habitat. In essence, it requires the assessment to consider the wider context of species or habitat distribution to ensure that the ecological processes that maintain such species or habitats are included. For example, this could refer to specific pollinators, food sources or movement corridors for CH-qualifying species. Such areas should therefore be considered when defining the Ecologically Appropriate Area of Analysis (EAAA) for the CHA.	There is no quantitative threshold for this criterion. Criterion 5 is reliant on scientific knowledge and understanding of the ecology of species and habitats. A qualitative / descriptive approach should be taken to identifying and assessing the applicability of this criterion.

Source: ESS6 (2018) and IFC Guidance Note,(IFC 2019).

For projects in protected areas or regionally or internationally recognised areas (e.g. KBAs), both ESS6 and IFC PS6 requires borrowers to ensure activities are consistent with the legal protection status and management objectives, consult relevant stakeholders and implement additional actions to enhance the conservation area aims and effective management. Further, ESS6 specifically states that borrowers are also required to "identify and assess potential project related adverse impacts and apply the mitigation hierarchy to prevent or mitigate impacts from projects that could compromise the integrity, conservation objectives or biodiversity importance of such an area".

The IFC PS6 guidance also requires that where projects are located within or adjacent to internationally and/or nationally recognised areas of high biodiversity values, such as Key Biodiversity Areas (KBAs), which encompass Important Bird and Biodiversity Areas (IBAs), these should be mapped and also taken into account during the CHA.

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9.1.3 Definition of Terms

Ruzizi Basin covers 6059 km^2 and is the spatial area within which species have been initially screened for potential critical habitat. This boundary has been used as context to show the species that may qualify for critical habitat at a basin scale.

The Ecologically Appropriate Area of Analysis (EAAA) is the geographic area considered during the CHA and is specific to each feature or group of similar features considered within the assessment. The approximate location of a project and its Area of Influence (AOI) are considered when establishing an EAAA. The project type, its impacts and its mitigation strategy are irrelevant when determining if Critical Habitat is present within the EAAA. The EAAA boundaries used in this CHA are described and mapped in Section 0 and are applicable only to selected fish species.

The Project Area of Influence (AOI) is the spatial geographic area within which the majority of direct and indirect project impacts are anticipated to occur and takes into account impacts such as habitat loss (temporary and permanent), and hydrological changes and disturbance, including edge effects.

The Study Area – this is the extent of the field survey area which has been studied during the 2022 surveys for terrestrial and aquatic ecology and which includes areas inside and outside of the AoI. The study area for this ESIA was focussed on the AoI upstream of Burundi. However, fish data for the downstream reaches to Lake Tanganyika have also been reviewed and referenced in this CHA where relevant.

9.1.4 Methodology

The field survey methodology is detailed in Volume III (Annexures) of the ESIA report with a detailed baseline description in Chapter 7. A short summary is listed below.

9.1.4.1 Data Sources

Key sources of available information for biodiversity were sourced from the following:

- Baseline study for the basin of Lake Kivu and the Ruzizi River (Sher Consult 2020)
- Draft ESIA for proposed Ruzizi III HPP (SOFRECO 2021a)
- Ruzizi III Fish Survey (SOFRECO 2021b)
- Ruzizi III Limnological Survey (Mulungula 2020)
- Rwanda Dragonfly Biotic Index (Uyizeye *et al.* 2021)
- Checklist of fishes of Rwanda (de Vos *et al*. 2001)
- IUCN Red list of threatened species (www.iucnredlist.org)
- Global Biodiversity Information Facility (www.gbif.org)
- Global information system on fishes (www.fishbase.org)
- African Dragonflies and Damselflies Online (http://addo.adu.org.za/)
- Published data on key species (various sources)
- Biodiversity of the Albertine Rift (Plumptre *et al.* 2003)
- Terrestrial Ecoregions of Africa (Burgess *et al.* 2004)
- Potential Natural Vegetation of East Africa project (Lillesø *et al*., 2011) (https://vegetationmap4africa.org)
- Various volumes of the Flore d'Afrique centrale (Meise Botanic Garden, Belgium)
- Birds in Rwanda – an atlas and handbook (Vande weghe & Vande weghe, 2011)
- Rwanda chapter of the Important Bird Areas of Africa (Kanyamibwa, 2001)
- Field guide to the Mammals of Africa (Kingdon, 2015)
- Field guide to the reptiles of East Africa (Spawls, 2002)

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Distribution maps in IUCN Online Assessments.

Unpublished and summarised fish survey data collected between 2015 and 2022 for the upper, middle and lower Ruzizi River was kindly made available from fish researchers at the Centre of Research in Biodiversity, Ecology, Evolution and Conservation (CRBEC) in DRC in collaboration with the Research Centre in Natural Sciences and Environment (CRSNE) at the University of Burundi [6]. In addition, fish location records for the potentially CH-qualifying species from the Royal Museum of Central Africa in Belgium was kindly provided by Jos Snoeks at the Royal Museum for Central Africa who supplied museum records on five potential CH-qualifying fish species.

Fish species identifications were supported and verified by fish taxonomist Denis Tweddle at the Southern African Institute for Aquatic Biodiversity (SAIAB) with input from Emmanuel Vreven and Kisekelwa Kisse (from CRBEC) on *Labeobarbus* species.

A Field Surveys

To supplement the available ecology data for the region, including that collected previously in the Ruzizi River by ecologists for SOFRECO (2020a), a five-day field survey was undertaken by Dr Robert Palmer (aquatic ecologist) and Warren McCleland (terrestrial ecologist) between 19 and 24 January 2022. An additional low flow fish survey was also undertaken on 27 February 2022 coinciding with non-peaking by upstream hydropower plants. A follow up bird and flora survey was also undertaken from 13 to 17 May 2024 to confirm the potential presence of target plant and bird species. Survey sites undertaken by SLR are shown in Figure 9-3 to Figure 9-2 while fish sampling sites conducted by CRBEC/CRSNE are shown in Figure 9-4.

Sampling activities included:

- Crab sampling using a baited crab net
- Sweep netting for macroinvertebrates
- Fish sampling using electrofisher and seine net, and
- Botanical, bird and mammal walked transect surveys.

B Sampling Sites

Terrestrial Biodiversity: A total of 18.87 km of walked transects were performed and 75 points sampled for flora in the Ruzizi III HPP area, including reservoir and dam wall, downstream reaches, transmission line, access road and proposed quarry sites. The supplementary flora and bird survey in May 2024 covered 18 km focussed in the construction areas along the Ruzizi River and 15 km of habitats along the transmission line corridor.

Aquatic Biodiversity: A total of 21 sites were sampled for aquatic biodiversity including 12 sites on the main Ruzizi River and nine on tributaries: eight on the Rubyiro River (including upstream tributaries, the Ntondwe, and Katabavuga and Njambwe streams); and one on the Ruhwa River. Only fish were sampled in the Rubyiro and Ruhwa tributaries.

[66] Note: access to the fish data was conditional on not publishing the detailed fish catch data at sampled sites. Only a fish list for each site was provided for use in this CHA. Future planned publication is expected to make more survey data available.

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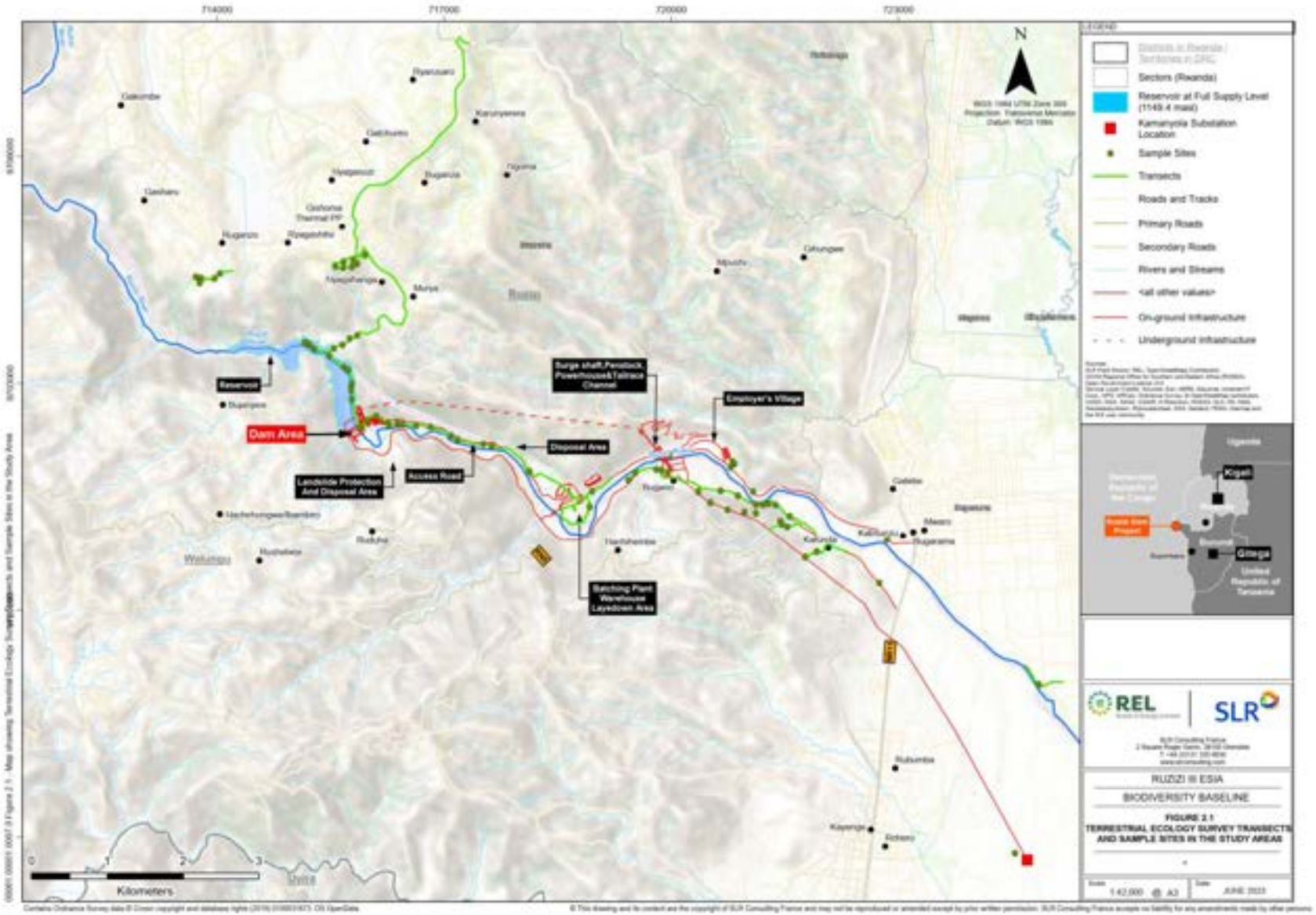


Figure 9-1 SLR 2022 Terrestrial Survey Sites Near Ruzizi III HPP within Rwanda and DRC Portion of Ruzizi Basin

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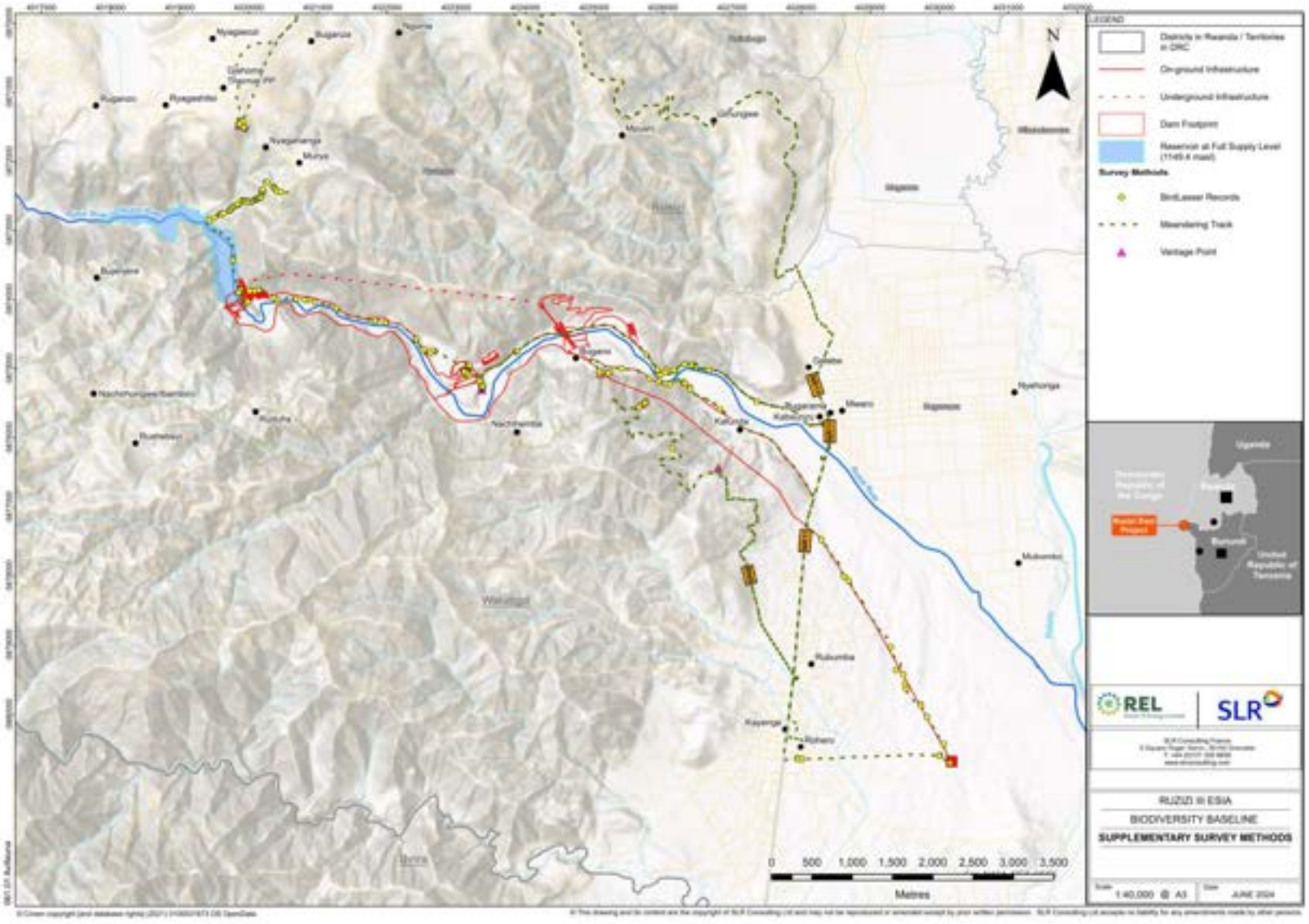


Figure 9-2 SLR May 2024 Terrestrial Survey Sites Near Ruzizi III HPP within Rwanda and DRC

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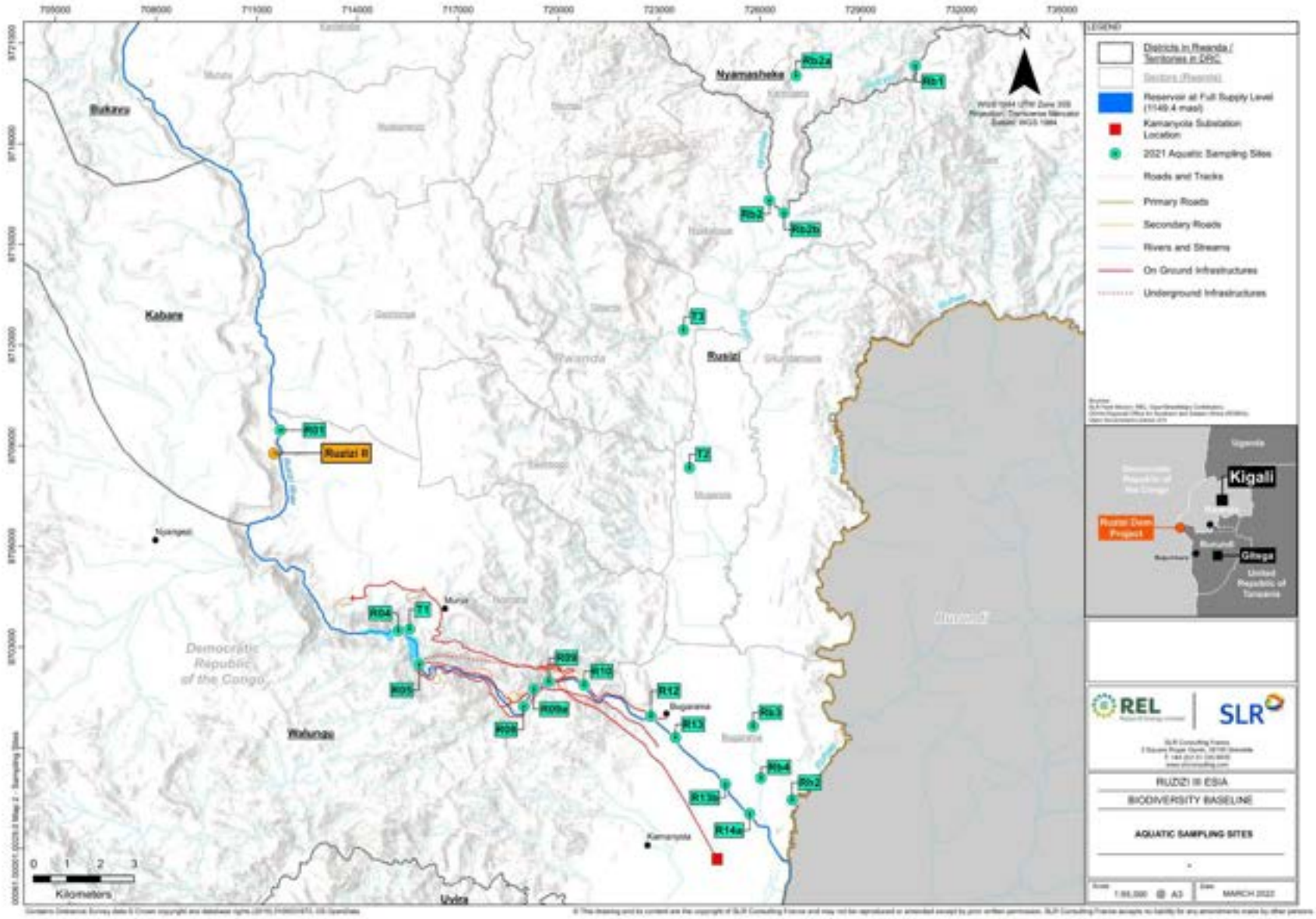


Figure 9-3 SLR 2022 Aquatic Survey Sites Near Ruzizi III HPP within Ruzizi Basin

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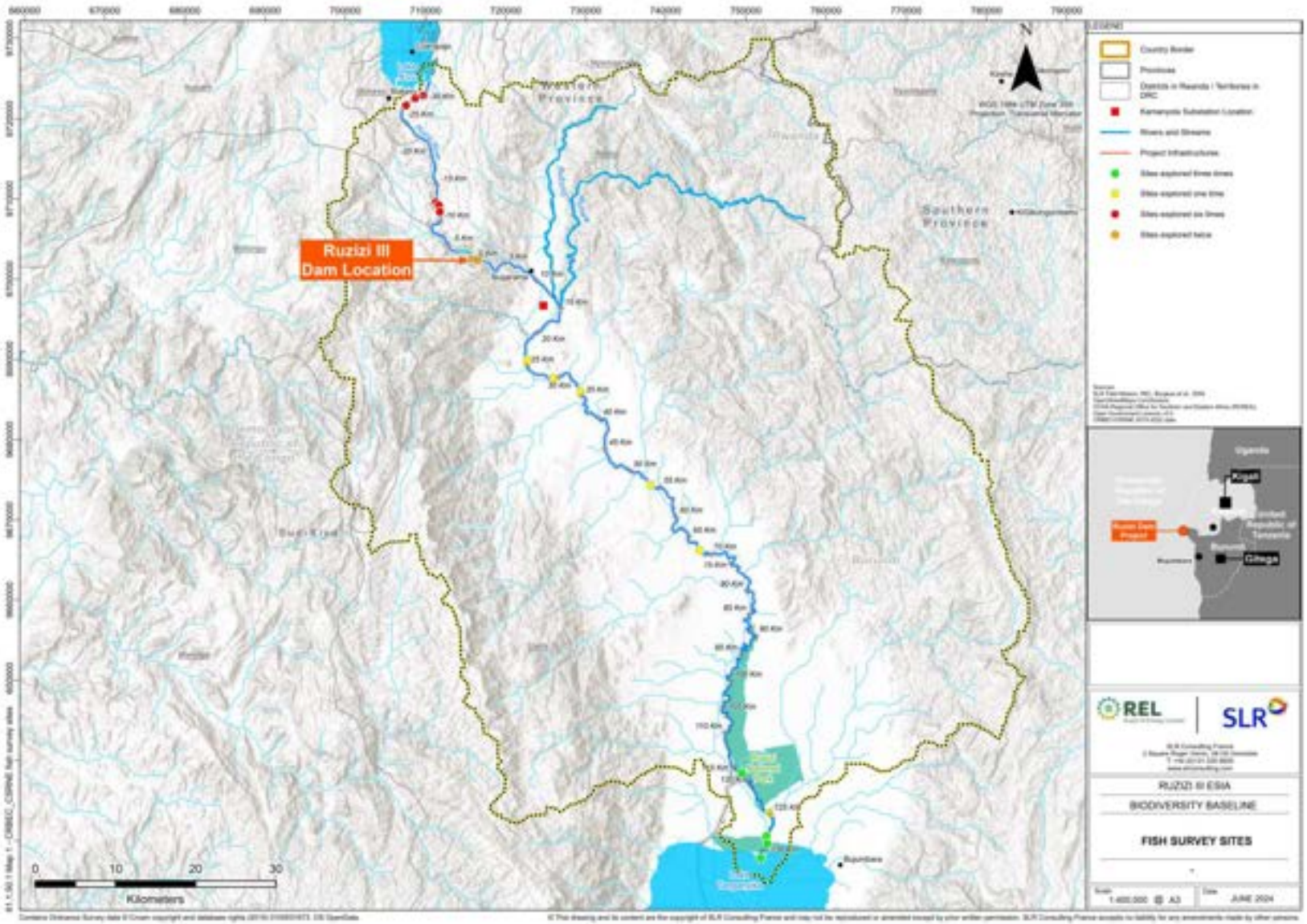


Figure 9-4 CRBEC/CRSNE 2015-2022 Fish Survey Sites in Ruzizi Basin

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9.1.5 Approach to Critical Habitat Assessment

The key steps undertaken to identify Critical Habitat and assess impacts on it and its qualifying biodiversity features, are as follows:

1. Assembly and review of available information, including field survey results.
2. Screening of potential Critical Habitat qualifying species in the Ruzizi Basin.
3. Defining the Ecologically Appropriate Area of Analysis (EAAA) for screened in fish species groups.
4. Confirming which biodiversity features qualify as Critical Habitat using IFC PS6 / GN6 thresholds.

9.1.6 Assumptions and Limitations

The assumptions and limitations applicable to the field activities and findings of this report are detailed in Table 9-2. The majority of limitations are focussed on fish as this is the biodiversity feature that is of most relevance to the determination of Critical Habitat in this CHA.

Table 9-2 Assumptions and Limitations

Item	Heading	Description
1	Available biodiversity data	Available biodiversity information in the Ruzizi Basin is limited. This assessment was conducted using the best available information on presence and distribution of the biodiversity of the region and informed by additional field surveys and observations of the status of habitats in the project study area. However, it is acknowledged that some potentially threatened or restricted range species could have been missed.
2	Survey coverage	The 2022 survey covered representative habitats in the proposed reservoir area and along the proposed powerline as well as two proposed quarry areas in Rwanda. The survey did not cover the full extent of the project footprint, including the entire 7 km transmission line, and 46 ha reservoir area. A supplementary flora and bird survey in May 2024 covered 15 km focussed on grassland portions of the transmission line and 18 km of the Ruzizi River area in the area earmarked for project construction infrastructure. Additional quarry sites are expected to be identified during detailed design which have not yet been surveyed. In addition, some infrastructure footprints within the project boundary have not been defined or may be modified during more detailed design. Therefore, it is possible that some priority species that could be present may have been overlooked. However, given the degraded status of the majority of habitats it is unlikely that any important biodiversity features are present that are not covered by this CHA. In terms of fish data, since the surveys conducted for this ESIA did not extend into Burundi down to the Rusizi Ramsar Site, the additional fish data obtained for 2015 to 2022 from researchers at CRBEC/CRSNE (and affiliated to the Royal Museum of Central Africa) contributed valuable supplementary data to support the findings of this CHA.
3	Fish data and species identification	Publicly available fish data for the Ruzizi River and its affluent tributaries, and the region in general, is sparse and much of the reliable information is old, pre-dating the construction and operation of the two upstream hydropower projects (Ruzizi-I and -II) and which may no longer reflect the current fish distribution and status. Additional unpublished fish data collected from CRBEC/CRSNE from 2016-2022 in the Ruzizi catchment has provided further inputs and confidence to support revision of the initial CHA findings. Given concerns on potential Critical Habitat status of the Ruzizi River, the SLR team has made considerable effort to engage with local and international fish consultants and obtain more recent site-specific data to support the CHA in order to provide more certainty on fish presence than is available in public or online documents. This additional information was considered sufficient to conclude on the CH status of the Ruzizi River as provided in this report. In many cases available fish data does not identify fish to species level - particularly in the taxonomically difficult *Labeo/Labeobarbus* genus -making interpretation of some of the species data and their status difficult. Considerable effort has been spent in validating fish identifications using taxonomic experts to view high quality photographs to provide a robust as possible analysis of critical habitat. Further work is ongoing by CRBEC/CRSNE on the taxonomy of the *Labeo/Labeobarbus* records (with several unidentified specimens considered morphotypes (see point 7 below).

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Item	Heading	Description
4	Spatial datasets	The spatial datasets on species distributions used for the purposes of this study were obtained from their EOO published by the IUCN (2021) and modified to include additional hydrobasins and IUCN designated 'possibly extant' areas where fish data has confirmed the presence of potential critical habitat qualifying species. These EOOs are determined based on known historical museum or published distributions, as well as by consulting experts. In all but instances of restricted-range species, sampling for fishes is impossible throughout their distribution ranges. Thus, many of the distributions are inferred based on expert knowledge and limited survey data and may therefore be inaccurate. This is particularly problematic where a species range may have contracted due to anthropogenic factors and may be misrepresented or excluded from the CHA.
5	Population size and extent of occurrence (Critical Habitat Assessment)	While the known and predicted spatial distribution of priority fish species is available on IUCN databases, there is no information on the population size in specific locations within each species' EOO. Therefore, a key assumption used in the Critical Habitat Assessment was that a species' EOO is a proxy for its population size which therefore assumes that a species population is evenly distributed across its EOO. This is unlikely to be the case as certain fish species will concentrate in different habitats on a seasonal basis depending on their feeding and breeding/spawning requirements. However, the approach of using a species EOO as a proxy for population size was used by Sayer *et al.* 2018 to identify Key Biodiversity Areas (KBAs) in the Lake Victoria Basin and therefore provides a precedent for this approach. Nonetheless it is important to infer potential variation in population distribution where habitats are not preferential for a species or where there is significant threat in certain areas of a species distribution.
6	Fish migration	Knowledge of cyclically predictable migrations of African freshwater fishes is incomplete and evidence is often anecdotal – relying largely on visual observations of large aggregations of juvenile or adult fish. While there is strong evidence to suggest that a large proportion of African tropical and subtropical fish depend on migration, the distances and functions of such migrations (e.g. dispersal, spawning, recolonization), is less clear. In the absence of a clearer understanding of the importance of the movement of priority fish species in the Ruzizi River including *Labeobarbus altianalis, L. caudovittatus, L. leleupanus, L. somereni* and *L. tropidolepis* a precautionary approach will have to be adopted to assess project impacts. Evidence for migration has therefore been obtained from the literature and based on inferences regarding habitat requirements. Freshwater fish movement can be inferred from repeated seasonal surveys, from radio telemetry studies, or mark recapture experiments. However, all these methods require lengthy multi-year studies which are not within the scope of the current assessment.
7	Fish taxonomy	Much of the freshwater fish research in the region is focussed on Lake Kivu and Lake Tanganyika both because of the importance of commercial fish catches and for the diversity of the endemic haplochromine cichlids that occur in both lakes. Taxonomic guides or keys for fish species in the Ruzizi River are not available and many anatomical features that distinguish species – particularly among the haplochromine species – require preserved specimens to be dissected by specialist taxonomists. Some of the fish species identities collected in this study are therefore types, or denoted "c.f." between the genus and species name, indicating that the specimen most strongly resembles the species indicated.

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9.2 Assessment of Natural and Modified Habitats

9.2.1 Habitat Types, Status and Extent

9.2.1.1 Habitat Types and Status

A full description of the habitats and species confirmed to occur in the Project AoI is described and mapped in Chapter 7. The habitat types present in the Project AoI and their assigned habitat status with rationale are described in Table 9-3.

Table 9-3 Habitat Status of Vegetation Communities/Faunal Habitats Represented in the Study Area

Vegetation Community/ Habitat	Habitat Status	Rationale
Hillslope Grassland / Savanna	Natural	Plant species composition is almost entirely indigenous species and typical ecological processes and functions are largely intact. However, landslides and soil erosion have reduced the integrity of certain functions of the vegetation, such as slope stabilisation; grassland patches are well connected, and important processes such as pollination and seed dispersal are likely to be largely intact.
Bare Rock	Largely Natural	Although this habitat is often associated with landslides, there are also areas of natural exposed sheetrock, particularly on steep slopes. These habitats have mostly been colonised by indigenous plant species and are likely to be moderately important habitat for the herpetofaunal assemblage (although these are likely exposed to human threat).
Riparian Thicket	Modified	The plant species composition of this community comprises mostly indigenous species, although certain thickets have been invaded by alien shrubs such as *Lantana camara* and *Tithonia diversifolia*. While most of the typical ecological processes and functions are largely intact, the thickets are fragmented and disconnected, which has likely impacted the integrity of some processes such as connectivity and dispersal for thicket fauna. Accordingly, the loss of connectivity and ecological functioning in areas of dense alien plant growth, denotes that the habitat has been modified
Riparian Wetland	Modified	The plant species composition of this community comprises mostly indigenous species, although some drier wetlands have been invaded by alien species such as *Parthenium hysterophorus, Ageratum conyzoides* and *Mimosa pigra.* Typical ecological processes and functions are intact in areas of indigenous vegetation, although some may be compromised by the unnatural daily flow modifications from upstream hydropower plants. The majority of the alluvium has been cleared for cultivation of cassava (*Manihot esculenta*). Due to the interspersed distribution of indigenous patches and their minimal size, the habitat was categorised as 'Modified'
Hillslope Thicket / Forest	Modified	While the plant species composition of this community comprises mostly indigenous species, many thickets remaining in the landscape are small and fragmented and have been invaded by alien shrubs such as *Lantana camara* and *Tithonia diversifolia*. Typical ecological processes and functions have been impacted due to the fragmented and disconnected nature of the thicket patches, which have reduced habitat connectivity and dispersal for thicket fauna.

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Vegetation Community/ Habitat	Habitat Status	Rationale
Open Water (Middle Shire)	Modified	The Middle Ruzizi River habitat has been assessed as Modified Habitat largely due to the alteration of riverine ecological processes and level of degradation exhibited by aquatic biota, largely caused by sub-daily hydropeaking from Ruzizi I and II upstream, and level of catchment degradation. The aquatic study was focussed on the middle reach of the Ruzizi River and assessed the Present Ecological State (PES) of aquatic macroinvertebrates as *Seriously Modified* (Category E). This was based on low diversity and abundance of macroinvertebrates mostly dominated by species tolerant of poor water quality with a high proportion of air breathers and predators, and indicator species typical of modified habitats. In addition, the aquatic plant community was dominated by a filamentous algae that are typical of polluted conditions and diatom composition also indicated elevated concentrations of nutrients and suspended sediments. While the fish community was dominated by indigenous species with a few alien species, the species complement and assemblage structure has changed from historic natural conditions due to the operation of upstream hydropower plants and inundation of lotic habitats. This is reflected by the low diversity and abundance of fish-eating waterbirds and lack of common species that would be expected along a large river. With increasing distance downstream, the effects of hydropeaking diminish – also with additional tributary inputs - and the river downstream of Bugurama still contains populations of hippopotamus and Nile crocodiles. Note: further downstream, as the river enters the Ruzizi floodplain and Ramsar site (approximately 88km from Ruzizi III) the lower Ruzizi River can be considered Natural Habitat.
Cultivation / Secondary Shrubland	Modified	This vegetation mosaic comprises habitat that is entirely Modified (cultivated lands, tree plantations) and largely Modified (Secondary Shrubland on fallow / abandoned fields). The Secondary Shrubland habitat has been classified as Modified even though it has regained some indigenous species and has regained some of the original functions of the habitat that was cleared for cultivation (e.g. slope stabilisation, carbon sequestration). However, it still has a high proportion of alien species and has severely impaired functionality compared to the woodland / thicket habitat that would originally have been cleared for cultivation.
Settlements (Towns & Villages)	Modified	Parts of the project area which comprise towns and villages, especially in the vicinity of Bugarama, Kamanyola and the numerous villages on the plateau near the quarry sites, are entirely Modified Habitat with very little evidence of the original plant species composition of the area; typical ecological process and functions are disrupted or severely impaired and human impact is evident throughout this habitat.

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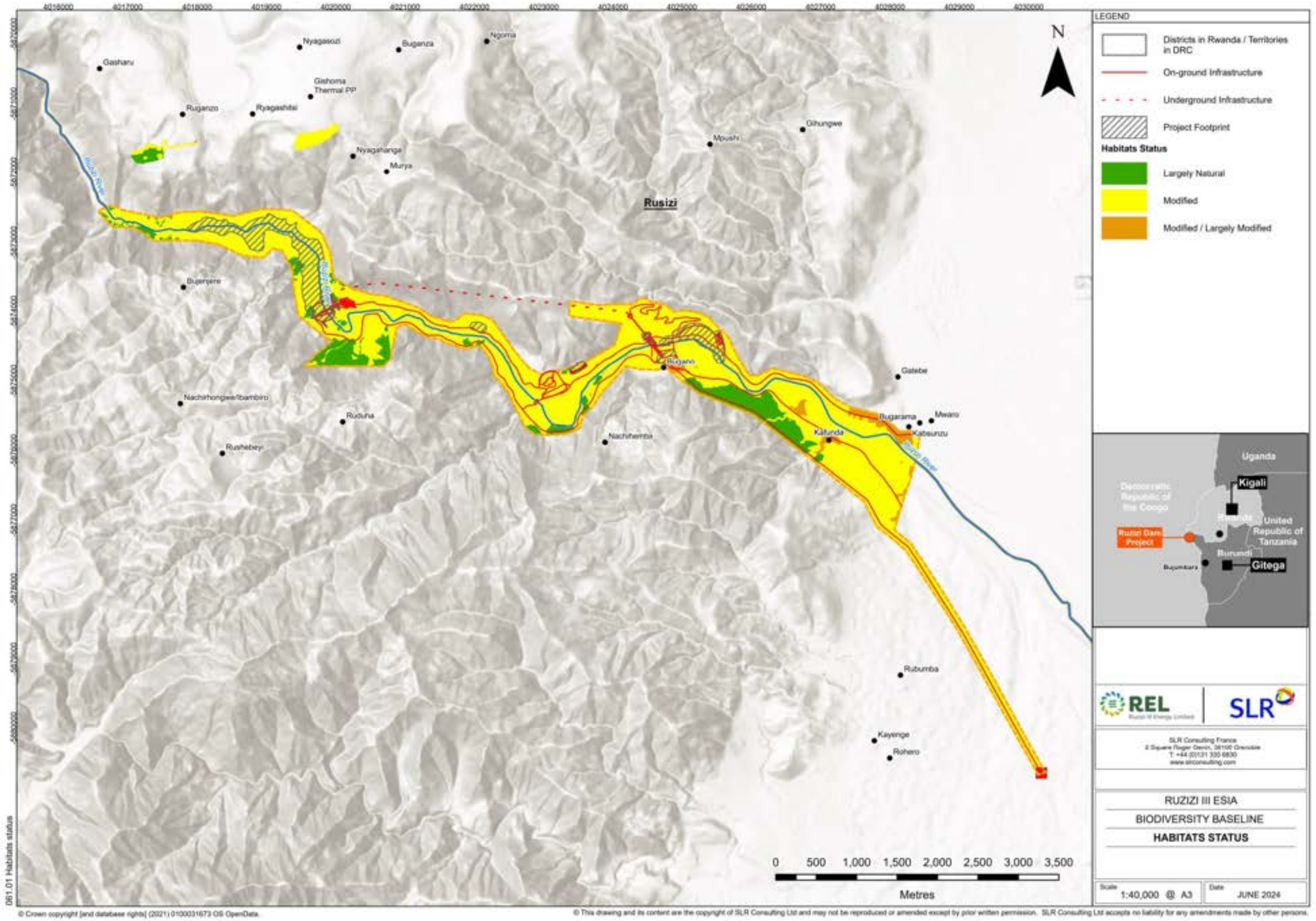


Figure 9-5 Habitat Status of the Ruzizi III HPP Project Area: Entire Terrestrial Area of Influence

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9.2.1.2 Quantification of Habitat Extents in the Project AoI

The extent of the various mapped habitat types and their habitat status (i.e. modified / natural) in the Project AoI are quantified in the below (Table 9-4). A detailed breakdown of the habitat type losses for different components is provided in Chapter 7.

In summary, the Ruzizi III Project will directly impact approximately 244 ha of terrestrial and aquatic habitats. The majority of land affected by the Project comprises a mosaic of cultivated land and degraded shrubland (approximately 154 ha or 63%). Included within the 244 ha of mapped units is 43 ha of open water which is assessed as Modified Habitat (as a result of the operation of upstream hydropeaking power projects and water pollution from upstream towns).

This quantification is based on broad areas identified for project infrastructure near the dam wall and powerhouse. Since no detailed design is available the actual project footprint within the infrastructure polygons is not confirmed and final residual habitat losses may be slightly different from estimated. The quantification should be refined once detailed layout and design footprints are available to quantify the net residual habitat losses.

Table 9-4 Summary Quantification of Spatial Extent of Habitat Status in the Project Area of Influence

Habitat Status	Direct AoI	
	Hectares	%
Largely Natural	18	7.5
Modified*	226	92.5
Total	**244**	**100**

* Includes 43 ha of open water

9.2.2 Protected Area and Internationally Recognised Areas

No protected areas and internationally recognised areas (Key Biodiversity Areas/Important Bird Areas) are located in close proximity to or within the project area of influence. Protected areas overlapping partially or entirely within the Ruzizi River Basin are described in Chapter 7 (Section 7.8.1) and shown in Figure 9-6.

The only conservation area of potential relevance to the evaluation of Project impacts is the Rusizi National Park located approximately 88 km downstream of the powerhouse which extends a further 40 km to Lake Tanganyika. This area is also a Wetland of International Importance (Ramsar Site) and a designated IBA, important for water birds and fish. Potential Critical Habitat-qualifying features of this area that may be relevant to the Ruzizi III HPP – migratory fish - are considered in the Critical Habitat Assessment, described in Section 9.3.

Upstream of the Rubyiro River (that joins the Ruzizi River just downstream of Ruzizi III) is the Nyungwe National Park, which is also an IBA and KBA mainly for forest biodiversity, located approximately 20 km from the Project. While this park is outside the Project AoI, it plays an important role in protecting the upper catchment of the Rubyiro River which contains important fish such as the Endangered *Chiloglanis asymetricaudalis* and possibly the Critically Endangered *Chiloglanis ruziziensis* which would qualify this river for Critical Habitat.

Table 9-5 provides a summary of potential CH-qualifying landscape features such as Protected Areas, Key Biodiversity Areas and Ramsar Sites (see Environmental Baseline for additional information).

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Table 9-5 Potential Critical Habitat Qualifying Protected Areas in the Project Area of Influence

Protected Area	Description
Nyungwe National Park (Rwanda) - 1019 km^2	Nyungwe forest is situated in south-west Rwanda between Lake Kivu and the international border with Burundi, where it is contiguous with Kibira National Park. These parks overlap with the western portion of the Ruzizi Basin covering an area of approximately 100,000 ha and located approximately 20 km to the east and north-east of the PAOI. CH-qualifying species include chimpanzee (EN), L'Hoest's monkey (VU), Angolan colobus (VU) and owl-faced monkey (VU), and birds such as Shelley's crimsonwing (EN), red-collared mountain-babbler (EN) and Congo Bay owl (EN). These parks are the source of the major tributaries of the Ruzizi River, namely the Rubyiro and Ruhwa Rivers. Rubyiro River which contains important fish such as the Endangered *Chiloglanis asymetricaudalis* and possibly the Critically Endangered *Chiloglanis ruziziensis* which would qualify this river for Critical Habitat.
Cyamudongo Forest Reserve (Rwanda) – 415 ha	Cyamudongo forest is a small relict forest that is an outlier of the much larger Nyungwe Forest with its entirety located within the Ruzizi Basin. It is located approximately 14 km from the PAOI. CH-qualifying species includes a small population of chimpanzee (EN) is present in the forest. Numerous Albertine Rift bird endemics are present, although none of the highly threatened species occurring in Nyungwe are present due to the lower altitude. Furthermore, there have been no reports of chimpanzees from the reserve foraging within the PAOI.
Rusizi National Park (Burundi) – 6.2 km^2	Rusizi National Park is located north-west of Bujumbura along the border with the DRC at the southern end of the Ruzizi Basin. It comprises a floodplain of about 2 km wide and 35 km long along the east bank of the Ruzizi River and a smaller area of delta where the Ruzizi enters Lake Tanganyika, with the main Bujumbura – Uwinka road separating these two areas. The delta is a mixture of islands and channels covered with *Phragmites* and papyrus swamps, while the northern floodplain comprises *Hyphaene* palm savannah. The delta section of the park is an important area for migratory waterbirds, such as Madagascar pond heron (EN), great snipe (NT), lesser flamingo (NT) and Eurasian curlew (NT) as well as other threatened species such as hippopotamus (VU) and Nile crocodile (VU).

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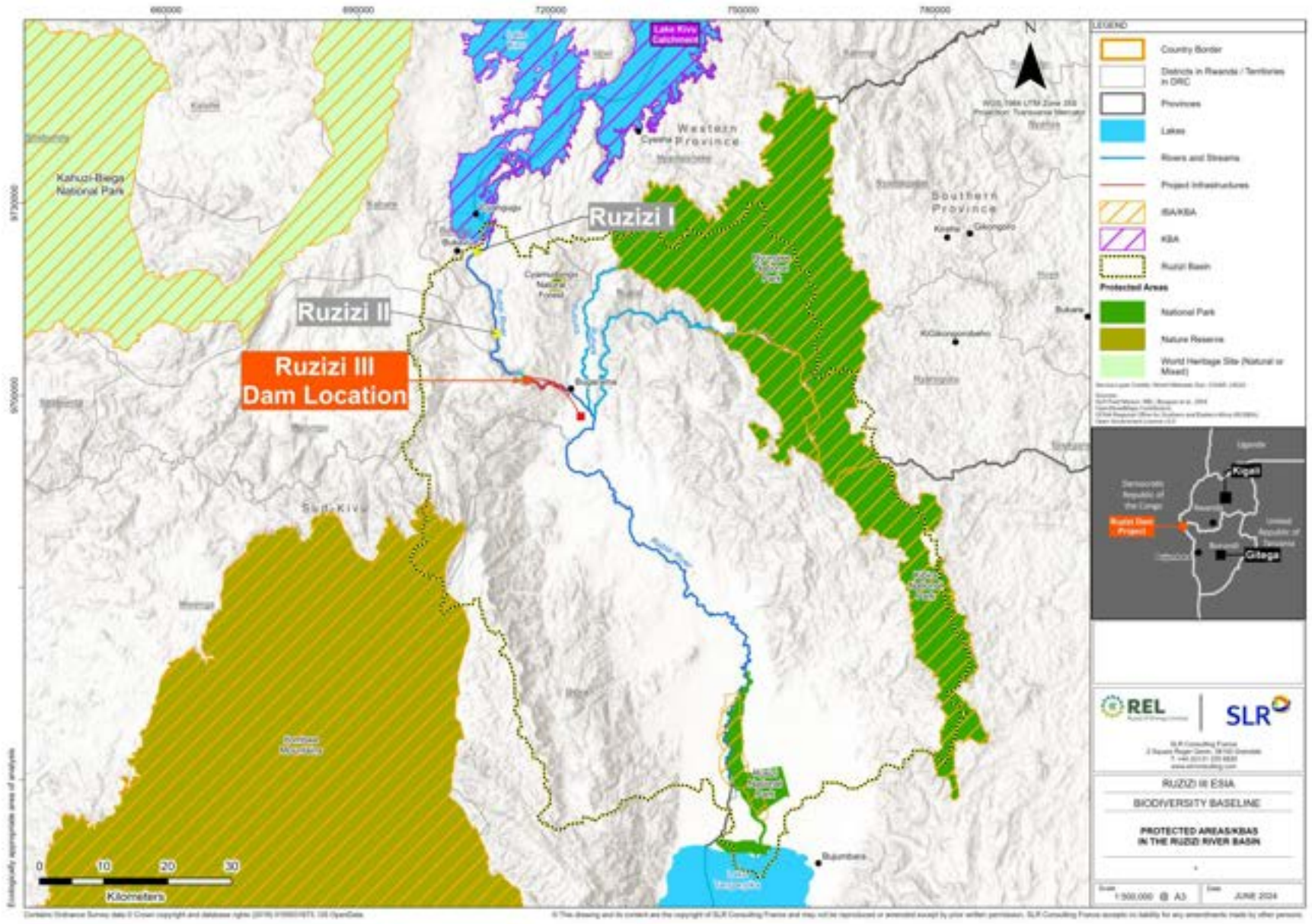


Figure 9-6 Protected Areas in Proximity to the Ruzizi River Basin

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9.3 Critical Habitat Assessment

9.3.1 Objectives and Approach

The aim of this chapter is to determine if Critical Habitat is present within the Ruzizi III HPP Project Area of Influence as a basis for determining impacts and mitigation and the need for any compensation requirements.

This was done by the following steps:

- Screen the biodiversity features that may be present or have been confirmed in the Ruzizi Basin that may trigger Critical Habitat and select those that potentially qualify for further evaluation using IFC PS6 thresholds.
- Determine an appropriate spatial scope for the CHA and define the Ecologically Appropriate Area of Analysis (EAAA) for species or groups of species (with similar or identical ecological requirements). For this CHA this was only relevant for fish and was done separate for migratory and non-migratory fish as and described in Section 0.
- Evaluate each screened in biodiversity feature against the criteria and thresholds for determining Critical Habitat based on the International Finance Corporation GN6 (IFC, 2019).

The identification of Critical Habitat using IFC PS6 is based on five criteria, for which four criteria have quantitative thresholds, as summarised in Table 9-1 in Section 9.1.2.3.

9.3.2 Screening of Potential CH-Qualifying Species

9.3.2.1 Initial Screening of CR/EN, Restricted-Range and Migratory/Congregatory Species

Species known to occur in the Ruzizi Basin, and which may occur in the Ruzizi Project Area based on habitat suitability, and which could qualify for Critical Habitat are identified and screened in Table 9-6. These include the following types of species:

- Threatened species that are listed as CR or EN at global or national level. Note: there are no regional or country-specific species red lists applicable to DRC, Rwanda or Burundi.
- Threatened species listed by IUCN as VU where these are confirmed or highly likely to occur and where they are close to the threshold for being listed as endangered or which are of potential stakeholder concern.
- Restricted range species that have a confirmed or likely Extent of Occurrence of <50,000 km^2 or where aquatic species have a distribution of 500 km linear geographic span.
- Migratory / congregatory species.
- Keystone Species (AfDB Criterion).
- Ecological Networks (AfDB Criterion).

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Table 9-6. Initial Screening of CH-qualifying Species Confirmed or Likely to Occur in the Ruzizi Basin and Project Area

Scientific Name	IUCN Status	Restricted range	Migratory/ Congregatory	Habitat and Distribution	Likelihood of Occurrence	Rationale for Critical Habitat Screening	Screened In or Out
Flora							
Emilia subscaposa	EN	Yes (EOO: 706 km^2)	N/A	Prefers swamps, but has also been reported from sandy fallows, cassava fields, and dry grassland, at 775–1,030 masl.	Low	While much suitable habitat is present downstream of the project, this poorly known species has not been collected since 1971 and is only known from six specimens from the southern reaches of the Ruzizi River and is therefore unlikely to occur in the project AoI.	**Out**
Chlorophytum hirsutum	EN	No (EOO: 12,155 km^2)	N/A	Grows in open forest, Loudetia grassland, forest margins among boulders, gallery forest, ravine with Euphorbia; at 675-1,200 masl.	Moderate	Globally EN, but while there is some suitable habitat present in the project AoI it is only known from a few locations and has a low likelihood of being present	**Out**
Bulbostylis longiradiata	EN	No (EOO: 111,949 km^2)	N/A	Grows in grassland and open woodland at 800-1,250 masl.	Moderate	Some suitable present in the project area.	**Out**
Vernonia melanocoma	NT	Yes (EOO: 40,813 km^2)	N/A	An annual herb of roadsides in wooded grassland and grassland.	Moderate	Some suitable present in the project area.	**Out**
Birds							
Hooded Vulture *Necrosyrtes monachus*	CR	No (EOO: 22,500,000 km^2)	No	Occurs in open grassland, forest edge, wooded savanna and desert, often associated with human settlements north of the Equator.	Low	Although CR, it has a wide distribution and is generally absent from western Rwanda.	**Out**
White-backed vulture *Gyps africanus*	CR	No (EOO: 23,400,000 km^2)	No	Occurs in open wooded savanna, particularly areas of *Acacia.*	Low	Although CR, it is absent from western Rwanda and occurs in less degraded habitats than those present in the project area.	**Out**
Rüppell's vulture *Gyps rueppelli*	CR	No (EOO: 14,200,000 km^2)	No	Prefers open landscapes such as open Acacia woodland, grassland and montane regions.	Low	Although CR, it is absent from western Rwanda and occurs in less degraded habitats than those present in the project area.	**Out**
Congo bay-owl *Phodilus prigoginei*	EN	Yes (EOO: 4,900 km^2)	No	Occurs in a mosaic of grassland and either montane or bamboo forest, above 1,800 masl.	Very Low	Extremely unlikely to be present in the project area since no suitable habitat present and occurs at higher altitudes than those in the project area.	**Out**
Lappet-faced vulture *Torgos tracheliotos*	EN	No (EOO: 34,200,000 km^2)	No	Found in dry savanna, arid plains, deserts and open mountain slopes, up to 3,500 masl.	Low	Absent from western Rwanda and occurs in less degraded habitats than those present in the project area.	**Out**

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Scientific Name	IUCN Status	Restricted range	Migratory/ Congregatory	Habitat and Distribution	Likelihood of Occurrence	Rationale for Critical Habitat Screening	Screened In or Out
Secretarybird *Sagittarius serpentarius*	EN	No (EOO: 23,200,000 km²)	No	Prefers open landscapes, ranging from open plains and grasslands to lightly wooded savanna, but is also found in agricultural areas and semi-desert.	Low	Very rare in Rwanda and not recorded in the west. Also prefers less degraded habitats than those in the project area.	**Out**
Steppe eagle *Aquila nipalensis*	EN	No (EOO: 12,600,000 km²)	Yes Migratory	Occurs in open habitats such as grasslands, lightly wooded savannah and semi-desert shrublands during passage and when overwintering.	Low	A very rare non-breeding migrant in Rwanda, which has not been recorded in the west. Also prefers less degraded habitats than those in project area.	**Out**
Madagascar pond-heron *Ardeola idae*	EN	No (EOO: 1,050,000 km²)	Yes Migratory	Prefers freshwater wetlands, particularly shallow waterbodies fringed with vegetation and adjacent trees.	Low	Absent from western Rwanda and there is limited suitable habitat in the project area.	**Out**
Grey parrot *Psittacus erithacus*	EN	No (EOO: 4,460,000 km²)	No	Occurs in dense forest, including forest edges and clearings; also in gallery forest, mangroves, wooded savannah and cultivated areas close to forest.	Low	Although this species can tolerate moderate habitat modification and some disturbance, the level of habitat fragmentation and human disturbance in the project area is much higher than areas where this species usually occurs. The project area is also at the edge of its known distribution.	**Out**
Grey crowned crane *Balearica regulorum*	EN	No (EOO: 6,070,000 km²)	No	Occurs in shallow wetlands such as marshes, pans and dams with tall emergent vegetation, as well as riverbanks, shallowly flooded plains and temporary pools, sometimes foraging in adjacent grasslands, open savannas and croplands. Nearest known locality is the large Butambamo wetland to the north of the project area at 1,600 masl.	Low	No suitable breeding habitat present within the reservoir and downstream reaches of the Ruzizi River (at least until the Burundi border). Possible it may occasionally forage in cultivated lands downstream of Bugurama. Given its wide distribution it would not meet thresholds for critical habitat.	**Out**
Shelley's crimsonwing *Cryptospiza shelleyi*	EN	No (EOO: 123,000 km²)	No	Prefers the understorey of closed-canopy moist forest, often in valleys near water; also in low secondary growth at forest edges, forest clearings and glades; above 1,900 masl.	Very Low	No suitable habitat present and occurs at higher altitudes than the project area.	**Out**
Red-collared mountain-babbler *Kupeornis rufocinctus*	EN	No (EOO: 89,100 km²)	No	Confined to montane forest and bamboo at altitudes of 1,500-3,200 masl.	Very Low	No suitable habitat present and occurs at higher altitudes than the project area.	**Out**

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PUBLIC DISCLOSURE AUTHORIZED

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Bateleur *Terathopius ecaudatus*	EN	No (EOO: 23,500,000 km^2)	No	Frequents open country, including grasslands, savanna and semi-desert, often foraging over secondary vegetation near towns. This species can tolerate significant disturbance and some habitat modification.	Moderate	Suitable foraging habitat present, but no extensive areas of natural habitat which would be important for breeding habitat. May only occur as a foraging non-breeding visitor. Given its wide distribution it would not meet thresholds for critical habitat.	**Out**
Martial eagle *Polemaetus bellicosus*	EN	No (EOO: 26,000,000 km^2)	No	Occurs in open woodland, wooded savanna, grassland and open thornbush; avoids densely populated areas.	Low	Absent from western Rwanda and occurs in less degraded habitats than those present in the project area. Given its wide distribution it would not meet thresholds for critical habitat.	**Out**
Lesser flamingo *Phoeniconaias minor*	NT	No (EOO:27,700,000 km^2)	Yes Congregatory	Occurs on large undisturbed alkaline and saline lakes and salt pans, occasionally occurring at other shallow open-water wetlands when on passage.	Low	Absent from western Rwanda; limited suitable open-water habitat present. Has a wide distribution.	**Out**
Black-winged pratincole *Glareola nordmanni*	NT	No (EOO: 5,560,000 km^2)	Yes Migratory	Occurs in open landscapes such as grasslands or large salt pans in its overwintering grounds in southern Africa.	Low	Very rare in Rwanda and not recorded in the west.	**Out**
Eurasian curlew *Numenius arquata*	NT	No (EOO: 20,700,000 km^2)	Yes Migratory	Mostly coastal habitats during the austral winter, rarely occurring inland at lakes and rivers.	Low	Very rare in Rwanda and not recorded in the west, although known to occur in the lower Ruzizi floodplain in Burundi.	**Out**
Pallid harrier *Circus macrourus*	NT	No (EOO: 10,900,000 km^2)	Yes Migratory	Occurs in open landscapes such as grasslands or lightly wooded savannah in its overwintering grounds in southern Africa.	Moderate	Scattered records from western Rwanda; known to forage over cultivated lands, so suitable habitat present.	**Out**
Black-tailed godwit *Limosa limosa*	NT	No (EOO: 30,300,000 km^2)	Yes Migratory	Occurs in freshwater habitats during the austral winter, such as swampy lake shores, pools, flooded grassland and irrigated rice fields.	Low	Very rare in Rwanda and not recorded in the west.	**Out**
Great snipe *Gallinago media*	NT	No (EOO: 9,730,000 km^2)	Yes Migratory	Occurs in marshlands and short grass or sedges on lake edges or in flooded fields.	Low	Absent from western Rwanda; limited suitable habitat present.	**Out**
Red-footed falcon *Falco vespertinus*	VU	No (EOO: 2,280,000 km^2)	Yes Migratory	Occurs in open landscapes such as grasslands or lightly wooded savannah in its overwintering grounds in southern Africa.	Low	Occurs on passage over the project area, usually flying at great height, so unlikely to forage within the project area.	**Out**
Rockefeller's sunbird *Cinnyris rockefelleri*	VU	Yes (EOO: 16,000 km^2)	No	Prefers thickets along streams in bamboo forest, as well as montane forest and afro-alpine moorland.	Very Low	No suitable habitat present and does not occur at similar altitudes as project area	**Out**

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PUBLIC DISCLOSURE AUTHORIZED

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Grauer's broadbill *Pseudocalyptomena graueri*	VU	Yes (EOO: 45,600 km²)	No	Inhabits interior of primary rainforest, occasionally at edges or clearings.	Very Low	Not yet recorded in Rwanda; no suitable habitat present.	**Out**
Chapin's flycatcher *Fraseria lendu*	VU	Yes (EOO: 31,900 km²)	No	Occurs in dense montane forest between 1,470 and 1,820 masl.	Very Low	Not yet recorded in Rwanda; no suitable habitat present.	**Out**
Mammals							
African forest elephant *Loxodonta cyclotis*	CR	No (EOO: >50,000 km²)	No	Occurs in a variety of forest habitats including lowland humid forest, swamp forests, lower reaches of Afromontane forests, dry forests and forest-savanna mosaics.	Very Low	No suitable habitat present and high disturbance levels in project AoI.	**Out**
Chimpanzee *Pan troglodytes*	EN	No (EOO: >50,000 km²)	No	Occurs in primary and secondary moist lowland forest, swamp forest, submontane and montane forest, dry forest, forest galleries in savanna woodland, and farmland.	Low	Limited suitable habitat present, habitat degradation is severe and human density is high.	**Out**
Foa's red colobus *Piliocolobus foai*	EN	Yes (EOO: 6,700 km²)	No	Occurs in primary montane and submontane forest from 800 to 2,270 masl.	Very Low	No suitable habitat present and high disturbance levels.	**Out**
White-bellied pangolin *Phataginus tricuspis*	EN	No (EOO: >50,000 km²)	No	Occurs in moist tropical lowland forests and secondary growth, but also occurs in dense woodlands, especially along water courses; associated with abandoned oil palm plantations in some areas.	Low	Limited suitable habitat present, habitat degradation is severe and human density is high.	**Out**
Ulindi River red colobus *Piliocolobus lulindicus*	EN	No (EOO: 104,800 km²)	No	Poorly known; recorded from primary lowland forest and along rivers.	Very Low	No suitable habitat present and high human density in project AoI.	**Out**
Giant ground pangolin *Smutsia gigantea*	EN	No (EOO: >50,000 km²)	No	Occurs in primary and secondary rainforest forest formations, gallery forests, swamp forests, forest-savannah mosaic habitats and wooded savannah.	Very Low	No suitable habitat present and high human density in project AoI.	**Out**
Rahm's brush-furred rat *Lophuromys rahmi*	NT	Yes (EOO: 25,832 km²)	No	Inhabits dense primary montane forest; has been recorded in secondary forest and sparse bamboo stands covered with grass.	Very Low	No suitable habitat present.	**Out**
Moon forest shrew *Sylvisorex lunaris*	NT	Yes (EOO: 46,659 km²)	No	Occurs in primary and secondary montane tropical moist forest and swamps above 1,700 masl.	Very Low	No suitable habitat present.	**Out**

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PUBLIC DISCLOSURE AUTHORIZED

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African straw-coloured fruit-bat *Eidolon helvum*	NT	No (EOO: >50,000 km²)	Yes Migratory	Occurs in a very wide range of habitats; can also inhabit wooded areas in large urban areas, often roosting in cities and towns	High (not confirmed)	Suitable habitat present and can persist in degraded habitats and densely settled areas. However, even if it is present, it is highly unlikely to occur in numbers high enough to trigger the criterion for migratory species, i.e. over 100 000 individuals[7]	**Out**
Hippopotamus *Hippopotamus amphibius*	VU	No (EOO: >50,000 km²)	No	Occurs along rivers and lakes throughout the savanna zone of Africa, and in the main rivers of the forest zone in Central Africa.	Confirmed	This species has been included as a species of potential stakeholder concern. However, as a widespread VU species it does not trigger any of the CH criteria since it is not close to the threshold for being upgraded to EN or CR and does not occur in sufficient numbers to trigger Criterion 1 even if it was listed as EN.	**Out**
Ruwenzori shrew *Ruwenzorisorex suncoides*	NT	Yes (EOO: 54,551 km²)	No	Associated with damp and dense mossy vegetation in montane primary tropical moist forest.	Very Low	Has been included based on its EOO being very close to the threshold of 50,000 km². However, there is no suitable habitat present in the project area and the species also occurs at higher altitudes than the project AoI.	**Out**
Delany's swamp mouse *Delanymys brooksi*	VU	Yes (EOO: 16,941 km²)	No	Confined to high altitude marshes within bamboo and montane forest.	Very Low	There is no suitable habitat present in the project area and the species also occurs at higher altitudes than those in the project AoI.	**Out**
Lemara shrew *Crocidura lanosa*	VU	Yes (EOO: 8,548 km²)	No	Prefers primary montane forest, Cyperus swamps, and bamboo forests; has been recorded from secondary montane forest and in disturbed areas above 1,850 masl.	Very Low	No suitable habitat present.	**Out**
Medium-tailed brush-furred rat *Lophuromys medicaudatus*	VU	Yes (EOO: 14,204 km²)	No	Inhabits montane forests and swamps, avoiding modified habitats.	Very Low	No suitable habitat present.	**Out**
Kemp's thicket rat *Thamnomys kempi*	VU	Yes (EOO: 18,935 km²)	No	Occurs in thickets in open areas of montane secondary forests (and occasionally in primary forests).	Very Low	Project area well below the altitudinal limit for this species.	**Out**

[7] Based on a conservative global estimate of 10 000 000 individuals (Cooper-Bohannon et al. 2020)

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PUBLIC DISCLOSURE AUTHORIZED

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Herpetofauna							
Kivu screeching frog *Arthroleptis pyrrhoscelis*	LC	Yes (EOO: 34,662 km²)	No	Occurs primarily in montane grasslands, although it has also been observed in disturbed areas such as road ditches and banana plantations; 1,000 to 2,100 masl.	High	Although there might be some suitable to support this species in the project area, the low proportion of natural habitat makes it unlikely that sufficiently large populations would be present to trigger CH status	**Out**
Bururi long-fingered frog *Cardioglossa cyaneospila*	NT	Yes (EOO 24,458 km²)	No	A species of montane forests, presumably breeding along streams; 1,467 to 2,000 masl.	Moderate	Although there might be some suitable habitat to support this species in the project area, the low proportion of forest habitat makes it unlikely that it is present or in sufficiently large populations to trigger CH status. Most of the project area is below its typical elevation range.	**Out**
Kivu banana frog *Afrixalus orophilus*	LC	Yes (EOO 46,537 km²)	No	Poorly known species, but has been found in montane grassland, montane bamboo forests, and in wetland areas in reeds and papyrus. Recorded at 1,500 masl.	High	Although there might be some suitable habitat to support this species in the project area, the low proportion of suitable habitat makes it unlikely that sufficiently large populations would be present to trigger CH status. Most of the project area is below its typical elevation range.	**Out**
Hyperolius discodactylus	LC	Yes (EOO 12,383 km²)	No	Known to occur mostly in montane forests, usually near rivers, streams and swamps; 1,600 to 2,700 masl.	Moderate	Although there might be some suitable habitat to support this species in the project area, the low proportion of suitable habitat makes it unlikely that sufficiently large populations would be present to trigger CH status. Most of the project area is below its typical elevation range.	**Out**
Bushoho reed frog *Hyperolius frontalis*	LC	Yes (EOO 26,818 km²)	No	Occurs across a wide altitudinal range (700 to 2,000 masl) and has been recorded in lowland and montane forest; also occurs in dense secondary vegetation overhanging streams and in small marshes in forest.	Moderate	Although there might be some suitable habitat to support this species in the project area, the low proportion of suitable habitat makes it unlikely that sufficiently large populations would be present to trigger CH status.	**Out**

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PUBLIC DISCLOSURE AUTHORIZED

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De Saeger's river frog *Amietia desaegeri*	LC	Yes (EOO 37,203 km²)	No	Occurs in streams in submontane and montane rainforest; known to tolerate significant habitat disturbance; 1,000 to 3,000 masl.	High	Although there might be some suitable to support this species in the project area, the low proportion of natural habitat makes it unlikely that sufficiently large populations would be present to trigger CH status and much of the project area is below its typical elevation range.	**Out**
Schoutenden's Montane Dwarf Chameleon *Trioceros schoutedeni*	DD	Yes (EOO 14,000 km²)	No	Habitat poorly known but has been collected in montane forest; 1,000 to 3,000 masl.	Moderate	Although there might be some suitable to support this species in the project area, the low proportion of natural habitat makes it unlikely that sufficiently large populations would be present to trigger CH status	**Out**
Uvira thread snake *Leptotyphlops latirostris*	NT	Yes (EOO 14,000 km²)	No	Occurs in savanna, evergreen bushland and secondary Acacia grassland below 1,000 masl.	High	Although there might be some suitable to support this species in the project area (along the transmission line route), the low proportion of natural habitat makes it unlikely that sufficiently large populations would be present to trigger CH status.	**Out**
Rwanda five-toed skink *Leptosiaphos graueri*	EN	Yes (EOO <50,000 km²)	No	Has been recorded in various microhabitats in wet montane forest and upland wetlands; 1,500 to 3,000 masl.	Moderate	Although there might be some suitable to support this species in the project area, the low proportion of natural habitat makes it unlikely that sufficiently large populations would be present to trigger CH status and most of the project area is below its typical elevation range.	**Out**
Macroinvertebrates							
Potamonautes semilunaris (crab)	DD	Yes EOO unknown	No	Known from two sites in the DRC near Lake Kivu, neither of which are protected (Cumberlidge 2008).	Uncertain	Not expected to occur in the Project AoI and none were found during surveys in 2022.	**Out**
Agriocnemis palaeforma (damselfly)	VU	Yes EOO 127,552 km² AOO = 200 km²	No	Typically associated with Papyrus swamps	Low	IUCN listed as VU but not range restricted. Unlikely to occur in the Project AoI because there are no Papyrus swamps.	**Out**
Platycypha pinheyi (damselfly)	NT	Yes EOO = 15,931 km²	No	Known only from five locations in the DRC, Tanzania and Zambia, including the northern shores of Lake Tanganyika where it is typically associated on lake shores.	Low	IUCN listed as NT and although restricted range it is unlikely to occur in the Project AoI, but may occur in the Burundi portion of the project AoI, in the Rusizi National Park.	**Out**

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PUBLIC DISCLOSURE AUTHORIZED

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Stenocypha molindica (damselfly)	NT	Yes EOO = <5,000 km^2	No	Typically associated with shaded forested streams.	Low	IUCN listed as NT and although restricted range it is unlikely to occur in Project AoI because there are no forested streams.	**Out**
Stenocypha jacksoni (damselfly)	NT	Yes EOO = 20,000 km^2	No	Typically associated with shaded forested streams.	Low	IUCN listed as NT and although restricted range it is unlikely to occur in Project AoI because there are no forested streams.	**Out**
Tropodiaptomus burundensis (copepod)	VU	Yes EOO unknown	No	Endemic to the Ruzizi River in Burundi (Reid 1996). Associated with standing or slow-moving water.	Low	IUCN listed as VU and although restricted range to Ruzizi River in Burundi, it is unlikely to occur in the Project AoI because of limited standing or slow-moving water.	**Out**
Fish							
Amphilius ruziziensis	NE	Yes (EOO: 7,790 km^2)	No	Range-restricted and endemic to the Ruzizi River and west bank Tanganyikan affluent tributaries. *Amphilius* species are adapted to fast-flowing rocky streams at high elevation, feeding on benthic aquatic macroinvertebrates.	Possible. Similar species confirmed in Rubyiro River in 2022	Range-restricted species to Ruzizi River (<500 km geographic span), listed by the IUCN as Not-Evaluated and therefore its conservation status is currently unknown. Likely to qualify Ruzizi Basin as CH under Criterion 2 threshold.	**In**
Astatoreochromis straeleni Bluelip haplo	LC	Yes (EOO: 15,335 km^2)	No	Range-restricted species with its global extant distribution including Lake Kivu and the northern shores of Lake Tanganyika, including the Ruzizi and Malagarazi Rivers. Primarily a lacustrine (lake-dwelling) fish.	Not confirmed in 2021/22	Restricted range (<500 km geographic span), non-migratory species listed by IUCN as LC. Likely to qualify Ruzizi Basin as CH under Criterion 2 threshold.	**In**
Astatoreochromis vanderhorsti	LC	No (EOO: 52,790 km^2)	No	This is a junior synonym of *A. straeleni* and therefore equivalent to the above species.	-	-	**Out**
Astatotilapia burtoni Burton's haplo	LC	No (EOO 155,792 km^2)	No	*H. burtoni* is common in Lake Tanganyika lagoons associated with inflowing rivers. Primarily a lacustrine (lake-dwelling) species in the early phases of adaptive divergence between river and lake populations.	Confirmed in 2021/22 fish surveys. Likely present in low abundance.	IUCN listed as LC and although it is a localised endemic it does not qualify as restricted-range and does not meet the Criterion 2 threshold for the Ruzizi Basin.	**Out**
Astatotilapia stappersii	LC	No (EOO: 88,162 km^2)	No	Present in Lake Tanganyika and affluent rivers. Mouth-brooding haplohromine cichlid. Primarily a lacustrine (lake-dwelling) fish.	Not confirmed in 2021/22 fish surveys. Likely present in low abundance.	IUCN listed as LC and is a localised endemic.	**Out**

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PUBLIC DISCLOSURE AUTHORIZED

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Ctenochromis horei Hore's haplo	LC	Yes (EOO 55,535 km^2)	No	*C. horei* is a Lake Tanganyika endemic but is common in rivers including the Lukuga River draining into the Congo Basin and the Ruzizi. It is piscivorous occurring on sand bottoms in the lake. Primarily a lacustrine (lake-dwelling) fish.	Confirmed in Ruzizi River in 2021/22	IUCN listed as LC and is a localised endemic (<500 km geographic span). Likely to qualify the Ruzizi Basin as CH under Criterion 2 threshold.	**In**
Gnathochromis pfefferi	LC	Yes (EOO 55,535 km^2)	No	Endemic to Lake Tanganyika, Adults inhabit lakes, often solitary. Feed mainly on shrimps. Females brood their young in the mouth. Primarily a lacustrine (lake-dwelling) fish.	Not confirmed in 2021/22 fish surveys.	IUCN listed as LC and is a localised endemic (<500 km geographic span). Likely to qualify the Ruzizi Basin as CH under Criterion 2 threshold.	**In**
Oreochromis tanganicae Tanganyika tilapia	LC	No (EOO: 34,377 km^2)	No	Primarily a lacustrine (lake-dwelling) fish and not usually found in rivers.	Not confirmed in 2021/22 fish surveys.	IUCN listed as LC and although it is a restricted-range species mainly found in lake habitat it does not qualify the Ruzizi Basin under the Criterion 2 threshold.	**Out**
Chrysichthys sianenna Kanimba	LC	Yes (EOO:34,465 km^2)	No	Present in Lake Tanganyika and affluent rivers including Lower Malagarazi River. Common in deep water with a sandy bed. Upstream spawning migrations have been reported.	Not confirmed in 2021/22 fish surveys.	IUCN listed as LC and although it is a restricted-range species it is found mainly around Lake Tanganyika and therefore it has been screened out.	**Out**
Limnothrissa miodon Lake Tanganyika sardine	LC	No (34,377 km^2)	Yes Migratory	Endemic to Lake Tanganyika. Introduced into Lake Kivu. Primarily a lacustrine (lake-dwelling) fish.	Not confirmed in 2021/22 fish surveys.	IUCN listed as LC and although it is a restricted-range species endemic to Lake Tanganyika and migratory, it does not meet the Criterion 2 threshold for Ruzizi Basin and has been screened out.	**Out**
Acapoeta tanganicae Mbaraga	LC	No (EOO: 42,403 km^2)	Yes Migratory	Recorded from Lake Tanganyika and Lake Rukwa area of Western Tanzania. Occurs in rocky areas of lake and rivers in rapids. Migratory and common in rivers where it frequents rapids.	Not confirmed in 2021/22 fish surveys but IUCN report non-dated records exist of it occurring in Ruzizi River	IUCN listed as LC but is a migratory species recorded previously in the Ruzizi River with high conservation priority due its Evolutionary Distinctiveness (ED). Likely to qualify Ruzizi Basin as CH under Criterion 3 thresholds.	**In**

ORIZED

PUBLIC DISCLOSURE AUTHORIZED

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Enteromius lufukiensis	NT	Yes (EOO: 40,597 km²)	No	Known from rivers draining the western shores of Lake Tanganyika and the Ruzizi, and also reported from the Luama River, Congo River Basin, DRC. Its extent of occurrence is less than 41,000 km² and area of occupancy less than 2,000 km².	Not confirmed in 202122 fish surveys	IUCN listed as NT and is a restricted-range species (<500 km geographic span). Likely to qualify Ruzizi Basin as CH under Criterion 2 threshold.	**In**
Enteromius taeniopleura	LC	No (EOO: 168,180 km²)	No	*E. taeniopleura* is associated more strongly with the Tanganyikan-Congo basin and with rivers draining into Lake Tanganyika as well as the Lukuga River from the lake into the Congo system.	Not confirmed in 2021/22 surveys. Likely present in Ruzizi tributaries.	IUCN listed as LC but not a restricted-range species and does not meet the Criterion 2 threshold for Ruzizi Basin.	**Out**
Labeo cylindricus Redeye labeo	LC	No, although EOO: 19,851 km² (based on IUCN red list) is not accurate)	Yes Migratory	*L. cylindricus*, widespread throughout southern, central and eastern Africa. It is considered part of the "forskalii" group of species which are closely related and difficult to distinguish morphologically.	Confirmed in Ruzizi River in 2022	IUCN listed as LC which although appears to be restricted range based on IUCN red list has a wide distribution based on related morphological types. Although it is migratory it does not meet the Criterion 3 thresholds for Ruzizi Basin.	**In**
Labeobarbus altianalis Ripon barbel	LC	No (EOO 244,889 km²)	Yes Migratory	Widely distributed species. *L. altianalis* are rheophilic gravel-bed spawners and migrate upstream to spawn during the wet season. They are considered long-distance migrators (over 80 km), potentially migrating from as far downstream as the Ruzizi River mouth at Lake Tanganyika.	Confirmed in 2021/2022 surveys	Listed by IUCN as LC with wide distribution and migratory. Likely to qualify Ruzizi Basin as CH under Criterion 3 threshold.	**In**
Labeobarbus caudovittatus	LC	No (EOO: 70,198 km²)	Yes Migratory	Widely distributed mainstem migratory species recorded from the Congo River system DRC, as well as Angola and Zambia as well as the Ruzizi.	Not confirmed in 2021/2022 surveys but known to occur here	Listed by IUCN as LC, is not a restricted range species but is migratory. Likely to qualify Ruzizi Basin as CH under Criterion 3 threshold.	**In**

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PUBLIC DISCLOSURE AUTHORIZED

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Labeobarbus leleupanus Leleup's carp	VU	Yes (EOO: 42,403 km^2)	Yes Migratory	Range-restricted species with its global extant distribution including Lake Kivu and the northern shores of Lake Tanganyika including the Ruzizi and Malagarazi Rivers.	Not confirmed in 2021/2022 surveys, but was present in the 1950s and 1960s.	Listed by IUCN as VU, is a range-restricted species (<500 km geographic span) and migratory. Qualifies the Ruzizi Basin as CH under Criterion 2 and 3 thresholds.	**In**
Labeobarbus somereni Someren's barb	LC	No (EOO: 51,339 km^2)	Yes Migratory	Occurs in the Ruzizi, Malagarazi and the middle and upper Kagera Rivers, and known from fast-flowing rivers in the Ruwenzoris. It is considered migratory of medium to long distances. It is mainly located in mountain stream ecosystems and is found in fast-flowing reaches in the Ruwenzori area.	Confirmed in October 2021 survey but not in 2022 surveys. Suggesting seasonality may be an important factor	Listed by IUCN as LC and migratory. Qualifies the Ruzizi Basin as CH under Criterion 3 threshold.	**In**
Labeobarbus tropidolepis	LC	No (EOO: 127,546 km^2)	Yes Migratory	Endemic to the Lake Tanganyika Basin where it is common in inshore catches. It is considered migratory of medium to long distances.	Not confirmed during the 2021/2022 surveys.	Listed by IUCN as LC, is a restricted-range and migratory species. Likely to qualify the Ruzizi Basin as CH under Criterion 3 threshold.	**In**
Raiamas moorii Lake Rukwa minnow	LC	No (EOO: 119,133 km^2)	No	Present in Lakes Tanganyika and Rukwa. Inhabits rivers and lakes where it is found in sandy bays.	Confirmed in Ruzizi River in 2022	IUCN listed as LC and although it is a near restricted-range species (mainly in lakes but confirmed in the Ruzizi River) it does not meet the Criterion 2 thresholds for Ruzizi Basin.	**Out**
Chiloglanis asymetricaudalis Longtail suckermouth	**EN**	Yes (EOO: 9,545 km^2)	No	Known from Ruzizi Basin but is also more widely distributed in the south to the Luiche River, an affluent river into Lake Tanganyika. The species is well adapted for inhabiting fast-flowing riffle-rapid habitats in rivers. With a sucker mouth that enables it to feed on algae and invertebrates in fast currents.	Possible. Confirmed in Rubyiro River in 2022. Unconfirmed recently in Ruzizi River.	IUCN listed as EN and is restricted range (<500 km geographic span) with historical records from Ruzizi River Basin, mainly in tributaries. Confirmed in Rubyiro River and likely to occur in Ruzizi River in low numbers. Qualifies Ruzizi Basin as CH under Criterion 1 and 2.	**In**
Chiloglanis ruziziensis Ruzizi suckermouth	**CR**	Yes (EOO: 10,347 km^2)	No	This species is known only from the Ruzizi River and tributaries. Inhabits rapids where it feeds on macro-invertebrates.	Possible. Not recorded in 2021/2022 Last official recording was in 1950s and mid-1980s	IUCN listed as CR and restricted range (<500 km geographic span), and there are historical records from Ruzizi River and its tributaries. Current abundance and distribution not known but may occur in Ruzizi River in low numbers. Qualifies Ruzizi Basin as CH under Criterion 1 and 2.	**In**

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Scientific Name	IUCN Status	Restricted range	Migratory/ Congregatory	Habitat and Distribution	Likelihood of Occurrence	Rationale for Critical Habitat Screening	Screened In or Out
Lamprichthys tanganicanus Tanganyika killifish	LC	Yes (EOO: 34,377 km^2)	No	A native of Lake Tanganyika, it is primarily a lacustrine (lake-dwelling) species and its presence in the Ruzizi River may be incidental as recorded as introduced to Lake Kivu.	Confirmed in Ruzizi River in 2022	IUCN listed as LC and is a restricted-range species (<500 km geographic span).	**In**

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9.3.2.2 Screening of Keystone Species and Ecological Networks

Keystone species and Ecological Networks are two additional criteria required by AfDB OS3.

A keystone species is a species that has a disproportionately large effect on its environment relative to its abundance (Paine,1995). There are no keystone species present in the Project Area. While hippopotamus is present in the Ruzizi River and will under normal circumstances play a significant ecological role in recycling nutrients and managing riparian vegetation density, they are not present in sufficient numbers in the Project AoI to be considered a keystone species in this predominantly modified environment. Further, no elephants or Nile crocodiles are present in the Ruzizi River reach (where the project is located) which would likely qualify as a keystone species.

In terms of ecological networks, the Project area would not qualify as Critical Habitat due to the extent of habitat modification and fragmentation across most of the area resulting in compromised ecological networks. It is not located within any corridor that serves as an important connection between discrete areas of natural biodiversity or protected areas where animal movement or plant pollinators or gene flow is critical to the survival of important species.

While the Ruzizi River serves as an important corridor for migratory fish species to reach upstream spawning grounds, the functionality of this corridor has been significantly compromised by other hydropower projects upstream that form barriers to fish connecting between Lake Tanganyika and Lake Kivu. For these reasons, the Project AoI is not considered to be located within an Ecological Network that could qualify as Critical Habitat, although the ecological processes that maintain migratory fish need to be recognised and managed to optimise their survival.

In summary, there are no keystone species or ecological networks in the Ruzizi River mainstem or the project area of influence that would qualify for Critical Habitat under these two AfDB criteria and they are not considered further.

9.3.2.3 Summary of Initial Critical Habitat Screening Results at Ruzizi Basin Scale

In summary, after an initial screening assessment using online data sources, 23 species were evaluated, 17 fish species were screened in (Figure 9-11**Error! Reference source not found.**). Of these, 15 were assessed to qualify for Critical Habitat at Ruzizi Basin scale. These include:

- 2 which qualify as threatened species (EN/CR) under criterion 1 with >1% of their IUCN distribution in the Ruzizi Basin (*Chiloglanis ruziziensis* and *C. asymetricaudalis*);
- 9 (including the 2 threatened species above) which qualify as restricted range; and
- 7 of these qualify as migratory species under Criterion 3, of which one species (*Labeobarbus leleupanus*) also qualifies for Criterion 2, restricted range.

These 15 species were screened once more in greater detail using historical and other available data and information obtained from recent surveys of the Ruzizi River (e.g. from CRBEC/CRSNE) and for a defined Ecological Area of Analyses in Section 9.3.3.1.

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9.3.3 Critical Habitat Assessment for Fish

9.3.3.1 Defining the EAAA for Fish

A Introduction

The CHA was based on IFC GN6 (2019; GN59). The assessment requires an Ecologically Appropriate Area of Analysis (EAAA) to be determined for each species with regular occurrence in the Project's Area of Influence (AoI) (or groups of species with overlapping distribution and ecosystem requirements) or at an ecosystem level. These are defined considering the distribution of species or ecosystems and ecological patterns, processes, features or functions necessary to maintain them. For wide-ranging (or migratory/congregatory) species, these need to include consideration of areas of aggregation and recruitment (e.g. for feeding or spawning). Where appropriate and to maintain connectivity, these boundaries may extend to a catchment level of analysis. Typically, the EAAA will be larger than the area of influence of the project, especially where species such as fish rely on fluvial systems for movement between breeding and feeding areas and for other ecological processes (e.g. food supply) to sustain them.

The IFC GN6 stresses that delineating the EAAA for a Critical Habitat Assessment (CHA) should be informed by the AoI of the Project but that the definition of Critical Habitat is done irrespective of the impact of a project. In other words, when defining the spatial boundary for the CHA it is necessary to understand the potential zone of project influence before identifying the biodiversity values (e.g. priority species or habitats) that occur within this zone and the spatial extent of their ecological requirements needed to sustain these identified values. In cases of uncertainty about a species' distribution or ecological requirements to complete its lifecycle, delineations should ensure the EAAA is sufficient to encompass the possible or likely habitat or connectivity needs of a species. The size of the Critical Habitat can be amended after closer examination and collection of additional information.

However, the larger the spatial extent of the EAAA the more likely that Critical Habitat will be determined, irrespective of whether the project may impact on the biodiversity values that trigger Critical Habitat. For instance, the length of river reach or catchment extent that sustains a migratory species may provide the basis for the CHA on a precautionary basis, which is often a good basis for screening potential CH species. However, one or more revised EAAAs may be more appropriate in situations where i) IUCN distribution data is outdated and more recent field data is available that can provide more reliable species distribution, and ii) where the extent of influence of the Project is better understood to support a more refined and smaller EAAA. This is the case for the Ruzizi III project where sub-basin level EAAAs have been defined (see below) for the more detailed CHA analysis. These are deemed appropriate for a more precise determination of the fish species that may qualify in the area of influence of the project.

Regardless of the EAAA used for the CHA, once a Critical Habitat has been defined, it is important to link the potential impacts of the Project on the biodiversity triggers as a basis for informed decision-making. When using a large EAAA, it is useful to link species requirements to specific zones or river reaches as a basis for determining potential project impacts. This may help to avoid raising a 'red flag' without contextualising the project impacts and to determine whether mitigation can effectively minimise the project risks on Critical Habitat-qualifying features.

B EAAAs for Migratory and Non-Migratory Fish

The EAAAs used in this CHA are defined only for fish that were screened in and may qualify as Critical Habitat (Table 9-6). Separate EAAAs were defined for migratory and non-migratory fish rather than individual species as the distribution of these two categories of fish largely overlap. There is insufficient data to map EAAAs separately for individual fish species or their habitat types.

The EAAA in this assessment has been delineated using a global standardised hydrological framework that delineates basins and sub-basins at 12 resolutions i.e. the global digital drainage

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networks (HydroBASINS) Level 10 (Lehner and Grill 2013) in QGIS Version 2.20.2. These HydroBASINs are used by the IUCN to define a species Extent of Occurrence (EOO) and are widely used for numerous other freshwater species conservation assessments where the river basin is generally accepted as the most appropriate unit of assessment.

EOOs defined by the IUCN are produced from existing distribution and museum records with expert input but are not always up to date. Figure 9-7 shows the spatial extent of EAAAs for migratory and non-migratory fish species which are further elaborated on as follows:

- **Migratory Species**: the EAAA is defined by Level 10 HydroBASINS within the Ruzizi Basin between an area 4.5 km downstream of the Ruzizi II hydropower plant[8] (representing the uppermost barrier for migratory species) down to the Ruzizi floodplain where the river enters the Lake Tanganyika (an area important for breeding/spawning of migratory and other fish endemic to the lake). Only those HydroBASINS that intersected with the Ruzizi River main channel were selected as the this is the reach which falls within the project area of influence, where impacts on fish migrating between Lake Tanganyika and the Middle Ruzizi could be affected. This EAAA stretches ~105 km from just downstream of the Ruzizi II hydropower plant to Lake Tanganyika and includes the HydroBASINS that intersect with the river over this distance. The migratory species EAAA covers an area of 1,059 km^2.
- **Non-migratory Species**: the EAAA for non-migratory species is defined as the HydroBASIN that include the uppermost reach of the Ruzizi III reservoir (extending 4.5 km downstream of Ruzizi II HPP) down to 6 km past the expected furthest reach where peaking flow releases may impact the river near Bugurama. This EAAA for non-migratory species stretches 23 km and the relevant HydroBASINS cover an area of 113 km^2.

Note: For the purposes of this assessment the HydroBASIN layers are considered the most appropriate unit of assessment rather than river length for which no comparable distribution data are available.

[8] The nearest HydroBASIN boundary extends to 4.5 km downstream of the Ruzizi II HPP. The next upstream Hydroshed boundary would have included the entire reach up to Lake Kivu and including Ruzizi I HPP and Bukavu. Hence, it was decided that since only a small portion of the reach to Ruzizi II HPP was excluded from the EAAA that it would be appropriate to exclude the 4.5 km section rather than including the full reach to the lake which is not accessible to migratory species moving upstream from the Ruzizi III HPP AoI.

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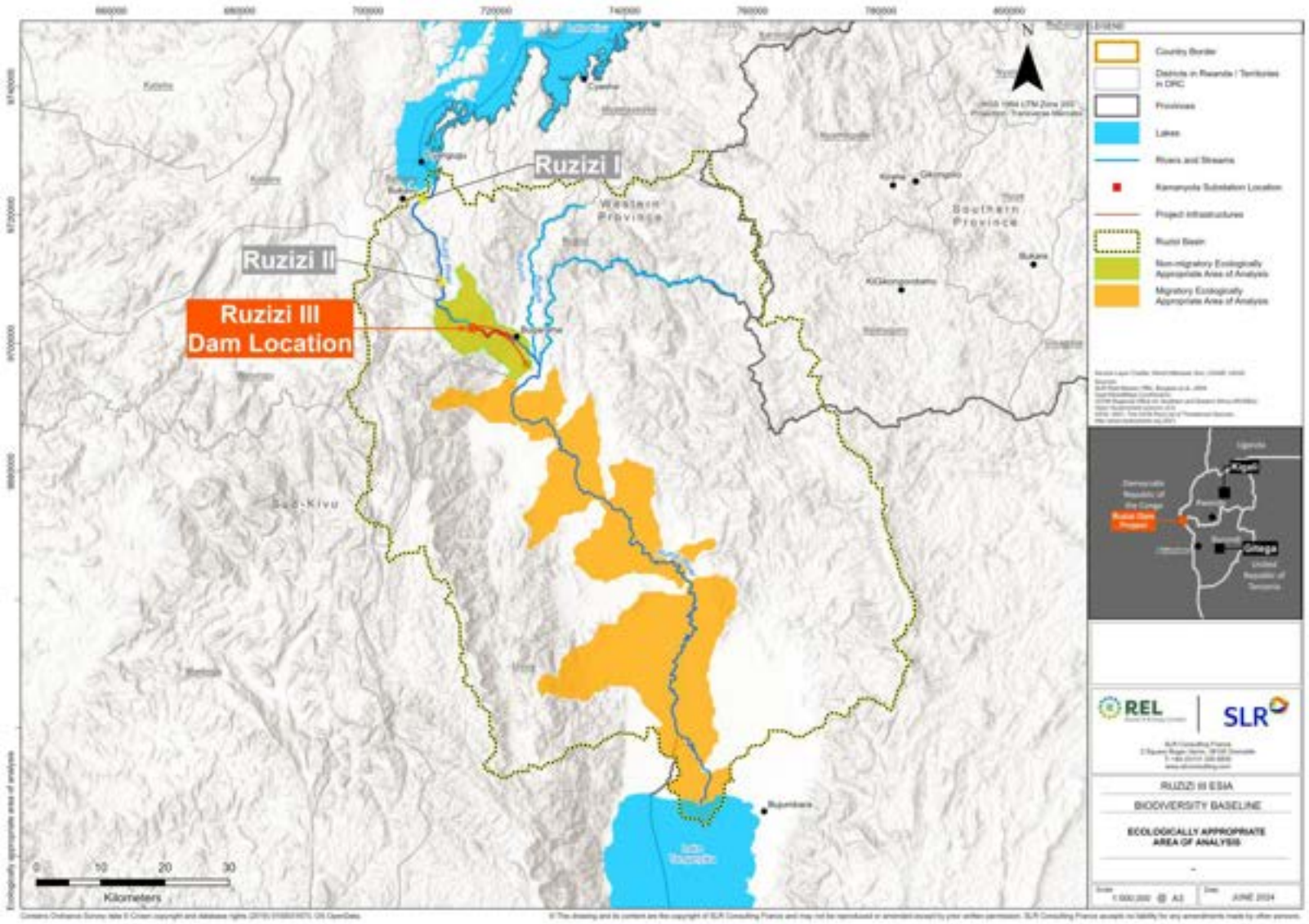


Figure 9-7 Project EAAA for Migratory Fish (1,059 km^2) and Non-Migratory Fish (113 km^2) in Ruzizi Basin (6,078 km^2)

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9.3.3.2 Application of IFC PS6 Thresholds to the Detailed CHA for Fish

The thresholds for each criterion and their application in this CHA for the Ruzizi River are indicated in Section 9.1. Note: IFC GN6 (2018) includes thresholds for criteria 1-4 only. Criterion 5 is an ESS6 criterion and does not have specific thresholds. The approach to applying each criterion and their thresholds is summarised in Table 9-7.

A Note on Calculating Species Spatial Extent in the EAAA for Criteria 1-3

Where population data is limited, which is largely the case for freshwater biota in remote areas, the global spatial extent of a species distribution (i.e. EOO) based on IUCN data are typically used as a surrogate for population size (Sayer et al., 2018). Sayer et al.'s (2018) approach was followed for the aquatic CHA which used 'extant' (i.e. known) distributions to determine the extent to which the EAAA intersected with a species global EOO.

This approach assumes species are equally abundant across all planning units although this is likely an incorrect assumption as some habitats will be favoured by certain species over others. This is a precautionary approach and is necessitated as population abundance data are lacking for most freshwater species in African rivers. It is also a conservative approach because the Ruzizi River has been significantly modified over the last 50 years by the hydropeaking mode of operation of the Ruzizi-I and -II hydroelectric schemes.

The proportion of a species' extant EOO was used to calculate the threshold percentage and determine if it met the threshold percentage for each IFC criterion The global EOO for each species in this CHA that triggered one or more of the Critical Habitat criteria was obtained from the IUCN spatial datasets (IUCN, 2018). These datasets consist of polygons delineating the 'extant' (resident) and 'possibly extant' distributions. The EOO is determined based on known historical museum or published distributions and by consulting experts. Areas that are likely to support a species, but for which there are no known records are considered 'possibly extant'. In most instances, the original IUCN EOOs were used to define EAAAs. However, where additional data on species distributions became available, the EOO was revised to include these data. Further discussion on the known habitat preferences and records of the species was then applied to determine if a species qualifies for CH.

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Table 9-7 Application of ESS6 Criteria 1, 2 and 3 and IFC PS6 Thresholds for Critical Habitat to the Ruzizi III HPP CHA

ESS6 Criteria & Thresholds (IFC GN6)	**Notes on approach for Ruzizi HPP CHA**
Criterion (a): Habitat of Significant Importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches [9]	
Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units[10] of a CR or EN species).	Insufficient data is available to determine the global population size or reproductive units of EN or CR fish in the EAAA. Therefore, as described above, the proportion of a species' Extent of Occurrence (EOO) within an EAAA is used as a proxy for percentage of population, following a similar approach used by Sayer (2018)
Areas that support globally important concentrations of an IUCN Red-listed VU species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72(a).	As above. Note: one Vulnerable species of fish - *Labeobarbus leleupanus* Leleup's carp (previously *Varicorhinus leleupanus*)- is endemic to the Ruzizi River and other streams flowing into the northern end of Lake Tanganyika where it is inferred to have a small population and is very rare in fisheries catches, and only recorded from less than five locations. It is threatened by sedimentation and water turbidity from watershed erosion. It was last assessed by IUCN in 2006 and needs updating. It is possible that its reassessment could result in an upgrade to EN.
As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.	No national or regional red list of aquatic species exists for Rwanda, DRC or Burundi. Only IUCN globally red-listed species are used for Criterion 1.
Criterion (b): Habitat of significant importance to endemic or restricted-range species [11]	
Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species	Insufficient data is available to determine the global population size or reproductive units of endemic or restricted range fish in the EAAA. As for Criterion 1a, the proportion of the defined EAAA catchment area within the confirmed EOO of each species is used as a proxy for percentage of a fish population within the EAA zones following Sayer *et al* ., 2018[12].
Criterion (c): Habitat supporting globally or nationally significant concentrations of migratory or congregatory species [13]	
Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle.	This criterion has been applied to migratory fish confirmed to occur in the Ruzizi River based on the proportion of a migratory species' EOO that falls within the EAAA. Insufficient data is available to determine whether certain parts of the Ruzizi catchment are more important than others for sustaining the global population of migratory or congregatory species.

[9] Where subspecies and sub-populations have been separately assessed for inclusion in the IUCN Red List, they may be considered under Criteria 1, as appropriate (GN68)

[10] The IUCN Biodiversity Areas standard uses the following definition for reproductive unit: "the minimum number and combination of mature individuals necessary to trigger a successful reproductive event at a site Examples of five reproductive units include five pairs, five reproducing females in one harem, and five reproductive individuals of a plant species." Eisenberg, 1977. The Evolution of the Reproductive Unit in the Class Mammalia (footnote GN16 under GN72)

[11] Restricted range species are those with limited Extent of Occurrence (EOO) (GN74): (i) For terrestrial vertebrates and plants, a restricted-range species is defined as those species that have an EOO less than 50,000 square kilometers (km^2). (ii) For marine systems, restricted-range species are provisionally being considered those with an EOO of less than 100,000 km^2. (iii) For coastal, riverine, and other aquatic species in habitats that do not exceed 200km width at any point (for example, rivers), restricted range is defined as having a global range of less than or equal to 500 km linear geographic span (i.e., the distance between occupied locations furthest apart).

[12] Sayer, C.A., Máiz-Tomé, L. and Darwall, W.R.T. (2018). Freshwater biodiversity in the Lake Victoria Basin: Guidance for species conservation, site protection, climate resilience and sustainable livelihoods. Cambridge, UK and Gland, Switzerland: IUCN. xiv +226pp.

[13] Migratory species are defined as any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem) (GN76). Congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis (GN77).

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ESS6 Criteria & Thresholds (IFC GN6)	Notes on approach for Ruzizi HPP CHA
Areas that predictably support ≥10% of the global population of a species during periods of environmental stress.	There is insufficient data to apply this criterion. One could only assume that the larger rivers draining into Lake Tanganyika such as the Ruzizi River would be of greater importance in times of environmental stress, especially if other tributaries (e.g. Ruhwa and Rubyiro River) are impacted by further irrigation development.
Criterion (d): Highly threatened or unique ecosystems	
Areas representing ≥5% of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN. Note: This requires use of the IUCN Red List of Ecosystems where formal IUCN assessments have been performed or "assessments using systematic methods at the national/regional level, carried out by governmental bodies, recognized academic institutions and/or other relevant qualified organizations (including internationally recognized NGOs)".	No formal Red List process has been done for ecosystems in the Project Area and therefore this threshold has not been applied in this CHA.
Other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.	No regional or national conservation plan or identification of KBAs has been conducted covering the Ruzizi Basin. However, the Rusizi National Park is a Ramsar site and KBA located 88 km downstream of the Ruzizi III HPP powerhouse and would likely qualify for Critical Habitat. While the Ruzizi River is important for fish migration between the lower and upper river reaches, it does not qualify as a Highly Threatened or Unique Ecosystem under this criterion.
Criterion (e): Ecological Processes or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)	
No thresholds are defined.	Considerations are given to aspects such as landscape connectivity to support and maintain migratory species and facilitate gene flow.

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9.3.3.3 Critical Habitat Assessment of Screened in Fish Species

A ***IFC PS6 Criterion 1 to 3: CR/EN; Restricted Range and Migratory/Congregatory Species***

The initial screening described in Section 9.3.2 identified 23 fish species in the Ruzizi Basin that potentially qualify for critical habitat of which 15 species potentially qualify as Critical Habitat at the basin scale (Table 9-6).

These 15 screened-in fish species were shortlisted for more detailed analysis by assessing them against IFC PS6 thresholds for the migratory and non-migratory EAAAs (described in Section 9.3.3.1).

Distribution records of these species in the Ruzizi Basin were obtained in early 2023 from the Royal Museum for Central Africa, Belgium, and CRBEC / CRSNE and the Global Biodiversity Information Facility (GBIF). Experts at these institutions were also consulted on their understanding of current species distributions. This information was used to inform the critical habitat assessment.

The results of the more detailed assessment for the 15 five fish species are summarised in Table 9-8.

In summary, threshold analysis for five of the 15 species indicate that they may qualify for Critical Habitat based on the spatial extent of their known distribution that overlaps within the migratory or non-migratory species EAAA. It should be noted that this approach does not take into account differences in their distribution range where these species are more likely to have a higher population as insufficient data is available. However, there are some inferences that can be draw on their habitat preference and likely areas of higher abundance that can be used to infer whether they can be considered to qualify for Critical Habitat.

Information on each species is described below with a concluding statement on their status as CH qualifying species.

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Table 9-8 Fish Species Screened in for CHA in Table 9-6

(A)						(B) Ruzizi Basin applied to Migratory and Non-migratory species				(C) EAAAs for Non-migratory and Migratory species			
Family	Species	Status	Migratory	Range-restricted	Global EOO (km^2)	Intersection of EOO with Area of Analysis (km^2)	% of EOO in Ruzizi Basin	Criterion	Triggered (Criterion)	Intersection of EOO with Area of Analysis (km^2)	% of EOO in EAAA	Criterion	Triggered (Criterion)
Amphiliidae	*Amphilius ruziziensis*	NE	No	**< 500 km**	7,790	6,078	**78.0%**	1(a)&2	**Y (2)**	113	1.5%	1(a)&2	N
Cichlidae	*Astatoreochromis straeleni* Bluelip haplo	LC	No	**< 500 km**	15,335	6,078	**39.6%**	2	**Y (2)**	113	0.7%	2	N
	Ctenochromis horei Hore's haplo	LC	No	**< 500 km**	55,535	6,078	**10.9%**	2	**Y (2)**	113	0.2%	2	N
	Gnathochromis pfefferi	LC	No	**< 500 km**	55,535	6,078	**10.9%**	2	**Y (2)**	113	0.2%	2	N
Cyprinidae	*Enteromius lufukiensis*	NT	No	**< 500 km**	40,597	6,078	**15.0%**	2	**Y (2)**	113	0.3%	2	N
	Acapoeta tanganicae Mbaraga*	LC	**Yes**	> 500 km	75,279	6,078	**8.1%**	2&3	**Y (3)**	1059	**1.4%**	3	**Y (3)**
	Labeo cylindricus Redeye labeo	LC	**Yes**	> 500 km	4,831,479	6,078	0.1%	3	N	1059	0.0%	3	N
	Labeobarbus altianalis Ripon barbel	LC	**Yes**	> 500 km	244,889	6,078	**2.5%**	3	**Y (3)**	1059	0.4%	3	N
	Labeobarbus caudovittatus	LC (global) NT (E.Africa)	**Yes**	> 500 km	70,198	6,078	**8.7%**	3	**Y (3)**	1059	**1.5%**	3	**Y (3)**
	Labeobarbus leleupanus Leleup's carp*	VU	**Yes**	**< 500 km**	42,403	6,078	**14.3%**	2&3	**Y (2&3)**	1059	**2.5%**	3	**Y (3)**
	Labeobarbus somereni Someren's barb*	LC	**Yes**	> 500 km	127,265	4,383	**3.4%**	3	**Y (3)**	1059	0.8%	3	N
	Labeobarbus tropidolepis	LC	**Yes**	> 500 km	127,546	6,078	**4.8%**	3	**Y (3)**	1059	0.8%	3	N
Mochokidae	*Chiloglanis asymetricaudalis* Longtail suckermouth*	**EN**	No	**< 500 km**	13,090	6,078	**46.4%**	1(a)&2	**Y (1a)&2**	113	**0.9%**	1(a)	**Y (1a)**
	Chiloglanis ruziziensis Ruzizi suckermouth*	**CR**	No	**< 500 km**	10,347	6,078	**58.7%**	1(a)&2	**Y (1a)&2**	113	**1.1%**	1(a)	**Y (1a)**
Poeciliidae	*Lamprichthys tanganicanus* Tanganyika killifish	LC	No	> 500 km	34,377	28	0.1%	2	N	28	0.1%	2	N

(NE = Not Evaluated, LC = Least Concern, VU = Vulnerable, EN = Endangered, CR = Critically Endangered); Y = yes / N = no

Fish species screened in for CHA in Table 9-6 are listed in Table (A) with their conservation status, migratory status, extant distribution based on IUCN records, range restricted species (<500 km) and global Extent of Occurrence (EOO); Table (B) assesses the extent of overlap of their EOO with the Ruzizi Basin (1) in Figure 9-7 and (C) the extent of overlap with their EOO with separate and smaller EAAAs for migratory and non-migratory species. The IFP criterion and whether it is triggered or not is listed in adjacent columns.

* Indicates a revised EOO based on additional records obtained from additional sources including the Royal Museum for Central Africa, Belgium, and CRBEC / CRSNE and the Global Biodiversity Information Facility (GBIF). Experts at these institutions were also consulted on their understanding of current species distributions.

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***Acapoeta tanganyicae* (Boulenger 1900) Mbaraga**

Acapoeta tanganicae is reportedly a migratory species that occurs predominantly in Lake Tanganyika and is considered a common species around rocky shorelines and the rapids of influent tributaries (Eccles 1992). Once considered endemic to Lake Tanganyika, a population outside the species' expected geographic range was recently recorded in an influent tributary of Lake Rukwa, an endorheic system in eastern Tanzania which supports a historical connection to Lake Tanganyika (Genner *et al.* 2015). This population has been added to the extant area of this species (Figure 9-8). With the addition of the Lake Rukwa locality, the proportion of this species' EOO overlapping with the EAAA for migratory species comprises 1.4% and therefore would potentially qualify for Critical Habitat under Criterion 3 (migratory species) (Figure 9-8). However, as with *L. leleupanus*, *A. tanganicae* was last recorded in the Ruzizi Basin in the 1950s (based on available data) and it has not been recorded in recent surveys either by the CRBEC/CRSNE, SOFRECO or by SLR. This includes the surveys in the lower Ruzizi River and Ramsar site done between 2018 and 2020 by CRBC/CRSNE researchers who confirmed that they had not encountered it. Based on these results, *A. tanganicae* has been reassessed and screened out of the CHA on the basis of lack of evidence for its continued occurrence in the Ruzizi River.

In summary, since there are no records of Acapoeta tanganicae in the Ruzizi River since the 1950's (despite more recent surveys in the middle and lower reaches) plus the fact records suggest it is mainly a lake-dwelling species, it is not considered to qualify for critical habitat.

***Labeobarbus caudovittatus* (Boulenger 1902)**

Specimens of *Labeobarbus caudovittatus* have been recorded from a number of Central and West African countries, including the Democratic Republic of the Congo, Gabon, Burundi, Angola and Zambia including the Ruzizi River (De Vos and Thys van den Audenaerde 1990). The Royal Museum for Central Africa houses several specimens collected from the Ruzizi in 1994 (De Vos 1994) and it is considered to occur in a number of other river systems affluent to Lake Tanganyika including the Malagarisi and Lukuga Rivers (Figure 9-9). The global status of its populations is largely unknown, but it is not considered threatened at global level (Moelants 2010). However, it is assessed as Near Threatened in East Africa where it is threatened by fishing pressures and regression of habitat due to farming (Ntakimazi; IUCN redlist).

It was collected by the CRBEC in unpublished surveys conducted between 2018-2022 at a site in the middle reach of the Ruzizi River downstream of the proposed Ruzizi III HPP (Figure 9-9). Occurrences from 1973 museum records also confirm its occurrence here (GBIF 2024). As with many of the larger *Labeobarbus* species, it is considered migratory.

In summary, although this species has been confirmed in the Middle Ruzizi River and the analysis indicates that 1.5% of its global EOO occurs in the migratory EAAA, Labeo caudovittatus is a widespread species occurring in several rivers of central Africa and the Ruzizi River is not considered Critical Habitat for this species.

***Labeobarbus leleupanus* (Matthes 1959) Leleup's carp**

There are only four records of the species in the GBIF database dating from 1952 to 1960 and three occurrence records from 2016-2018 in three affluent rivers of the lower Ruzizi in Burundi, all located >34 km downstream of the Ruzizi III HPP according to (as yet) unpublished data of the CRBEC/CRSNE. In addition, Bayona (1991) recorded *L. leleupanus* from beach seine catches on the shores of Lake Tanganyika. Its distribution is shown in Figure 9-10. The original holotype comes from the Ruzizi River Basin (Vreven *et al.* 2016). It is listed by the IUCN as Vulnerable (VU) due to increased sedimentation as a result of poor land management practices and erosion in the catchments (Ntakimazi 2006) and likely impacted by existing hydropower developments. It is considered rare and endemic to the Ruzizi Basin (Eccles 1992, Banyankimbona *et al.* 2012, De Vos *et al.* 2001) and the rivers flowing into the northern end of Lake Tanganyika. Since no additional distribution records for this species could be found, the proportion of the EAAA overlapping the EOO of *L. leleupanus* remains the same.

In summary, given the lack of evidence for the continued presence of Labeobarbus leleupanus in the middle or upper Ruzizi River (with only four historic records prior to 1960) and its reported

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occurrence in tributaries of the lower Ruzizi River (2016-2018) (from 34 km downstream of the Ruzizi III project), the upper and middle Ruzizi River mainstem is not assessed to be Critical Habitat for this species. However, the lower Ruzizi River and its affluent rivers may qualify for Critical Habitat.

***Chiloglanis asymetricaudalis* (De Vos 1993) Longtail suckermouth**

Chiloglanis asymetricaudalis was initially considered endemic to the Ruzizi River Basin when it was described by de Vos (1993). It is currently considered rare and endangered (EN) as a consequence of erosion and sedimentation. Subsequently, in 2011, a population was discovered in the Luiche River, a small tributary draining the east bank of Lake Tanganyika north of the Malagarisi catchment confirming its presence outside of the Ruzizi Basin (Friel & Vigliotta 2011). This population has been added to the known extant population for this species (Figure 9-11) This additional Level 06 HydroBASIN was therefore included in the extant EOO for this revised CH assessment. With the addition of this catchment, the threshold for triggering Criterion 1 (a) for CR/EN species is still exceeded (0.9 %) (Table 9-8). *C. asymetricaudalis* was caught in SLR surveys from the Rubyiro River in 2022 and in other tributaries by CRBEC/CRSNE. All the historical records and records from CRBEC/CRSNE of this species are from tributaries and at the confluence of tributaries with the Ruzizi River. Ad hoc interviews with fishermen (in May 2024) indicated that they occasionally catch *Chiloglanis* spp. in the Middle Ruzizi River. While it does appear to be more common in tributaries such as the Rubyiro, it is also possible that available fish catch results do not reflect its presence in the Ruzizi River mainstem. While its numbers may be reduced from hydropeaking effects of Ruzizi I and II, it is also likely less recorded in the mainstem river because of the difficult fishing conditions (deep water and high flow) and because this fish occurs on the river bottom amongst rocks, where it is difficult to access.

On a precautionary basis, given its Endangered threat status and confirmed recent records, Chiloglanis asymetricaudalis is screened in as a potential CH qualifying species for the Middle Ruzizi River non-migratory EAAA.

***Chiloglanis ruziziensis* (Boulenger 1900) Mbaraga**

Chiloglanis ruziziensis was described with *C. asymetricaudalis* by De Vos (1993). It is considered endemic to the Ruzizi Basin and the rivers draining the western shoreline of Lake Kivu and is listed by the IUCN as Critically Endangered (CR). It is considered rare in fish catches and threatened by sedimentation in the catchment (Ntakimazi 2006). It has been historically recorded in the Ribyiro River near Bugarama.

The threshold for triggering Criterion 1 (a) for CR/EN species is exceeded (the EAAA for non-migratory fishes exceeds 0.5% of the EOO) (Table 9-8). Although, it has not been caught in recent surveys (the last records date to 1986) (Figure 9-12) it is assessed as qualifying for Critical Habitat for the Middle Ruzizi River on a precautionary basis. As for *C. asymetricaudalis*, it may occur in the mainstem river where it is difficult to catch but if so, it is likely to be rare.

On a precautionary basis, given its Critically Endangered threat status, Chiloglanis ruziziensis is screened in as a potential CH qualifying species for the Middle Ruzizi River non-migratory EAAA.

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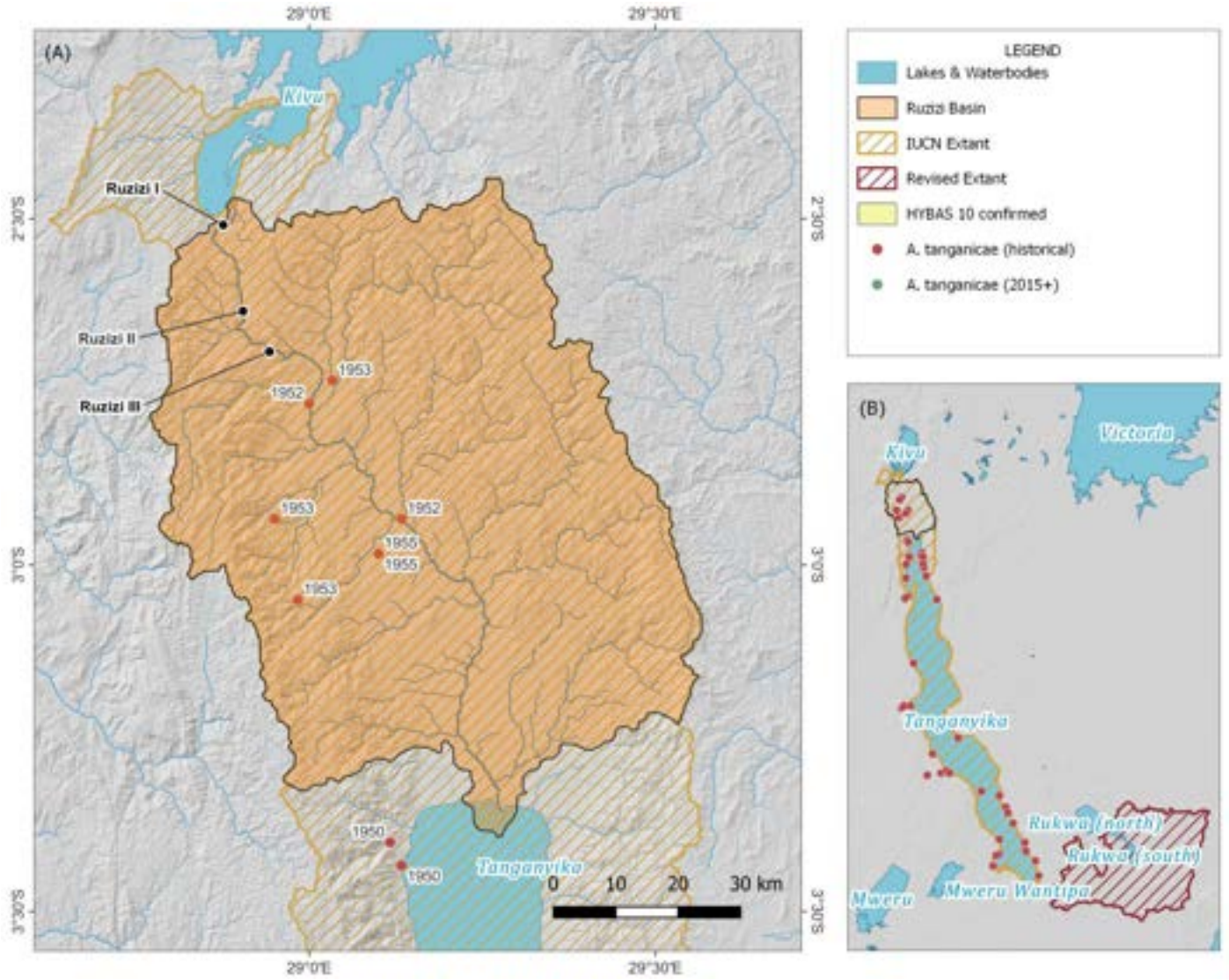


Figure 9-8 Distribution of *Acapoeta tanganicae* in the Ruzizi Basin

(A) historical and recent (2015+) records with overlapping HydroBASINS level 10 (HYBAS 1) of confirmed records and (B) revised EOO showing (1) IUCN Extant (resident) – regions in which resident populations were confirmed by the IUCN (2) IUCN Possibly Extant (revised) – regions in which populations were thought to occur, but which are here considered confirmed, (3) Revised Extant – new regions identified by a review of distribution records undertaken in this report.

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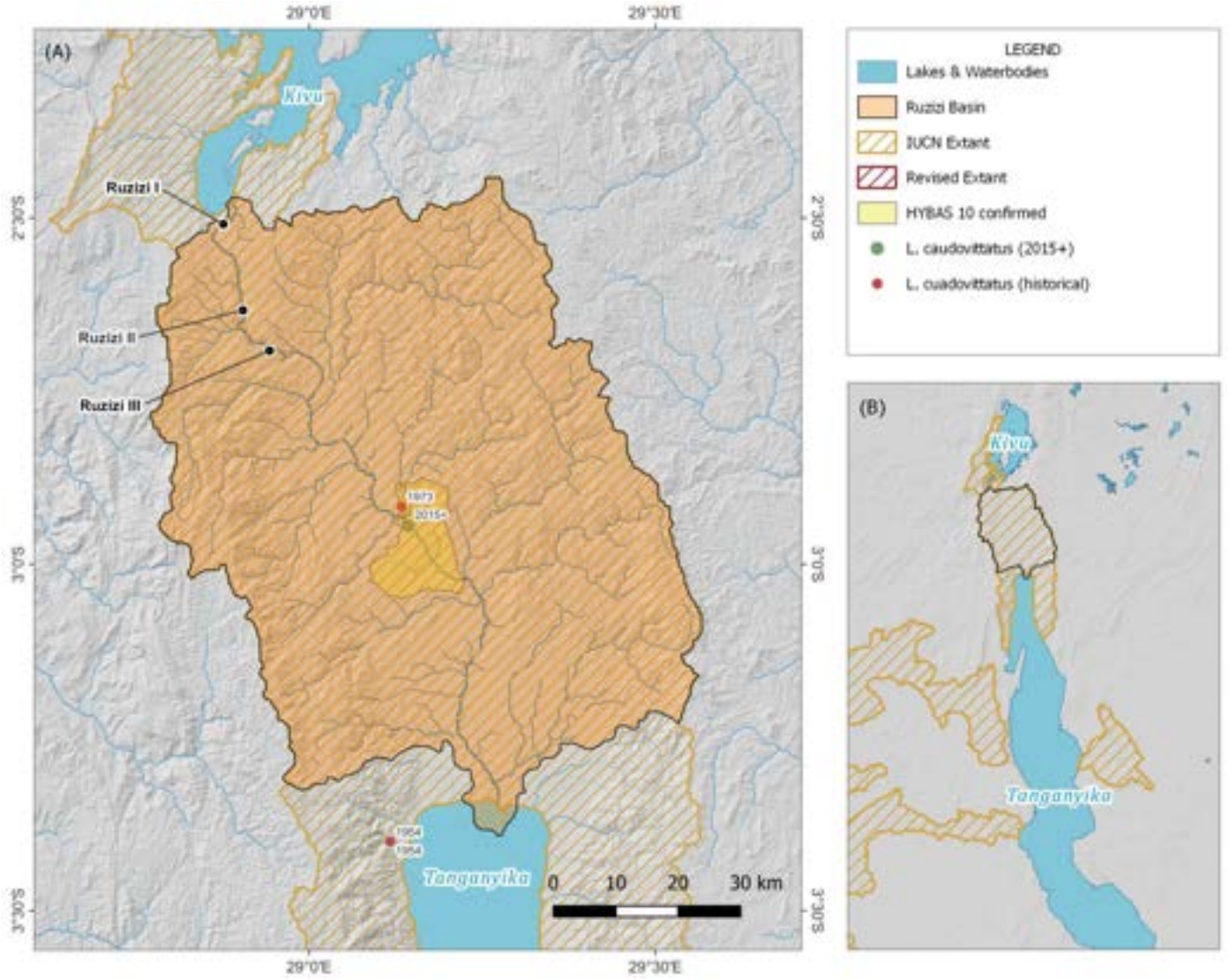


Figure 9-9 Distribution of *Labeobarbus caudovittatus* in the Ruzizi Basin

(A) historical and recent (2015+) records with overlapping HydroBASINS level 10 (HYBAS 1) of confirmed records and (B) revised EOO showing (1) IUCN Extant (resident) – regions in which resident populations were confirmed by the IUCN (2) IUCN Possibly Extant (revised) – regions in which populations were thought to occur, but which are here considered confirmed, (3) Revised Extant – new regions identified by a review of distribution records undertaken in this report.

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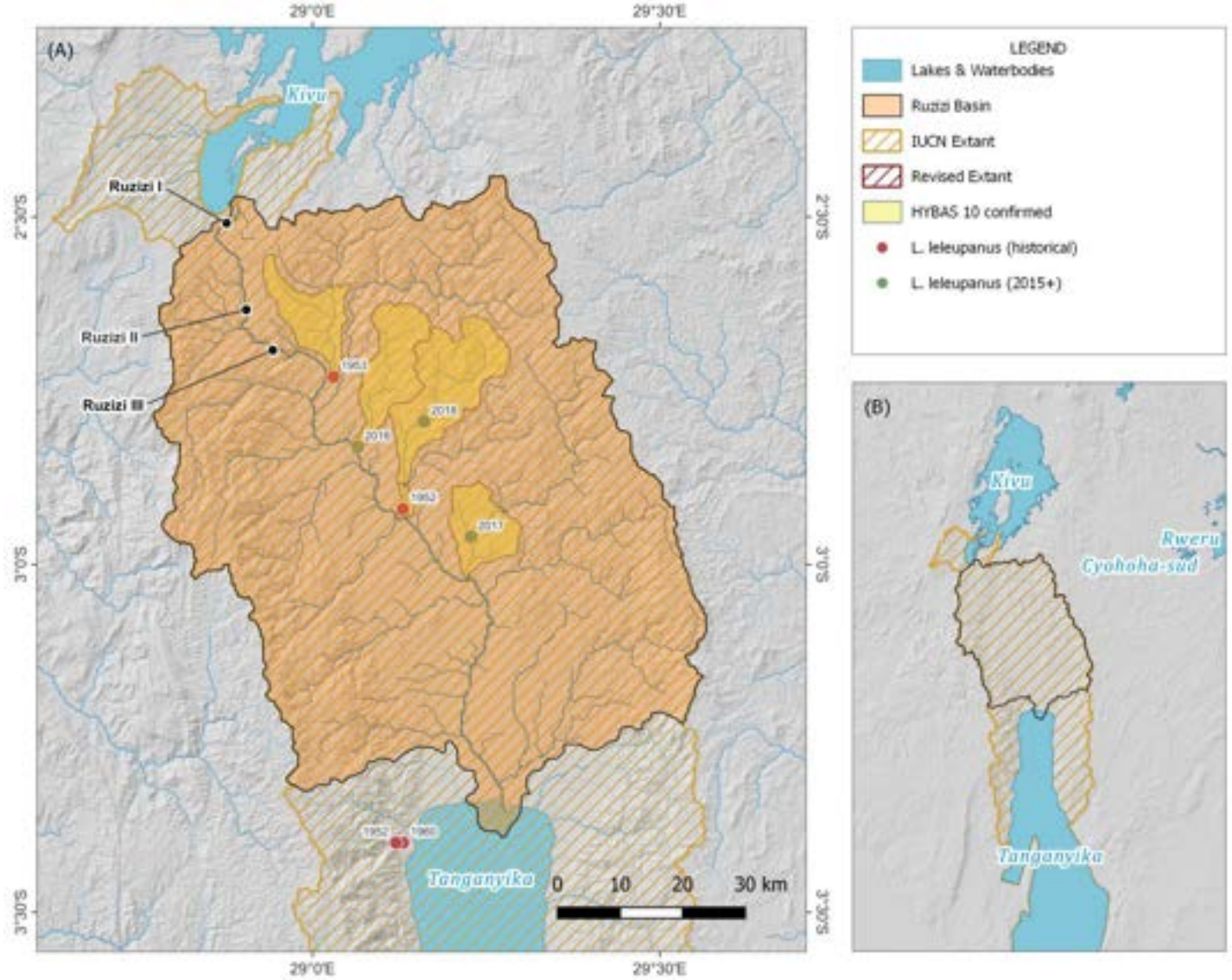


Figure 9-10 Distribution of *Labeobarbus leleupanus* in the Ruzizi Basin

(A) historical and recent (2015+) records with overlapping HydroBASINS level 10 (HYBAS 1) of confirmed records and (B) revised EOO showing (1) IUCN Extant (resident) – regions in which resident populations were confirmed by the IUCN (2) IUCN Possibly Extant (revised) – regions in which populations were thought to occur, but which are here considered confirmed, and (3) Revised Extant – new regions identified by a review of distribution records undertaken in this report.

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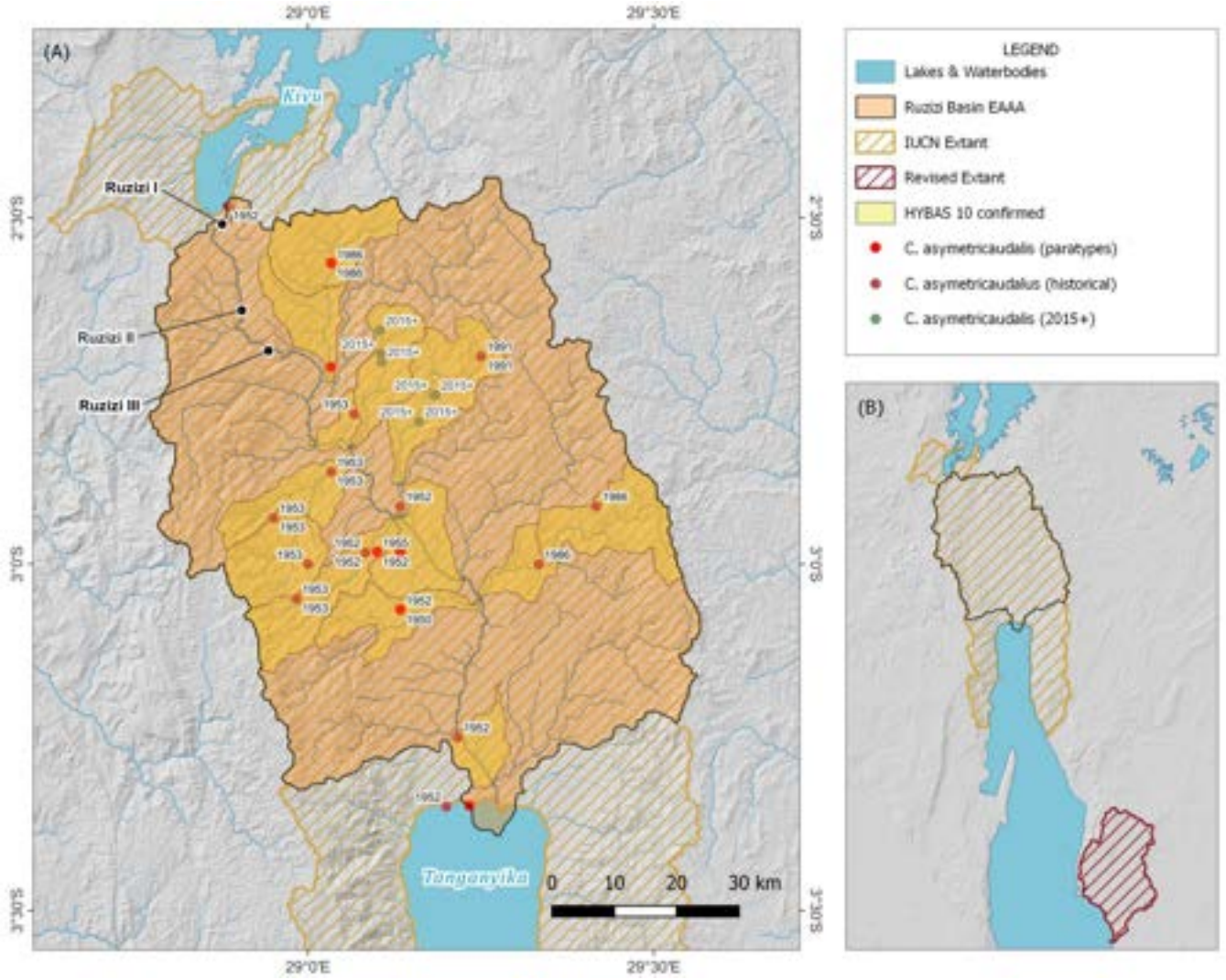


Figure 9-11 Distribution of *Chiloglanis asymetricaudalis* (Endangered) in the Ruzizi Basin

(A) historical and recent (2015+) records with overlapping HydroBASINS level 10 (HYBAS 1) of confirmed records and (B) revised EOO showing (1) IUCN Extant (resident) – regions in which resident populations were confirmed by the IUCN (2) IUCN Possibly Extant (revised) – regions in which populations were thought to occur, but which are here considered confirmed, (3) Revised Extant – new regions identified by a review of distribution records undertaken in this report.

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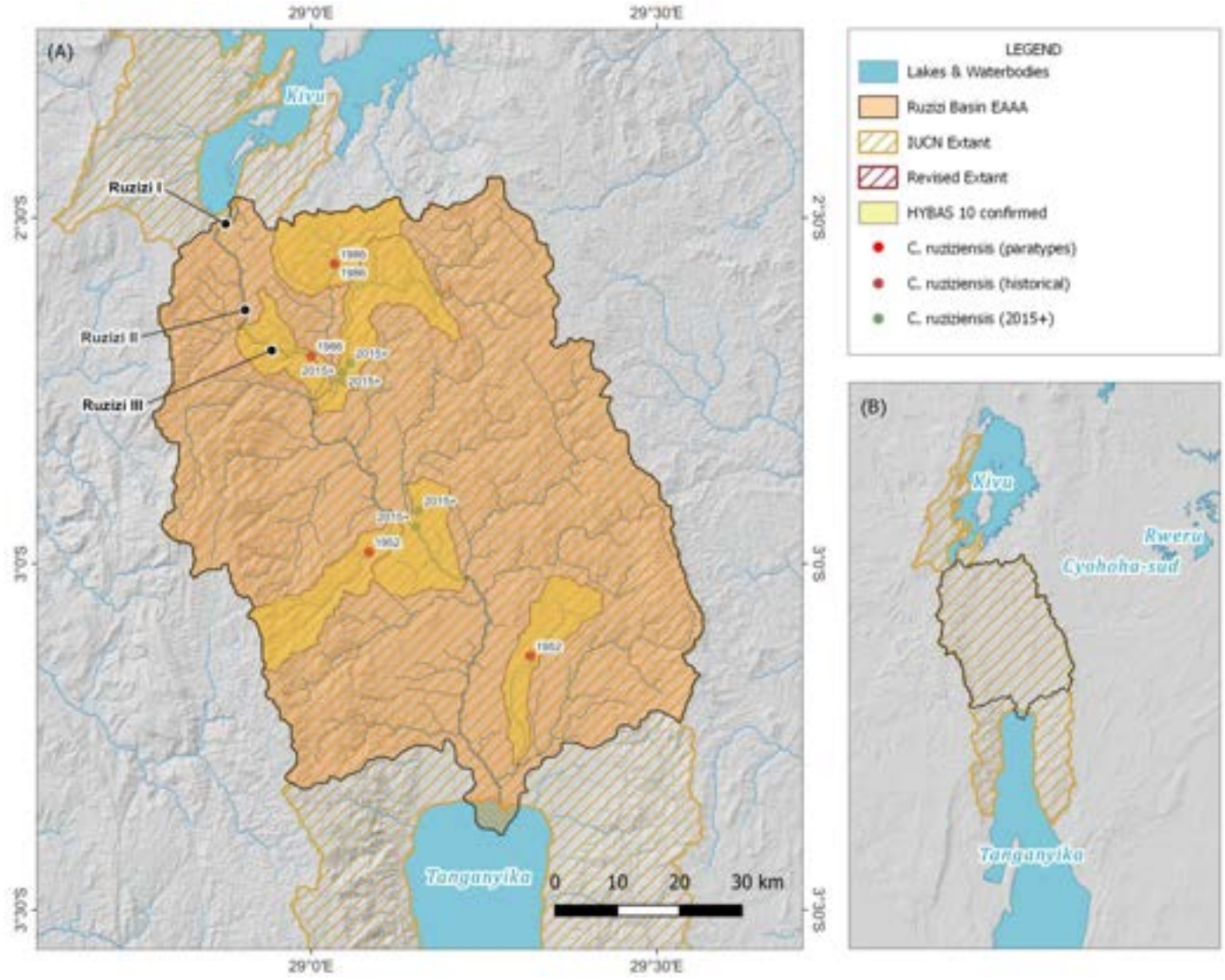


Figure 9-12 Distribution of *Chiloglanis ruziziensis* (Critically Endangered) in the Ruzizi Basin

(A) historical and recent (2015+) records with overlapping HydroBASINS level 10 (HYBAS 1) of confirmed records and (B) revised EOO showing (1) IUCN Extant (resident) – regions in which resident populations were confirmed by the IUCN (2) IUCN Possibly Extant (revised) – regions in which populations were thought to occur, but which are here considered confirmed, (3) Revised Extant – new regions identified by a review of distribution records undertaken in this report.

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B ***IFC PS6 Criterion 4: Highly Threatened and/or Unique Ecosystem***

No red listing of ecosystems or systematic conservation prioritisation process has been done that identifies the Ruzizi Basin as an area that would qualify under this criterion.

C ***ESS6 Criterion 5: Ecological Processes***

Two species of *Chiloglanis* (rock catlets) qualify the non-migratory EAAA for Critical Habitat under Criterion 1 and possibly Criterion 2. They are non-migratory species that inhabit rocky river bottoms where they graze on benthic algae. The Project will need to assess impacts to these species and identify measures to achieve Net Gain for any residual impacts.

Three migratory species qualify the migratory EAAA for Critical Habitat based on threshold analysis but are not considered CH-qualifying species for the mainstem of the Middle Ruzizi River in the Project AoI. Whether they qualify for CH or not, the Project needs to assess impacts to migratory fish and identify suitable mitigation to minimise impacts. Ecological processes required to support CH-qualifying species are summarised below.

Table 9-9 Ecological Processes Required to Sustain CH-Qualifying Fish Species

Critical Habitat trigger species	EAAA	Ecological Processes
Chiloglanis asymetricaudalis *Chiloglanis ruziziensis*	Non-migratory EAAA	• River flow rate sufficient to maintain rapid habitats year round • Water quality (including sediment loads) of an acceptable standard
Labeobarbus leleupanus Leleup's carp* *Labeobarbus caudovittatus* *Acapoeta tanganicae*	Ruzizi Basin	• River connectivity - absence of barriers or presence of fish passages to maintain migratory species movements for breeding and gene flow. • River flow rates or flood pulses as cues as well as habitats for migration and reproduction • Water quality (including sediment loads) of an acceptable standard

9.3.4 Summary of Critical Habitat Assessment

No terrestrial species qualify for Critical Habitat. A summary of the CHA for fish is provided below.

9.3.4.1 Criterion 1: Critically Endangered or Endangered Species.

Two fish species in the Non-Migratory EAAA qualify for Critical Habitat: *Chiloglanis ruziziensis* (CR) and *Chiloglanis asymetricaudalis* (EN). Records of these species from fish surveys are primarily from tributaries of the Ruzizi River, including close to the confluence of the Rubyiro and Ruhwa Rivers. Only *C. asymetricaudalis* has been confirmed in recent surveys to occur in the Rubyiro River and Nyamagana Rivers where they typically occur as bottom dwellers in riffle and rapid habitats. Given that they are both restricted range species with over 0.5% of their EOO in the Ruzizi catchment, these two species would qualify the affluent rivers in which they are found as Critical Habitat. It is however possible that individuals may occur in low numbers in the main Ruzizi River (as reported by fishermen) where they occur at the bottom of the deep and fast flowing river and are difficult to catch. It is uncertain if they qualify as having "regular occurrence" in the Ruzizi River but are included on a precautionary basis as CH qualifying species for the Project Area of Influence.

9.3.4.2 Criterion 2: Restricted-Range Species

While there are several restricted-range species in the Ruzizi River Basin only the two *Chiloglanis* species referred to under Criterion I potentially qualify for CH under Criterion 2, although the

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small size of the non-migratory EAAA does not meet the >10% threshold. They would definitely qualify as CH – qualifying species if a larger EAAA was applied.

9.3.4.3 Criterion 3: Migratory Species

The Ruzizi River is known to contain several migratory fish species, mostly *Labeobarbus* species.

Three species are potential Critical Habitat qualifying species potentially with over >1% of their known 'extant' population (i.e. based on IUCN spatial distribution) in the Ruzizi River based on the migratory EAAA. However, based on more recently acquired fish data for the Lower and Middle Ruzizi River, none of the three species are assessed to qualify the Ruzizi River mainstem in the area of influence as Critical Habitat based on the following:

A ***Acapoeta tanganicae***

This is a Least Concern, restricted-range, migratory species to Lake Tanganyika and Lake Rukwa area of Western Tanzania, and the Ruzizi River, where it is recorded from rocky substrate areas of lakes and in rapids in rivers. Most records are from Lake Tanganyika. Based on available data, it has not been confirmed in surveys conducted along the Lower to Middle Ruzizi River between 2015-2022 (CRSNE/CRBEC data), or in SOFRECO surveys in 2021 and 2022, or in SLR surveys in 2022 in the project area of influence or downstream reaches. Since there is no reliable evidence of recent or regular occurrence of this species in the Ruzizi River it does not qualify for Critical Habitat.

B ***Labeobarbus leleupanus***

This is a Vulnerable and range-restricted species with a global extant distribution including Lake Kivu and the northern shores of Lake Tanganyika including the Ruzizi and Malagarasi Rivers. It was not confirmed in recent surveys by SOFRECO in 2021 and 2022 or SLR in 2022 in the project area of influence in the Middle Ruzizi River, but was confirmed by CRSNE/CRBEC over 34 km downstream of Ruzizi III HPP in the Nyakagunda, Nyamagarana and the Kaburantwa Rivers. Since there is no evidence for regular occurrence of this species in the Upper and Middle Ruzizi River mainstem it is not assessed to be Critical Habitat for this species. However, it is possible that the Lower Ruzizi River and its affluent rivers may qualify for Critical Habitat but further surveys and assessment would need to confirm this.

C ***Labeobarbus caudovittatus***

This migratory species is Near Threatened in East Africa and Least Concern at global level with a global extant distribution in a number of Central and West African countries, including the Democratic Republic of the Congo, Gabon, Burundi, Angola and Zambia. In East Africa it occurs in the Ruzizi River, and in a number of other river systems affluent to Lake Tanganyika including the Malagarisi and Lukuga Rivers. However, it is assessed as Near Threatened in East Africa where it is threatened by fishing pressures and regression of habitat due to farming. It was confirmed at a site in the Middle Ruzizi River downstream of the proposed Ruzizi III HPP by CRSNE/CRBEC. Given its wide distribution and low number of records in the Ruzizi River, the Middle Ruzizi is not assessed to be Critical Habitat for this species.

In summary, based on available data, none of the three species above appear to qualify the Middle Ruzizi River for Critical Habitat under Criterion 3, although they qualify for Critical Habitat at Ruzizi Basin level. Nonetheless, migratory fish are important fish species in the Ruzizi River and measures to mitigate project impact on these species are required.

9.3.4.4 Criterion 4: Highly Threatened and/or Unique Ecosystems

No red listing of ecosystems or systematic conservation prioritisation process has been done that identifies the Ruzizi River as an area that would qualify under this criterion.

Two protected and internationally recognised areas that would qualify Critical Habitat in the wider Project Area outside the Project Area of Influence are:

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- **Rusizi National Park and KBA**: Located 88 km downstream of the Ruzizi III Project it is a protected area and internationally recognised biodiversity area primarily for its floodplain wetlands and birds and fish, and may qualify under this criterion. This area is threatened by pollution from upstream and expanding human settlement and associated fishing, harvesting and agricultural expansion pressures in the floodplains. However, while there is limited information to assess this area under Criterion 4, there is no evidence to suggest the Ruzizi River would qualify under this criterion.
- **Nyungwe National Park and KBA**: Located approximately 20 km to the east of Ruzizi River in the upper catchment of the Rubyiro River it is of conservation importance for forest biodiversity, including chimpanzees. While this park is outside the Project AoI, it plays an important role in protecting the upper catchment of the Rubyiro River which contains important fish such as the Endangered *Chiloglanis asymetricaudalis* and possibly the Critically Endangered *Chiloglanis ruziziensis.*

9.3.4.5 Criterion 5: Ecological Functions or Characteristics

This criterion relates to the ecological processes or characteristics that are needed to maintain the viability of the biodiversity values described in the above four Critical Habitat criteria, and is the fifth criterion of the World Bank ESS6, for which there are no defined thresholds.

This criterion only applies to the ecological processes required to sustain the presence of *Chiloglanis* rock catlets in the rapids of tributaries of the Ruzizi River, and possibly the mainstem river itself. These processes include maintenance of flowing water and rocky river bottom habitat on the riverbed and acceptable water quality (including turbidity levels).

Criterion 5 under the IFC PS6 applies to Key Evolutionary Processes. There are no areas along the Ruzizi River that are believed to qualify under this criterion. The fish community in the Ruzizi Basin are not evolutionarily distinct and exhibits a high degree of species transitional between Lake Kivu and Lake Tanganyika.

9.3.4.6 Criterion: Keystone Species (AfDB OS3 Criterion)

There are no confirmed keystone species such as African elephants or vulture colonies in the Project AoI. Crocodile and hippopotamus (Vulnerable) are present in the Lower and Middle reaches of the Ruzizi River and may play a role in nutrient cycling but are not of such key importance that they would qualify the Ruzizi River as Critical Habitat.

9.3.4.7 Criterion: Ecological Networks (AfDB OS3 Criterion)

The Project area is dominated by modified habitats comprising a mosaic of agriculture with small, fragmented portions of degraded but largely natural habitat such as riparian and hillslope thickets. The Ruzizi River does serve as an important corridor for migratory fish to access upstream spawning habitats from Lake Tanganyika to the upper catchment. However, the Project is not located within an area that could be considered an important ecological network linking priority areas of conservation areas.

9.3.4.8 Concluding Summary

In summary, the Middle Ruzizi River Basin has been degraded through a long period of hydropeaking from two upstream hydropower projects and water pollution, and is assessed as Modified Habitat. Nevertheless, the Ruzizi III HPP AoI appears to qualify for Critical Habitat for two species of fish (*Chiloglanis asymetricaudalis* and *C. ruziziensis*) under Criterion 1 (CR/EN species) and possibly under Criterion 2 (Restricted-Range species). Three other fish species were considered to potentially qualify the Middle Shire as CH under Criterion 3 (Migratory species) but this is unlikely due to lack of evidence for their presence in the Middle to Upper Ruzizi River reach.

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Implications for the Project to achieve a no net loss or net gain are summarised in Table 9-10.

Table 9-10 Implications of CHA Findings for Project

Biodiversity Feature	Residual Impact			NNL/NG Requirement
	Footprint	Barrier	Flow Alteration	
Natural Habitat				
Hillslope Grassland / Savanna	Loss of ~18.3 ha in project footprint (transmission line & construction infrastructure) - likely to be lower in final design footprint)	-		No Net Loss (Design avoidance / restoration measures)
Critical Habitat				
Chiloglanis asymetricaudalis (EN)	Possibly through flooding & dewatering of 10 km of river. Note: most species records in tributaries of Ruzizi River.	-	-	Possible Net Gain (based on pre-construction fish surveys)
Chiloglanis ruziziensis (CR)		-	-	
Priority Biodiversity				
Migratory fish species (*Labeobarbus* species) (River is Modified Habitat but some migratory fish are Critical Habitat for Ruzizi Basin)	-	Barrier to fish migration - reduced to 18 km of Middle Shire		No Net Loss (fishing restrictions & reduction of fishing pressures)
Rusizi National Park (88-130 km downstream in Burundi)	No direct or indirect impacts expected	-	No significant residual impact	No intervention
Nyungwe National Park (20 km upstream Rubyiro River, in Rwanda)	No direct or indirect impacts expected	-	-	No intervention

The Project is required to confirm residual impacts on the priority biodiversity features and to implement additional mitigation and compensation measures to achieve a no net loss and net gain for confirmed impacts. Mitigation measures are specified in Vol. IV – ESMP, outlined in the framework Biodiversity Action Plan.

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10 Environmental Flow Assessment

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Contents

10.1 Introduction 10-1

10.2 Preparatory Activities 10-3

10.3 Eco-hydraulics 10-5

10.3.1 Introduction 10-5
10.3.2 Hydrological Inflows 10-5
10.3.3 1D Hydraulic Modelling 10-5
10.3.4 2D Hydraulic Modelling 10-10

10.4 Assessment of EFlows 10-11

10.4.1 Introduction 10-11
10.4.2 The Dewatered Reach – Ruzizi III Dam Wall to Powerhouse Tailrace 10-14
10.4.3 The Hydropeaking Reach – Ruzizi III Powerhouse Tailrace to Burundi Border 10-27
10.4.4 The Extended Hydropeaking Reach – Downstream Burundi Border to Lake Tanganyika 10-68

10.5 Summary and Conclusions 10-69

10.5.1 Hydrological and Hydraulic Changes 10-69
10.5.2 Geomorphology and Sedimentology 10-72
10.5.3 Aquatic Ecology 10-73
10.5.4 Terrestrial Ecology 10-74
10.5.5 Social 10-75
10.5.6 EFlows 10-75

PUBLIC DISCLOSURE AUTHORIZED

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List of Tables

Table 10-1 Summary of hydraulic model inflows (current conditions) 10-9
Table 10-2 Summary of hydraulic model inflows (post-project conditions) 10-9
Table 10-3 Summary of Ecological and Social Functional Relationship / Impacts within the Dewatered Reach 10-25
Table 10-4 Summary of current baseline hydrological inflows in the Ruzizi II – Burundi Border Reach .. 10-29
Table 10-5 Summary of future post-project hydrological inflows in the Ruzizi II – Burundi Border Reach. 10-29
Table 10-6 Downstream Ruzizi III Powerhouse Location – Flow Summary 10-31
Table 10-7 Downstream Ruzizi III Powerhouse Location – Level Summary 10-32
Table 10-8 Downstream Ruzizi III Powerhouse Location – Velocity Summary 10-33
Table 10-9 Downstream Ruzizi III Powerhouse Location – Cross-section Area Summary 10-34
Table 10-10 Downstream Ruzizi III Powerhouse Location – Ramp-up and Ramp-down Rates Summary 10-35
Table 10-11 Summary of Ecological and Social Functional Relationship / Impacts at Downstream Ruzizi III powerhouse location 10-37
Table 10-12 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Flow Summary 10-41
Table 10-13 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Level Summary 10-42
Table 10-14 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Velocity Summary 10-43
Table 10-15 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Cross-section Area Summary 10-44
Table 10-16 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Ramp-up & Ramp-down Rates Summary 10-45
Table 10-17 Summary of Ecological and Social Functional Relationship / Impacts at Upstream Bugarama Bridge / Kamanyola Monitoring Station 10-47
Table 10-18 Upstream Rubyiro Tributary – Flow Summary 10-50
Table 10-19 Upstream Rubyiro Tributary – Level Summary 10-51
Table 10-20 Upstream Rubyiro Tributary – Velocity Summary 10-52
Table 10-21 Upstream Rubyiro Tributary – Cross-section Area Summary 10-53
Table 10-22 Upstream Rubyiro Tributary – Ramp-up and Ramp-down Rates Summary 10-54
Table 10-23 Upstream Burundi Border / Ruhwa Tributary – Flow Summary 10-56
Table 10-24 Upstream Burundi Border / Ruhwa Tributary – Level Summary 10-56
Table 10-25 Upstream Burundi Border / Ruhwa Tributary – Velocity Summary 10-57
Table 10-26 Upstream Burundi border / Ruhwa Tributary – Cross-section Area Summary 10-58
Table 10-27 Upstream Burundi Border / Ruhwa Tributary – Ramp-up and Ramp-down Rates Summary 10-59
Table 10-28 Downstream Burundi Border / Ruhwa Tributary – Flow Summary 10-61
Table 10-29 Downstream Burundi border / Ruhwa Tributary – Level Summary 10-61
Table 10-30 Downstream Burundi border / Ruhwa Tributary – Velocity Summary 10-62
Table 10-31 Downstream Burundi Border / Ruhwa Tributary – Cross-section Area Summary 10-63

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Table 10-32 Downstream Burundi border / Ruhwa Tributary – Ramp-up and Ramp-down Rates Summary 10-64

Table 10-33 Summary of Ecological and Social Functional Relationship / Impacts at Upstream Rubyiro Tributary to Downstream Burundi Border / Ruhwa Tributary 10-66

Table 12-9 Alteration to Natural Conditions Minimum Water Level vs River Length 10-71

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PUBLIC DISCLOSURE AUTHORIZED

List of Figures

Figure 10-1 Environmental Flow Assessment study area 10-1
Figure 10-2 Lake Kivu catchment (Rubavu to Kamembe) 10-3
Figure 10-3 Ruzizi II reservoir 10-4
Figure 10-4 Ruzizi River (selected locations) 10-4
Figure 10-5 Ruzizi III cross-section survey data 10-6
Figure 10-6 Ruzizi 1D hydraulic model of the main study area 10-7
Figure 10-7 Ruzizi extended study area tributary inflows (downstream River Ruhwa) 10-8
Figure 10-8 Selected Daily Water Levels at Kamanyola (2019) 10-12
Figure 10-9 Ruzizi System Energy Demand Profile (after Tractebel, 2020) 10-12
Figure 10-10 Ruzizi I, Ruzizi II, and Ruzizi III Operational Release Curves (after Tractebel, 2020) 10-13
Figure 10-11 Ruzizi River from Lake Kivu to downstream the Ruhwa River 10-14
Figure 10-12 Ruzizi Reach between Ruzizi III Dam Wall and Powerhouse 10-15
Figure 10-13 Longitudinal Profile of the Ruzizi Reach from Ruzizi II Dam wall to the Powerhouse 10-16
Figure 10-14 Variation of dewatered reach total wetted area under different flow conditions 10-17
Figure 10-15 Sub-daily Variation of Dewatered Reach Total Wetted Area 10-17
Figure 10-16 Intra-annual and Inter-annual Variation of Dewatered Reach Total Wetted Area 10-18
Figure 10-17 Variation of Dewatered Reach Average Depth Under Different Flow Conditions 10-19
Figure 10-18 Variation of Dewatered Reach Average Velocity Under Different Flow Conditions 10-20
Figure 10-19 Modelled depth under 10% MAF flow conditions in the reach below Ruzizi III dam wall 10-21
Figure 10-20 Longitudinal slope and water level under 10% MAF flow conditions in the 1-km reach immediately below Ruzizi III dam wall 10-21
Figure 10-21 Modelled velocity under 10% MAF flow condition in the reach below Ruzizi III dam wall .. 10-22
Figure 10-22 Ruzizi III Powerhouse to Ruhwa Tributary 10-28
Figure 10-23 Ruzizi II Powerhouse Release Schedules 10-29
Figure 10-24 Ruzizi III Powerhouse Release Schedules 10-30
Figure 10-25 Downstream Ruzizi III Powerhouse Location 10-30
Figure 10-26 Downstream Ruzizi III Powerhouse Location – Photo 10-31
Figure 10-27 Downstream Ruzizi III Powerhouse Location – Flow Summary 10-32
Figure 10-28 Downstream Ruzizi III Powerhouse Location – Level Summary 10-33
Figure 10-29 Downstream Ruzizi III Powerhouse Location – Velocity Summary 10-34
Figure 10-30 Downstream Ruzizi III Powerhouse Location – Cross-section Summary 10-35
Figure 10-31 Upstream Bugarama Bridge / Kamanyola Monitoring Station 10-40
Figure 10-32 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Photo 10-41
Figure 10-33 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Flow Summary 10-42
Figure 10-34 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Level Summary 10-43
Figure 10-35 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Velocity Summary 10-44

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Figure 10-36 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Cross-section Summary.10-45
Figure 10-37 Upstream Rubyiro Tributary 10-49
Figure 10-38 Upstream Rubyiro Tributary – Photo....10-50
Figure 10-39 Upstream Rubyiro Tributary – Flow Summary....10-51
Figure 10-40 Upstream Rubyiro Tributary – Level Summary 10-52
Figure 10-41 Upstream Rubyiro Tributary – Velocity Summary 10-53
Figure 10-42 Upstream Rubyiro Tributary – Cross-section Summary 10-54
Figure 10-43 Upstream Burundi border / Ruhwa Tributary....10-55
Figure 10-44 Upstream Burundi border / Ruhwa Tributary – Photo 10-55
Figure 10-45 Upstream Burundi Border / Ruhwa Tributary – Flow Summary 10-56
Figure 10-46 Upstream Burundi Border / Ruhwa Tributary – Level Summary 10-57
Figure 10-47 Upstream Burundi Border / Ruhwa Tributary – Velocity Summary....10-58
Figure 10-48 Upstream Burundi Border / Ruhwa Tributary – Cross-section Summary....10-59
Figure 10-49 Downstream Burundi Border / Ruhwa Tributary 10-60
Figure 10-50 Downstream Burundi Border / Ruhwa Tributary – Photo....10-60
Figure 10-51 Downstream Burundi Border / Ruhwa Tributary – Flow Summary....10-61
Figure 10-52 Downstream Burundi Border / Ruhwa Tributary – Level Summary 10-62
Figure 10-53 Downstream Burundi border / Ruhwa Tributary – Velocity Summary 10-63
Figure 10-54 Downstream Burundi Border / Ruhwa Tributary – Cross-section Summary 10-64
Figure 12-11 % Alteration to Natural Conditions Minimum Water Level vs River Length (Illustrative) 10-72

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10.1 Introduction

The Environmental Flow Assessment (EFA) assesses the impacts on aquatic ecology and social reliance of flow alteration due to the planned operation of Ruzizi III HEPP. The EFA provides support towards assessment of flow-related impacts but does yield recommendations for development of mitigation.

The EFA considers both the impacts in the dewatered reach between the dam wall and the powerhouse tailrace and the impacts of hydropeaking downstream of the powerhouse tailrace. The initial scope of the EFA was to assess the impacts upstream of the Burundi order. However, due to concerns that were identified during the assessment, the scope was extended to also assess potential impacts downstream of the Burundi border.

As such, the EFA study area (Figure 10-1) is defined as:

- The main study area is the Ruzizi River from the existing Ruzizi II HEPP at the upstream extent to the confluence of the Ruzizi River with the Ruhwa River at the downstream extent (28 km).
- The extended study area is the Ruzizi River from the existing Ruzizi II HEPP at the upstream extent to Lake Tanganyika at the downstream extent (150 km).

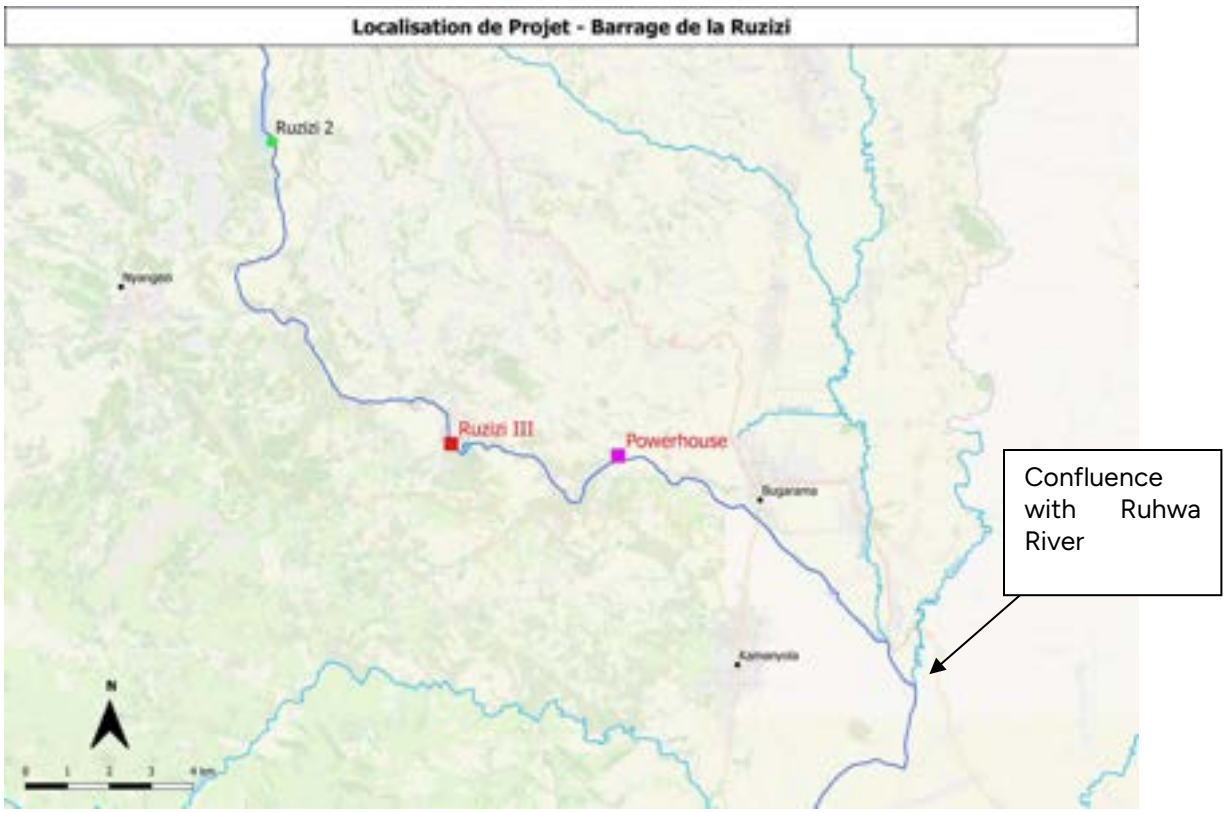


Figure 10-1 Environmental Flow Assessment study area

The EFA as presented is informed by the IFC Good Practice Handbook (The 'Handbook') on Environmental Flows for Hydropower Projects.

Based on the guidance provided in The Handbook (see the accompanying annex for further details), the EFA approach adopted herein aligns with a medium-resolution assessment in that:

- it assesses the hydrological and hydraulic characterisation (state) of both the dewatered reach between the dam wall and tail race and the downstream hydropeaking reach; and
- it establishes functional relationships between the hydrological and hydraulic characteristics (state) and the ecological and social context (impact) of the two reaches

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– geomorphology, aquatic ecology, terrestrial ecology, and social reliance are all explicitly considered.

In adopting a medium-resolution assessment, key characteristics of Ruzizi III have been explicitly considered. Although the Project will be in a location that is subject to selected attributes that suggest that a high-resolution assessment is required (potential significant transboundary issues, position in a cascade), it is also located in a reach that is already heavily modified (due to the presence and operation of upstream Ruzizi I and II HEPP), suggesting that a low-resolution assessment is sufficient.

The Critical Habitat Assessment (Chapter 9) indicates that the middle and upper Ruzizi River in which Ruzizi III is located potentially qualifies for Critical Habitat for two non-migratory threatened catlet species: *Chiloglanis ruziziensis* (Critically Endangered) and *C. asymetricaudalis* (Endangered). It appears these species mainly occur in tributaries such as the Ribyiro, Ruhwa and others, where they have been found at the confluence with the Ruzizi River. There are, however, no recent formal records for these species in the main Ruzizi but this may be an artefact of difficult sampling conditions due to high flow and water depth. There are several other restricted range fish species that qualify for Critical Habitat at the basin scale, including three migratory fish species that occur in the Lower to Middle Ruzizi River downstream of the Ruzizi III Project (*Labeobarbus leleupanus; L. caudovittatus* and *Acanopoeta tanganicae*).

The sufficiency of such a medium-resolution assessment has been confirmed by a broad-scale assessment of the hydrological and hydraulic characteristics in the extended study area downstream of the border with Burundi, to identify if any potential significant transboundary impacts may arise including potential impacts on Critical Habitat.

This assessment has shown that the effects of Ruzizi II / III hydropeaking are expected to significantly attenuate with distance from the Ruzizi III Project.

Flow fluctuations 60 km downstream of the Burundi /Rwanda border (some 20 km upstream of the northern limit of the Ruzizi National Park and Ramsar site will only be slightly detectable or measurable. The minimum water level during off peak flows will be in the order of 3 cm lower than the current minimum water level caused by Ruzizi-I/II operation. Maximum water levels will be no higher than those of the current conditions, which are also no higher than the natural conditions (before operation of Ruzizi-I and -II).

A small incremental effect in flow level increase and speed of change of water levels is predicted to occur due to the proposed operation of Ruzizi III. Importantly, the associated community safety related ramp-up rates remain well below threshold values of 5 cm/minute. The water level change amplitude during ramp up and ramp down is 160 cm immediately downstream from the Ruzizi III powerhouse tailrace, and this amplitude decreases with distance downstream. Similarly, the associated fish-stranding related ramp-down rates are well below threshold values of 1 cm/minute. As such, it is concluded that the hydrological and hydraulic hydropeaking effects present no significant transboundary impacts with Burundi nor impact potential Critical Habitat in the Ruzizi River system.

This EFA has adopted a medium-resolution assessment, and this is considered suitable by the ESIA Consultant and REL, it is nevertheless recognised that the suitability will be assessed by the Environment and Social Independent Panel of Experts (IPoE) and if necessary, will be revised to address the panels comments post financial closure.

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10.2 Preparatory Activities

Prior to undertaking the assessment of EFlows, a variety of preparatory steps were undertaken to better set the context for the assessment. This included:

- Review and collection of available hydrological and hydraulic data;
- Desk-based geomorphology and sediment assessment; and
- Collection of field data – hydrological; terrestrial ecology; aquatic ecology; socio-economic surveys.

The review and collection of available hydrological and hydraulic data is more fully described in Chapter 7 - Environmental Baseline Situation (Section 7.6 - Hydrology). This includes an assessment of the monthly inflows to Ruzizi II and the study area, an assessment of the study area hydrology including observed water levels and the hydrological and hydraulic characteristics of the study area and water levels near Lake Tanganyika, and a summary of flood risk at the Ruzizi III dam site. Key baseline hydrology characteristics include:

- Potential longer-term variations in hydrological conditions. The EFA is undertaken for the existing hydrological conditions which represent the current baseline situation.
- Short-term / daily variation in river water level due to existing hydropeaking from the operation of Ruzizi II. This is observed at the Manda monitoring site (approximately 2 km downstream of the Ruzizi III dam wall) and at the Kamanyola water level monitoring site (approximately 6 km downstream of the Ruzizi III dam wall), but is not observed at the Ruzizi monitoring site in Burundi (located 125 km downstream of Ruzizi III / 14 km upstream of Lake Tanganyika).

The geomorphology and sediment assessment are more fully described in Chapter 7 – Environmental Baseline Situation (Section 7.4 – Geomorphology). This includes a general geomorphological description of the Ruzizi River from Lake Kivu to Lake Tanganyika and a summary of Ruzizi III sediment load estimates for suspended sediment, bedload, and landslides.

A hydrological field visit was undertaken in January 2022. This included stakeholder meetings with GIZ, the Rwanda Water Resources Board (RWB), and the Ministry of Infrastructure (MININFRA) in Kigali, and ABAKIR in Rubavu. The field visit included a drive through of the Lake Kivu catchment from Rubavu to Kamembe (Figure 10-2), a visit to Ruzizi II reservoir (Figure 10-3), a detailed walk-over of the Ruzizi River from Ruzizi III to the Ruhwa River, and water level observations at Kamanyola monitoring station (Figure 10-4). A photographic and video record of river flow conditions, and laser measure readings of selected channel features along the Ruzizi River, were obtained and used to inform the development of the reach hydraulic model.



Sediment laden inflows to Lake Kivu at Rubavu



Sediment laden Lake Kivu tributary inflow near Rutungura



Lake Kivu outlet

Figure 10-2 Lake Kivu catchment (Rubavu to Kamembe)

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View of Ruzizi II reservoir



Spill over Ruzizi II reservoir



Ruzizi River channel downstream Ruzizi II spill

Figure 10-3 Ruzizi II reservoir



View upstream of unfinished bridge



Braided channels (1.3 km downstream unfinished bridge)



Riffles (2.1 km downstream unfinished bridge)



Natural weir across the river (3.2 km downstream unfinished bridge)



Left-bank still water (0.5 km upstream Bugarama Bridge)



Kamanyola monitoring station (upstream Bugarama bridge)



Natural weir across the river (1.5 km downstream Bugarama bridge)



Natural weir and channel braiding (3.8 km downstream Bugarama Bridge)



Left-bank channel at confluence with Rubyiro River

Figure 10-4 Ruzizi River (selected locations)

A Terrestrial and Aquatic Ecology field visit was undertaken in January 2022, with an additional half day aquatic survey in February 2022 (under low flow/off peaking conditions). These field visits have informed the Terrestrial and Aquatic Ecology sections of the Environmental Baseline chapter. The terrestrial baseline includes an assessment of vegetation and flora, and terrestrial fauna (birds; mammals; and herpetofauna). The aquatic baseline includes an assessment of: i) hydrogeomorphological types; ii) aquatic biotopes; iii) benthic diatoms; iv) aquatic flora; v) aquatic macroinvertebrates, and vi) fish.

A socio-economic field visit was undertaken in January-February 2022. This is more fully described in Chapter 8 – Social Baseline Situation (Section 8.1.3 Primary Data Collection), and

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has informed the assessment of, *inter alia*: i) land-use along the reach of the Ruzizi River downstream of the Project; ii) river uses (water supply and domestic activities, river crossing, medicinal and spirituality properties, irrigation); iii) economic activities (agriculture, fishing, fish farming); and iv) community infrastructure (water supply).

10.3 Eco-hydraulics

10.3.1 Introduction

The assessment of eco-hydraulics provides a description of the hydrological and hydraulic characteristics in the study area that are (potentially) affected by the Project. This characterisation is undertaken for current baseline conditions and for post-project conditions such that the change in conditions induced by the project can be assessed.

The EFA eco-hydraulics have been developed by SLR based on: i) the hydrological inflows presented in the baseline hydrological assessment; ii) 1D hydraulic modelling of the main and extended study area; and iii) a local 2D hydraulic model for an approximate 1.7 km reach centred around the Ruzizi III dam wall.

10.3.2 Hydrological Inflows

The assessment of hydrological inflows is presented in Chapter 7 – Environmental Baseline Situation, and includes the following components relevant to the EFA:

- An assessment of the monthly inflows to Ruzizi III and study area inflows including: i) intervening catchment inflows between Ruzizi II and Ruzizi III; ii) Rubyiro River inflows; and iii) Ruhwa River inflows.
- An assessment of the study area hydrology including: i) observed water level variations at the Kamanyola (Bugarama Bridge), Manda, and Ruzizi in Burundi (14 km upstream of Lake Tanganyika) water level monitoring stations; and ii) modelled hydrological / hydraulic characteristics for the "Ruzizi III Reach" between the proposed dam wall and powerhouse locations, and the "Ruzizi II – Burundi Border Reach". The "Ruzizi III Reach" represents the proposed future "dewatered reach" and as such an analysis of reach area, depths, velocities, shear stress, and hazard is presented for the current range of observed flows (i.e., from 10 m^3/s to 160 m^3/s). The "Ruzizi II – Burundi Border Reach" represents the current study area (upstream of Burundi) that is subject to hydropeaking effects, and as such an analysis of variation in flow and level, and ramp-up and ramp-down rates, for selected key locations along the reach is presented.

10.3.3 1D Hydraulic Modelling

The "River Channel Hydraulics" report (December 2020), produced as part of the Ruzizi II Feasibility Study, describes the analysis and modelling undertaken to develop high flow level-flow rating curves at selected sites of interest between the Ruzizi III dam wall and powerhouse. A HEC-RAS 1D hydraulic model was developed for the river reach between the dam wall and approximately 1.4 km downstream of the powerhouse based on cross-section survey data (see Figure 10-5) and local LiDAR data.[1] During model development, any discrepancies between cross-section survey data and LiDAR were removed by adjusting the survey data.

[1] The cross-section survey data is more thoroughly described in the "Draft Report of Ruzizi Bathymetric Survey for Ruzizi III HEPP" report (Tiger Engineering Company Limited, January 2021). An ADCP was used to survey cross-sections at 68 out of 80 planned locations – 12 locations were not able to be surveyed due to the high level of turbulence. The ADCP surveyed data was extended onto the riverbanks using Total Station topographic survey.

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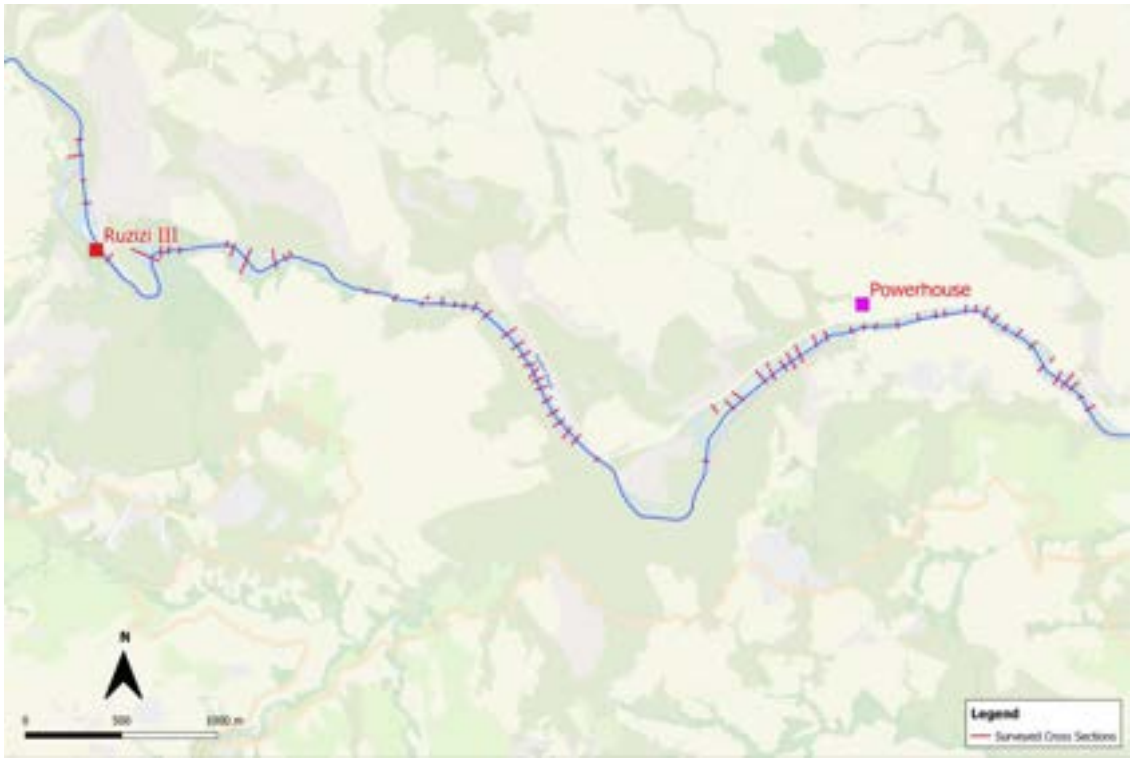


Figure 10-5 Ruzizi III cross-section survey data

The existing HEC-RAS model of the reach between the Ruzizi III dam wall and approximately 1.4 km downstream of the powerhouse includes the 5.5 km-long Ruzizi III dewatered reach. The model has been obtained and re-run for a range of steady state flows to provide a hydraulic characterisation of the reach representing the proposed Ruzizi III dewatered reach. Flows over a range of 10 m^3/s to 160 m^3/s have been modelled as these correspond to the typical flow range currently observed in the reach due to the hydropeaking operation of Ruzizi II, located 12 km upstream of Ruzizi III dam wall.

The existing HEC-RAS model has been used as the basis for constructing a 1D hydraulic model of the extended study area from Ruzizi II dam wall to Lake Tanganyika. The model has been constructed as follows:

- 166 model cross-sections and Ruzizi II outflow and three tributary inflows / Ruzizi III outflow and two tributary inflows providing a detailed representation of 27.2 km of the Ruzizi River in the main study area and the uppermost part of the extended study area downstream of the Burundi border (Figure 10-6), and
- 8 model cross-sections and five additional tributary inflows providing a broad-scale representation of a further 61 km of the Ruzizi River in the remainder of the extended study area down towards Lake Tanganyika (Figure 10-7).

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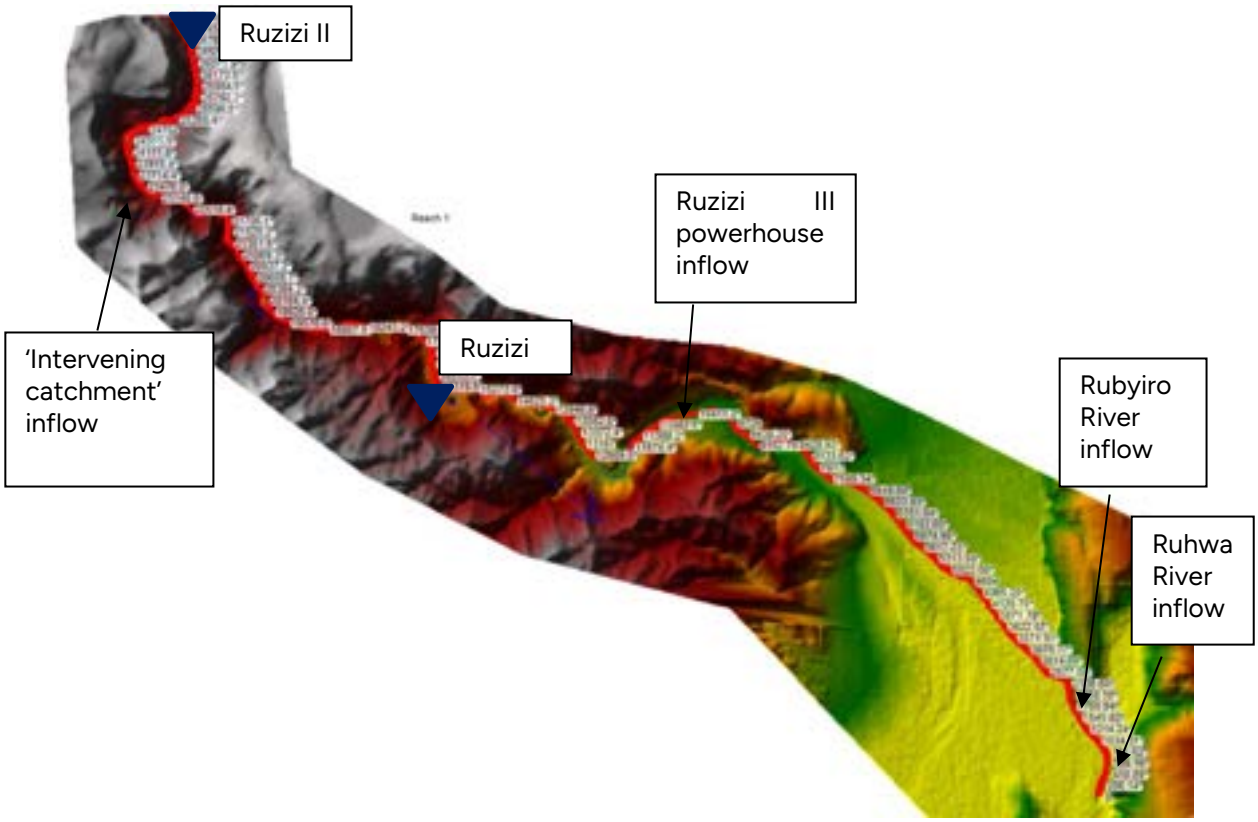


Figure 10-6 Ruzizi 1D hydraulic model of the main study area

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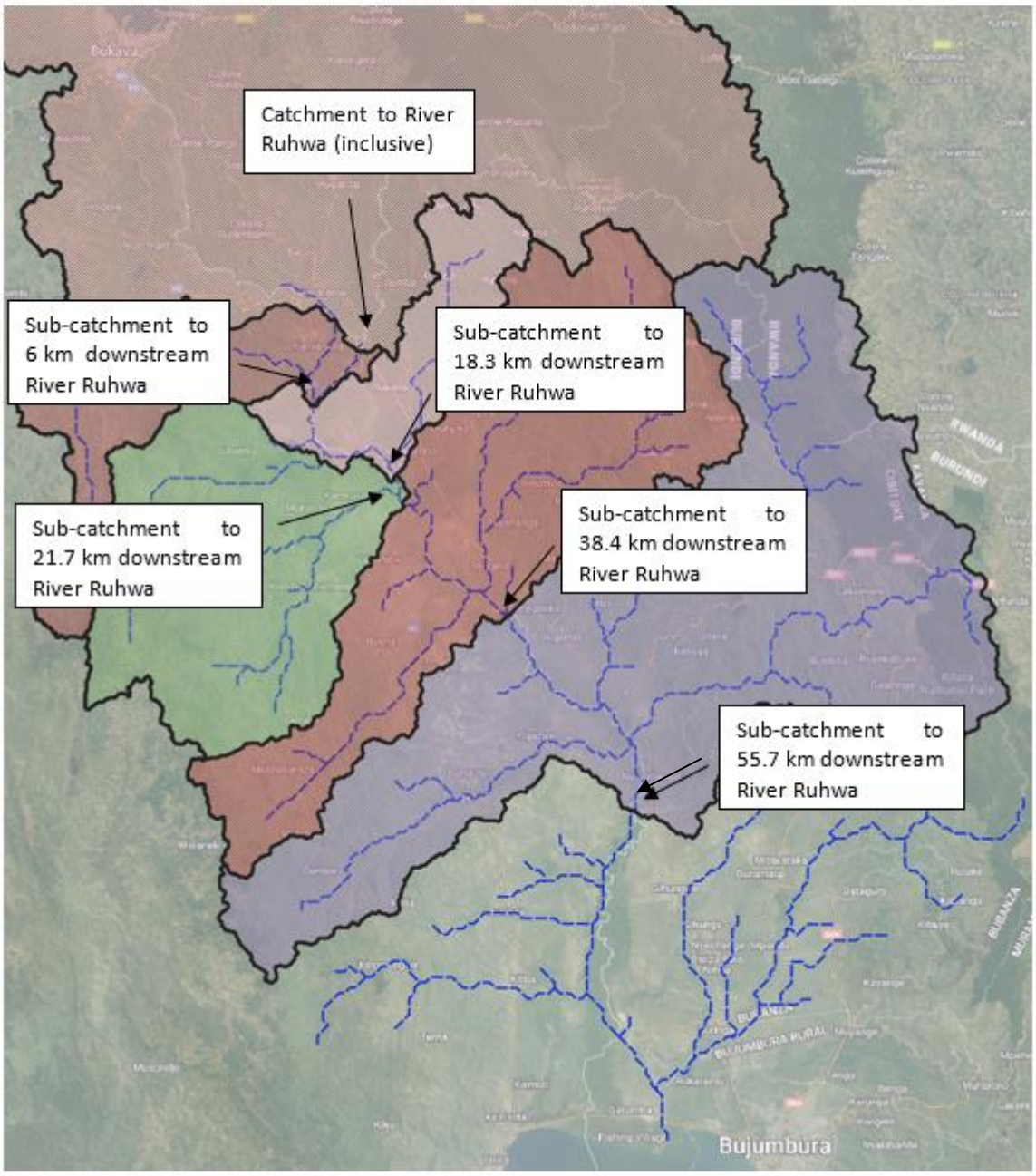


Figure 10-7 Ruzizi extended study area tributary inflows (downstream River Ruhwa)

Surveyed cross-section data has been reviewed and cross-sections generated for the non-surveyed reaches. The cross-sections explicitly take into account both the general pattern of in-bank river geomorphology and local variation. Cross-section width has been estimated from satellite imagery. Bank-full levels have been defined with reference to available DTM data, ALOS 30 m data in the reach downstream of Bugarama Bridge and 2m photogrammetry data (Fichtner, 2009) in the remainder of the (non-surveyed) reach upstream of Bugarama Bridge. The DTM data bank-full long profile was reviewed – and included use of field observations (January 2022) of the river profile – to smooth out local discrepancies. Field observations were also used in assigning roughness values to the synthetic cross-sections. As with the existing HEC-RAS model, the main channel was assigned a Manning's n value of 0.07, while out-of-bank was assigned a value of 0.1.

A summary of the model inflows from (i) the upstream location at Ruzizi II for current conditions and (ii) the upstream location at Ruzizi III for post-project conditions, and including tributary inflows from the River Rubyiro and River Ruhwa, is provided in Table 10-1 and Table 10-2. Model inflows vary according to general hydrological conditions and are related to optimised reservoir

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operation schedule scenarios as defined in the Feasibility Report. Five flow conditions are presented:[2]

- "Very dry" conditions (95% exceedance probability);
- "Dry" conditions (90% exceedance probability);
- "Normal" conditions (50% exceedance probability);
- "Wet" conditions (10% exceedance probability); and
- "Very wet" conditions (5% exceedance probability).

Table 10-1 Summary of hydraulic model inflows (current conditions)

Location	Very Dry	Dry	Normal	Wet	Very Wet
Ruzizi II Environmental Flow (m^3/s)	10.8	10.8	10.8	10.8	10.8
Ruzizi II powerhouse release (m^3/s)	Between 0 m^3/s and 150 m^3/s depending on powerhouse release schedule and upstream flow conditions				
Intervening Catchment Flow (m^3/s)	1.3	1.6	2.4	3.7	4.9
Total Flow to Ruzizi III (m^3/s)	78.3	84.3	108.4	131.1	139.2
River Rubyiro Flow (m^3/s)	4.0	4.9	7.0	11.3	14.9
River Ruhwa Flow (m^3/s)	8.6	10.6	15.2	24.5	33.4

Table 10-2 Summary of hydraulic model inflows (post-project conditions)

Location	Very Dry	Dry	Normal	Wet	Very Wet
Ruzizi III Environmental Flow (m^3/s)	11.0	11.0	11.0	11.0	11.0
Ruzizi III powerhouse release (m^3/s)	Between 0 m^3/s and 150 m^3/s depending on powerhouse release schedule and upstream flow conditions				
Intervening Catchment Flow (m^3/s)	N/A	N/A	N/A	N/A	N/A
Total Flow from Ruzizi III (m^3/s)	78.5	84.5	108.6	131.3	139.4
River Rubyiro Flow (m^3/s)	4.0	4.9	7.0	11.3	14.9
River Ruhwa Flow (m^3/s)	8.6	10.6	15.2	24.5	33.4

Hydrological conditions in the extended study area are derived from the 'Baseline Study for the Basin of Lake Kivu and the Ruzizi River' (Sher Consult, 2020) and represent annual average flow conditions. These are given as:

- Additional tributary inflows, 6 km downstream Burundi border – 6.5 m^3/s;
- Additional tributary inflows, 18.3 km downstream Burundi border – 10 m^3/s;
- Additional tributary inflows, 21.7 km downstream Burundi border – 7.1 m^3/s;
- Additional tributary inflows, 38.4 km downstream Burundi border – 17.4 m^3/s; and
- Additional tributary inflows, 55.7 km downstream Burundi border – 16.1 m^3/s;

The two-scale 1D model representation of the Ruzizi River provides the required hydrological and hydraulic characterisation of the river reach affected by hydropeaking. It enables an assessment to be made of the predicted effects of hydropeaking and its attenuation in the extended study area and supports the selection of a medium-resolution assessment method.

The 1D hydraulic model has been used to provide preliminary assessment of the hydraulic characteristics in the extended study area downstream of the River Ruhwa / Burundi border to help determine the study area over which it is necessary to relate project-induced change in

[2] Flow conditions are specified with reference to % exceedance probability, i.e., the percentage of time for which flow conditions are exceeded. For example, "very dry" conditions are exceeded 95% of the time such that they would only occur, on average, for approximately 7 days in any given year.

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hydrological and hydraulic conditions to ecological and social reliance impacts. Further details are provided in 10.4.4.

10.3.4 2D Hydraulic Modelling

A 2D hydraulic model of the 1 km reach downstream of the Ruzizi III dam wall has been constructed in TUFLOW based on the available LiDAR data and surveyed cross-section data in this reach. This first kilometre reach is typically representative of the whole dewatered reach. It comprises both steep sections with low depths and high velocities and a flatter, slower flowing section with deeper water. The LiDAR representation of the main channel was compared with the cross-section data to best inform the representation of the river channel. As the LiDAR data does not fully represent the conveyance capacity of the river channel adequately, the surveyed cross-sections were used to incorporate into the model representation of an appropriately scaled river channel.

The 2D hydraulic model has been developed to illustrate the variety of flow conditions experienced in the dewatered reach under current hydropeaking conditions. Water depths in this reach vary between less than 0.5 m to greater than 4 m and velocities vary between less than 0.5 m/s to greater than 2.5 m/s based on channel morphology and slope. Further details are provided in the accompanying annex.

The 2D hydraulic model has also been used during the assessment of EFlows in the 5.5 km dewatered reach to provide additional hydrological and hydraulic characterisation of the 1 km reach downstream of the Ruzizi III dam wall, providing further evidence to support the assessment of the functional relationship / impact on aquatic ecology of the 10% MAF proposed by the Project as the EFlow for this reach. Further details are provided in section 10.4.2.

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10.4 Assessment of EFlows

10.4.1 Introduction

The assessment of EFlows presented herein explicitly considers **3 distinct reaches**:

- the 5.5 km long **dewatered reach** between Ruzizi III dam wall and the powerhouse release;
- the 10 km long **hydropeaking reach** downstream of the Ruzizi III powerhouse release to (just downstream of) the Burundi border; and
- the 123-km-long **extended hydropeaking reach** downstream of the Burundi border to Lake Tanganyika.

Importantly, the assessment is presented with reference to the current baseline hydrological conditions, under which river flow upstream of Ruzizi II is determined by Lake Kivu water levels (and its associated natural variation) and the operation of Ruzizi I and, more directly, Ruzizi II hydropower plants.

Lake Kivu water levels and its associated natural variability govern the monthly intra-annual and inter-annual variability of inflows to Ruzizi III. Similar natural variability is also apparent in tributary inflows downstream of Lake Kivu, both in the 'intervening catchment' between Ruzizi II and Ruzizi III and further downstream near the Burundi border (the Rubyiro and Ruhwa tributaries, 13 km and 15 km downstream for the Ruzizi III HPP, respectively).

The operation of Ruzizi I and Ruzizi II hydropower plants varies according to this broader hydrological context. However, under all broad hydrological conditions, both plants operate under hydropeaking conditions such that a wide variation in sub-daily flows occurs in the Ruzizi River.

The hydrology baseline summarises recent operation of Ruzizi II HEPP illustrating the impact on water levels observed at Kamanyola at, Bugarama Bridge, 4 km downstream of the Ruzizi III powerhouse tailrace (see Figure 10-8). This shows: i) the regular occurrence of variation in sub-daily water levels of between 1 m and 1.5 m; and ii) such variation is not predictable – it can occur at different times of the day. These variations are within the threshold ramp up and ramp down rates for human safety and fish of 5 cm/min and 1 cm/min, respectively.

As the current baseline hydrological conditions in the Ruzizi River are not predictable, the EFA is based on the Ruzizi Cascade Model presented in the Feasibility Study (Tractebel, 2020). This explicitly takes into account the hydrological conditions in the Lake Kivu catchment as well as the optimised operational rules of Ruzizi I, Ruzizi II, and Ruzizi III. These operating conditions are based on a system-wide energy demand curve (see Figure 10-9) that divides the day into three periods: Peak Period 1; Peak Period 2; and Off-peak. Operational release curves have been defined for Ruzizi I, Ruzizi II and Ruzizi III, as shown in Figure 10-10:

- For Ruzizi I, it is optimal to release at the maximum installed capacity during the morning and afternoon peak periods. Outflow during the late-morning / early-afternoon secondary peak period and during the off-peak period vary according to hydrological condition – outflows are maximised when the reservoir level is greater than 1462.3 masl.
- For Ruzizi II, releases are constrained during the morning and afternoon peak periods due to limited storage and lag between Ruzizi I and Ruzizi II. Releases during the secondary peak period and during the off-peak period are conditioned by the Ruzizi I releases and the limited storage.

For Ruzizi III, it is optimal to release at the maximum installed capacity during the morning and afternoon peak periods. Outflow during the late-morning / early-afternoon secondary peak period and during the off-peak period vary according to hydrological condition. The high storage at Ruzizi III helps to mitigate against occurrences of "non-optimal" operation at Ruzizi II.

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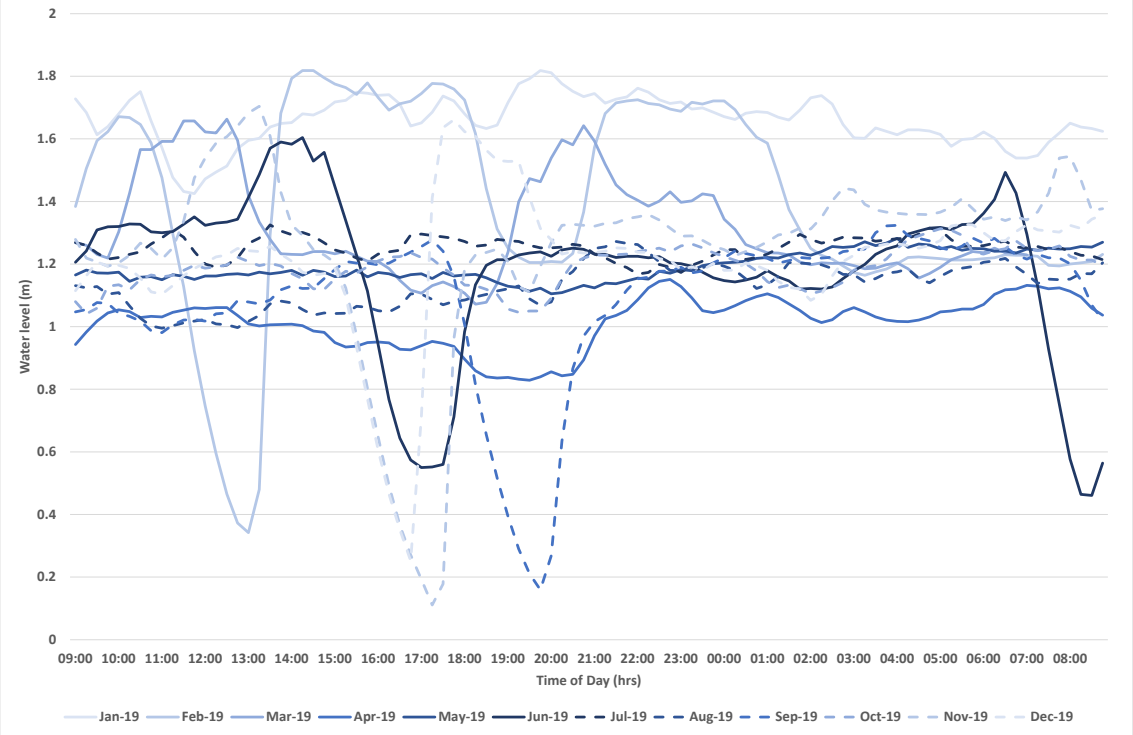


Figure 10-8 Selected Daily Water Levels at Kamanyola (2019)

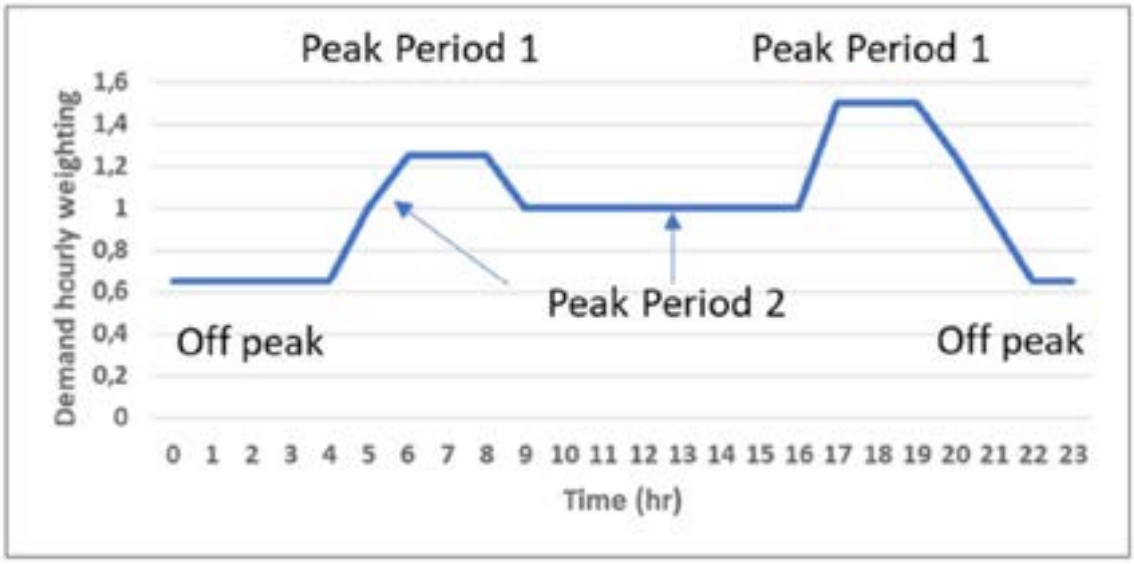
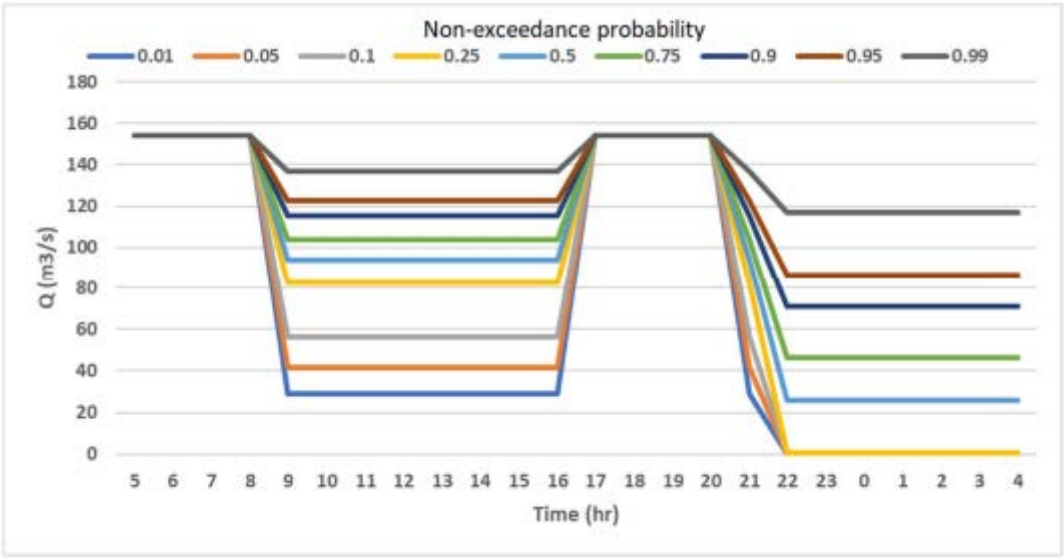


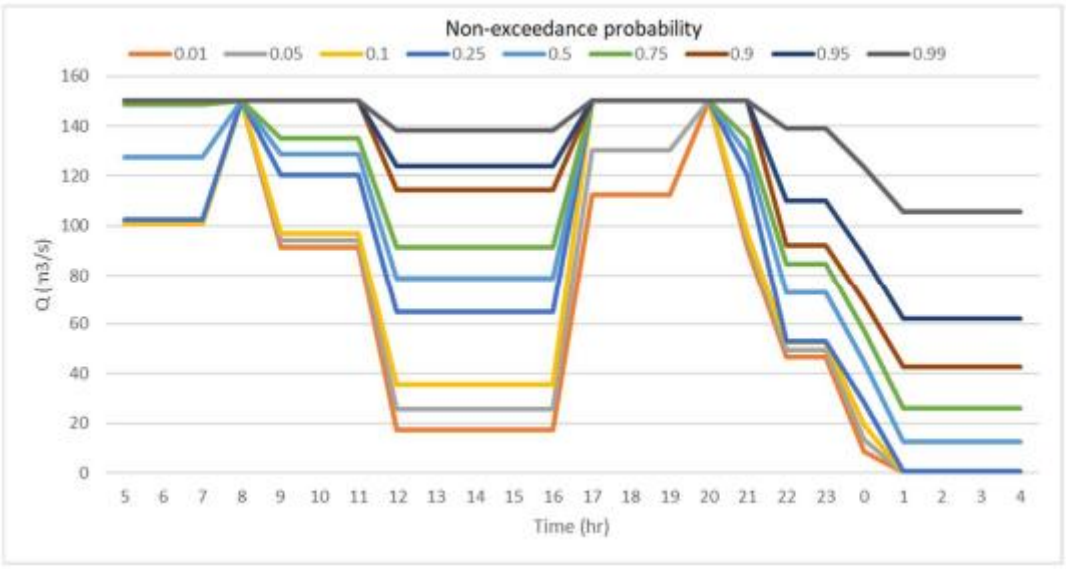
Figure 10-9 Ruzizi System Energy Demand Profile (after Tractebel, 2020)

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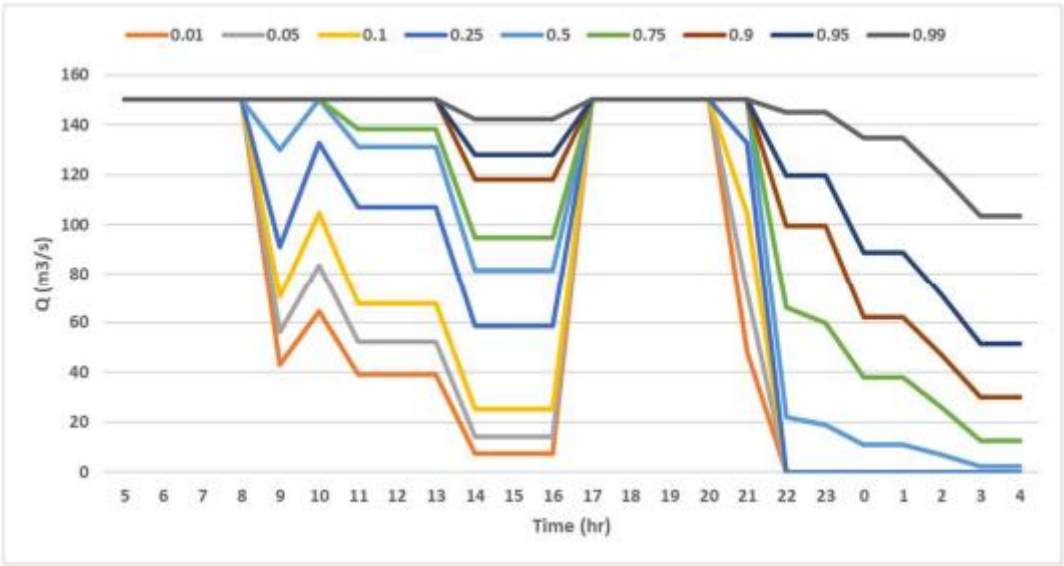
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Ruzizi I



Ruzizi II



Ruzizi III

Figure 10-10 Ruzizi I, Ruzizi II, and Ruzizi III Operational Release Curves (after Tractebel, 2020)

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An important feature of hydropower operation is the ramp-up and ramp-down rates at the powerhouse, i.e., the time taken to change from one flow rate to another. Based on the hydrological analysis of existing water level data and discussions with REL, it has been assessed that the Ruzizi III powerhouse ramp-up and ramp-down rates are expected to be faster than the existing Ruzizi II ramp-up and ramp-down rates. Changes in turbined flow at Ruzizi II have been assessed to occur over a 30-minute duration whereas changes in turbined flow at Ruzizi III have been taken to occur over a 15-minute duration. However, the expected rate of water level variations from ramp up and ramp down rates are expected to be within thresholds for human safety and fish of 5 cm/min and 1 cm/min, respectively. During the start-up the Project will monitor rates of water level variations as strategic points and adapt ramp-up and ramp-down rates accordingly (see Vol. IV ESMP).

The full reach from Lake Kivu to downstream the Ruhwa River, showing the location of Ruzizi I, Ruzizi II, and Ruzizi III, is shown in Figure 10-11.



Figure 10-11 Ruzizi River from Lake Kivu to downstream the Ruhwa River

10.4.2 The Dewatered Reach – Ruzizi III Dam Wall to Powerhouse Tailrace

The dewatered reach is approximately 5.5 km long and is located between the planned Ruzizi III dam wall and the powerhouse release of turbined water back into the Ruzizi River.

The hydrological and hydraulic characteristics associated with the dewatered reach can be readily differentiated between the current baseline in which the reach is subject to hydropeaking effects associated with the operation of the Ruzizi II powerhouse release and the future post-project conditions in which an environmental flow release is to be made from the Ruzizi III dam wall. To date, the project has envisaged a simple, single value of 11 m^3/s for flow releases (approximately 10% Mean Annual Flow (MAF)) (Tractebel, 2020).

An assessment the of hydrological and hydraulic conditions of the dewatered reach has been made over a range of different flow rates, varying from 10 m^3/s (current environmental flow release from Ruzizi II to 160 m^3/s (the combined current environmental flow release and

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maximum hydropeaking release from Ruzizi II). Hydrological and hydraulic conditions associated with 10 m^3/s and 160 m^3/s are highlighted as these represent the current conditions experienced in the reach due to the hydropeaking operation of Ruzizi II.

Due to the irregular and unpredictable nature of historic releases from Ruzizi II, the proposed optimised Ruzizi II powerhouse release schedule (Tractebel, 2020) has been taken to represent "typical" current conditions. Such conditions each day include those associated with a minimum flow of approximately 11 m^3/s and a maximum flow of approximately 160 m^3/s. Selected hydraulic characteristics are highlighted for different modified environmental flows (10% MAF; 15% MAF; and 20% MAF) to assist in contextualising the expected ecological and social impacts in the dewatered reach at different flow thresholds.

Figure 10-12 and Figure 10-13 show the extent of the 5.5-km reach between Ruzizi III dam wall and the powerhouse. The reach is heterogeneous in nature with a steeper, more turbulent, section in the middle-upper reach and a relatively shallower, less turbulent, section in the lower section near the powerhouse.



Figure 10-12 Ruzizi Reach between Ruzizi III Dam Wall and Powerhouse

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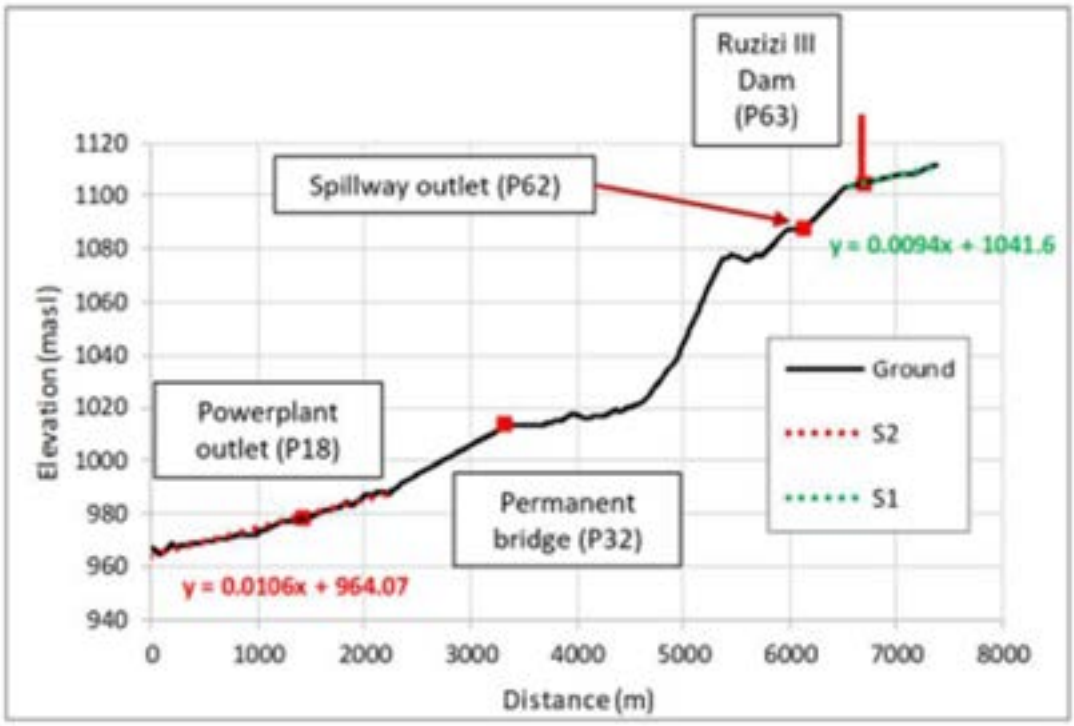


Figure 5-2: Riverbed longitudinal profile

Figure 10-13 Longitudinal Profile of the Ruzizi Reach from Ruzizi II Dam wall to the Powerhouse (after Tractebel, 2020)

A Hydrological and Hydraulic Characteristics

The hydrological and hydraulic characteristics in the 5.5-km dewatered reach is currently subject to a high level of sub-daily variation in river flow. The total wetted area typically varies between 157,000 m^2 and 354,000 m^2. Compared with average flow conditions, it both shrinks to half of its usual size and expands by approximately one-sixth of its usual size on a daily basis. Average depth changes on a typical day between 0.55 m and 1.60 m. Average velocity changes on a typical day between 0.55 m/s and 1.15 m/s.

The transition to a future post-project environmental flow release for the dewatered reach will necessarily remove the variation in sub-daily river flow and provide more stable hydrological and hydraulic characteristics.

Figure 10-14 and Figure 10-15 summarise the variation of total wetted area for different flow conditions between 10 m^3/s (current minimum flow) and 160 m^3/s (current peak flow):

- At a flow of 10 m^3/s (approximately 10% MAF), the total wetted area is 157,000 m^2 (44% and 48% of peak and natural Average Annual Flow (AAF), respectively);
- At a flow of 16.5 m^3/s (approximately 15% MAF), the total wetted area is 183,000 m^2 (52% of peak flow);
- At a flow of 22 m^3/s (approximately 20% MAF), the total wetted area is 204,000 m^2 (58% of peak flow);
- At a flow of 160 m^3/s, the total wetted area is 354,000 m^2 (100%, 109% peak/natural AAF);
- Under normal conditions, the total wetted area is at least 86% (also 86 m^3/s) for 75% of the time – and even under dry conditions it is at least 74% (48 m^3/s) for 75% of the time;
- During daylight hours, the total wetted area varies between 87% and 100% under normal conditions (and drops to 74% under dry conditions). During night-time hours, the total

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wetted area drops to 61% under normal conditions (and drops to 46% under dry conditions); and

- The largest change in total wetted area (and indeed all hydrological and hydraulic characteristics) is expected to occur during the transition between end of night-time operation to start of daylight operation as a switch is made between reservoir refill operations to energy production operations.

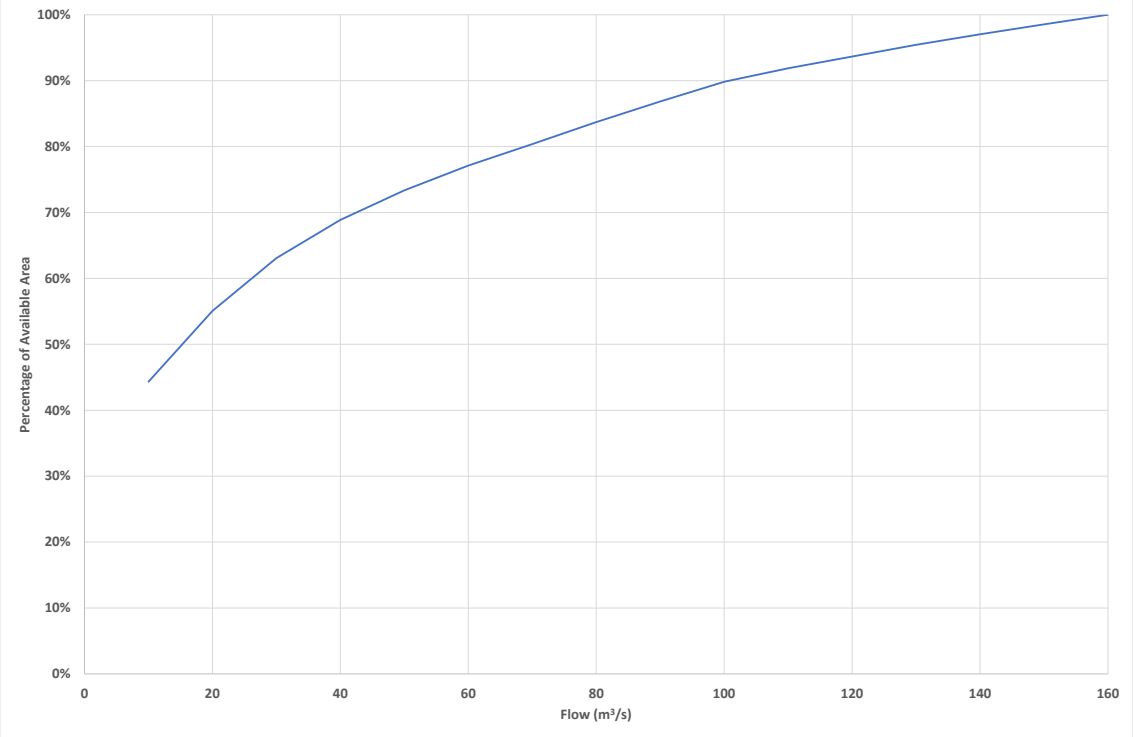


Figure 10-14 Variation of dewatered reach total wetted area under different flow conditions

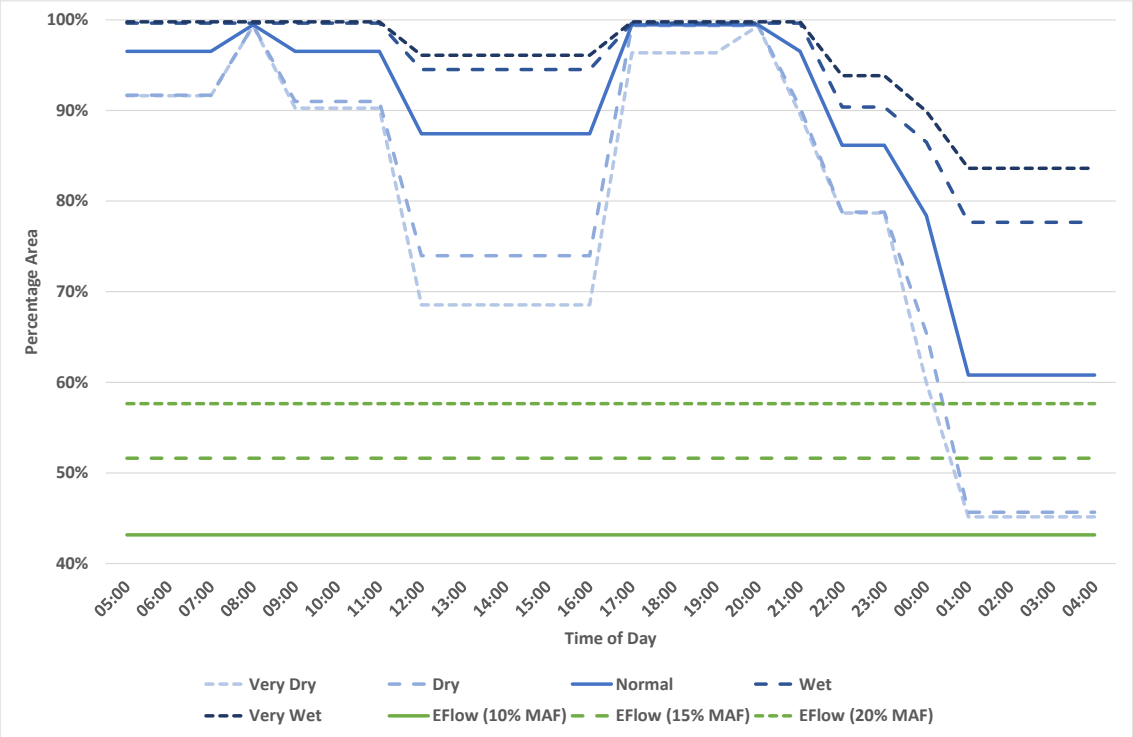


Figure 10-15 Sub-daily Variation of Dewatered Reach Total Wetted Area

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Figure 10-16 summarises the monthly average intra-annual and inter-annual variation of dewatered reach total wetted area:

- Under normal wet period conditions, the dewatered reach total wetted area varies between 88% and 94% throughout the year. The wetted area reduces to up to 83% in dry conditions and increases by up to 98% in wet conditions.
- Under normal dry period conditions, the dewatered reach total wetted area varies between 87% and 84% throughout the year. The wetted area reduces to up to 80% in dry conditions and increases by up to 91% in wet conditions.
- The total wetted area under different levels of environmental flow is also presented, showing clearly that the total wetted area is significantly lower than the current (monthly average) total wetted area.

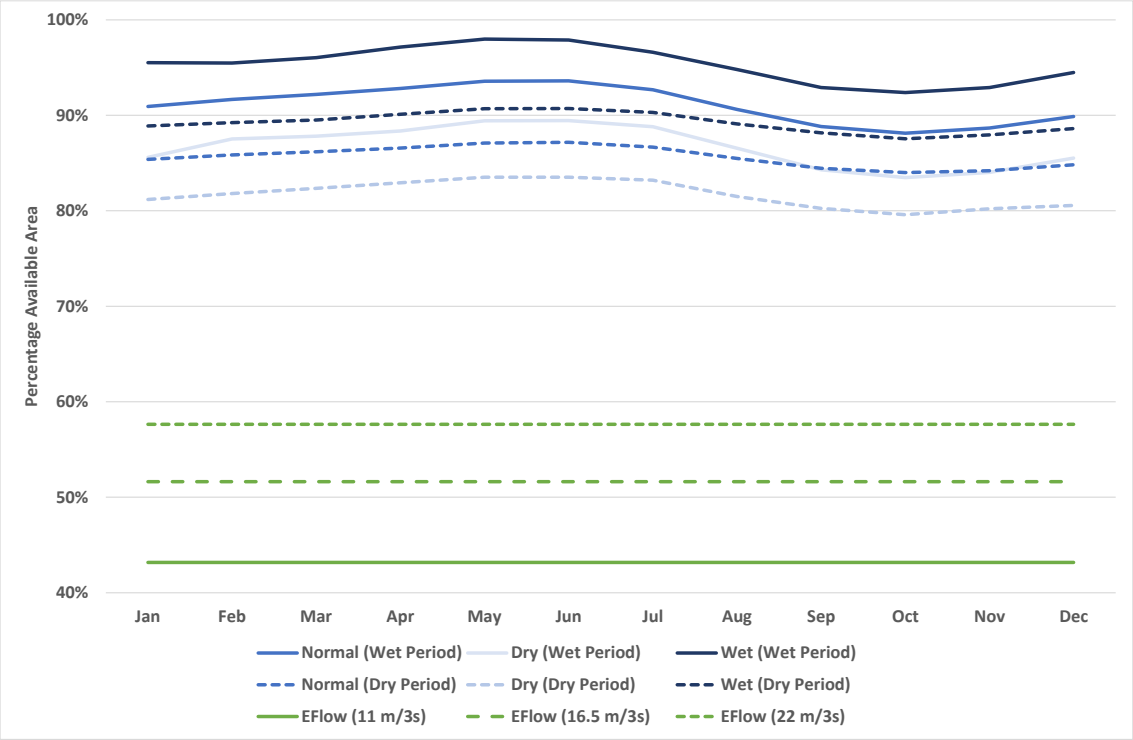


Figure 10-16 Intra-annual and Inter-annual Variation of Dewatered Reach Total Wetted Area

Figure 10-17 summarises the variation of average depth (and total wetted area) in the dewatered reach for different flow conditions between 10 m^3/s (current minimum flow) and 160 m^3/s (current peak flow):

- At a flow of 10 m^3/s, the average depth is 0.55 m (over a wetted area of 44%, 48% peak/natural AAF); and
- At a flow of 160 m^3/s, the average depth is 1.60 m (over a wetted area of 100%, 109% peak/natural AAF).

Significant variability of water depths within the reach can also be identified, for example:

- At a flow rate of 10 m^3/s, 91,000 m^2 (26%, 28% peak/natural AAF) is at least 0.5 m deep, 40,000 m^2 (11%) is at least 1 m deep, and 6,000 m^2 (2%) is at least 2 m deep; and
- At a flow rate of 160 m^3/s, 335,000 m^2 (95%, 103% peak/natural AAF) is at least 0.5 m deep, 287,000 m^2 (81%) is at least 1 m deep, and 131,000 m^2 (37%) is at least 2 m deep.

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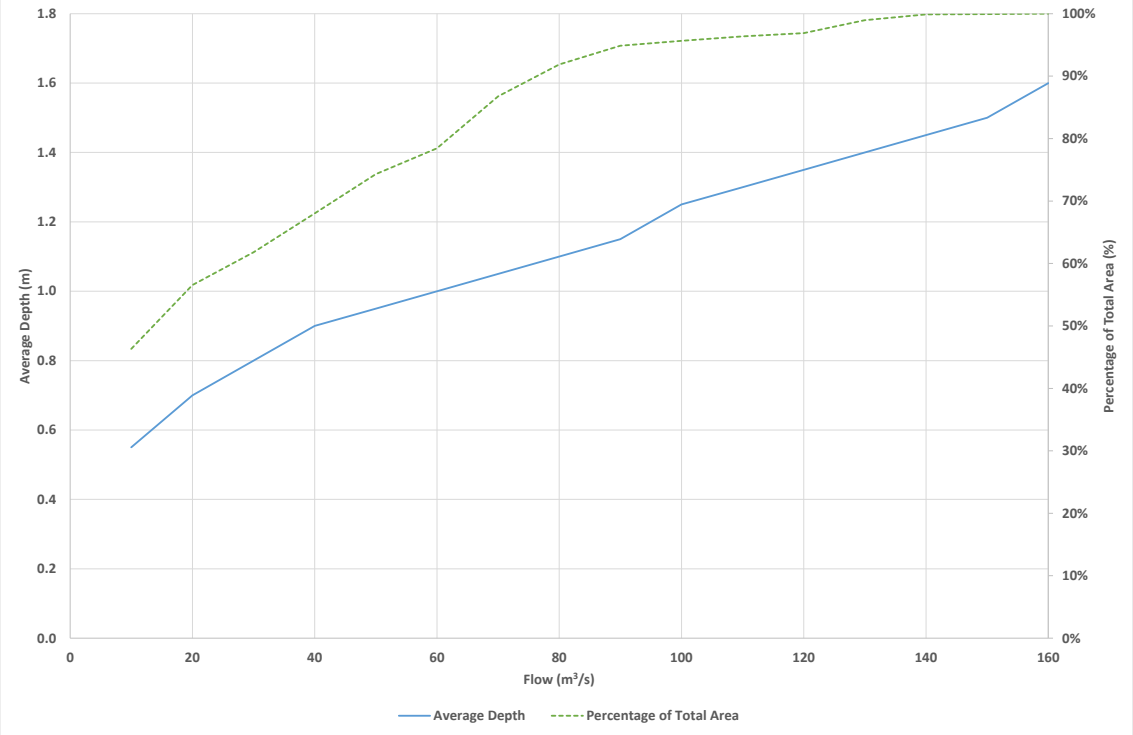


Figure 10-17 Variation of Dewatered Reach Average Depth Under Different Flow Conditions

Figure 10-18 summarises the variation of average velocity (and total wetted area) in the dewatered reach for different flow conditions between 10 m^3/s (current minimum flow) and 160 m^3/s (current peak flow):

- At a flow of 10 m^3/s, the average velocity is 0.55 m/s (over a wetted area of 44%, 48% peak/natural AAF); and
- At a flow of 160 m^3/s, the average velocity is 1.15 m/s (over a wetted area of 100%,109% peak/natural AAF).

Significant variability of within reach velocities can also be identified, for example:

- At a flow rate of 10 m^3/s, 82,000 m^2 (23%, 28% peak/ natural AAF) is at least 0.5 m/s fast, 37,000 m^2 (10%) is at least 1 m/s fast, and 3,000 m^2 (1%) is at least 2 m/s fast.
- At a flow rate of 160 m^3/s, 339,000 m^2 (96%, 103 peak/natural AAF) is at least 0.5 m/s fast, 185,000 m^2 (52%) is at least 1 m/s fast, and 98,000 m^2 (28%) is at least 2 m/s fast.

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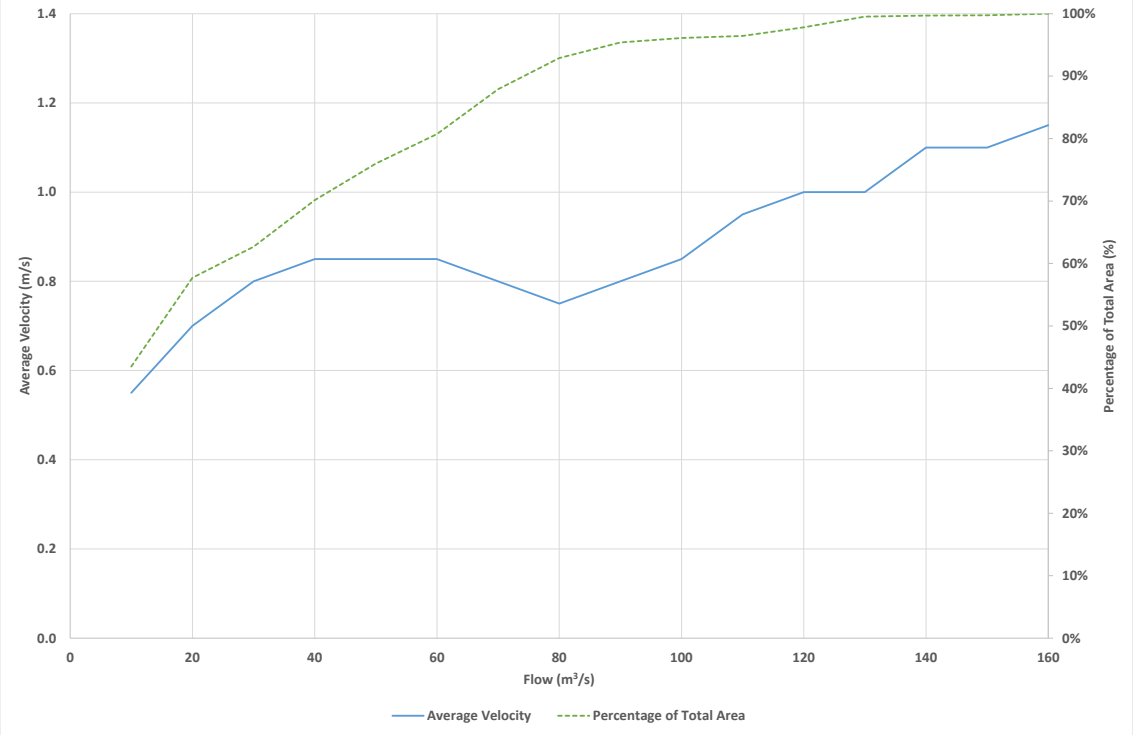


Figure 10-18 Variation of Dewatered Reach Average Velocity Under Different Flow Conditions

A summary of the combined effects of depth and velocity (hazard) is presented in the accompanying annex. Hazard status is particularly relevant to considering community safety. Hazard is significantly lower at low flows (approximately 10 m^3/s) than it is at high flows (approximately 160 m^3/s), illustrating the potential danger that may be faced during ramp-up from off-peaking to peaking conditions in the river.

The hydraulic conditions in the 1 km reach below the Ruzizi III dam wall at 10% MAF conditions are further illustrated by the 2D hydraulic modelling as illustrated in Figure 10-19, Figure 10-20, and Figure 10-21.

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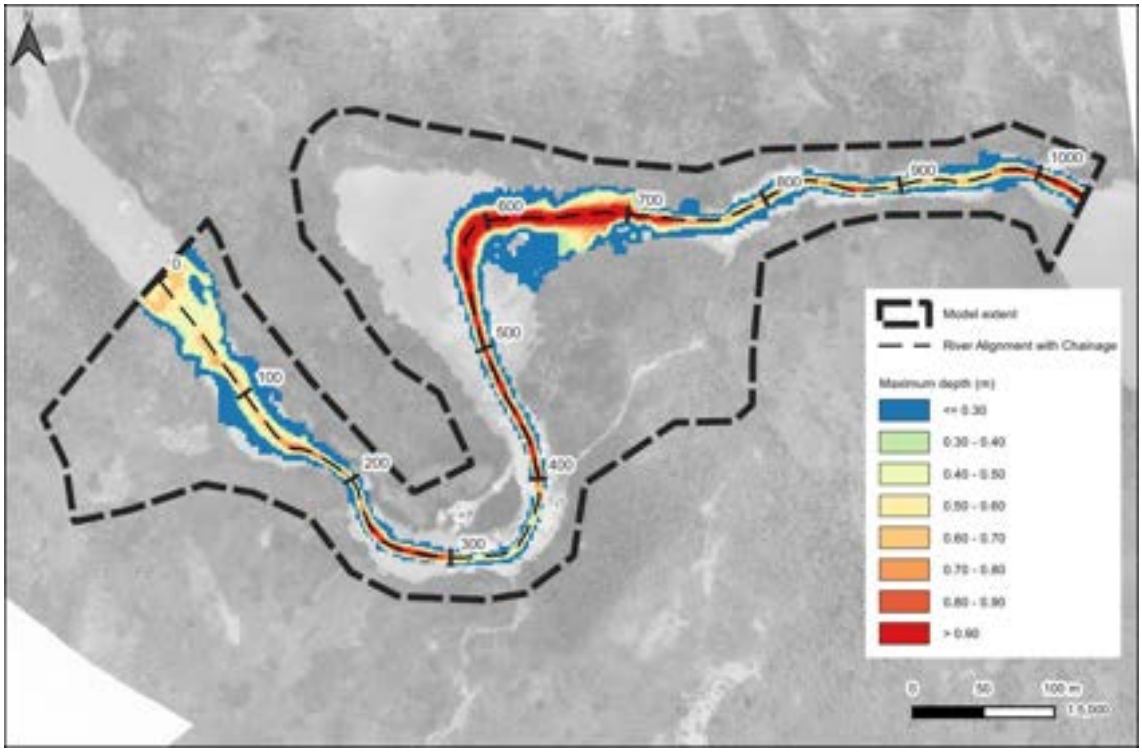


Figure 10-19 Modelled depth under 10% MAF flow conditions in the reach below Ruzizi III dam wall

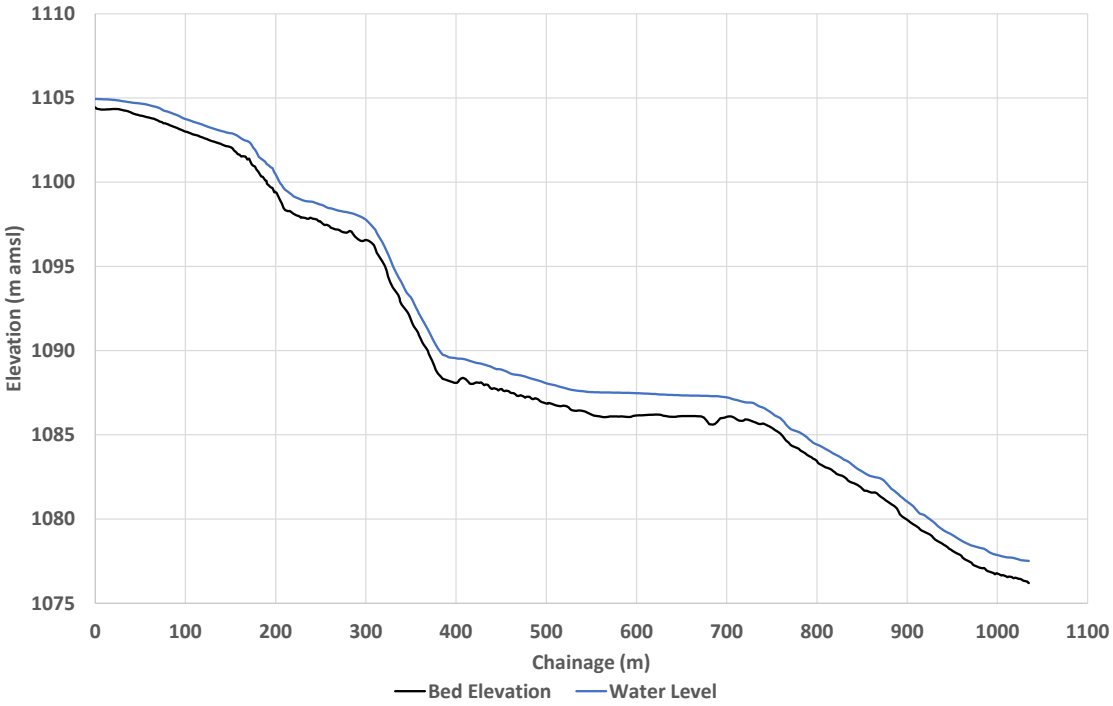


Figure 10-20 Longitudinal slope and water level under 10% MAF flow conditions in the 1-km reach immediately below Ruzizi III dam wall

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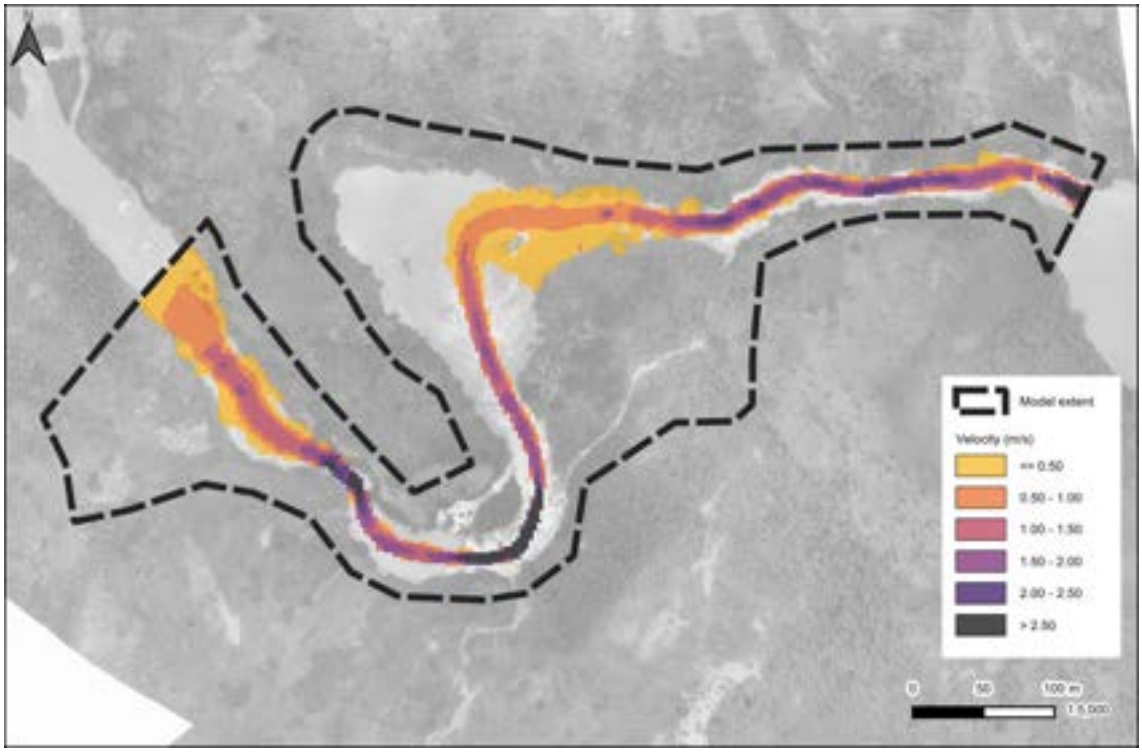


Figure 10-21 Modelled velocity under 10% MAF flow condition in the reach below Ruzizi III dam wall

It can be seen that the reach below the Ruzizi III dam wall is typically very steep, dropping almost 30 m in a little over 1,000 (slope = 0.027 m/m). The stretch between approximately 300 m and 400 m downstream of the dam wall is particularly steep, dropping almost 10 m (slope = 0.103). There is a good continuity of minimum depth of water (greater than the 0.3 m depth considered necessary for fish movement) throughout the reach, with lower marginal depths particularly in the flatter parts of the reach. Velocity tends to be high in the steeper parts of the reach (exceeding 2.5 m/s in places) with lower velocities (less than 0.5 m/s) on the channel margins and in the flatter areas. These modelled predictions are important for assessing potential impacts on the aquatic ecosystem, particularly fish.

B Geomophological, Ecological and Social Context

B.1 Geomorphology

The dewatered reach is located along a confined valley setting of the Ruzizi River with an average gradient of 0.0238 m/m over the 5.5 km distance between the dam wall and tail race. Due to the confined nature of the river, there is no or limited floodplain development. The riverbed is largely bedrock and boulder dominated with pool-rapid or pool-riffle reach types. This steep reach is characterised by short pools (except one long pool) and long rapids. The calcrete/bedrock and large stable blocky material form rapids. Small bedrock islands form anastomosing channels.

Sediment deposition on these islands supports vegetation establishment. The banks are composed of large blocky material filled with a finer sand and clay matrix. The channel is relatively straight to wandering and follows the abrupt bends of the valley floor. Agriculture is widespread on the hillslopes, and landslide scars suggest sediment input directly to the river or tributary channels.

There is a right bank tributary approximately 3.2 km downstream of Ruzizi III dam wall location supplying significant sediment volumes to this reach (frequent blanket sediment deposits and channel avulsions on the tributary fan can be seen on satellite images). These lateral inputs contribute both fine suspended sediment and coarser bedload material to the channel.

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B.2 Aquatic Ecology

Macroinvertebrates:

Aquatic biotopes within the dewatered reach comprised the following:

- Five stretches of Deep-Very Fast Cascade, with a total length of approximately 1.6 km, and seven stretches of Deep-Fast Rapids, with a total length of approximately 2.7 km. Limited information was available on aquatic macroinvertebrates in these biotopes, suggesting that they are likely to support mostly grazing and filter-feeding taxa that tolerate extreme current speeds. Taxa expected include freshwater limpets (*Burnupia* sp), Tricorythid mayflies and certain species of blackflies, such as *Simulium damnosum* and *S. dentulosum.* Macroinvertebrate production in these areas is typically very high, so these areas constitute potentially important nodes of secondary production (i.e., food for fish).
- One area of Shallow-Fast Riffle, approximately 0.6 km downstream of the proposed HEPP. This area is likely to support a high diversity of macroinvertebrates that would include most functional feeding categories. The high diversity of macroinvertebrates expected in this area is attributed partly to interstitial spaces between bed substrates that provide a large surface area for colonisation by macroinvertebrates, the bed substrates that provide protection to macroinvertebrates from predation and flood events, and shallow conditions that are conducive to benthic algal growth, which provide food for vegetarian macroinvertebrates (and fish). The quality of such biotopes is typically reduced by the accumulation of fine sediments, and this highlights the need for periodic high flow events to flush and mobilise fine sediments from these areas.
- Two stretches of Deep-Slow Pools, with a total length of approximately 1.2 km. No information was available on macroinvertebrates in such pools, but diversity and abundance in these areas is likely to be low because of light limitation and the limited diversity of hydraulic conditions.

Fish:

This reach is characterised by alternating Fast Deep, Very-Fast Deep and Slow Deep habitat classes. In this high- to medium-gradient transitional geomorphic zone of the Ruzizi River, Slow Deep habitats are uncommon and important both as maintenance habitat for fish guilds selecting for semi-lotic pool and lentic fish guilds, including the haplochromine cichlids and *Enteromius* barbs. These areas will also provide hydraulic cover and resting areas for the migratory Lithophilic guild including the *Labeo* and *Labeobarbus* species. The Fast Deep and Very-Fast Deep habitats are important for the non-migratory lotic riffle-rapid guilds including the *Amphilius* genera. The large bed-elements – cobble and boulder – will provide important interstitial habitat for these species, as well as providing spawning beds for the *Labeo* and *Labeobarbus* species that are typically migratory.

Maintenance flows to provide adequate depth cover (greater than 0.3 m) over shallow riffles and rapids for most of the year is important, especially over the migration season (likely August to October) together with flushing flows for moving sediment from the bed elements. Maintaining the quality of the interstitial substrate habitats will also be important.

B.3 Terrestrial Ecology

Riparian Vegetation:

Natural riparian habitat is limited on the riverbanks along this reach and can be found on small islands in the river. Two types of riparian vegetation are represented, namely Riparian Thicket and Riparian Wetlands. Riparian Thicket is most prevalent on the rocky islands in the long section of rapids about 600 m downstream of the dam wall site, although narrow, fragmented strips of thicket are located on riverbanks at a few places. Riparian Wetlands are mostly located on islands away from the rapids and not along the riverbanks on this reach, and several are cultivated. Species dependent on a wet bank are more prevalent in the Riparian Wetland

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community, while flow-dependent species are not well represented in either Riparian Wetland or Riparian Thicket. The thicket on islands in the rapids comprise species that are more associated with rocky substrate than a wet bank or river flows. No threatened species were recorded in either of these two riparian vegetation types.

Riparian Fauna:

The riparian avifauna, mammal and herpetofauna assemblages are species-poor in this reach. Riparian mammals such as marsh mongoose and otter species may be present occasionally, but larger herbivores such as hippopotamus are not represented along this reach. The riparian avifauna assemblage contains surprisingly few fish-eating species although a limited number are expected to be present in this reach, e.g., white-breasted cormorants were recorded foraging in the rapids during fieldwork. Herpetofauna will be mostly represented by widespread generalist amphibians as well as a few riparian reptile species such as water snakes (*Lycodonomorphus* species) and terrapins (*Pelusios* species). No threatened species of fauna were recorded in the dewatered reach.

B.4 Social

The following paragraphs provide an overview of local communities' reliance on Ruzizi's water for livelihoods and domestic needs in the dewatered reach. Issues related to water quality and sediment load will not be covered in this analysis, as no discernible difference from current conditions is expected, due to the low residence time of water in the Ruzizi III reservoir.

The dewatered reach is characterised by a low level of social reliance on the river, due to difficulty of access from surrounding villages (mostly located much higher up above the steep Ruzizi valley slopes) and high velocity of water. Agriculture is dominated by a mix of steep slope cultivation alongside farming of taro, maize, cassava, banana, and fruit trees on riverside plots. These riverside plots are irrigated directly from the river, mainly by using buckets and less frequently irrigation pumps. The collection of water for consumptive use is not as high as it is downstream of the powerhouse, due to the higher distance from surrounding villages. Activities such as bathing or clothes-washing in the river have also not been observed in the dewatered reach and river crossing here is rare due to high water velocities. Fishing is practiced, but not as frequently as it is downstream of the powerhouse, and it does not represent an important source of livelihood for many households in the local communities.

In this stretch, there are two intangible cultural heritage sites which require villagers to physically enter the river on a regular basis. The first site is an island which is used for praying downstream of the reservoir. This site was inaugurated in August 2021 by a group of Congolese Christians, who regularly cross the river at night or during the day to reach the praying area. The second site is a flat riverside opening used for baptisms which is located within the footprint of the proposed Disposal Area.

C Indicators Linked to Hydrological and Hydraulic Characteristics

Table 10-3 provides and overall summary of the ecological and social functional relationships with hydrological and hydraulic characteristics within the dewatered reach.

The change in hydrological and hydraulic characteristics from a highly varying hydropeaking reach in which sub-daily flows vary from 10 m^3/s to 160 m^3/s to a reach in which ecological and social reliance is maintained by an environmental flow release is predicted to result in a significant increase in in-channel sedimentation and a significant improvement in aquatic ecology for non-migratory / migratory fish and macro-invertebrates.

These functional relationships and impacts have been assessed assuming a constant environmental flow of 10% MAF. During the assessment, higher environmental flows of 15% MAF and 20% MAF were also considered but have been assessed as not providing a material increase in ecological and social reliance value in the dewatered reach. Indeed, it is important to note that **a stable 10% MAF environmental flow release has been assessed as likely to provide an improvement in aquatic ecology for non-migratory / migratory fish and macro-invertebrates**

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in the dewatered reach. Although wetted area and depth will be significantly reduced in this reach, an improvement in aquatic ecosystem condition is predicted due to the more stable flow conditions that will be created. This includes the removal of sub-daily variation in depths associated with the existing hydropeaking that repeatedly dewater riffle-rapid habitats leading to aquatic biota mortality, and the removal of sub-daily variation in velocities that reduces the interstitial delivery of well-oxygenated water through bed elements following down-ramping. These potential aquatic ecology benefits will depend on maintaining continuity of flow across the dewatered reach that is not prevented from significant sediment inputs from landslides and limiting fishing pressures in the shallow water dewatered reach.

Table 10-3 Summary of Ecological and Social Functional Relationship / Impacts within the Dewatered Reach

Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Geomorphology		
Increased channel erosion Stable channel bed due to large bed material, cemented bed material (calcrete) and bedrock. Small gravel and sand bars present, but frequent flow level fluctuations have armoured the bed, so low potential for further channel incision.	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	Minor
	Ramping Rates	No / Insignificant
Increased sedimentation in channel Lateral sediment inputs could overwhelm the transport capacity of the reduced flow, resulting in sedimentation (coarse sediment bars downstream of tributaries and fine sediment blankets in slack waters) in low velocity habitats. Extreme mass movements of sediment, such as landslides could block the channel, resulting in back flooding. Due to the reduced flow rate, the dam will fill slower (longer period of damming) and cut/entrain through the deposited material at a lower rate.	Flow	Moderate
	Elevation / Depth	Minor
	Velocity	Moderate
	Area	Moderate
	Ramping Rates	Significant
Bank erosion Bank erosion is generally associated with reduced longitudinal sediment input, possibly leading to channel erosion and associated bank collapse and/or direct fluvial erosion. The fixed nature and large clast size of the banks are unlikely to be eroded due to the reductions in sediment load and flow energy. The banks have been exposed to high velocity flows with frequent variations in water level, thus erosion has already taken place along sensitive reaches. Some localised bank erosion might take place as vegetation and agriculture change along the banks. The riverbanks are low in elevation, so the risk is fairly low if bank erosion should take place.	Flow	Minor
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	Minor
Aquatic Ecology		
Non-migratory fish: abundance and diversity Fish habitat downstream of the powerhouse is comprised predominantly of the Fast Deep habitat class, with minimal Slow Deep habitat. Fish habitats of highest importance are the shallower riffle-rapid habitats with larger bed elements to provide habitat for the lotic riffle-rapid fish guilds (e.g. *Chiloglanis* and *Amphilius)* although fish abundance of these smaller fish species is likely to be lower than other reaches downstream due to the high and variable velocity of water caused by upstream hydropeaking.	Flow	
	Elevation / Depth	Significant Positive
	Velocity	Significant Positive
	Area	Significant Positive
	Ramping Rates	N/A
Migratory fish: abundance and diversity Fish habitat downstream of the powerhouse is comprised predominantly of the Fast Deep habitat class, with minimal Slow Deep habitat. Fish habitats of highest importance are the shallower riffle-rapid habitats with larger bed elements to provide habitat for the lotic lithophiic migratory fish guilds (e.g. *Labeobarbus* sp.). Fish abundance of these species is likely to be lower in the upper portion of this reach than further downstream due to the presence of a long steep rapid which pay pose a barrier to some migratory fish.	Flow	
	Elevation / Depth	Significant Positive
	Velocity	Significant Positive
	Area	Significant Positive
	Ramping Rates	N/A
	Flow	Minor
	Elevation / Depth	

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Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Macro-invertebrates: abundance and diversity Both are expected to increase compared to the current operation because stable daily and sub-daily water levels will improve the quality of instream habitats, particularly for taxa that are sensitive to hydraulic conditions. Stable hydraulic conditions and clear water released from the Ruzizi III are also likely to create conditions suitable for growth of submerged aquatic plants, such as *Potamogeton schweinfurthii*, and this will increase the availability of substrates for macro-invertebrate colonisation.	Velocity	Significant Positive
	Area	No / Insignificant
	Ramping Rates	N/A
Terrestrial Ecology		
Riparian vegetation: abundance and diversity The two types of riparian vegetation currently present in this reach, namely Riparian Thicket and Riparian Wetland, will be impacted in different ways by the project-related changes to the river that are likely to occur. This is mainly because of the differing ecological characteristics of the species in each habitat, such as the proportion of species requiring a constant wet bank or flow-dependent species. Riparian Wetlands have the higher proportion of these species and are thus more likely to be impacted as changes in depth and area of the river result in changes to the availability of a wet bank and accessibility of riparian species to flowing water. Neither habitat is dependent on the other, and merely occupy different microhabitats in the riparian zone.	Flow	Minor
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Moderate
	Ramping Rates	No / Insignificant
Riparian fauna: abundance and diversity The riparian fauna assemblage is associated with the two vegetation types described above, as well as open water habitat in the river. The species composition of the faunal assemblage is currently dominated by widespread habitat generalists and overall species richness is low. Changes in flow, depth and velocity are factors likely to have non-significant impacts on riparian fauna species.	Flow	Minor
	Elevation / Depth	Minor
	Velocity	Minor Positive
	Area	Minor
	Ramping Rates	No / Insignificant
Social		
Consumptive Water Use Local communities are frequently using this stretch of the river for domestic water collection and irrigation with buckets. Water is generally not collected for drinking in this area. Social reliance on this stretch of the river for consumptive use is moderate.	Flow	Minor
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Minor
	Ramping Rates	N/A
Non-Consumptive Water Use: Fishing Local communities are currently using this stretch of the river infrequently for casual fishing activities.	Flow	Minor Positive
	Elevation / Depth	Minor Positive
	Velocity	Minor Positive
	Area	Minor Positive
	Ramping Rates	N/A
Community Safety Local communities do not regularly physically enter or cross the river due to the hazardous nature of this stretch, aside from regular crossing to reach a praying spot downstream of the future dam. Social exposure to river crossing hazards is high.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	N/A

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10.4.3 The Hydropeaking Reach – Ruzizi III Powerhouse Tailrace to Burundi Border

A detailed assessment of hydropeaking has been undertaken for the approximately 10 km reach downstream Ruzizi III powerhouse to immediately downstream the Burundi border.

The following reach hydrological and hydraulic characteristics are presented:

- Minimum and maximum flow, and flow range (m^3/s): This provides an overall summary of the hydrological conditions experienced during a 24-hour period.
- Minimum and maximum elevation (masl) and elevation range (m): This provides a summary of the variation in water level. River cross-section profiles are also graphically presented such that depths – and impacts that are depth dependent – can be visually interpreted.
- Minimum and maximum average velocities, and average velocity range (m/s): This provides an overview to inform impacts that are velocity dependent.
- Minimum and maximum cross-section area, and cross-section area range (m^2): This provides an overview of the 'size' of the Ruzizi River and its overall available habitat area.
- Ramping-up and ramping-down rates (cm/min): This provides a summary of how quickly water levels change over different durations. Ramp-down rates of greater than 1 cm/minute can be associated with fish stranding impacts. Ramp-up rates of greater than 5 cm/minute can be associated with community safety impacts.

The hydrological and hydraulic characteristics are presented for five selected key representative locations:

- Downstream Ruzizi III powerhouse release location (DRIIIPH);
- Upstream Bugarama Bridge / Kamanyola Monitoring Station (UBBKMS);
- Upstream Rubyiro tributary (URUBTR);
- Upstream Burundi border / Ruhwa tributary (URUHTR); and
- Downstream Burundi border / Ruhwa tributary (DRUHTR).

Based on an expert assessment of similarity, the resultant hydrological and hydraulic characteristics are functionally related to the geomorphological, ecological, and social context in the following three sub-sections. Individual sub-sections are presented for (i) Downstream Ruzizi III powerhouse tailrace and (ii) Bugarama Bridge / Kamanyola Monitoring Station. The third sub-section groups together the hydrological and hydraulic characteristics for the locations from upstream Rubyiro tributary to downstream Burundi border / Ruhwa tributary.

Figure 10-22 shows the location of each of the selected key representative locations.

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Figure 10-22 Ruzizi III Powerhouse to Ruhwa Tributary

Five flow conditions are presented, based on the optimised reservoir operation schedules presented in the Feasibility Report:

- "Very dry" conditions (95% exceedance probability);
- "Dry" conditions (90% exceedance probability);
- "Normal" conditions (50% exceedance probability);
- "Wet" conditions (10% exceedance probability); and
- "Very wet" conditions (5% exceedance probability).

The accompanying annex illustrates the seasonality of such flow conditions. An understanding of seasonality (intra-annual conditions) and inter-annual conditions is an important dimension when considering the ecological and social impacts associated with the prevailing hydrological and hydraulic conditions. Typically, longer-term variation in flow conditions is more pronounced than season variation in flow conditions.

Table 10-4 and Table 10-5 summarise the model inflows adopted for each of these flow conditions, for the current baseline and future post-project scenarios:

- The model inflows for the current baseline scenario include: i) Ruzizi II environmental flow; ii) Ruzizi II powerhouse release; iii) 'intervening catchment' inflows; iv) River Rubyiro inflows; and v) River Ruhwa inflows.
- The model inflows for the future post-project scenario include: i) Ruzizi III environmental flow; ii) Ruzizi III powerhouse release; iii) River Rubyiro inflows; and iv) River Ruhwa inflows.

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Table 10-4 Summary of current baseline hydrological inflows in the Ruzizi II – Burundi Border Reach

Scenario	Ruzizi II Environmental Flow (m^3/s)	Ruzizi II powerhouse release (m^3/s)	Intervening Catchment Flow (m^3/s)	Total Flow to Ruzizi III (m^3/s)	River Rubyiro Flow (m^3/s)	River Ruhwa Flow (m^3/s)
Very Dry	10.8	Figure 10-23	1.3	78.3	4.0	8.6
Dry	10.8		1.6	84.3	4.9	10.6
Normal	10.8		2.4	108.4	7.0	15.2
Wet	10.8		3.7	131.1	11.3	24.5
Very Wet	10.8		4.9	139.2	14.9	33.4

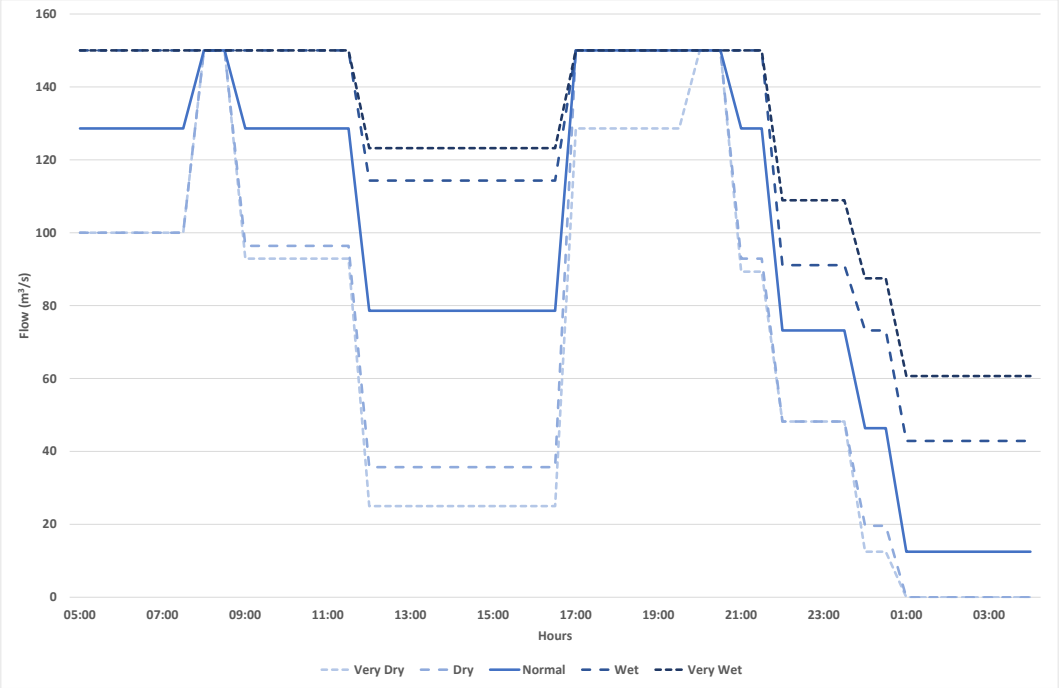


Figure 10-23 Ruzizi II Powerhouse Release Schedules

Table 10-5 Summary of future post-project hydrological inflows in the Ruzizi II – Burundi Border Reach

Scenario	Ruzizi III Environmental Flow (m^3/s)	Ruzizi III powerhouse release (m^3/s)	Total Flow to Ruzizi III (m^3/s)	River Rubyiro Flow (m^3/s)	River Ruhwa Flow (m^3/s)
Very Dry	11.0	Figure 10-24	78.5	4.0	8.6
Dry	11.0		84.5	4.9	10.6
Normal	11.0		108.6	7.0	15.2
Wet	11.0		131.3	11.3	24.5
Very Wet	11.0		139.4	14.9	33.4

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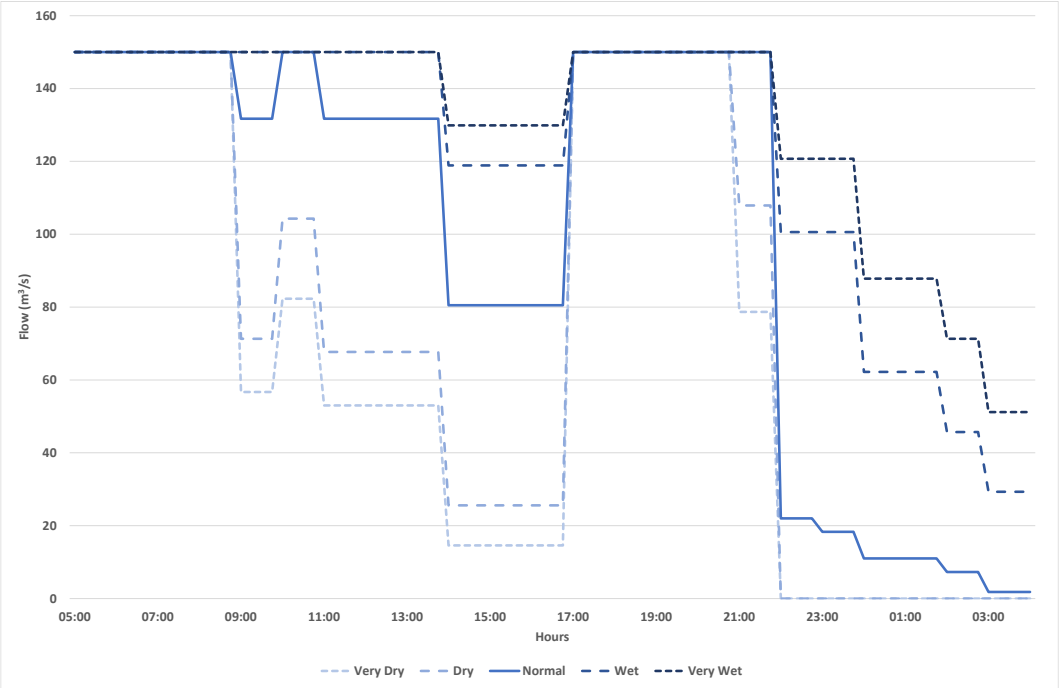


Figure 10-24 Ruzizi III Powerhouse Release Schedules

10.4.3.1 Downstream Ruzizi III powerhouse release location

A Hydrological and Hydraulic Characteristics

This section is located immediately downstream of the proposed Ruzizi III powerhouse. Figure 10-25 and Figure 10-26 provide a general overview of the river reach characteristics in this location. The model cross-section approximate reach is highlighted.



Figure 10-25 Downstream Ruzizi III Powerhouse Location

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Figure 10-26 Downstream Ruzizi III Powerhouse Location – Photo

A summary of the hydrological and hydraulic characteristics of this reach for normal flow conditions is provided as follows. Full details for the various different flow conditions (ranging from very dry to very wet) are provided in the accompanying annex.

Table 10-6 and Figure 10-27 show that the future maximum flow downstream of the tailrace is similar to the current maximum flow, but that the future minimum flow tends to be lower (by half) than the current minimum flow. As such, the change in flow range, i.e., the change in the amount of daily variation of flow, tends to be higher under the future post Ruzizi III scenario.

Table 10-6 Downstream Ruzizi III Powerhouse Location – Flow Summary

	Baseline	**Future**
Maximum Flow (m^3/s)	163	164
Minimum Flow (m^3/s)	26	13
Flow Range (m^3/s)	138	151

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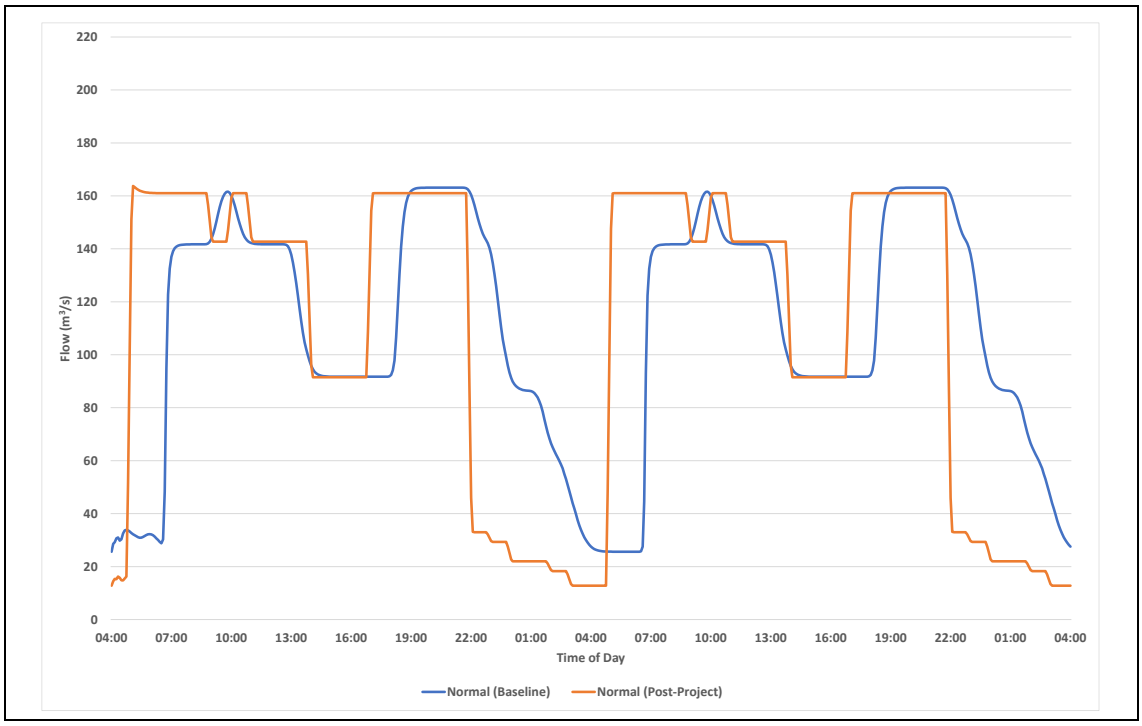


Figure 10-27 Downstream Ruzizi III Powerhouse Location – Flow Summary

Table 10-7 and Figure 10-28 show that the future maximum level (and hence depth) is similar to the current maximum level, but that the future minimum level tends to be lower than the current minimum level. As such, the level range, i.e., the amount of daily water level variation, tends to be higher under the future post Ruzizi III scenario.

The water level daily variation increases by 33 cm (from a daily variation of 1.33 m to 1.66 m) primarily due to the reduction in minimum water levels.

Table 10-7 Downstream Ruzizi III Powerhouse Location – Level Summary

	Baseline	**Future**
Maximum Elevation (mAOD)	979.64	979.64
Minimum Elevation (mAOD)	978.31	977.98
Elevation Range (m)	1.33	1.66

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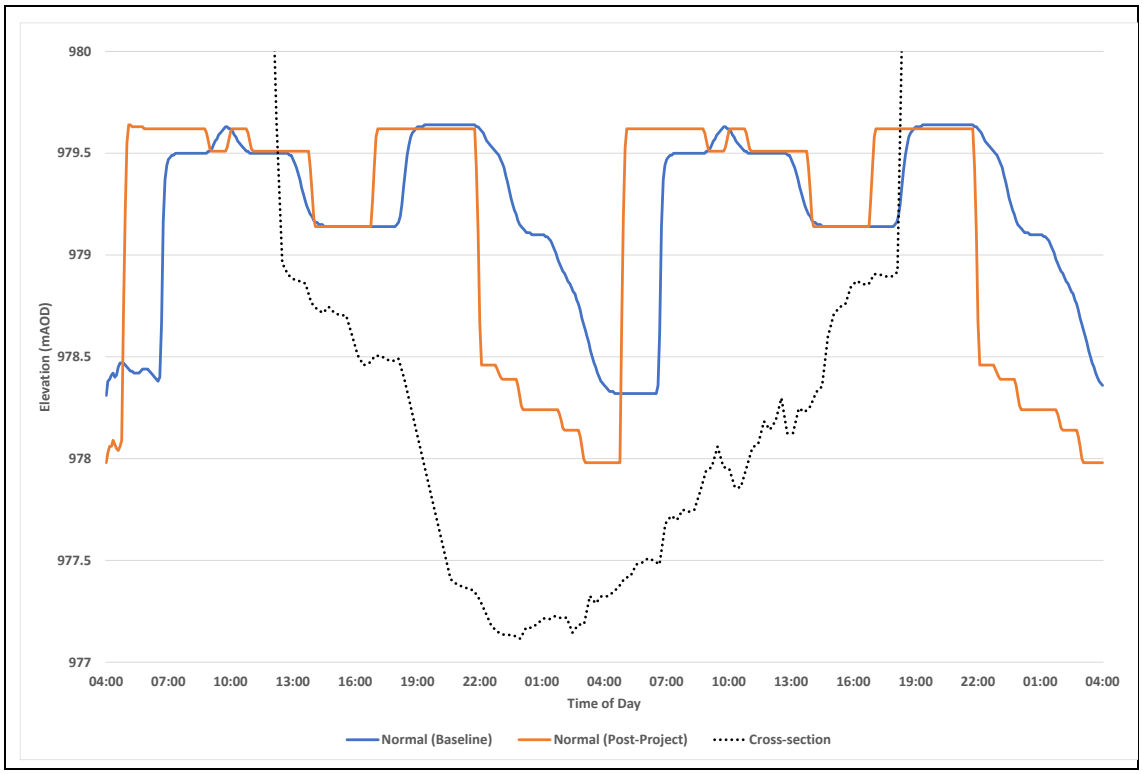


Figure 10-28 Downstream Ruzizi III Powerhouse Location – Level Summary

As with the flow and elevation variation, Table 10-8 and Figure 10-29 show that the future maximum velocity is similar to the current maximum velocity, but that the future minimum velocity tends to be lower than the current minimum velocity. As such, the velocity range tends to be higher under the future post Ruzizi III scenario.

The velocity daily variation increases by 0.19 m/s (from a daily variation of 1.12 m to 1.31 m) due to the reduction in minimum velocity.

Table 10-8 Downstream Ruzizi III Powerhouse Location – Velocity Summary

	Baseline	**Future**
Maximum Velocity (m/s)	2.50	2.50
Minimum Velocity (m/s)	1.38	1.19
Velocity Range (m/s)	1.12	1.31

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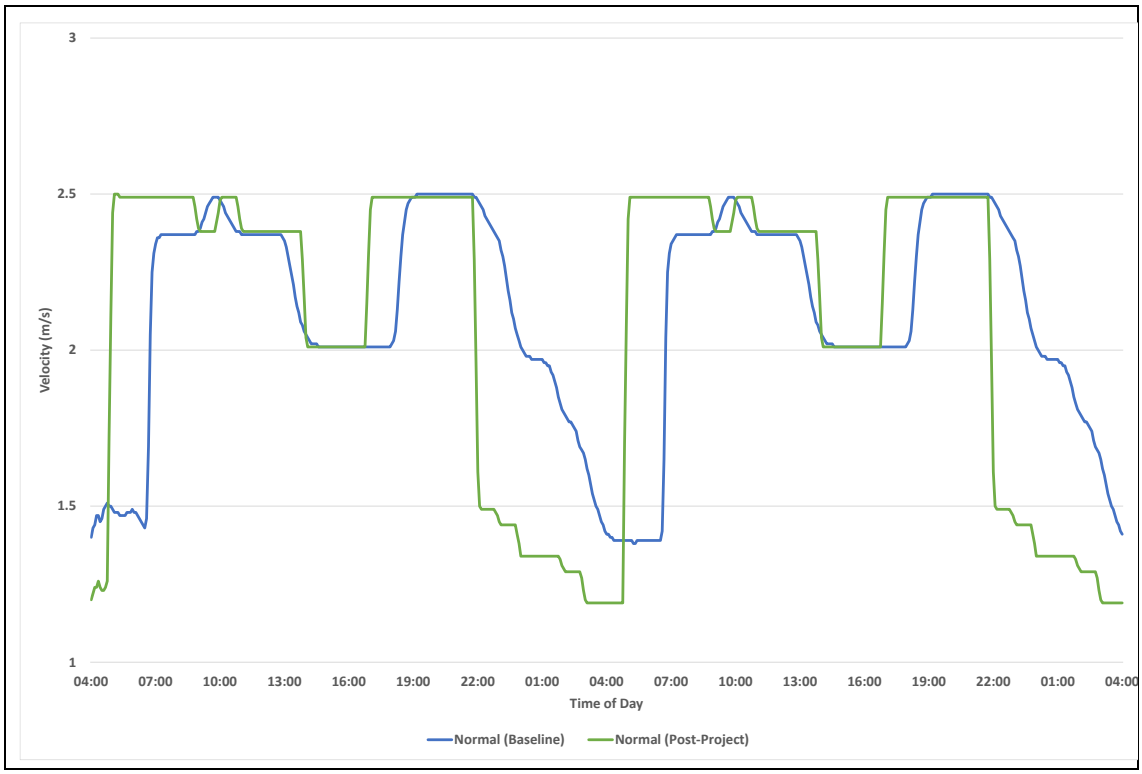


Figure 10-29 Downstream Ruzizi III Powerhouse Location – Velocity Summary

Table 10-9 and Figure 10-30 show the maximum, minimum, and daily range in cross-section area, providing an indication of the overall habitat area available. As with the other hydrological and hydraulic characteristics presented, the future maximum area is similar to the current maximum area, but the future minimum area tends to be lower than the current minimum area. As such, the area range tends to be larger under the future post Ruzizi III scenario.

The cross-section area daily variation increases by 7.8 m^2 (from a daily variation of 47 m^2 to 54.8 m^2) due to the reduction in minimum area.

Table 10-9 Downstream Ruzizi III Powerhouse Location – Cross-section Area Summary

	Baseline	**Future**
Maximum Area (m^2)	65.3	65.4
Minimum Area (m^2)	18.3	10.6
Area Range (m^2)	47.0	54.8

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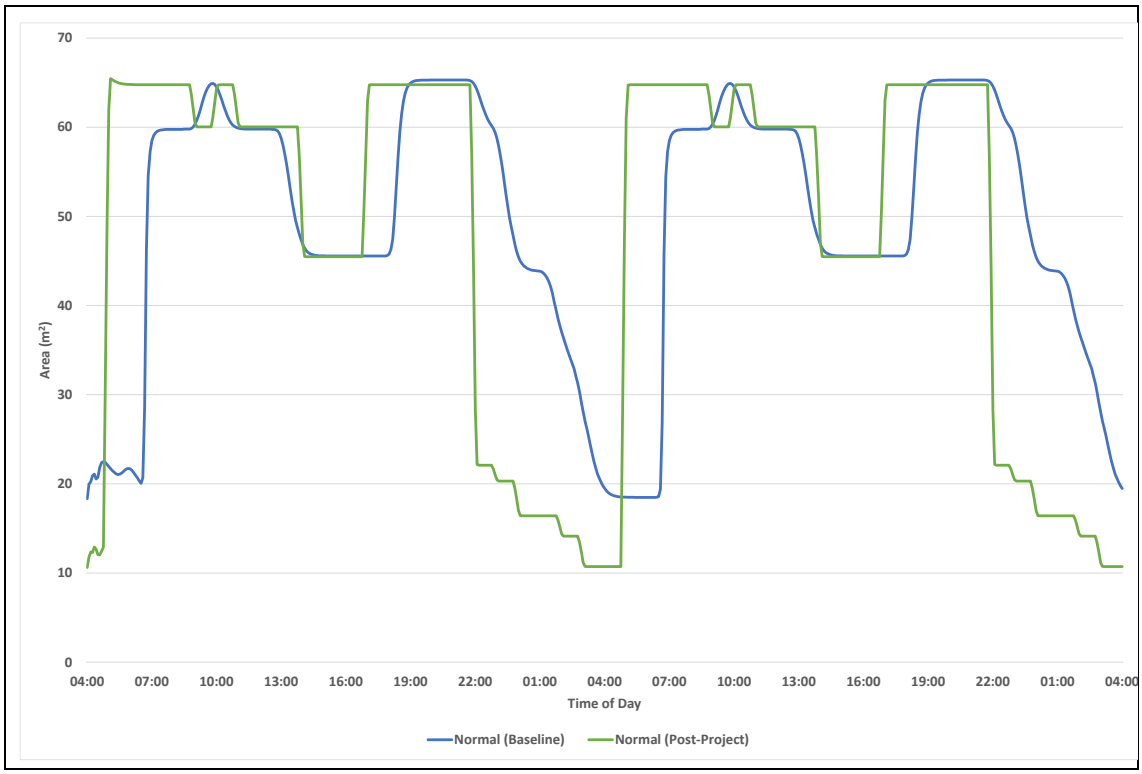


Figure 10-30 Downstream Ruzizi III Powerhouse Location – Cross-section Summary

Table 10-10 provides a summary of the average vertical ramp-up rates and ramp-down rates experienced.

It is notable that future ramp-up and ramp-down rates tend to be greater than current ramp-up and ramp-down rates. This is a reflection of the operating conditions for Ruzizi III where it is understood that operation changes between "off-peaking" and "peaking" will be quicker than they currently are at Ruzizi II.

Table 10-10 Downstream Ruzizi III Powerhouse Location – Ramp-up and Ramp-down Rates Summary

	Baseline	**Future**
Ramp-up (cm/min)	6.7	10.3
Ramp-down (cm/min)	-0.7	-6.5

B Geomorphological, Ecological and Social Context

B.1 Geomorphology

This moderately steep reach with a confined valley setting has a mixed boulder and cobble bed, supporting pool-rapid and pool-riffle reach types. The river morphology alternates between shorter pools interspersed by longer rapids and riffles. The bed elevation is controlled by bedrock/calcrete and larger immobile rocks.

Islands form where calcrete protrude from the channel floor or larger immobile sediment is deposited. Sediment deposition on these features supports vegetation establishment. The banks are composed of coarser alluvial material (boulders and cobble) filled with sandy and clayey material. The banks appear well-vegetated and relatively stable on satellite images despite the fluctuating water levels from Ruzizi II releases. Narrow floodplain sections are present along the inside bends of the lower section.

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Agriculture is common on the steep hillslopes and narrow floodplains, possibly contributing fine sediment to the main river channel. Most of the tributaries are small and drain the local slopes along the confined upper section. No recent landslide scars are visible along this reach, thus sediment inputs from mass wastings are less likely.

B.2 Aquatic Ecology

Macroinvertebrates:

Aquatic biotopes at the powerhouse outlet comprised Deep-Fast Rapids. These biotopes are likely to support mostly grazing and filter-feeding taxa that tolerate extreme current speeds. Taxa expected include freshwater limpets (*Burnupia* sp), Tricorythid mayflies and certain species of blackflies, such as *Simulium damnosum* and *S. harvreavesi*. Macroinvertebrate production in these areas is typically very high, so these areas often constitute potentially important nodes of biological production. However, macroinvertebrates sampled in this biotope near Bugarama (Site R12) on two occasions in February 2022 found that the diversity and abundance of macroinvertebrates was low, and this was attributed to short-term variation in water levels associated with the operation of Ruzizi II. The information suggested that the abundance and diversity of macroinvertebrates in this reach could be improved by reducing short-term fluctuations in water level. Notable taxa recorded in this biotope included the stonefly *Neoperla spio,* the leach *Salifa perspicax,* and the caddisfly *Hydropsyche* sp., all of which are predators. *Neoperla spio* is sensitive to water quality deterioration and is therefore a potentially useful indicator for monitoring ecological change.

Fish:

Fish habitat downstream of the powerhouse is comprised predominantly of the Fast Deep habitat class, with minimal Slow Deep habitat. The most important fish habitats will be the shallower riffle-rapid habitats with larger bed elements to provide habitat mainly for the lotic lithophilic guild (*Labeobarbus* sp.) but potentially also for the lotic riffle-rapid fish guilds (e.g. *Chiloglanis* and *Amphilius*). Surveys between 2018 and 2022 recorded the larger migratory species in this reach including *Labeo cylindricus, Labeobarbus altianalis* and *Labeobarbus somereni*.

The absence of deeper, slower flowing reaches means that the channel margins and slack waters are more important for the lentic and semi-lotic pools species including the haplochromine cichlids and *Enteromius* barbs.

B.3 Terrestrial Ecology

Riparian Vegetation:

There is almost no Natural Habitat along on the riverbanks between the powerhouse and Bugarama, with almost all alluvial soils cultivated to the riverbanks. The few islands located along this reach have some Natural Habitat in the form of Riparian Wetlands dominated by *Phragmites*. Species dependent on a wet bank are relatively prevalent in the Riparian Wetland community, although this is quite a mobile vegetation type and recolonises new areas fairly quickly if river levels change.

Riparian Fauna:

The riparian avifauna, mammal and herpetofauna assemblages are extremely species-poor in this reach, particularly the avifauna assemblage since there is limited overhanging riparian vegetation. The riparian avifauna assemblage contains surprisingly few fish-eating species although a limited number are present such as reed and white-breasted cormorants, and striated heron. Riparian mammals such as marsh mongoose and otter species may be present in very low numbers. Hippopotamus occurs infrequently upstream of the Bugarama – Kamanyola bridge and is not resident along this reach. Herpetofauna will be mostly represented

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by widespread generalist amphibians as well as a few riparian reptile species such as water snakes (*Lycodonomorphus* species) and terrapins (*Pelusios* species).

B.4 Social

The following paragraphs provide an overview of local communities' reliance on Ruzizi's water for livelihoods and domestic needs in the downstream powerhouse release stretch. Issues related to water quality and sediment load will not be covered in this analysis, as no discernible difference from current conditions is expected, due to the low residence time of water in the Ruzizi III reservoir.

This area is characterised by a strong social reliance on the river. In Rwanda, crops are irrigated directly from the river, using buckets or water pumps. Areas of manioc fermentation and drying have also been observed, using water directly abstracted from the river. The riverside of the villages of Kabusunzu and Gatebe is characterised by a confluence of domestic activities around the river, including washing clothes and objects, bathing and playing in the river. These activities tend to take place in areas where access is easy and the velocity of waster is low, as in the large opening at the entrance of Kabusunzu where river crossing is also frequently practiced by children, women, and men alike. One fish farming industry is also found in Gatebe, abstracting small amounts of water directly from the Ruzizi. Fishing is practiced regularly by the majority of households, but it does not represent a significant source of income or means of livelihood for the local community.

In DRC, water from the Ruzizi is fetched daily by the villagers of Kafunda and Bugano not only for all consumptive and drinking uses, but also for healing and spiritual practices, which require villagers to physically enter the river for bathing, washing, and drinking. On the riverside of these two villages, cultivation with bucket irrigation and recreational activities have often been observed.

There are two baptism and prayer sites which require villagers to regularly enter the river in this stretch, one in Bugano and one in Gatebe. Small-scale unpredictable flooding has been reported around Gatebe's baptism site, which has been previously submerged by sudden increases in water levels.

C Indicators Linked to Hydrological and Hydraulic Characteristics

Table 10-11 provides and overall summary of the ecological and social functional relationship with hydrological and hydraulic characteristics downstream of the Ruzizi III powerhouse location.

The change in hydrological and hydraulic characteristics are predicted to result in significant increase in social community safety impacts (due to increased ramp-up rates).

Table 10-11 Summary of Ecological and Social Functional Relationship / Impacts at Downstream Ruzizi III powerhouse location

Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Geomorphology		
Increased channel erosion The channel is largely composed of large immobile clasts, calcrete or bedrock. This makes the channel bed resistant to incision. Hydro peaking and reductions in longitudinal sediment connectivity has resulted in possible bed erosion and bed armouring over the past decades.	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	Minor
	Ramping Rates	No / Insignificant

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Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Increased sedimentation in channel Due to the reduced sediment supply downstream of the dam, and the increase in the frequency of high energy flows, it is unlikely that sedimentation will take place. Localised sedimentation might take place in slack waters.	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	Minor
	Ramping Rates	No / Insignificant
Bank erosion The banks are largely composed of boulders and cobbles with a finer gravel, sand and silt matrix. The banks are not steep or high and relatively stable and immobile. The banks have been exposed to hydropeaking for decades, thus bank erosion might have stabilised over time.	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	No / Insignificant
	Ramping Rates	Minor
Aquatic Ecology		
Non-migratory fish: abundance and diversity Fish habitat downstream of the powerhouse is comprised predominantly of the Fast Deep habitat class, with minimal Slow Deep habitat. It includes fish adapted to fast deep water with rapids in the Lotic riffle-rapid fish guild including species, such as *Amphilius* and *Chiloglanis.*	Flow	
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Minor
	Ramping Rates	Minor
Migratory fish: abundance and diversity Fish habitat downstream of the powerhouse is comprised predominantly of the Fast Deep habitat class, with minimal Slow Deep habitat. It includes fish adapted to fast deep water with rapids in the Lotic lithophilic fish guild, including migratory fish (e.g. *Labeo, Labeobarbus, Bagrus*). Fish migration to the powerhouse reach will still be possible despite high flow velocity during peaking periods. However, the lower water depth and reduced wetted area during inter-peaking periods may be a limiting factor for fish migration if connectivity between pools is reduced and/or due to increased human fishing pressures in shallow reaches.	Flow	
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Minor
	Ramping Rates	Minor
Macro-invertebrates: abundance and diversity Diversity and abundance of macroinvertebrates in the Ruzizi River, including this reach, was low, and this was attributed to short-term variation in water levels associated with the operation of Ruzizi II. These are expected to remain unchanged compared to the current baseline because of the large variation in daily and sub-daily water levels.	Flow	Minor
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	N/A
Terrestrial Ecology		
Riparian vegetation: abundance and diversity There is almost no Natural Habitat along on the riverbanks between the powerhouse and Bugarama, with most Riparian Wetlands present on a few islands in the river. These wetlands have species that are dependent on a wet bank and are thus likely to be impacted by changes in depth and area of the river because of changes to the availability of a wet bank.	Flow	Minor
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	Minor
	Ramping Rates	No / Insignificant
Riparian fauna: abundance and diversity. The species-poor riparian fauna assemblage is associated with the fragments of Riparian Wetland on islands, as well as open water habitat in the river. The species composition of the faunal assemblage is currently dominated by widespread habitat generalists and overall species richness is low. Changes in flow, depth and velocity are likely to impact riparian fauna species. Hippopotamus occurs infrequently upstream of the Bugarama – Kamanyola Bridge and is not resident along this reach.	Flow	Minor
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Minor
	Ramping Rates	Minor

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Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Social		
Consumptive Water Use: Local communities are currently using water from this stretch regularly, as the only available source of domestic water supply. Social reliance on this stretch of the river for consumptive water use is high.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	No / Insignificant
Non-Consumptive Water Use: Fishing Local communities are currently fishing regularly in this stretch. One Tilapia fish farming industry currently exists, with ponds covering a small area of 0.1 hectares.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	Moderate
Community Safety: Local communities frequently cross the river in this stretch. Additionally, villagers are physically entering the river on a regular basis for recreational purposes, baptisms and medicinal / spiritual practices. Social exposure to hazards due to the river's flow and velocity are high.	Flow	Minor
	Elevation / Depth	Minor
	Velocity	Significant
	Area	N/A
	Ramping Rates	Significant

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10.4.3.2 Upstream Bugarama Bridge / Kamanyola Monitoring Station

A Hydrological and Hydraulic Characteristics

This section is located immediately approximately 4 km downstream of the start of the proposed Ruzizi III powerhouse. Figure 10-25 and Figure 10-26 provide a general overview of the river reach characteristics in this location. The model cross-section approximate reach is highlighted.



Figure 10-31 Upstream Bugarama Bridge / Kamanyola Monitoring Station

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Figure 10-32 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Photo

A summary of the hydrological and hydraulic characteristics for this reach for normal flow conditions is provided as follows. Full details for the various different flow conditions (ranging from very dry to very wet) are provided in the accompanying annex.

Table 10-12 and Figure 10-33 show that the future maximum flow is similar to the current maximum flow, but that the future minimum flow tends to be lower than the current minimum flow. As such, the change in flow range, i.e., the change in the amount of daily variation of flow, tends to be larger under the future post Ruzizi III scenario by approximately 11m^3/s.

Table 10-12 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Flow Summary

	Baseline	**Future**
Maximum Flow (m^3/s)	163	162
Minimum Flow (m^3/s)	26	13
Flow Range (m^3/s)	138	149

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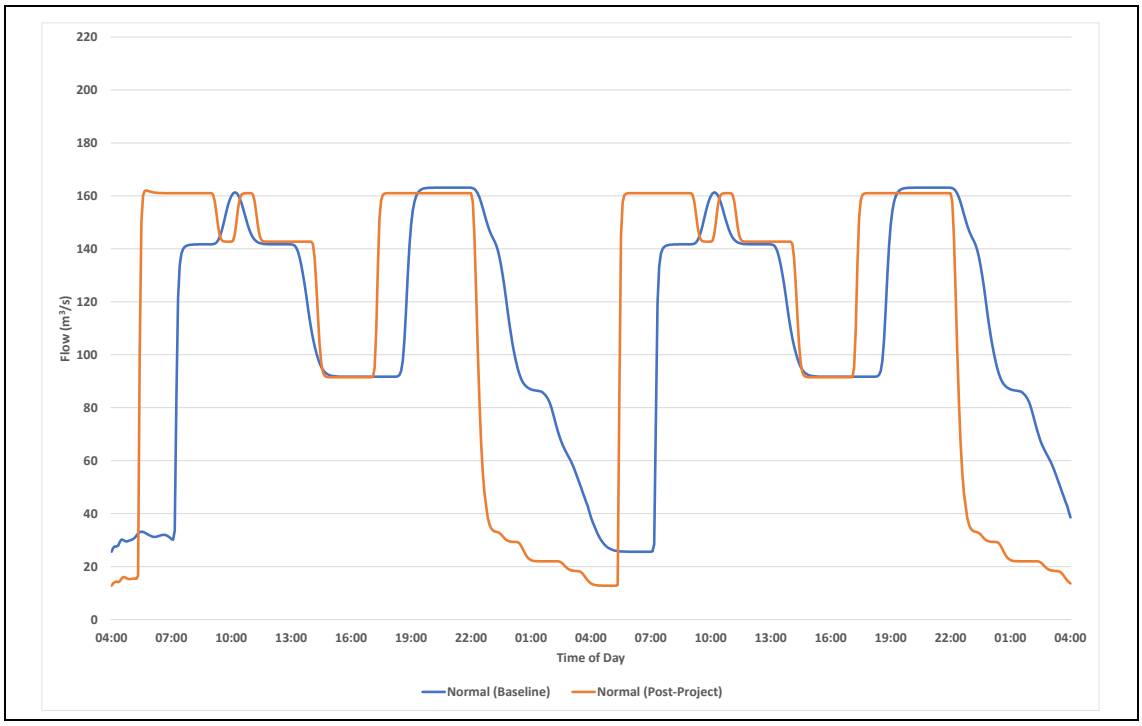


Figure 10-33 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Flow Summary

Table 10-13 and Figure 10-34 show that the future maximum level (and hence depth) is similar to the current maximum level, but that the future minimum level tends to be lower than the current minimum level. As such, the level range, i.e., the amount of daily water level variation, tends to be higher under the future post Ruzizi III scenario.

The water level daily variation is predicted to increase by 32 cm (from a daily variation of 1.49 m to 1.81 m) primarily due to the reduction in minimum water levels by a predicted average of 33 cm when the project is not hydropeaking.

Table 10-13 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Level Summary

	Baseline	**Future**
Maximum Elevation (mAOD)	947.58	947.57
Minimum Elevation (mAOD)	946.09	945.76
Elevation Range (m)	1.49	1.81

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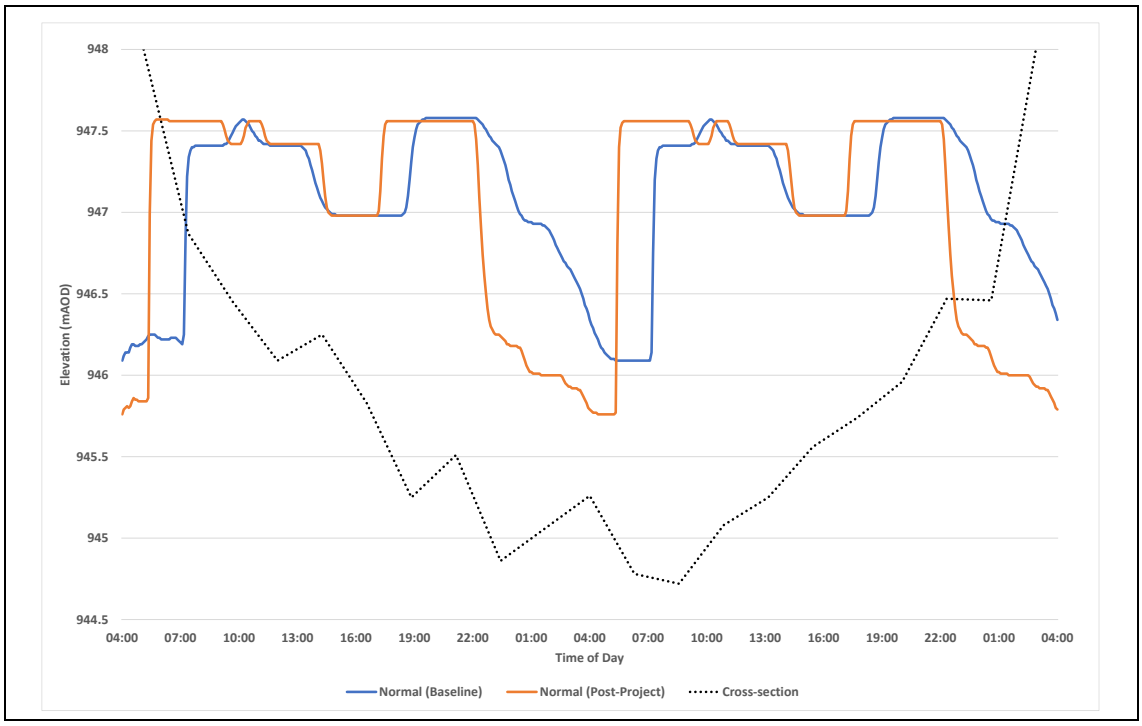


Figure 10-34 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Level Summary

As with the flow and elevation variation, Table 10-14 and Figure 10-34 show that the future maximum velocity is similar to the current maximum velocity under all flow conditions, but that the future minimum velocity tends to be lower than the current minimum velocity. As such, the velocity range tends to be larger under the future post Ruzizi III scenario.

The velocity daily variation increases by 0.20 m/s under normal conditions (from a daily variation of 0.82 m to 1.02 m) due to the reduction in minimum velocity by 0.2 m/s.

Table 10-14 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Velocity Summary

	Baseline	**Future**
Maximum Velocity (m/s)	1.87	1.87
Minimum Velocity (m/s)	1.05	0.85
Velocity Range (m/s)	0.82	1.02

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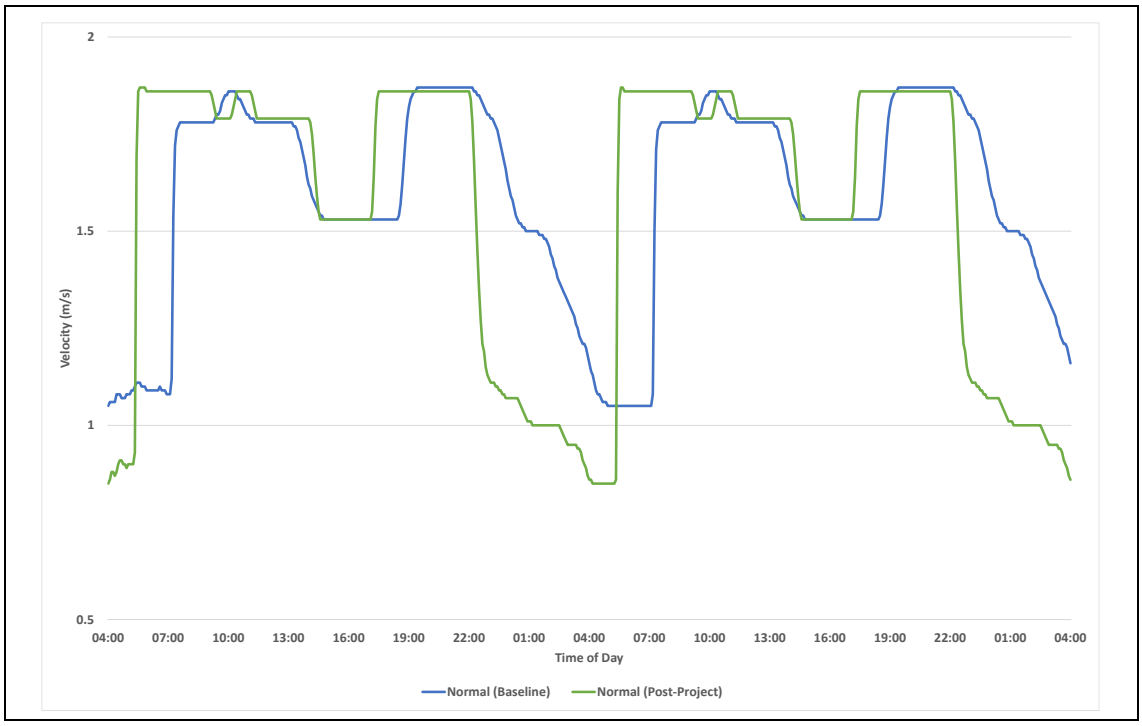


Figure 10-35 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Velocity Summary

Table 10-15 and Figure 10-36 show the maximum, minimum, and daily range in cross-section area, providing an indication of the overall habitat area available. As with the other hydrological and hydraulic characteristics presented, the future maximum area is similar to the current maximum area, but the future minimum area tends to be lower than the current minimum area. As such, the area range tends to be larger under the future post Ruzizi III scenario.

The cross-section area daily variation increases by 11.1 m^2 (from a daily variation of 62.8 m^2 to 71.7 m^2) due to the reduction in minimum wetted area from 24.4 to 15.1 m^2 under Ruzizi III HPP operation

Table 10-15 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Cross-section Area Summary

	Baseline	**Future**
Maximum Area (m^2)	87.3	86.8
Minimum Area (m^2)	24.4	15.1
Area Range (m^2)	62.8	71.7

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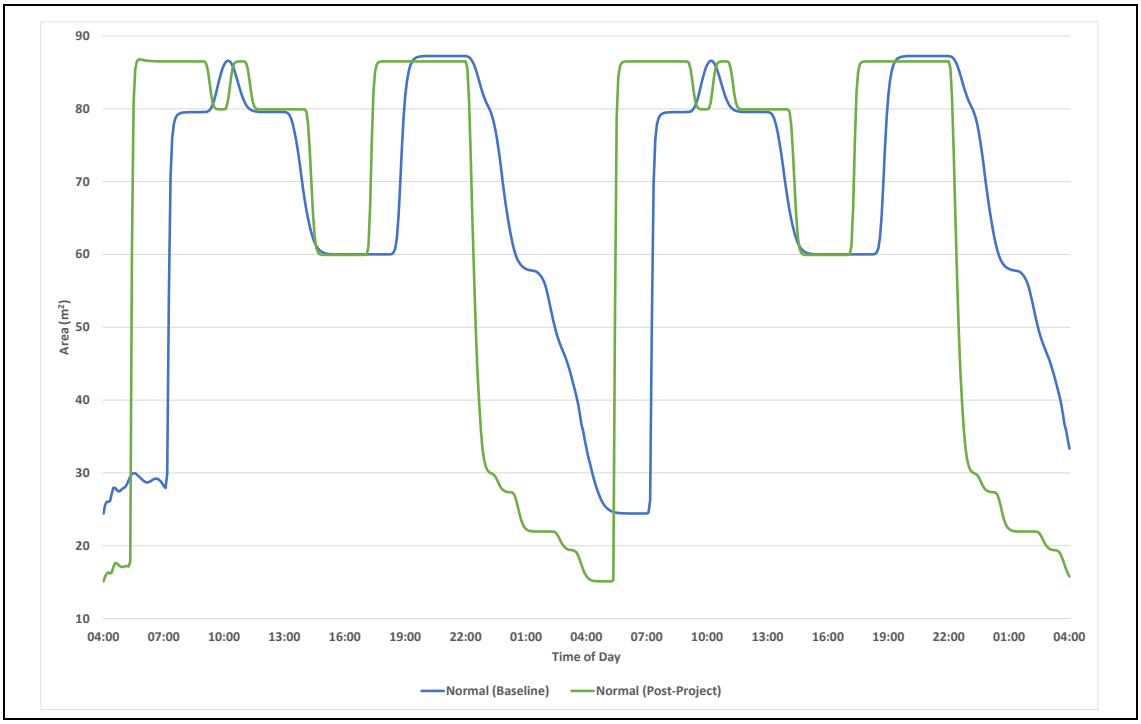


Figure 10-36 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Cross-section Summary

Table 10-16 provides a summary of the average vertical ramp-up rates and ramp-down rates experienced.

It is notable that future ramp-up and ramp-down rates tend to be greater than current ramp-up and ramp-down rates. This is a reflection of the operating conditions for Ruzizi III where it is understood that operation changes between "off-peaking" and "peaking" will be quicker than they currently are at Ruzizi II.

Table 10-16 Upstream Bugarama Bridge / Kamanyola Monitoring Station – Ramp-up & Ramp-down Rates Summary

	Baseline	**Future**
Ramp-up (cm/min)	7.9	11.7
Ramp-down (cm/min)	-0.8	-3.7

B Geomorphological, Ecological and Social Context

B.1 Geomorphology

This reach has a partly confined valley setting (the channel is incised into the plain) and a moderately steep channel gradient. It has a mixed boulder and cobble bed, with localised sections of resistant calcrete, supporting pool-rapid and pool-riffle reach types. The river morphology alternates between shorter pools, rapids and riffles. The bed elevation is controlled by bedrock/calcrete and larger immobile rocks.

Islands form where calcrete protrude from the channel floor or larger immobile sediment is deposited. Sediment deposition on these features supports vegetation establishment and agriculture. The river course is relatively straight across the plain to the confluence with the Rubyiro river with a narrow floodplain (approximately 100 m wide). The river and narrow floodplain are incised into the surrounding plain (5 to 10 m based on the SRTM dataset). The banks are composed of coarser alluvial material (boulders and cobble) supported or filled by sandy and clayey material. The banks appear well-vegetated and relatively stable on satellite and ground-based images despite the fluctuating water levels from the Ruzizi II releases, but

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localised bank erosion has been observed along agricultural fields. It is not clear if the localised bank erosion is due to vegetation clearing (associated with floodplain agriculture) or fluctuating water levels, but possibly driven by both processes.

Agriculture is common on the floodplains, surrounding plains and islands, contributing fine sediment to the channel. There is no significant sediment input from tributaries along this reach.

B.2 Aquatic Ecology

Macroinvertebrates:

Aquatic biotopes within this reach comprised the following:

- Mostly Deep-Fast Rapids. These biotopes are likely to support mostly grazing and filter-feeding taxa that tolerate extreme current speeds (as described in the downstream powerhouse location section).
- One area of Deep-Slow Pool. No information was available on macroinvertebrates in such pools, but diversity and abundance in these areas is likely to be low because of light limitation and the limited diversity of hydraulic conditions.
- One area of Shallow-Fast Riffle, approximately 4.3 km downstream of the proposed tailrace outlet. This area is likely to support a high diversity of macroinvertebrates (as described in the dewatered reach section).

Fish:

Fish habitats upstream and in the vicinity of Bugurama Bridge include Fast Deep and Fast Shallow habitat classes, with some Slow Shallow areas in the immediate vicinity of the sampling site (R12). Species of *Enteromius* barbs and migratory *Labeo* and *Labeobarbus* species were recorded here as well as several Haplochromine cichlids. *Labeo* cf. *cylindricus* and *Bagrus docmak* was reported in fisher catches downstream of the bridge.

As with the other reaches, the Deep and Shallow Fast habitats with large bed elements are important as living space for the lotic riffle-rapid guild (*Chiloglanis* and *Amphilius*) and for spawning and feeding by the lotic lithophilic guild (*Labeobarbus* species). The Slow Shallow and Fast Shallow habitats are especially susceptible to hydropeaking if these areas are regularly inundated and desiccated on a daily basis.

B.3 Terrestrial Ecology

Riparian Vegetation:

Even though this reach of the Ruzizi River is in a densely settled area, there is slightly more Riparian Wetland habitat than along the upstream reach (near the powerhouse), mostly on scattered islands but also occasionally in narrow strips along riverbanks. Riparian Thicket is poorly represented, although several groves of Raffia palms (*Raphia farinifera*) were observed on the right bank (DRC) during fieldwork. Riparian Wetlands are dominated by *Phragmites*, as well as other wetland species that are dependent on a wet bank such as *Leersia hexandra*, *Cyperus* species and *Pluchea ovalis*. Scattered trees in Riparian Wetlands along this reach include *Senegalia polyacantha, Phoenix reclinata* and *Ficus sycomorus*.

Riparian Fauna:

The riparian avifauna, mammal and herpetofauna assemblages have higher species richness in this reach compared to upstream reaches. Even though the avifauna assemblage has an unusually low proportion of few fish-eating species, more of these species were observed here than along upstream reaches, including species such as white-breasted and reed cormorants, striated heron and great egret. Insect-eating bird species that forage from riverside vegetation are also more prevalent along this reach, such as little bee-eater, greater swamp warbler and red-faced cisticola.

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Riparian mammals such as marsh mongoose and otter species are likely to be present but in higher numbers than in the previous reach. A small population of hippopotamus is resident along this reach. Herpetofauna will be mostly represented by widespread generalist amphibians, reed-dwelling frogs such as *Hyperolius* and *Aixalus* species, as well as a few riparian reptile species such as water snakes (*Lycodonomorphus* species) and terrapins (*Pelusios* species).

B.4 Social

The following paragraphs provide an overview of local communities' reliance on Ruzizi's water for their livelihoods and domestic needs in the Upstream Bugarama Bridge / Kamanyola Monitoring Station. Issues related to water quality and sediment load will not be covered in this analysis, as no discernible difference from current conditions is expected, due to the low residence time of water in the Ruzizi III reservoir.

This stretch is characterised by a high social reliance on the river and by significant hazards to the safety of the population. The villages of Mubombo and Mwaro abstract water from the Ruzizi on a daily basis for domestic purposes and to irrigate their fields using either buckets or water pumps. Various openings on the river are used for recreational activities, bathing and clothes washing. Fishing is practiced regularly by the majority of households, but it does not represent a significant source of income or means of livelihood for the local community.

Crossing the river is common in this stretch. Starting from the Bugarama Bridge area, some people cross the river daily by swimming across carrying large sacks or containers. Most of these people cross the river around 10 times a day every day to transport produce such as rice, maize and sugar from Rwanda into DRC, and cooking oil from DRC into Rwanda. Others cross twice a day every day for wage employment on fields, and a smaller minority visits family regularly on the other side of the river. Villagers have reported frequent incidents due to unpredictable sudden changes in water levels and velocity.

Regular flooding is also experienced in this area. In 2021, there were three flood events, one in May-April and two in June, on the 4th and on the 18th, which destroyed around 25 hectares of land according to local agronomists. The impact of these flood events on the loss of income and livelihoods is significant.

C Indicators Linked to Hydrological and Hydraulic Characteristics

Table 10-17 provides and overall summary of the ecological and social functional relationship with hydrological and hydraulic characteristics upstream Bugarama Bridge / Kamonyola Monitoring Station.

The change in hydrological and hydraulic characteristics are predicted to result in significant increase in social community safety impacts (due to increased ramp-up rates).

Table 10-17 Summary of Ecological and Social Functional Relationship / Impacts at Upstream Bugarama Bridge / Kamanyola Monitoring Station

Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Geomorphology		
Increased channel erosion The channel is largely composed of large immobile clasts, calcrete or bedrock. This makes the channel bed resistant to incision. Hydro peaking and reductions in longitudinal sediment connectivity has resulted in possible bed erosion and bed armouring.	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	Minor
	Ramping Rates	No / Insignificant
Increased sedimentation in channel Due to the reduced sediment supply downstream of the dam, and the increase in the frequency of high energy flows, it is unlikely that sedimentation will take place. Localised sedimentation might take place in slack waters.	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	Minor
	Ramping Rates	No / Insignificant

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Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Bank erosion The banks are largely composed of boulders and cobbles with a finer gravel, sand and silt matrix. The banks are not steep or high and relatively stable and immobile. The banks have been exposed to hydropeaking for decades, thus bank erosion might have stabilised over time.	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	No / Insignificant
	Ramping Rates	Minor
Aquatic Ecology		
Non-migratory fish: abundance and diversity Fish habitats upstream and in the vicinity of Bugurama Bridge include Fast Deep and Fast Shallow habitat classes, with some Slow Shallow areas. These provide habitat for fish in the Lotic riffle rapid fish guild such as *Enteromius* barbs and *Chiloglanis* and *Amphilius.*	Flow	
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Minor
	Ramping Rates	Minor
Migratory fish: abundance and diversity Fish habitats upstream and in the vicinity of Bugurama Bridge include Fast Deep and Fast Shallow habitat classes, with some Slow Shallow areas. These provide spawning and feeding habitat for fish in the Lotic lithophilic fish guild such as *Labeo* and *Labeobarbus* species.	Flow	
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Minor
	Ramping Rates	Minor
Macro-invertebrates: abundance and diversity These are expected to remain unchanged compared to the current operation because of the large variation in daily and sub-daily water levels.	Flow	Minor
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	N/A
Terrestrial Ecology		
Riparian vegetation: abundance and diversity Even though this reach of the Ruzizi River is in a densely settled area, there is slightly more Riparian Wetland habitat than along the previous reach, mostly on scattered islands but also occasionally in narrow strips along riverbanks. Riparian Thicket is poorly represented. Riparian Wetlands have species that are dependent on a wet bank and are thus likely to be impacted by changes in depth and area of the river result in changes to the availability of a wet bank.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	No / Insignificant
Riparian fauna: abundance and diversity The riparian avifauna, mammal and herpetofauna assemblages have higher species richness in this reach compared to upstream reaches. The species composition of the faunal assemblage is currently dominated by widespread habitat generalists and overall species richness is low. Changes in flow, depth and velocity will have a negligible impact on riparian fauna species. The small population of Hippopotamus that is resident along this reach is unlikely to be impacted by minor changes in flow, depth, velocity, area, and ramping rates.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	No / Insignificant
Social		
Consumptive Water Use Local communities in this stretch are currently using the river for domestic and drinking water supply. Social reliance on the river for consumptive water use is high.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	No / Insignificant

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Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Non-Consumptive Water Use: Fishing Local communities are currently fishing regularly in this stretch.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	Moderate
Community Safety Local communities cross the river regularly in this stretch. Additionally, villagers are physically entering the river on a regular basis for recreational purposes, and medicinal / spiritual practices. Social exposure to hazards due to the river's flow and velocity are high.	Flow	Minor
	Elevation / Depth	Minor
	Velocity	Significant
	Area	N/A
	Ramping Rates	Significant

10.4.3.3 Upstream Rubyiro tributary to Downstream Burundi Border/Ruhwa Tributary

A Hydrological and Hydraulic Characteristics

A.1 Upstream Rubyiro Tributary

This section is located immediately downstream of the proposed Ruzizi III powerhouse. Figure 10-25 and Figure 10-26 provide a general overview of the river reach characteristics in this location. The model cross-section approximate reach is highlighted.



Figure 10-37 Upstream Rubyiro Tributary

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Figure 10-38 Upstream Rubyiro Tributary – Photo

A summary of the hydrological and hydraulic characteristics for this reach for normal flow conditions is provided as follows. Full details for the various different flow conditions (ranging from very dry to very wet) are provided in the accompanying annex.

Table 10-18 and Figure 10-39 show that the future maximum flow is similar to the current maximum flow, but the future minimum flow tends to be lower than the current minimum flow. As such, the change in flow range, i.e., the change in the amount of daily variation of flow, tends to be higher under the future post Ruzizi III scenario.

Table 10-18 Upstream Rubyiro Tributary – Flow Summary

	Baseline	**Future**
Maximum Flow (m^3/s)	163	161
Minimum Flow (m^3/s)	26	13
Flow Range (m^3/s)	138	148

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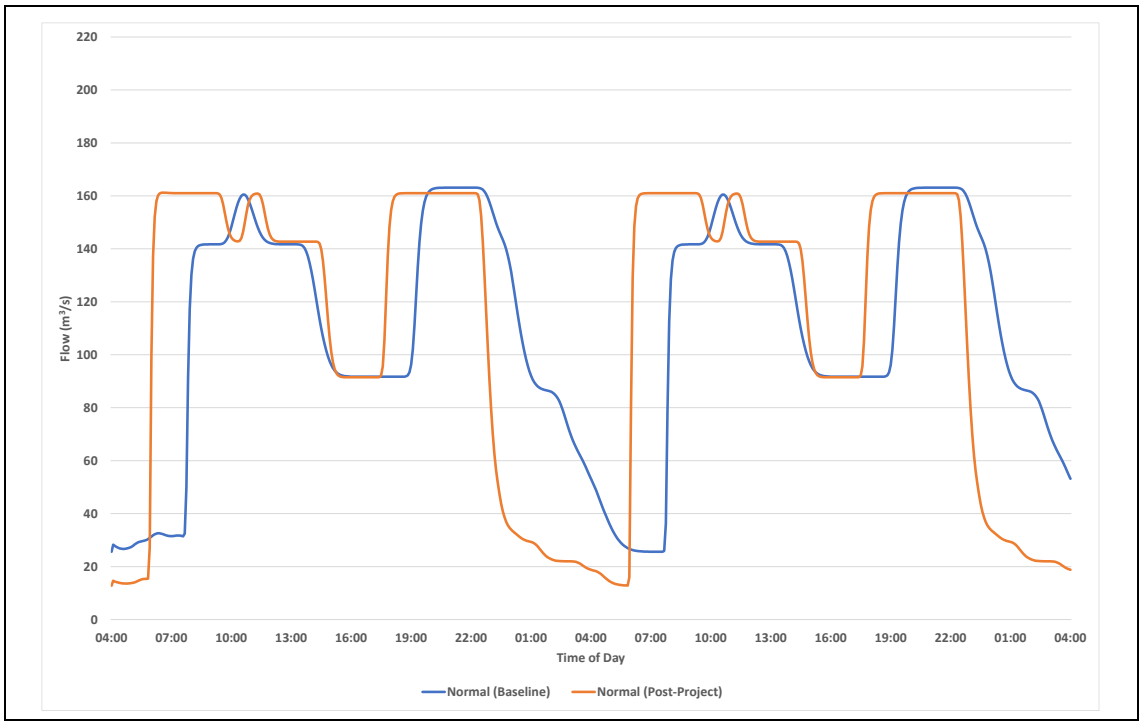


Figure 10-39 Upstream Rubyiro Tributary – Flow Summary

Table 10-19 and Figure 10-40 show that the future maximum level (and hence depth) is similar to the current maximum level, but the future minimum level tends to be lower than the current minimum level by 37 mm. As such, the level range, i.e., the amount of daily water level variation, tends to be higher under the future post Ruzizi III scenario.

The water level daily variation increases by 36 cm under normal conditions (from a daily variation of 1.63 m to 1.99 m) primarily due to the reduction in minimum water levels.

Table 10-19 Upstream Rubyiro Tributary – Level Summary

	Baseline	**Future**
Maximum Elevation (mAOD)	929.84	929.83
Minimum Elevation (mAOD)	928.21	927.84
Elevation Range (m)	1.63	1.99

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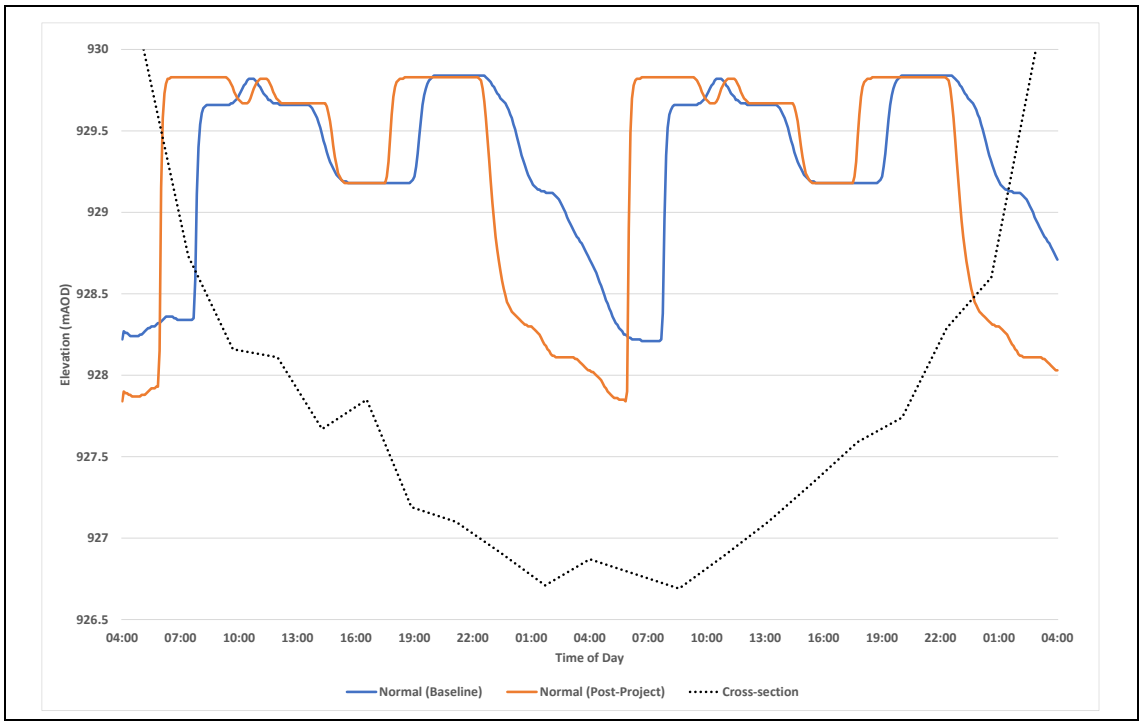


Figure 10-40 Upstream Rubyiro Tributary – Level Summary

As with the flow and elevation variation, Table 10-20 and Figure 10-35 show that the future maximum velocity is similar to the current maximum velocity, but the future minimum velocity tends to be lower than the current minimum velocity. As such, the velocity range tends to be higher under the future post Ruzizi III scenario.

The velocity daily variation increases by 0.16 m/s under normal conditions (from a daily variation of 0.86 m to 1.02 m) due to the reduction in minimum velocity.

Table 10-20 Upstream Rubyiro Tributary – Velocity Summary

	Baseline	**Future**
Maximum Velocity (m/s)	1.65	1.64
Minimum Velocity (m/s)	0.79	0.62
Velocity Range (m/s)	0.86	1.02

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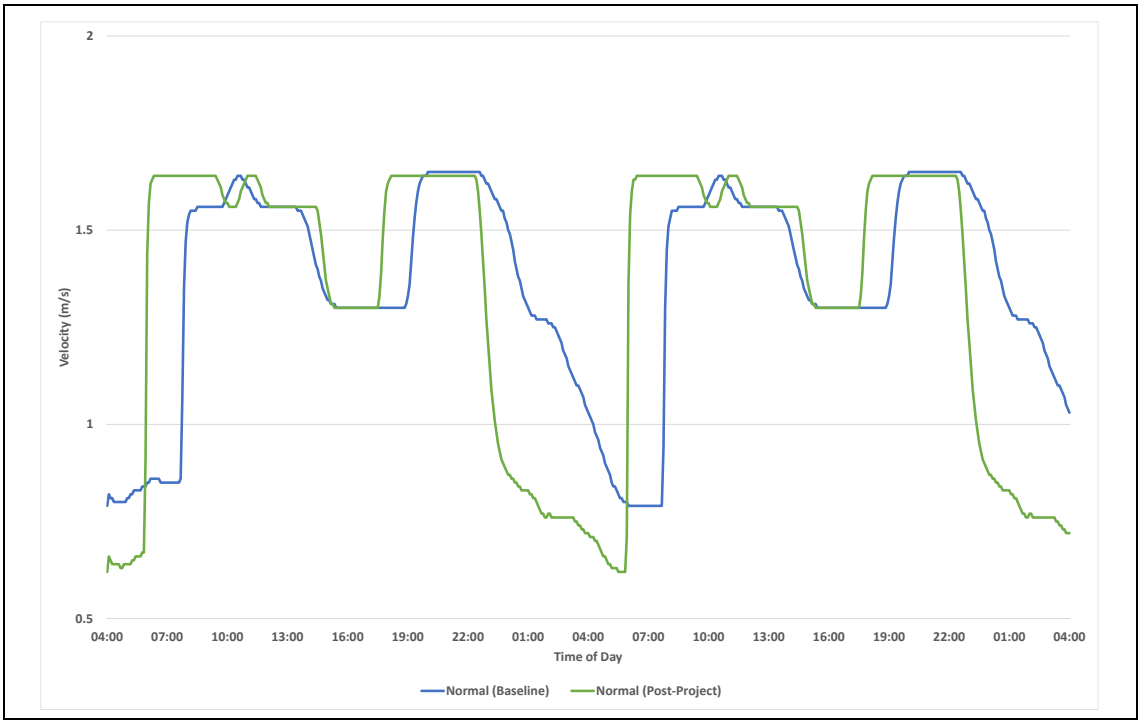


Figure 10-41 Upstream Rubyiro Tributary – Velocity Summary

Table 10-21 and Figure 10-42 show the maximum, minimum, and daily range in cross-section area, providing an indication of the overall habitat area available. As with the other hydrological and hydraulic characteristics presented, the future maximum area is similar to the current maximum, but the future minimum area tends to be lower than the current minimum area. As such, the area range tends to be higher under the future post Ruzizi III scenario in normal to very wet conditions.

The cross-section area daily variation increases by 11.2 m^2 in the normal conditions (from a daily variation of 66.4 m^2 to 77.6 m^2) due to the reduction in minimum area.

Table 10-21 Upstream Rubyiro Tributary – Cross-section Area Summary

	Baseline	**Future**
Maximum Area (m^2)	98.9	98.3
Minimum Area (m^2)	32.5	20.6
Area Range (m^2)	66.4	77.6

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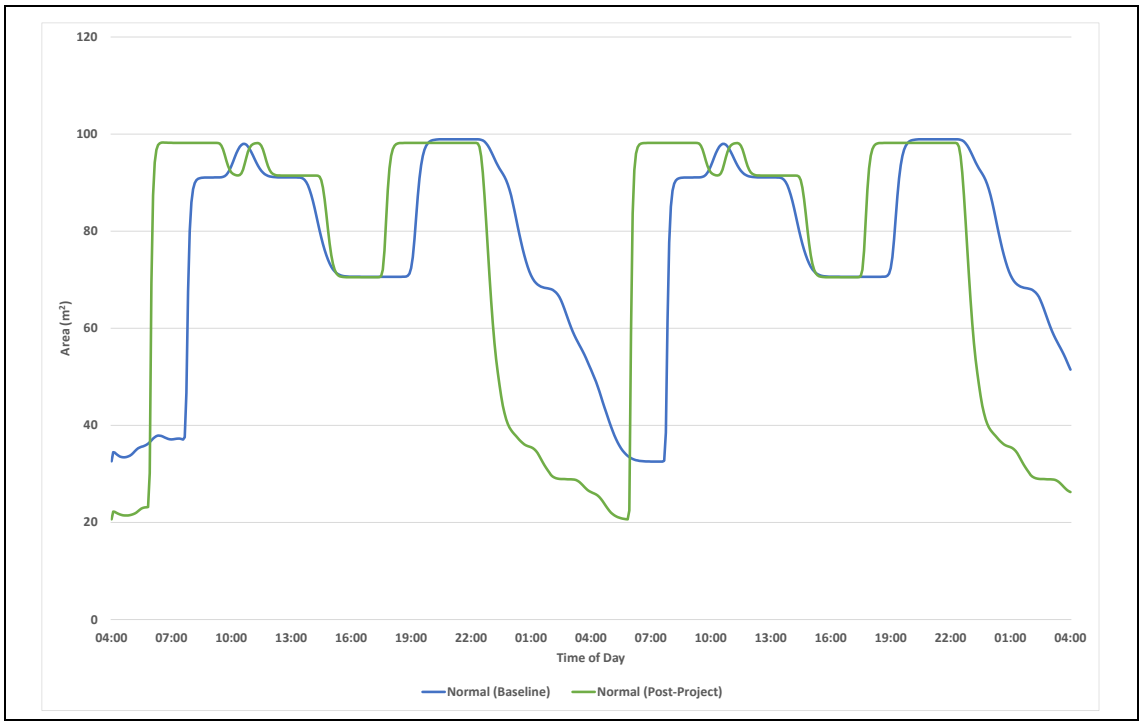


Figure 10-42 Upstream Rubyiro Tributary – Cross-section Summary

Table 10-22 provides a summary of the average vertical ramp-up rates and ramp-down rates experienced.

It is notable that future ramp-up and ramp-down rates tend to be greater than current ramp-up and ramp-down rates. This is a reflection of the operating conditions for Ruzizi III where it is understood that operation changes between "off-peaking" and "peaking" will be quicker than they currently are at Ruzizi II.

Table 10-22 Upstream Rubyiro Tributary – Ramp-up and Ramp-down Rates Summary

	Baseline	**Future**
Ramp-up (cm/min)	7.6	12.0
Ramp-down (cm/min)	-0.8	-2.6

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A.2 Upstream Burundi border / Ruhwa tributary

This section is located immediately downstream of the proposed Ruzizi III powerhouse. Figure 10-25 and Figure 10-26 provide a general overview of the river reach characteristics in this location. The model cross-section approximate reach is highlighted.



Figure 10-43 Upstream Burundi border / Ruhwa Tributary



Figure 10-44 Upstream Burundi border / Ruhwa Tributary – Photo

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A summary of the hydrological and hydraulic characteristics for this reach for normal flow conditions is provided as follows. Full details for the various different flow conditions (ranging from very dry to very wet) are provided in the accompanying annex.

Table 10-23 and Figure 10-45 show that the future maximum flow is similar to the current maximum flow, but the future minimum flow tends to be lower than the current minimum flow by 11 m^3/s. As such, the change in flow range, i.e., the change in the amount of daily variation of flow, tends to be higher under the future post Ruzizi III scenario.

Table 10-23 Upstream Burundi Border / Ruhwa Tributary – Flow Summary

	Baseline	Future
Maximum Flow (m^3/s)	170	168
Minimum Flow (m^3/s)	33	20
Flow Range (m^3/s)	138	148

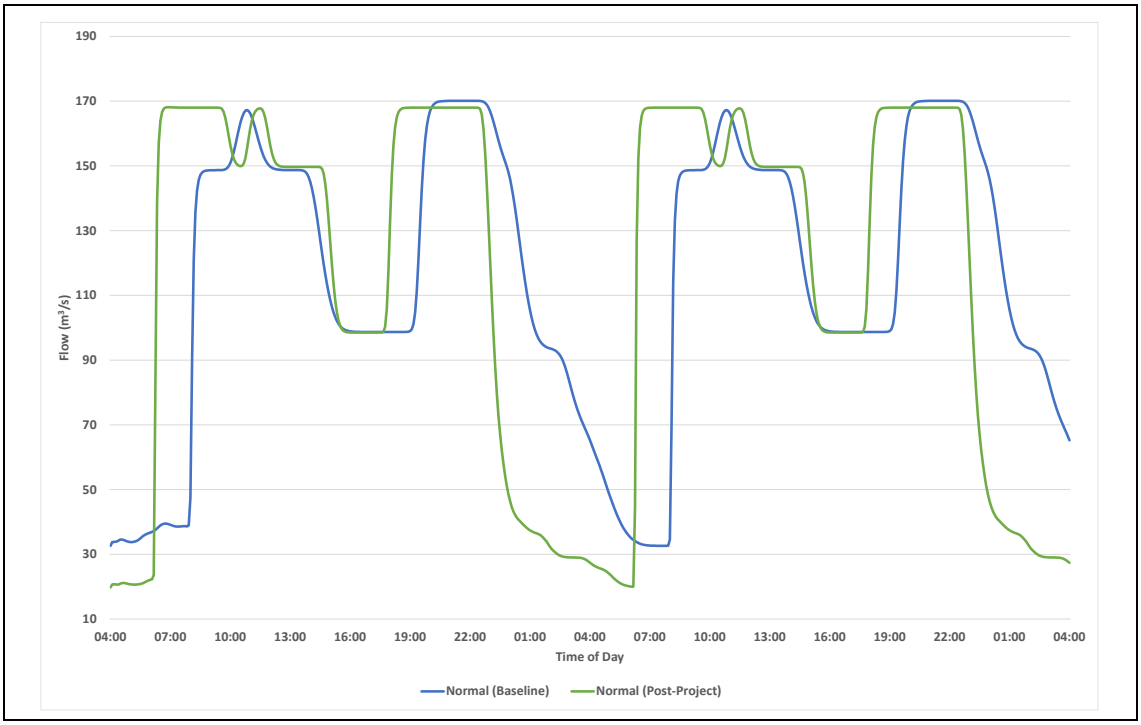


Figure 10-45 Upstream Burundi Border / Ruhwa Tributary – Flow Summary

Table 10-24 and Figure 10-46 show that the future maximum level (and hence depth) is similar to the current maximum level, but the future minimum level tends to be lower than the current minimum level. As such, the level range, i.e., the amount of daily water level variation, tends to be higher under the future post Ruzizi III scenario.

The water level daily variation increases by 18 cm (from a daily variation of 0.98 m to 1.16 m) primarily due to the reduction in minimum water levels.

Table 10-24 Upstream Burundi Border / Ruhwa Tributary – Level Summary

	Baseline	Future
Maximum Elevation (mAOD)	920.04	920.03
Minimum Elevation (mAOD)	919.06	918.87
Elevation Range (m)	0.98	1.16

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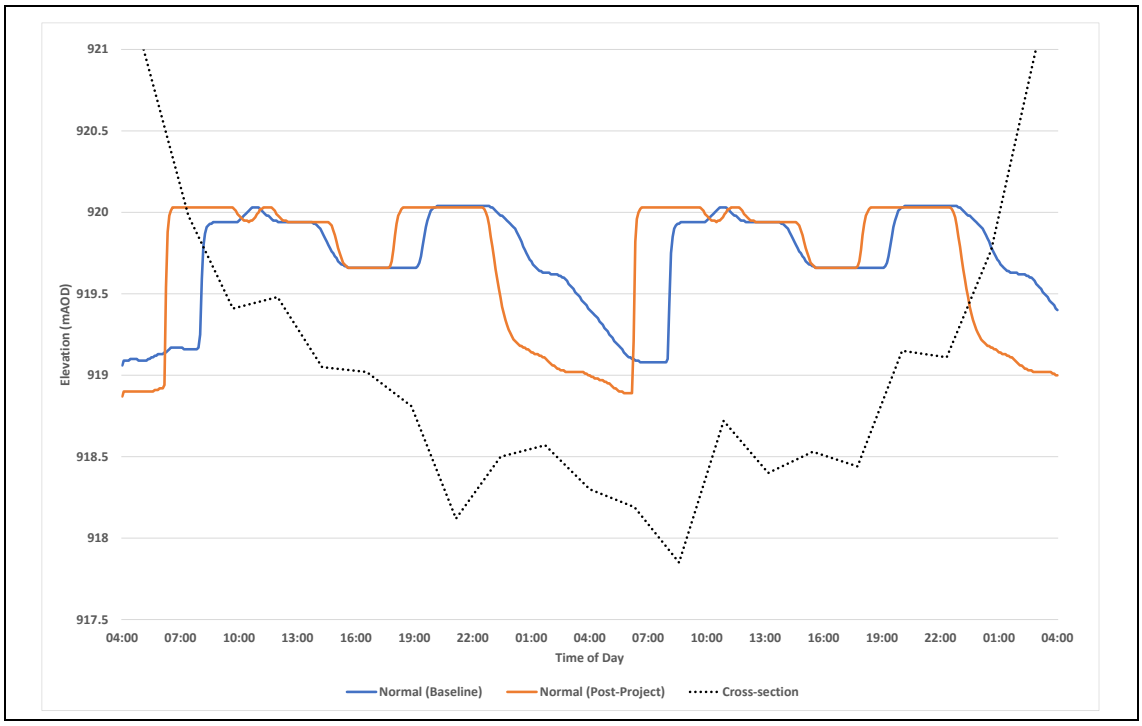


Figure 10-46 Upstream Burundi Border / Ruhwa Tributary – Level Summary

As with the flow and elevation variation, Table 10-25 and Figure 10-47 show that the future maximum velocity is similar to the current maximum velocity, but the future minimum velocity tends to be lower than the current minimum velocity. As such, the velocity range tends to be higher under the future post Ruzizi III scenario.

The velocity daily variation increases by 0.16 m/s (from a daily variation of 0.94 m to 1.10 m) due to the reduction in minimum velocity.

Table 10-25 Upstream Burundi Border / Ruhwa Tributary – Velocity Summary

	Baseline	**Future**
Maximum Velocity (m/s)	2.34	2.33
Minimum Velocity (m/s)	1.40	1.23
Velocity Range (m/s)	0.94	1.10

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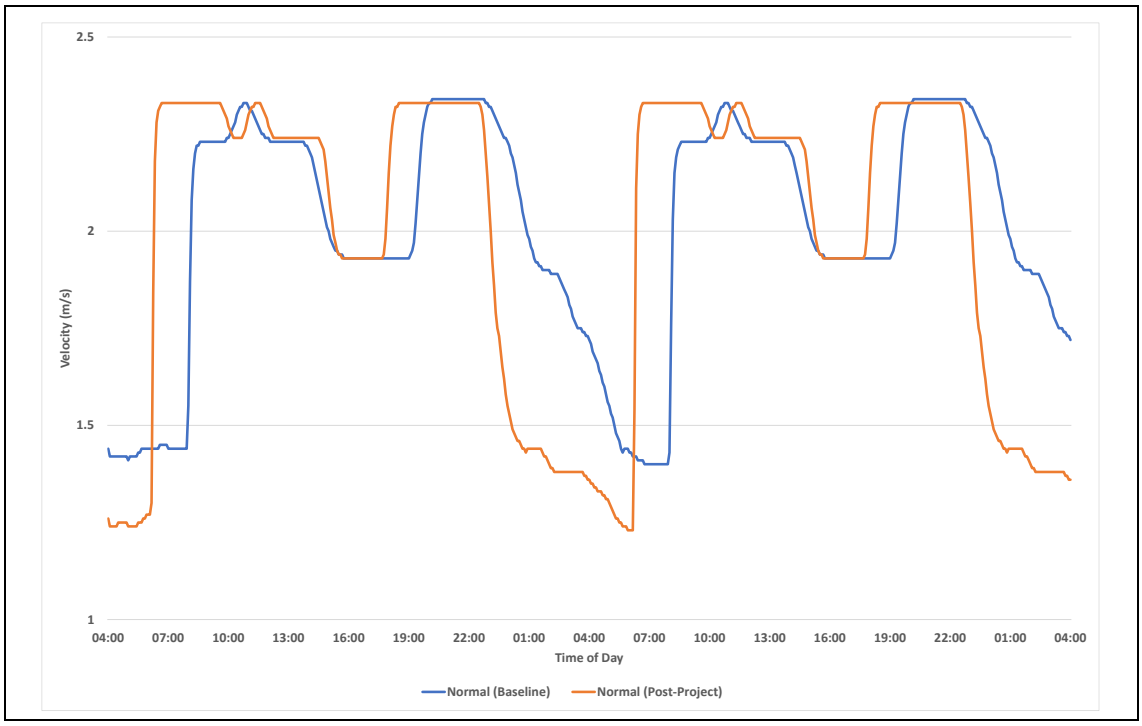


Figure 10-47 Upstream Burundi Border / Ruhwa Tributary – Velocity Summary

Table 10-26 and Figure 10-48 show the maximum, minimum, and daily range in cross-section area, providing an indication of the overall habitat area available. As with the other hydrological and hydraulic characteristics presented, the future maximum area is similar to the current maximum area, but the future minimum area tends to be lower than the current minimum area. As such, the area range tends to be higher under the future post Ruzizi III scenario in normal to very wet conditions.

The cross-section area daily variation increases by 6.4 m^2 (from a daily variation of 50.0 m^2 to 56.4 m^2) due to the reduction in minimum area.

Table 10-26 Upstream Burundi border / Ruhwa Tributary – Cross-section Area Summary

	Baseline	**Future**
Maximum Area (m^2)	72.7	72.1
Minimum Area (m^2)	22.7	15.8
Area Range (m^2)	50.0	56.4

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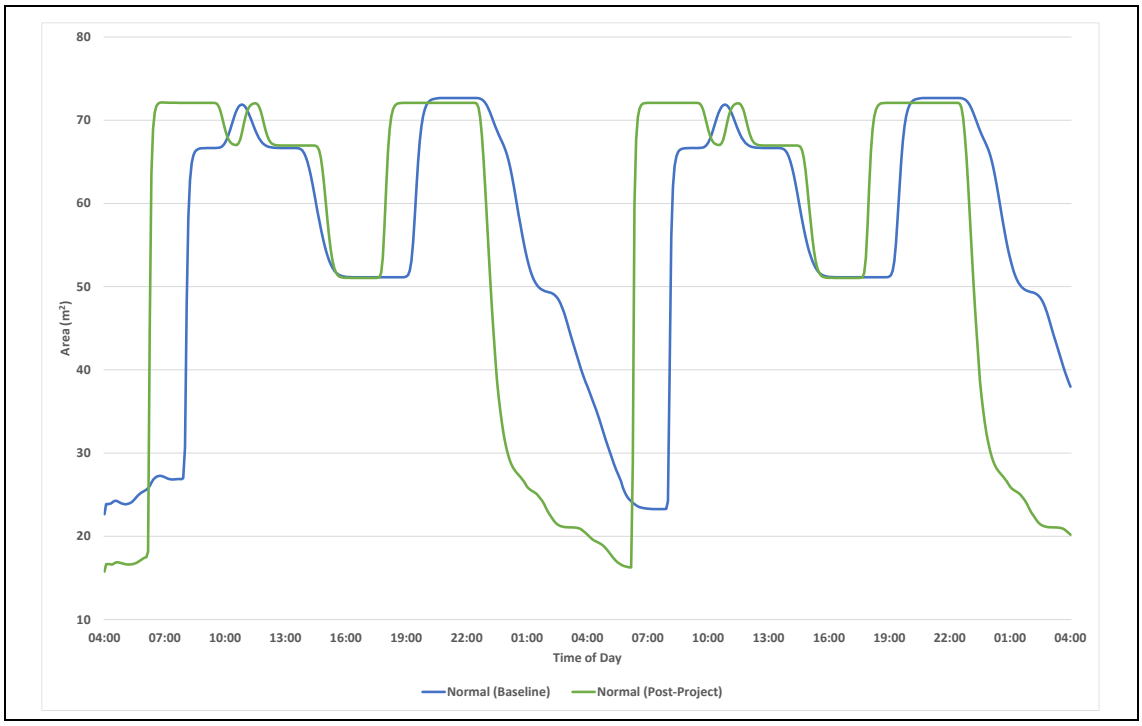


Figure 10-48 Upstream Burundi Border / Ruhwa Tributary – Cross-section Summary

Table 10-27 provides a summary of the average vertical ramp-up rates and ramp-down rates experienced.

It is notable that future ramp-up and ramp-down rates tend to be greater than current ramp-up and ramp-down rates. This is a reflection of the operating conditions for Ruzizi III where it is understood that operation changes between "off-peaking" and "peaking" will be quicker than they currently are at Ruzizi II.

Table 10-27 Upstream Burundi Border / Ruhwa Tributary – Ramp-up and Ramp-down Rates Summary

	Baseline	**Future**
Ramp-up (cm/min)	5.0	7.1
Ramp-down (cm/min)	-0.5	-1.3

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A.3 Downstream Burundi border / Ruhwa Tributary

This section is located 10 km downstream of the proposed Ruzizi III powerhouse. Figure 10-49 and Figure 10-50 provide a general overview of the river reach characteristics in this location. The model cross-section approximate reach is highlighted.



Figure 10-49 Downstream Burundi Border / Ruhwa Tributary



Figure 10-50 Downstream Burundi Border / Ruhwa Tributary – Photo

Table 10-28 and Figure 10-51 show that the future maximum flow is similar to the current maximum flow under all flow conditions, but that the future minimum flow tends to be lower

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than the current minimum flow. As such, the change in flow range, i.e., the change in the amount of daily variation of flow, tends to be higher under the future post Ruzizi III scenario.

Table 10-28 Downstream Burundi Border / Ruhwa Tributary – Flow Summary

	Baseline	Future
Maximum Flow (m^3/s)	185	183
Minimum Flow (m^3/s)	48	35
Flow Range (m^3/s)	138	148

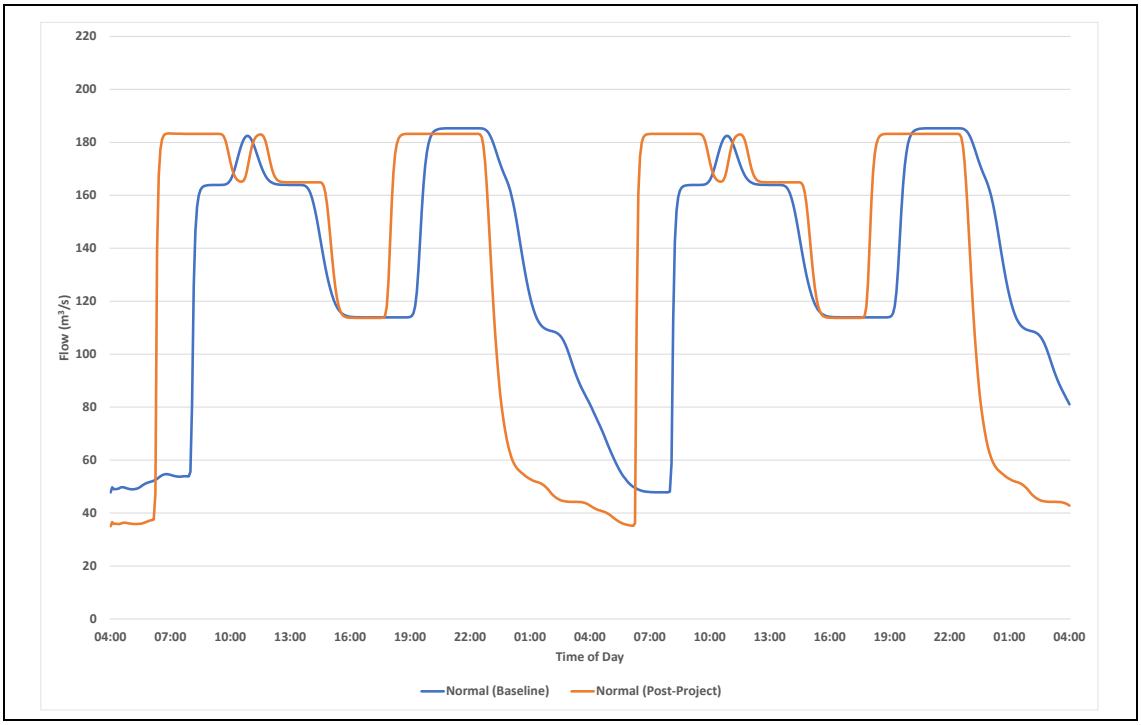


Figure 10-51 Downstream Burundi Border / Ruhwa Tributary – Flow Summary

Table 10-29 and Figure 10-52 show that the future maximum level (and hence depth) is similar to the current maximum level, but the future minimum level tends to be lower than the current minimum level. As such, the level range, i.e., the amount of daily water level variation, tends to be higher under the future post Ruzizi III scenario.

The water level daily variation increases by 14 cm (from a daily variation of 0.94 m to 1.08 m) primarily due to the reduction in minimum water levels.

Table 10-29 Downstream Burundi border / Ruhwa Tributary – Level Summary

	Baseline	Future
Maximum Elevation (mAOD)	908.89	908.89
Minimum Elevation (mAOD)	907.95	907.81
Elevation Range (m)	0.94	1.08

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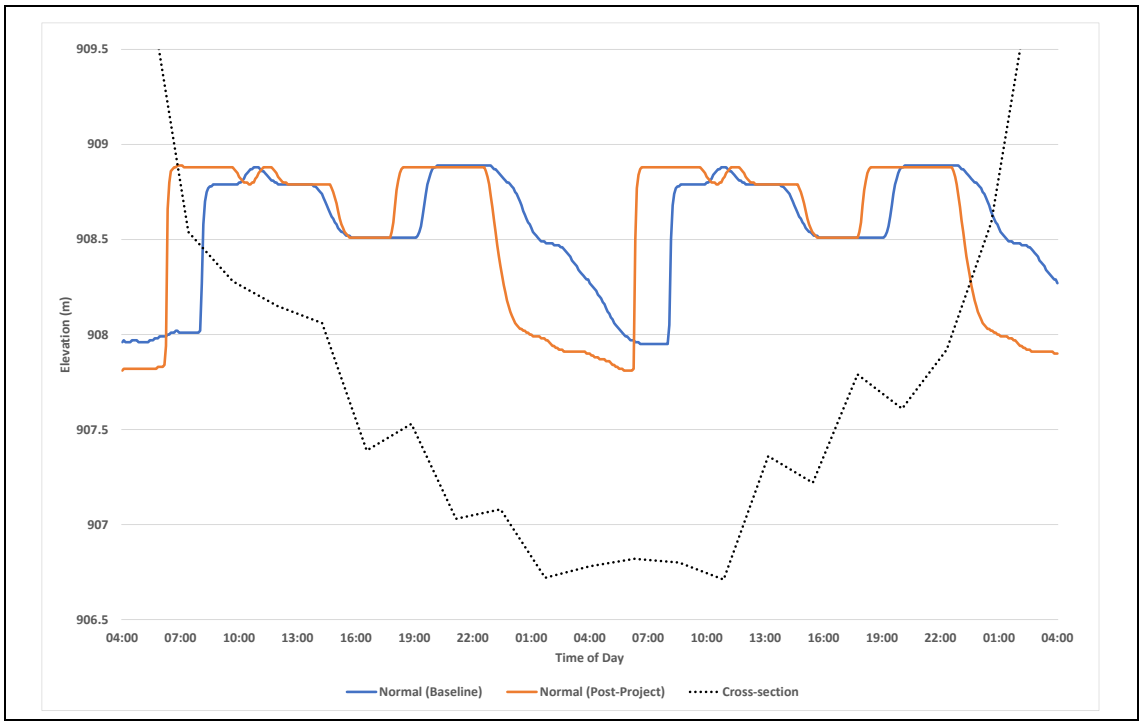


Figure 10-52 Downstream Burundi Border / Ruhwa Tributary – Level Summary

As with the flow and elevation variation, Table 10-30 and Figure 10-53 show that the future maximum velocity is similar to the current maximum velocity, but the future minimum velocity tends to be lower than the current minimum velocity. As such, the velocity range tends to be higher under the future post Ruzizi III scenario.

The velocity daily variation increases by 0.19 m/s (from a daily variation of 1.07 m to 1.26 m) due to the reduction in minimum velocity.

Table 10-30 Downstream Burundi border / Ruhwa Tributary – Velocity Summary

	Baseline	**Future**
Maximum Velocity (m/s)	3.00	2.99
Minimum Velocity (m/s)	1.93	1.73
Velocity Range (m/s)	1.07	1.26

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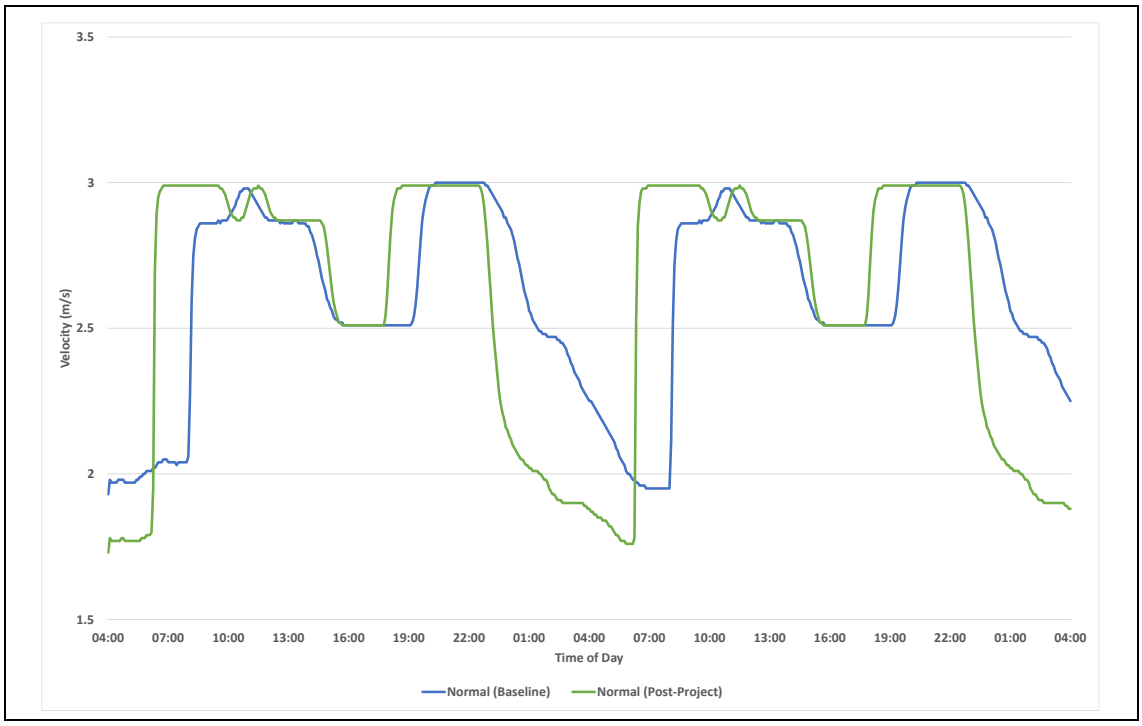


Figure 10-53 Downstream Burundi border / Ruhwa Tributary – Velocity Summary

Table 10-31 and Figure 10-54 show the maximum, minimum, and daily range in cross-section area, providing an indication of the overall habitat area available. As with the other hydrological and hydraulic characteristics presented, the future maximum area is similar to the current, but the future minimum area tends to be lower than the current minimum area. As such, the area range tends to be higher under the future post Ruzizi III scenario.

The cross-section area daily variation increases by 4.1 m^2 (from a daily variation of 37.3 m^2 to 41.4 m^2) due to the reduction in minimum area.

Table 10-31 Downstream Burundi Border / Ruhwa Tributary – Cross-section Area Summary

	Baseline	**Future**
Maximum Area (m^2)	61.8	61.4
Minimum Area (m^2)	24.5	20.0
Area Range (m^2)	37.3	41.4

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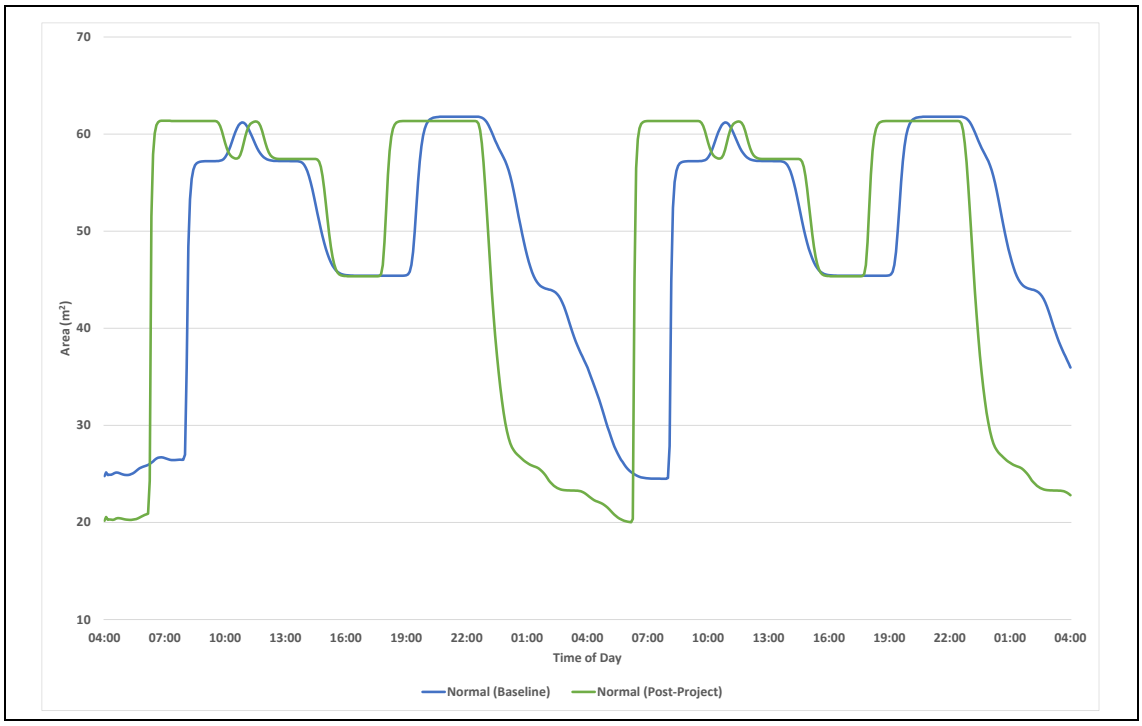


Figure 10-54 Downstream Burundi Border / Ruhwa Tributary – Cross-section Summary

Table 10-32 provides a summary of the average vertical ramp-up rates and ramp-down rates experienced.

It is notable that future ramp-up and ramp-down rates tend to be greater than current ramp-up and ramp-down rates. This is a reflection of the operating conditions for Ruzizi III where it is understood that operation changes between "off-peaking" and "peaking" will be quicker than they currently are at Ruzizi II.

Table 10-32 Downstream Burundi border / Ruhwa Tributary – Ramp-up and Ramp-down Rates Summary

	Baseline	**Future**
Ramp-up (cm/min)	4.9	6.8
Ramp-down (cm/min)	-0.5	-1.3

B Geomorphological, Ecological and Social Context

B.1 Geomorphology

This reach has a partly confined valley setting and a moderately steep channel gradient. It has a mixed boulder and cobble bed, with localised sections of resistant calcrete/bedrock, supporting pool-rapid and pool-riffle reach types. The river morphology alternates between rapids and riffles, with small poorly defined pool habitats. The bed elevation is controlled by bedrock/calcrete and larger immobile rocks.

Islands form where calcrete protrude from the channel floor or the river bifurcates around large immobile sediment deposits. Fine sediment deposition on these features support vegetation establishment. The river course is relatively straight across the plain to the confluence with the Ruwha River with a narrow floodplain (approximately 100 m wide). The river and narrow floodplain are incised into the surrounding plain (5 to 10 m based on the SRTM dataset) and are flanked by a ridge along the left bank at the Rubyiro river confluence. The banks are composed of coarser alluvial material (boulders and cobble) supported by sandy and clayey material. The banks appear well-vegetated and relatively stable on satellite and ground-based images despite the fluctuating water levels from Ruzizi II release. Agriculture is common on the floodplain, surrounding plains and hillslope, contributing fine sediment to the channel.

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Two large tributaries (Rubyiro and Ruhwa) contribute significant volumes of flow and sediment from the northern parts of the drainage basin. The Ruhwa appears more laterally active and turbid on satellite images and shows evidence of transporting and storing large quantities of sand and gravel. This suggests large sediment input from the Ruhwa.

B.2 Aquatic Ecology

Macroinvertebrates:

Aquatic biotopes within this reach are as per the upstream reach and comprised the following:

- Mostly Deep-Fast Rapids. These biotopes are likely to support mostly grazing and filter-feeding taxa that tolerate extreme current speeds (as described in the downstream powerhouse location section).
- One area of Deep-Slow Pool. No information was available on macroinvertebrates in such pools, but diversity and abundance in these areas is likely to be low because of light limitation and the limited diversity of hydraulic conditions.
- One area of Shallow-Fast Riffle. This area is likely to support a high diversity of macroinvertebrates (as described in the dewatered reach section).

Fish

Much like the previous reach, a combination of Fast Shallow and Fast Deep habitats characterise this reach. Lotic lithophilic species such as *Labeo* cf. *cylindricus; Labeobarbus altianalis* and *Bagrus docmak* have been recorded in this reach during previous surveys due to the suitability of spawning and feeding habitats.The Deep and Shallow Fast habitats with large bed elements are important as living space for the lotic riffle-rapid guild (*Chiloglanis* and *Amphilius*). The Slow Shallow and Fast Shallow habitats are especially susceptible to hydropeaking if these areas are regularly inundated and desiccated on a daily basis.

B.3 Terrestrial Ecology

Riparian Vegetation:

Even though this reach of the Ruzizi River is in a densely settled area, there is greater complexity of riparian habitats compared to upstream reaches, primarily because of the presence of large islands and associated braided river channels, and an extensive system of fishponds along the right bank. Riparian Thicket is poorly represented, mostly on island edges. Riparian Wetlands are dominated by *Phragmites*, as well as other wetland species that are dependent on a wet bank such as *Leersia hexandra*, *Cyperus* species and *Pluchea ovalis*. Scattered trees in Riparian Wetlands along this reach include *Senegalia polyacantha, Phoenix reclinata* and *Ficus sycomorus*.

Riparian Fauna:

The riparian avifauna, mammal and herpetofauna assemblages has the highest species richness of any of the reaches assessed, mostly because of the fishponds along the right bank, which provide significant waterbird habitat, as well as the complexity of microhabitats provided by the islands and adjacent channels. The avifauna assemblage showed a slightly higher proportion of fish-eating species and waterfowl such as white-faced duck, most likely because of the shallow water habitat provided in the fish ponds. Insect-eating bird species that forage from riverside vegetation are relatively common along this reach, such as little bee-eater, greater swamp warbler and red-faced cisticola.

Riparian mammals such as marsh mongoose and otter species are likely to be present in similar numbers to the previous reach. A small population of hippopotamus is resident in the vicinity of the confluence with the Ruhwa River and the territory of the population resident in the previous reach overlaps with the islands near the confluence with the Rubyiro River. Herpetofauna will be mostly represented by widespread generalist amphibians, reed-dwelling frogs such as *Hyperolius* and *Afrixalus* species, as well as a few riparian reptile species such as water snakes (*Lycodonomorphus* species) and terrapins (*Pelusios* species).

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B.4 Social

The following paragraphs provide an overview of local communities' reliance on Ruzizi's water for their livelihoods and domestic needs in the section from the Upstream Rubyiro Tributary to Downstream Ruhwa Tributary. Issues related to water quality and sediment load will not be covered in this analysis, as no discernible difference from current conditions is expected, due to the low residence time of water in the Ruzizi III reservoir.

This stretch is characterised by a high social reliance on the river. Various access points to fetch water for consumptive use were observed, alongside areas used for livestock drinking. For agriculture, some irrigation canals are used in DRC, but the population relies mostly on bucket or water pump irrigation. Unpredictable flooding of cultivated fields has been reported as a frequent event in this area, with a serious impact on local communities' livelihoods. Local communities are also crossing over to the neighbouring country regularly for work or visiting family, by swimming across the river. Fishing is practiced regularly by the majority of households, but it does not represent a significant source of income or means of livelihood for the local community.

In DRC, water is also abstracted for fish farming on several ponds, covering an area of around 5-6 hectares. This activity does not represent a major source of income or livelihood for the communities involved.

C Indicators Linked to Hydrological and Hydraulic Characteristics

Table 10-33 provides and overall summary of the ecological and social functional relationship with hydrological and hydraulic characteristics for the reach just upstream of the Rubyiro confluence to the Burundi border, just downstream of the Ruhwa River confluence.

The change in hydrological and hydraulic characteristics are predicted to result in significant increase in social community safety impacts (due to increased ramp-up rates), although it is noted that the increased social community safety impacts notably reduce along the length of this reach.

Table 10-33 Summary of Ecological and Social Functional Relationship / Impacts at Upstream Rubyiro Tributary to Downstream Burundi Border / Ruhwa Tributary

Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Geomorphology		
Increased channel erosion The channel is largely composed of large immobile clasts, calcrete or bedrock. This makes the channel bed resistant to incision. Hydro peaking and reductions in longitudinal sediment connectivity has resulted in possible bed erosion and bed armouring	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	Minor
	Ramping Rates	No / Insignificant
Increased sedimentation in channel Due to the reduced sediment supply downstream of the dam, and the increase in the frequency of high energy flows, it is unlikely that sedimentation will take place. Localised sedimentation might take place in slack waters	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	Minor
	Ramping Rates	No / Insignificant
Bank erosion The banks are largely composed of boulders and cobbles with a finer gravel, sand and silt matrix. The banks are not steep or high and relatively stable and immobile. The banks have been exposed to hydropeaking for decades, thus bank erosion might have stabilised over time	Flow	Moderate
	Elevation / Depth	Moderate
	Velocity	Moderate
	Area	No / Insignificant
	Ramping Rates	Minor

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Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Aquatic Ecology		
Non-migratory fish: abundance and diversity This reach has a combination of Fast Shallow and Fast Deep habitats. The Deep and Shallow Fast habitats with large bed elements are important for the lotic riffle-rapid guild. The Slow Shallow and Fast Shallow habitats are especially susceptible to hydropeaking if these areas are regularly inundated and desiccated on a daily basis. Depth of water and wetted area is a key criterion determining habitat suitability for this guild, which could be impacted by reduced baseflow during inter-peaking periods.	Flow	
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Minor
	Ramping Rates	Minor
Migratory fish: abundance and diversity This reach has a combination of Fast Shallow and Fast Deep habitats. The Deep and Shallow Fast habitats with large bed elements are important for spawning and feeding by fish in the lotic lithophilic guild (*Labeobarbus* species). The Slow Shallow and Fast Shallow habitats are especially susceptible to hydropeaking if these areas are regularly inundated and desiccated on a daily basis. Depth of water and wetted area is a key criterion determining habitat suitability for this guild, which could be impacted by reduced baseflow during inter-peaking periods.	Flow	
	Elevation / Depth	Minor
	Velocity	Minor
	Area	Minor
	Ramping Rates	Minor
Macro-invertebrates: abundance and diversity These are expected to remain largely unchanged compared to the current operation because of the large variation in daily and sub-daily water levels despite a slight reduction in wetted area during inter-peaking operations.	Flow	Minor
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	N/A
Terrestrial Ecology		
Riparian vegetation: abundance and diversity Even though this reach of the Ruzizi River is in a densely settled area, there is greater complexity of riparian habitats compared to upstream reaches, primarily because of the presence of large islands and associated braided river channels, and an extensive system of fishponds along the right bank. Some flow-dependent species are present in the scattered fragments of Riparian Thicket and species dependent on a wet bank are present in the Riparian Wetland community. While these species may be impacted in the upper reaches of the project, the changes in flow, velocity, depth and wetted area in this reach are minor and thus unlikely to have a significant impact.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	No / Insignificant
Riparian fauna: abundance and diversity The riparian avifauna, mammal and herpetofauna assemblages have higher species richness in this reach compared to upstream reaches. The species composition of the faunal assemblage is currently dominated by widespread habitat generalists and overall species richness is low. Changes in flow, depth and velocity will have a negligible impact on riparian fauna species. The small population of hippopotamus that is resident along this reach is unlikely to be impacted by minor changes in flow, depth, velocity, area, and ramping rates.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	No / Insignificant
Social		
Consumptive Water Use Local communities in this stretch are currently using the river for domestic and drinking water supply. Social reliance on the river for consumptive water use is high.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	No / Insignificant

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Indicator & Brief Description	Hydrological / Hydraulic Characteristic	Functional Relationship / Impact (FR/I)
Non-Consumptive Water Use: Fishing Local communities are currently fishing regularly in this stretch. Local communities are currently farming fish in a number of ponds alimented by the Ruzizi on a surface of around 5-6 hectares.	Flow	No / Insignificant
	Elevation / Depth	No / Insignificant
	Velocity	No / Insignificant
	Area	No / Insignificant
	Ramping Rates	Moderate
Community Safety Local communities cross the river regularly in this stretch. Additionally, villagers are physically entering the river on a regular basis for recreational purposes, and medicinal / spiritual practices. Social exposure to hazards due to the river's flow and velocity are high.	Flow	Minor
	Elevation / Depth	Minor
	Velocity	Significant
	Area	N/A
	Ramping Rates	Significant

10.4.4 The Extended Hydropeaking Reach – Downstream Burundi Border to Lake Tanganyika

The assessment of EFlows in the Ruzizi River between downstream the River Ruhwa / Burundi Border and Lake Tanganyika (123 km) has been undertaken using a broad-scale 1D hydraulic model (see Figure 10-7) and with reference to observed water level data recorded during the period 10/02/2023 and 11/03/2023 at the Ruzizi Monitoring Station 14 km upstream of Lake Tanganyika.

The 1D hydraulic model has been used to predict hydrological and hydraulic conditions associated with the Ruzizi II hydropeaking regime (current baseline situation) and Ruzizi III hydropeaking regime (future post-project situation), with reference to change in water level and ramp-up and ramp-down rates. Under normal flow conditions, it is noted that:

- Immediately downstream of the Burundi border, water levels vary by up to 1.5 m on a daily basis under current baseline conditions, taking approximately 2 hours to increase and 8.5 hours to decrease by this amount. However, under proposed future post-Ruzizi III hydropeaking conditions water levels vary by up to 1.7 m on a daily basis (i.e. 20 cm more), taking approximately 1.5 hours to increase (i.e. 30 minutes faster than baseline) and 8 hours to decrease (i.e. 30 minutes shorter). Ramp-down rates increase slightly from 0.29 cm/minute to 0.36 cm/minute (i.e. 7 cm/min faster) and ramp-up rates increase from approximately 1.2 cm/minute to 2.2 cm/minute (i.e. 1 cm/minute faster).
- Further downstream, at the upper end of the potential Critical Habitat reach, approximately 18 km downstream of the Burundi border, water levels vary by up to 1.1 m on a daily basis under current baseline conditions, taking approximately 3 hours to increase and 10 hours to decrease by this amount. However, under proposed future post-Ruzizi III hydropeaking conditions, water levels vary by up to 1.2 m on a daily basis (i.e. 10 cm higher than baseline), taking approximately 2.5 hours to increase (30 minutes quicker than baseline) and 10 hours to decrease by this amount. Ramp-down rates remain the same as the baseline at approximately 0.2 cm/minute whereas ramp-up rates increase slightly from 0.6 cm/minute to 0.9 cm/minute.
- At approximately 60 km downstream of the Burundi border, water levels vary by up to 0.80 m on a daily basis under current baseline conditions, taking approximately 4.5 hours to increase and 10 hours to decrease by this amount. Under proposed future post-Ruzizi III hydropeaking conditions, water levels vary by up to 1.0 m on a daily basis (i.e. 20 cm higher), taking approximately 5 hours to increase and 10 hours to decrease by this amount. Ramp-down rates increase slightly from 0.13 cm/minute to 0.17 cm/minute, whereas ramp-up rates remain constant at approximately 0.3 cm/minute.

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The observed water level data at 14 km upstream Lake Tanganyika (136 km downstream from Ruzizi II dam) shows that the current average daily range of water levels is 0.07 m, with a rate of change of 0.3 cm/hour. This represents further significant attenuation of hydropeaking effects and is expected to be in part attributable to the backwater effect of Lake Tanganyika.

In summary, based on the broad-scale modelled assessment of hydropeaking and observation of current baseline water levels in the extended study area, the effects of Ruzizi II / III hydropeaking are expected to significantly attenuate with distance downstream in Burundi. Flow fluctuations 60 km downstream of the Burundi /Rwanda border (just upstream of the Ruzizi National Park and Ramsar site) will only be slightly detectable or measurable. Current observed water level variation at 14 km upstream of Lake Tanganyika is less than 10 cm.

A small incremental effect in water level increase and speed of change of water levels can be attributed to the proposed operation of Ruzizi III. Importantly, the associated **community safety related ramp-up rates remain well below threshold values of 5 cm/minute**. Similarly, the associated **fish-stranding related ramp-down rates are well below threshold values of 1 cm/minute**. As such, it is concluded that **the hydrological and hydraulic hydropeaking effects present no significant transboundary impacts with Burundi nor impact potential Critical Habitat in the lower Ruzizi River system.**

10.5 Summary and Conclusions

The hydrological, hydraulic, and geomorphological characteristics of the Ruzizi River and how they are modified by the Ruzizi III HEPP drive the predicted responses of the ecological and social components or receptors.

This section focuses on summarising the predicted changes in hydrology and geomorphology and the current baseline environmental and social context related to the river as a basis for interpreting the downstream impacts of the project that are described and assessed, together with identified mitigation measures, in the Impact Assessment & Mitigation chapter.

The hydrological and hydraulic changes identified have been determined by the application of 1D and 2D hydraulic modelling. Such modelling can provide useful general information for assessing the hydraulic characteristics but has particular limitations in describing the heterogeneity found at the micro- and meso-habitat scale required for a full assessment of the expected aquatic ecosystem impacts associated with different EFlow regimes.

This EFA has adopted a medium-resolution and this is considered suitable by the ESIA Consultant and REL, it is nevertheless recognised that the suitability will be assessed by the IPoE and if necessary will be revised to address the panels comments post financial closure.

10.5.1 Hydrological and Hydraulic Changes

10.5.1.1 The Dewatered Reach – Ruzizi III Dam Wall to Powerhouse Tailrace

A Current Baseline Conditions

The reach downstream of Ruzizi III dam wall is currently subject to large daily variations in flow, water levels and depths, velocities, and wetted area due to the hydropeaking operation of Ruzizi II.

Based on the 1D hydraulic modelling, under normal conditions, flows in the reach between the dam wall and powerhouse vary between approximately 25 m^3/s and 163 m^3/s on a daily basis – although are at least 86 m^3/s throughout daylight hours and for 75% of the time. The greatest impact in terms of hydraulic characteristics is on wetted area (available aquatic habitat). This varies between 61% and 100% - and is at least 86% throughout daylight hours and for 75% of the time. Variations in average depth and average velocity are also apparent. Average depth

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varies between approximately 1.1 m and 1.8 m (1.7 m for 75% of the time), average velocity varies between approximately 0.7 m/s and 1.4 m/s (0.8 m/s for 75% of the time).

B Future Post-project Conditions

The reach from Ruzizi III dam wall to the powerhouse tailrace will be dewatered – flows will be maintained by environmental flow releases.

Given a constant flow of 11 m^3/s as proposed by the Feasibility Study, significant reductions in wetted area, average depths and average velocities would occur in this reach. The wetted area reduces to 44% and 48% of peak and natural AAF respectively, average depth reduces to 0.55 m and average velocity reduces to 0.55 m/s. It is important to note though that the reported figures are averages – depths and velocities vary markedly within the dewatered reach and such variation may have important impacts on the ecological and social health of the reach. Although wetted area and depth will be significantly reduced in this reach, an improvement in aquatic ecosystem condition is predicted due to the more stable conditions that will be created. Furthermore, a constant flow, whatever the magnitude, does not contribute to the ecological and social health of the aquatic ecosystem for those aspects associated with intra-annual and inter-annual variation.

10.5.1.2 The Hydropeaking Reach – Ruzizi III Powerhouse tailrace to Burundi Border

In the reach downstream of the Ruzizi III powerhouse tailrace to the Burundi border, differences between the current hydrological regime and the predicted future hydrological regime are associated with the capture of the 177 km^2 right-bank tributary inflows (located 7.2 km upstream of Ruzizi III dam wall) and operational control curves relating to powerhouse releases. It is predicted that there will be no / insignificant change in maximum flows, depths, and velocities as the maximum powerhouse capacities of Ruzizi II and III are both 150 m^3/s. However, **differences in both ramp-up rates and ramp-down rates are predicted, with the critical ramp-up threshold (5 cm/minute) and critical ramp-down threshold (1 cm/minute) likely to be exceeded more often under Ruzizi III operating conditions**.

It is also notable that **the effects of hydropeaking are predicted to reduce along the hydropeaking reach** such that ramp-up and ramp-down rates decrease due to in-channel attenuation and the effect of downstream tributary inflows (primarily from the Rubyiro and Ruhwa rivers). For example, under predicted Ruzizi III operating conditions, maximum ramp-up rates near the powerhouse are approximately 10 cm/minute under normal flow conditions, reducing to approximately 7 cm/minute downstream of the Ruhwa River. Similarly, maximum ramp-down rates reduce from 6.5 cm/minute to 1.3 cm/minute over this same stretch.

10.5.1.3 The Extended Hydropeaking Reach – Downstream Burundi Border to Lake Tanganyika

In the 123-km-long reach downstream of the Burundi border to Lake Tanganyika, the effects of Ruzizi II / III hydropeaking are expected to significantly attenuate with distance. Flow fluctuations at the Ruzizi National Park and Ramsar site (118 km downstream from the Ruzizi III powerhouse) will only be slightly detectable or measurable. Current observed water level variation at the location (14 km upstream of Lake Tanganyika) is less than 10 cm.

A small incremental effect in water level increase and speed of change of water levels can be attributed to the proposed operation of Ruzizi III. Importantly, the associated **community safety related ramp-up rates remain well below threshold values of 5 cm/minute**. Similarly, the associated **fish-stranding related ramp-down rates are well below threshold values of 1 cm/minute**. As such, it is concluded that **the hydrological and hydraulic hydropeaking effects present no significant transboundary impacts with Burundi nor impact potential Critical Habitat in the lower Ruzizi River system.**

10.5.1.4 Alteration of Minimum Water Depth Along the Whole of the Ruzizi River

The Cumulative Impact Assessment (CIA) provided in Chapter 12 includes an assessment of the impacts on hydrology of the Ruzizi River caused by the operation of the existing Ruzizi-I and -II hydropower schemes and the incremental changes caused by the operation of the proposed

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Ruzizi-III Project. The metric used for the assessment is the % alteration to natural minimum water depth of the river, i.e. the water depth before implementation of Ruzizi-I HEPP in 1959.

The minimum water depths at different points along the river for the natural conditions and with operation of Ruzizi I/II and with Ruzizi-III were estimated using the results from this EFA which computes water depth for different flow conditions at several EFlow sites.

The key findings of the CIA for hydrology are as follows:

- Operation of Ruzizi-I and -II has altered flow conditions of the Ruzizi River over the total distance between Ruzizi-I and the outflow into Lake Tanganyika (165 km).
- In the reach between Ruzizi-I and Ruzizi-II reservoir, variations in flow rate of 10 to 150 m^3/s occur on a sub-daily basis. The peak flows do not exceed the upper limit of inter-annual variations. However, the off peak flows create water depths that are ~50% lower than for natural conditions.
- Downstream from Ruzizi-II, the lowering of minimum water depth decreases with distance because of flow attenuation effects and the inflow of tributaries. In the reach immediately downstream, the off peak water depth is ~50% lower than natural conditions, and at the outflow into Lake Tanganyika the depth is <1% lower.
- The proposed Ruzizi-III Project will alter flow conditions of the Ruzizi River and overlap the alterations caused by Ruzizi-I and -II. The Ruzizi-III Project is located 12 km downstream from Ruzizi-II and consequently the alterations to the Ruzizi River extend slightly further downstream than the alterations caused by Ruzizi III.

A Degree of Alterations to Minimum Water Depth

The % alterations to natural conditions minimum water level for each of the hydropower schemes are presented in Table 10-34 and Figure 10-55.

Table 10-34 Alteration to Natural Conditions Minimum Water Level vs River Length

Reach (km)	Alteration to natural conditions minimum water level (%)			Comments
	Ruzizi-I	Ruzizi-II	Ruzizi-III	
0-3	-	-	-	No alteration
3-4	-	-	-	No alteration - Ruzizi-I reservoir
4-16	-50%	-	-	Ruzizi-I off peak flows
16-19	-	-	-	No alteration - Ruzizi-II reservoir
19-28	-50%		-	Ruzizi-II off peak flows
28-31	-		-	No alteration - Ruzizi-III reservoir
31-37	-50%		-50%	Ruzizi-III dewatered reach, also altered by Ruzizi-I/II, Alterations overlap, but do not cumulate
31- 41	-50% to -38%		-50% to -41%	Ruzizi-III dewatered reach also altered by Ruzizi-I/II
41-61	-38% to -14%		-41% to -19%	Alterations from Ruzizi-I, -II and -III overlap, but do not cumulate.
61-81	-14% to -5%		-19% to -9%	
81-101	-5% to -1.5%		-9% to -3.7%	
101-121	-1.5% to <-1%		-3.7% to -1.5%	
121-141	<-1%		-1.5% to <-1%	
141-168	<-1%		<-1%	

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B **Alteration from Ruzizi-I and -II and Incremental Changes Caused by Ruzizi III Project**

It is concluded that the operation of Ruzizi-I and II has caused a significant impact on river hydrology, ~60 km of river (36%) has been affected by a significant (>10%) lowering of minimum water level. The operation of the proposed Ruzizi-III Project is expected, to cause minor (<10%) lowering of water levels along an additional 40 km (24%) of the river. The degree of alteration decreases with distance downstream from the Project.

It is noteworthy that river flow rates and water levels during Ruzizi-I, -II and -III peak flows do not exceed the seasonal high flows / high water levels encountered under natural conditions.

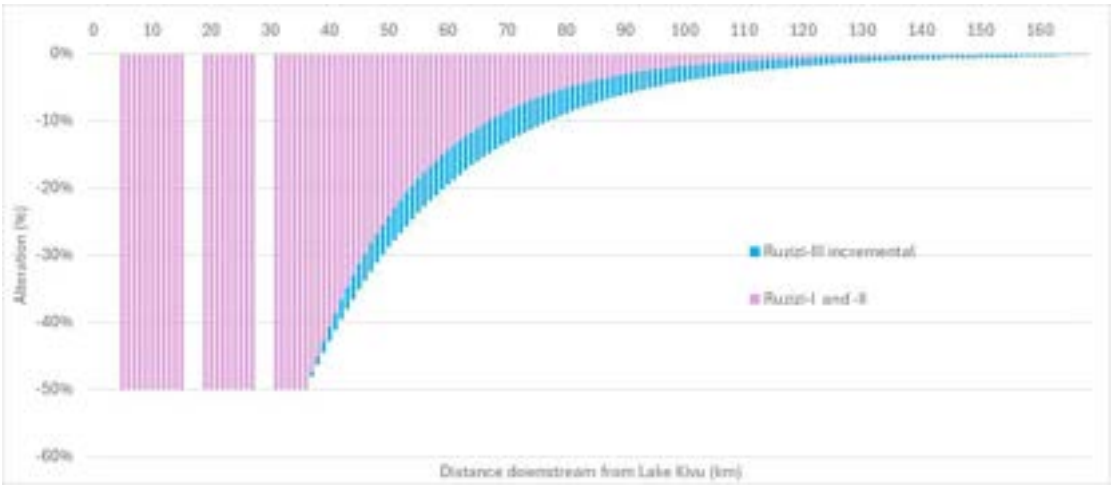


Figure 10-55 % Alteration to Natural Conditions Minimum Water Level vs River Length (Illustrative)

10.5.2 Geomorphology and Sedimentology

The Ruzizi River from the Ruzizi III dam to the confluence with the Ruwha River has a stable bed composed of large immobile material, bedrock and calcrete (cemented boulders, cobble and gravel). The banks are composed of large material, with a finer matrix amongst the larger clasts. The banks are relatively low, of a low to moderate angle and well vegetated for most parts. The upper confined reach has no floodplain, but once the river flows across the plain, a narrow floodplain exists. The floodplain is incised into the larger plain.

The Ruzizi River has been exposed to significant hydropeaking over the last few decades from Ruzizi I and II HEPPs. The trapping of bedload in the upstream reservoirs and frequent high flows would have armoured most of the confined and semi-confined reaches. This might include localised bank erosion where agriculture is taking place close to the bank edge.

The proposed Ruzizi III development is likely to trap the longitudinal supply of bed material and will possibly lead to further armouring (removal of fine sediment from the bed matrix) directly downstream of the reservoir along the dewatered reach. The effect of this on the bed elevation lowering is predicted to be minor and localised. Where tributaries or hillslope processes from the steep valley sides contribute large volumes of sediment to the Ruzizi along the dewatered reach, sediment fans or bars could develop as the river transport capacity will be reduced in this reach. This can improve the aquatic and riparian habitat diversity but may lead to sedimentation of slack waters. In extreme mass wasting events (i.e. during landslides), the channel could be blocked, leading to blockage of flow and damming of the valley. In such an event, it will take longer to fill, breach, and erode this natural dam as the proposed flow of 11 m^3/s is relatively low.

Downstream of the Ruzizi III powerhouse the increased flow rate fluctuations will increase the peak energy (shear stress) of the river, driving sediment entrainment of slightly larger sediment particles. This is likely to drive the process of armouring, stripping the channel further of finer substrates in this reach. No significant sediment contributions take place between the Ruzizi III

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powerhouse and the confluence with the Rubyiro River to mitigate this armouring process, although some lateral contributions from localised landslides, bank erosion, and surface runoff and erosion may occur. The removal of finer substrates is likely to happen along the banks too, but due to the stable bed-rock controlled nature of the channel perimeter, no significant incision or widening is likely to occur. The sediment inputs from the Rubyiro and Ruhwa are likely to increase the occurrence of finer sediment habitat, but the extent of the possible amelioration of finer habitats is unknown with the current information on daily flow variability and sediment supply downstream of the Ruhwa River.

The geomorphological and sedimentology assessment has been undertaken primarily as a desk-based assessment supported by field inputs from team members. Recommendations for monitoring geomorphological and sediment changes in the project Area of Interest are required to confirm these predictions and are documented in Vol. IV ESMP.

10.5.3 Aquatic Ecology

10.5.3.1 Aquatic Habitats and Macroinvertebrates

Aquatic habitats in the Project Area of Interest were classified as *'modified'*, primarily due to the altered flow regime from upstream hydropower projects and reflected in the very low macroinvertebrate diversity and abundance, mostly dominated by hardy, tolerant species, while ecological functions of the Ruzizi River within the Project Area of Influence were assessed as '*seriously modified*'.

While overall diversity and abundance of macroinvertebrates was very low, the most sensitive macroinvertebrate recorded was the Stonefly *Neoperla spio*, a common species that provides a potential useful indicator for monitoring ecological change. The most common taxa recorded were non-biting midges (Chironomidae). The Proportion of Sediment-Sensitive taxa (PSI) was low, and this suggests elevated levels of suspended sediments. Whilst the proportion of air-breathing taxa was moderate, and higher than expected for a river that appears to be well-oxygenated. Functional feeding groups comprised a dominance of predators, and this is typically associated with disturbance and an ecosystem that is in poor health. However, no alien macroinvertebrate taxon was recorded.

The main cause of the modified ecological state was attributed to short-term fluctuations in water level associated with the operation of Ruzizi II. Marginal habitats and all instream habitats above the lowest water level were largely devoid of aquatic life because of frequent exposure associated with short-term (daily) fluctuations in water level. Other drivers of ecological deterioration were elevated nutrients and solid waste associated with the City of Bukavu, and elevated sediments associated with the cultivation of most catchment areas that drain into the Project Area of Influence. Aquatic flora was dominated by a monoculture of the filamentous alga *Cladophora glomerata*, a typical indicator of polluted water. The presence of this alga on the stream bed at about 0.5 m depth indicated that light was not limited, although deeper areas are likely to be light limited because of elevated turbidity. The composition of benthic diatoms also indicated elevated concentrations of nutrients and suspended sediments.

The proposed development will permanently inundate aquatic habitats and associated macroinvertebrate biota within the reservoir inundated area (as defined at Full Supply Level). In the 5.5 km dewatered reach, the reduced flow will potentially impact macroinvertebrates due to the reduction in wetted area but the more stable flow is predicted to compensate for this. However, the proposed development is unlikely to have a measurable detrimental impact on aquatic macroinvertebrates within the hydropeaking reach compared to the baseline conditions.

The proposed development provides an opportunity to improve aquatic ecological conditions in the dewatered and hydropeaking reaches, and in doing so, compensate for the potential negative impacts within the area of inundation.

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10.5.3.2 Fish

Despite the modified condition of the Ruzizi River, historical catch data indicates it hosted a number of threatened, restricted range and migratory fish species although the current distribution and abundance of these and extent of migration is not well understood. However, it appears that several restricted range and migrator fish that were historically documented for this river may no longer exist in reaches impacted by the upstream hydropower projects, or if they do, only in low abundance. For instance, surveys in the last five years have not recorded species such as *Labeobarbus leleupan*us and *Acapoeta tanganicae* which were recorded in surveys in the mid 1950's with some last recorded in the early 1980's based on records of the Central African Museum in Brussels. It also includes threatened and restricted range species such as *Chiloglanis ruziziensis* (CR) and *Chiloglanis asymetricaudalis* (EN) which are typically associated with rapids and riffles, as well as several other migratory species endemic to the Ruzizi Basin or region.

Although the aquatic ecosystem of the upper and Ruzizi River in the area of project influence is assessed as modified habitat, and does not have critical habitat qualifying species, it provides habitat for several non-threatened migratory species, particularly in the *Labeo* and *Labeobarbus* genera. This is described in detail in the Aquatic Ecology section of the Environmental Baseline chapter and Critical Habitat Assessment.

Besides the obvious barrier effect of dams that restrict upstream fish migration, hydropeaking downstream of hydropower facilities affects foraging, refuge seeking, and predator avoidance behaviours in fishes as well affecting migration, growth, and survival. Such projects typically alter the natural hydrological cues that stimulate fish migration and breeding through altering the seasonal periodicity of water levels. Behavioural shifts to adapt to these changes can result in increased energetic costs relative to natural conditions, often resulting in decreased fish recruitment. Hydropeaking effects can also result in increased exposure to unsustainable fishing practices if fishing is easier during lower flow conditions.

The extent to which fish will be affected by the project is linked to the degree to which water depths are reduced in the dewatered reach and during off-peaking periods in downstream reaches (when the reservoir is filling). Fish typically require a depth of 0.3 m particularly over the migration and spawning season to move through the water body. Maintaining a minimum flow in this reach will also need to ensure continuity of water connectivity to assist migration by ensuring pools are not isolated from each other or do not become sedimented from lateral sediment inputs (e.g., landslides or erosion). Such effects may require the release of additional water (freshets) to flush the dewatered reach and to enhance fish migration.

Downstream impacts on fish are also linked to the rate of river level drop after peaking depending on the ramp-down rates applied, as hydropeaking operations can result in fish mortality from stranding on riverbanks or in pools if water levels drop faster than 5 cm/hour, as seen downstream of Ruzizi II HEPP. This can be managed through extending ramp down rates to reduce rate of water level drop below this threshold. Ultimately, fish monitoring will be essential to confirm the extent of impacts and adaptively manage flow releases if required.

10.5.4 Terrestrial Ecology

10.5.4.1 Riparian Vegetation

Natural Habitat on the riverbanks along all reaches of the river is limited but most of all in the dewatered zone and in the reach between the dewatered zone and Bugarama, where Natural Habitat is mostly confined to small islands in the river.

Two types of riparian vegetation are represented, namely Riparian Thicket and Riparian Wetlands. Species dependent on a wet bank are more prevalent in the Riparian Wetland community, while flow-dependent species are not well represented in either Riparian Wetland or Riparian Thicket. Riparian Thicket species are more positively associated with rocky substrate than a wet bank or river flows.

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The project-related changes are likely to be most apparent in the dewatered reach, where some limited loss of Riparian Wetland habitat is likely to occur as a result of a reduced wet bank. However, this is of minor consequence since this habitat is represented along all the reaches of the river covered in this assessment.

Downstream changes in flow, depth, velocity, and area of wet bank will be attenuated with increasing distance from the dewatered zone and are unlikely to result in any significant changes in riparian vegetation.

10.5.4.2 Riparian Fauna

The riparian avifauna, mammal and herpetofauna assemblages are characterised by low species richness and diversity along the entire stretched of the Ruzizi River covered in this assessment. Species richness is particularly low in the reach between the dewatered zone and Bugarama as a result of the small extent of Natural Habitat present in this reach.

The riparian avifauna assemblage contains surprisingly few fish-eating species although a limited number are present, with diversity increasing slightly in the reaches closer to the Burundi border. Riparian mammals such as marsh mongoose and otter species may be present throughout in small numbers, but larger herbivores such as Hippopotamus are mostly represented downstream of the Bugarama – Kamanyola Bridge and are thus unlikely to be significantly impacted by project-related changes to the river. Herpetofauna are mostly represented by widespread generalist amphibians as well as a few riparian reptile species.

None of these assemblages is likely to be significantly impacted by the by minor changes in flow, depth, velocity, area of wet bank and ramping rates.

10.5.5 Social

The social dependence of local communities on the Ruzizi River is high downstream of the power release location down to the Ruhwa confluence, but slightly lower in the dewatered stretch due to difficulty of access from surrounding villages. Downstream of the powerhouse, the social reliance on water from the Ruzizi revolves around (i) all consumptive needs, including drinking water, cooking water supply and sanitation water, (ii) fishing and fish farming and (iii) all recreational and cultural activities involving physically entering or crossing the river.

In the dewatered stretch, none of the cited elements of social dependence are likely to be affected by any discernible deviation from current conditions. Equally, downstream of the powerhouse release, water collection for consumptive use and water use for fish farming are not expected to be affected by a discernible deviation from current conditions. However, in terms of community safety the expected higher frequency of ramping up rates is likely to have a significant negative impact on local communities crossing or physically entering the river. In fact, it is expected that ramp-up rates over 5 cm/minute, a threshold which has been selected as critical for community safety, are likely to be exceeded more frequently than they are in current conditions. In the downstream stretches of the Ruzizi, the expected higher frequency of ramping down rates is also likely to have a negative impact on the availability of fish in the long term, potentially threatening the productivity of fishing activities.

The assumptions and limitations of the assessment of social dependence are related to the adopted methodology as described more fully in the Social Baseline Situation chapter. Identified limitations include poor definition of village boundaries, time constraints in conducting formal interviews, gender-imbalance of the DRC social team, and limited, partial consultation of Historically Marginalised People.

10.5.6 EFlows

The EFlow assessment that has been undertaken has considered the ecological and social functional relationships with the hydrological and hydraulic characteristics of the reach between

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the Ruzizi III dam wall and powerhouse tail race (the dewatered reach), the reach downstream of the powerhouse tail race to the Burundi border (the hydropeaking reach), and the extended hydropeaking reach from the Burundi Border to Lake Tanganyika.

A **medium-resolution assessment has been applied** considering key characteristics of the Project. Although the Project is located in a context which would appear to suggest that a high-resolution assessment is required (i.e. potential significant transboundary issues and lowest position in a cascade), it is located in a reach that is already heavily modified (due to the presence and operation of upstream Ruzizi I and II HEPP). These aspects suggest that a medium-resolution assessment, as performed for the Project, is sufficient to adequately assess the flow-related impacts of the project on the downstream environment.

The sufficiency of a medium-resolution assessment in the project affected area has been confirmed by a broad-scale assessment of the hydrological and hydraulic characteristics in the extended study area downstream of the border with Burundi (**no potential significant transboundary issues have been identified**), and by the results of the accompanying Critical Habitat Assessment that has confirmed the project is not located in or will impact on potential Critical Habitat qualifying features.

The **impacts associated with a constant 10% MAF environmental flow in the dewatered reach and expected hydropeaking operations (based on optimised energy revenue), and the proposed associated mitigation measures, are presented in the Impact Assessment & Mitigation chapter** of this report. Associated mitigation measures include hydrological measures (e.g., improved hydrological and hydraulic characterisation of micro-/meso-scale habitats and monitoring), sediment management measures (e.g., development of a Dewatered Reach Sediment Management Plan), and aquatic habitat and biodiversity measures (e.g., release freshets of at least 50 m^3/s over a few days on a biannual basis, fish monitoring).

An associated framework level Environmental Flow Management Plan (EFMP) that outlines and describes activities required to implement, monitor, and review the proposed operational flow regime from the perspective of adaptive management is included in the associated Environmental and Social Management Plan (ESMP).

This 'framework' EFMP will need to be updated to an operational EFMP through further investigation and collaboration with key stakeholders including, *inter alia*, upstream HEPP operators, with the aim of agreeing and implementing an optimised flow regime that is at once socially equitable, economically efficient, and ecologically sustainable.

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11 Impact Assessment & Mitigation

PUBLIC DISCLOSURE AUTHORIZED

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Contents

11.1 Introduction 11-1

11.2 Climate Change Vulnerability 11-2

11.2.1 Introduction 11-2
11.2.2 Phase 1: Screening of the Project Climate Risks 11-2
11.2.3 Phase 2: Initial Analysis 11-3
11.2.4 Phase 3: The Climate Stress Test 11-3
11.2.5 Climate Change Vulnerability Risks 11-5
11.2.6 Phase 4: Climate Risk Management Plan 11-6
11.2.7 Phase 5: Monitoring, Reporting and Evaluation 11-6

11.3 Greenhouse Gas Emissions 11-8

11.3.1 Construction GHG Emissions 11-8
11.3.2 Reservoir GHG Emissions 11-12
11.3.3 Overall GHG Emissions 11-13
11.3.4 Comparison with Rwanda's National GHG Emissions and Worldwide Emissions 11-15
11.3.5 GHG Offsets Resulting from Project Implementation 11-15
11.3.6 Impact Significance and Mitigation Measures 11-15

11.4 Air Quality, Dust and Odour 11-17

11.4.1 Impact Producing Factors 11-17
11.4.2 Assessment of Receptor Sensitivity 11-17
11.4.3 Impacts during Pre-Construction and Construction 11-17
11.4.4 Predicted Impacts during Operation 11-20

11.5 Noise and Vibration 11-21

11.5.1 Impact Producing Factors 11-21
11.5.2 Assessment of Receptor Sensitivity 11-21
11.5.3 Predicted Impacts during Pre-Construction and Construction 11-22
11.5.4 Predicted Impacts during Operation 11-25

11.6 Soils, Groundwater and Surface Water 11-27

11.6.1 Impact Producing Factors 11-27
11.6.2 Assessment of Receptor Sensitivity 11-27
11.6.3 Predicted Impacts during Pre-Construction and Construction 11-29
11.6.4 Predicted Impacts during Operation 11-33

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

11.7 Hydrology 11-35

11.7.1 Impact Producing Factors 11-35
11.7.2 Assessment of Receptor Sensitivity 11-35
11.7.3 Predicted Impacts during Pre-Construction and Construction 11-36
11.7.4 Predicted Impacts during Operation 11-37

11.8 Geomorphology and Sediment Transport 11-41

11.8.1 Impact Producing Factors 11-41
11.8.2 Assessment of Receptor Sensitivity 11-41
11.8.3 Predicted Impacts during Pre-Construction and Construction 11-42
11.8.4 Predicted Impacts during Operation 11-44

11.9 Wastes 11-46

11.9.1 Impact Producing Factors 11-46
11.9.2 Assessment of Receptor Sensitivity 11-46
11.9.3 Predicted Impacts during Pre-Construction and Construction 11-46
11.9.4 Predicted Impacts during Operation 11-49

11.10 Aquatic Habitats and Biodiversity 11-50

11.10.1 Impact Producing Factors 11-50
11.10.2 Assessment of Receptor Sensitivity / Importance 11-50
11.10.3 Predicted Impacts during Pre-Construction, Construction and Reservoir Filling 11-52
11.10.4 Predicted Impacts during Operation 11-57

11.11 Terrestrial Habitats and Biodiversity 11-71

11.11.1 Impact Producing Factors 11-71
11.11.2 Assessment of Receptor Sensitivity 11-71
11.11.3 Potential Impacts during Pre-Construction, Construction & Reservoir Filling 11-72
11.11.4 Predicted Impacts during Operation 11-79

11.12 Impacts on Local Communities' Livelihoods . 11-84

11.12.1 Impact Producing Factors 11-84
11.12.2 Overview of Land Acquisition and Involuntary Resettlement Impacts 11-84
11.12.3 Assessment of Receptor Sensitivity 11-86
11.12.4 Predicted Impacts during Pre-Construction and Construction 11-88
11.12.5 Predicted Impacts during Operation 11-89

11.13 Labour and Working Conditions 11-91

11.13.1 Working Conditions and Management of Worker Relationships 11-91
11.13.2 Protecting the Work Force 11-93

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

11.13.3 Occupational Health and Safety 11-94
11.13.4 Workers Engaged by Third Parties 11-95

11.14 Community Health and Safety 11-101

11.14.1 Health and Safety Hazards 11-101
11.14.2 Health and Safety Management Measures 11-103
11.14.3 Project Induced In-Migration Health & Safety Risks 11-109

11.15 Human Rights 11-117

11.16 Gender-related Risks and Impacts 11-119

11.16.1 Land Tenure and Livelihood Security Impacts 11-120
11.16.2 Gender-based Violence Impacts 11-120

11.17 Cultural Heritage 11-123

11.17.1 Impact Producing Factors 11-123
11.17.2 Assessment of Receptors Sensitivity 11-123
11.17.3 Predicted Impacts during Pre-Construction and Construction 11-127
11.17.4 Predicted Impacts during Operation 11-131

11.18 Ecosystem Services 11-133

11.18.1 Ecosystems Services the Project Could Impact 11-133
11.18.2 Ecosystem Services Screening 11-133
11.18.3 Ecosystem Services Scoping 11-134
11.18.4 Types and Value of Ecosystem Services 11-134
11.18.5 Ecosystem Services Assessment 11-140

11.19 Landscape and Visual Amenity 11-142

11.19.1 Impact Producing Factors 11-142
11.19.2 Assessment of Landscape Value and Visual Sensitivity 11-142
11.19.3 Predicted Impacts 11-146

11.20 Positive Impacts and Benefits 11-150

11.20.1 Impact Producing Factors 11-150
11.20.2 Predicted Impacts during Pre-Construction and Construction 11-150
11.20.3 Predicted Impacts during Operation 11-150
11.20.4 Local Area Development Plan 11-151

11.21 Impacts on Historically Marginalised People 11-152

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED



11.22 Recap of Impacts and Mitigation Measures. 11-152

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Tables

Table 11-1 Sensitivity analysis range of changes 11-3
Table 11-2 Climate Change Projections Plausibility Range 11-4
Table 11-3 Plausibility Thresholds for Cascade's Mean Energy with Projected Climate Changes 11-4
Table 11-4 Plausibility Thresholds of the Energy Guaranteed at 95% in the Cascade with Projected Climate Changes 11-4
Table 11-5 Plausibility Thresholds of the Sedimentation Rate with Projected Climate Changes 11-5
Table 11-6 Recommended Monitoring for Hydropower Generation and Flood Security 11-7
Table 11-7 Estimated Quantities of Construction Materials 11-9
Table 11-8 Estimated GHG Emissions from Construction 11-12
Table 11-9 – Overall Construction and Reservoir GHG Emissions Averaged over 100 Years 11-13
Table 11-10 – Project Emissions Compared with Rwanda's National and Worldwide Emissions 11-15
Table 11-11 – GHG Offset from Project Implementation 11-15
Table 11-12 Air Quality Sensitivity Criteria 11-18
Table 11-13 Air Quality Impact Magnitude Criteria 11-18
Table 11-14 Potential Impacts - Air Quality & Odour during Pre-Construction/Construction 11-19
Table 11-15 Mitigations & Residual Impacts - Air Quality & Odour during Pre-Construction/ Construction 11-19
Table 11-16 Potential Impacts - Air Quality & Odour during Operation 11-20
Table 11-17 Noise and Vibration Receptor Sensitivity 11-21
Table 11-18 Noise Impact Magnitude Criteria 11-22
Table 11-19 Potential Impacts – Noise & Vibration during Pre-Construction/ Construction 11-23
Table 11-20 Mitigations & Residual Impacts – Noise & Vibration during Pre-Construction/ Construction ..11-24
Table 11-21 Potential Impacts – Noise and Vibration during Operation 11-25
Table 11-22 Mitigations & Residual Impacts – Noise and Vibration during Operation 11-26
Table 11-23 Geology and Soils Sensitivity Criteria 11-28
Table 11-24 Soils, Groundwater, Surface Water Impact Magnitude Criteria 11-29
Table 11-25 Potential Impacts – Soils, Groundwater & Surface Water during Pre-Construction/Construction 11-30
Table 11-26 Mitigations & Residual Impacts – Geology & Soils during Pre-Construction/Construction ... 11-31
Table 11-27 Potential Impacts – Soils, Groundwater & Surface Water during Operation 11-33
Table 11-28 Mitigations & Residual Impacts – Soils, Groundwater & Surface Water during Operation 11-33
Table 11-29 Hydrology Sensitivity Criteria 11-35
Table 11-30 Hydrology Alteration Magnitude Criteria 11-36
Table 11-31 Potential Impacts – Hydrology during Pre-Construction and Construction 11-37
Table 11-32 Potential Impacts – Hydrology during Operation 11-37
Table 11-33 Mitigations & Residual Impacts – Hydrology during Operation 11-39

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Table 11-34 Geomorphology and Sediment Sensitivity Criteria 11-41

Table 11-35 Geomorphology and Sediment Transport Alteration Magnitude Criteria 11-42

Table 11-36 Potential Impacts – Geomorphology and Sediment Transport during Pre-Construction/Construction 11-42

Table 11-37 Mitigations & Residual Impacts – Geomorphology & Sediment Transport during Pre-Construction/Construction 11-43

Table 11-38 Potential Impacts – Geomorphology and Sediment Transport during Operation 11-44

Table 11-39 Mitigations & Residual Impacts – Geomorphology and Sediment Transport during Operation 11-45

Table 11-40 Waste Impact Significance Criteria 11-47

Table 11-41 Assessment of Potential Impacts – Wastes during Pre-Construction/Construction 11-47

Table 11-42 Mitigations & Residual Impacts – Wastes during Pre-Construction/Construction 11-48

Table 11-43 Aquatic Habitat and Biodiversity Impact Magnitude Criteria 11-50

Table 11-44 Aquatic Habitat and Biodiversity Sensitivity Criteria 11-51

Table 11-45 Summary of Impacts on Aquatic Habitats and Biodiversity during Pre-Construction/Construction & Reservoir Filling 11-56

Table 11-46 Mitigations & Residual Impacts – Aquatic Habitat & Biodiversity during Operation. 11-67

Table 11-47 Terrestrial Habitat and Biodiversity Impact Magnitude Criteria 11-71

Table 11-48 Terrestrial Habitat and Biodiversity Sensitivity Criteria 11-72

Table 11-49 Summary of Impact on Terrestrial Habitat & Biodiversity during Pre-Construction/Construction and Reservoir Filling 11-76

Table 11-50 Summary of Impacts on Terrestrial Habitats & Biodiversity during Operation 11-83

Table 11-51 Overview of Estimated Involuntary Resettlement Impacts 11-85

Table 11-52 – Estimated Number of Physically Displaced People (2022 Preliminary Census) 11-85

Table 11-53 – Estimated Economic Displacement, Disaggregated by Country and Sector/Groupement (2022 Preliminary Census) 11-86

Table 11-54 – Estimated Loss of Structures (Residential and Non-Residential) 11-86

Table 11-55 Estimated Loss of Crops and Trees 11-86

Table 11-56 Criteria for Determining Sensitivity 11-87

Table 11-57 Percentage of Households per Vulnerability Category 11-88

Table 11-58 Criteria for Determining Magnitude 11-88

Table 11-59 Potential Impacts – Physical & Economic Displacement during Pre-Construction/Construction 11-89

Table 11-60 Mitigations & Residual Impacts – Physical & Economic Displacement during Pre-Construction/Construction 11-89

Table 11-61 Potential Impacts – Local Communities' Livelihoods during Operation 11-90

Table 11-62 Mitigations & Residual Impacts – Local Communities' Livelihoods during Operation 11-90

Table 11-63 Potential Impacts – Occupational Health & Safety during Construction 11-96

Table 11-64 Potential Impacts – Occupational Health & Safety during Operation 11-99

Table 11-65 Hazards for Community Health and Safety during Construction 11-101

Table 11-66 Hazards for Community Health and Safety during Operation 11-102

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

Table 11-67 Community Health and Safety Management Measures – Construction and Operation 11-104
Table 11-68 Assessment of Risks and Magnitude of Project Related In-Migration 11-109
Table 11-69 Influx Scenario Compared to the Existing Population in the Villages close to the Construction Camp 11-111
Table 11-70 Factors Increasing the Risks Related to Influx Management 11-114
Table 11-71 Human Rights in the ESIA 11-117
Table 11-72 Cultural Heritage Receptor Sensitivity 11-124
Table 11-73 List of Potential Cultural Heritage Receptors 11-125
Table 11-74 Cultural Heritage Impacts Magnitude Criteria 11-127
Table 11-75 Potential Impacts on Cultural Heritage during Pre-Construction/ Construction 11-128
Table 11-76 Mitigations & Residual Impacts – Impacts on Cultural Heritage during Pre-Construction/ Construction 11-131
Table 11-77 Potential Impacts on Cultural Heritage during Operation 11-132
Table 11-78 Mitigations & Residual Impacts on Cultural Heritage during Operation 11-132
Table 11-79 Ecosystems and Habitats 11-133
Table 11-80 Ecosystem Services Potentially Present in the Study Area 11-133
Table 11-81 Values of Ecosystem Services in the Study Area 11-135
Table 82 – Mitigation Measures for impacted Ecosystem Services 11-140
Table 11-83 Landscape and Visual Amenity Receptor Sensitivity Classification 11-145
Table 11-84 Assessment of Sensitivity of Landscape Character 11-145
Table 11-85 Assessment of Sensitivity of Visual Receptors 11-146
Table 11-86 Landscape and Visual Amenity Receptor Sensitivity Classification 11-146
Table 11-87 Potential Impacts – Landscape & Visual Amenity during Pre-Construction/Construction. 11-148
Table 11-88 Potential Impacts – Landscape & Visual Amenity during Operation 11-149
Table 11-89 Summary of Potential Impact and Risks and Mitigation Measures 11-153

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Figures

Figure 11-1 Vulnerability Indicators Defined for the Great Lakes Region and Ruzizi Plain 11-3

Figure 11-2 Reservoir GHG Emissions 11-13

Figure 11-3 Construction and Reservoir GHG Emissions 11-14

Figure 11-4 Comparison of Project Emissions with Worldwide Benchmark Values 11-14

Figure 11-5 Photographs illustrating effective console designs for reducing the risk of electrocution. Source – RPS (2021). 11-81

Figure 11-6 Photographs illustrating the various types of bird diverters that can be fitted on the transmission line to mitigate against bird collisions 11-82

Figure 11-7 – Construction Camp and Potential Areas Targeted by Project-Induced In-Migration 11-112

Figure 11-8 – Location of Cultural Heritage Elements Receptors of Potential Impacts 11-126

Figure 11-9 – Church affected by the Access Road in DRC 11-129

Figure 11-10 – Baptism sites and island used as a praying site, close to the Access Roads 11-130

Figure 11-11 View on the Ruzizi gorge from the Plateau (Rwanda) toward Southeast 11-143

Figure 11-12 View on the Ruzizi floodplain (from Rwanda) toward North West 11-144

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

11.1 Introduction

This chapter provides the assessment of the Project impacts and mitigation measures. It is structured as per the IHA guideline for Hydropower Environmental and Social Assessment and Management (IHA, 2021).

The chapter is broken down into topics which correspond to the receptors that make up the physical, biological and socioeconomic environment. In addition to the receptors, the topics of climate change vulnerability, greenhouse gas emissions and waste are also included.

The methodology used for the assessment is described in Chapter 3 – ESIA Process and Methodology. However, for ease of reading and to avoid cross-referencing, receptor specific criteria for sensitivity and impact magnitudes are provided in this assessment chapter.

To produce a concise document the assessment has been prepared avoiding repetition of detailed information from the Project Description (Chapter 4) and the Description of the Baseline Situation (Chapters 7 and 8). Therefore, the reader may need to refer to these chapter when more detailed information on impact producing activities and the affected environment is required.

General outlines of mitigation measures to reduce the magnitude of significant impacts are listed in the assessment. However, the reader should refer to the Environmental and Social Management Plan (ESMP) for more detailed descriptions of these measures, information on responsibilities and descriptions of tangible actions and processes for implementation.

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11.2 Climate Change Vulnerability

11.2.1 Introduction

The Project's climate vulnerability has been assessed by Tractebel during the feasibility study through the application of the Hydropower Sector Climate Resilience Guide (Tractebel, 2020c). Consideration is given to climate vulnerability risks associated with both hydrological inflows and flood risk.

The assessment of climate vulnerability of the Project follows the five-phase approach outlined in the Climate Resilience Guide:

- Phase 1: Screening of the Project Climate Risks.
- Phase 2: Initial Analysis.
- Phase 3: The Climate Stress Test.
- Phase 4: Climate Risk Management Plan.
- Phase 5: Monitoring, Reporting and Evaluation.

11.2.2 Phase 1: Screening of the Project Climate Risks

The screening of Project climate risks considered the geographic, regulatory, technical and socioeconomic conditions of the Project.

According to the Government of the Netherlands, 2019 (as cited in Tractebel, 2020c), DRC and Rwanda are estimated to be the most vulnerable to climate change in the Ruzizi Plain due to the high density in this region (2,000 people per km^2), a large dependency on natural resources and an agricultural productivity considered to be particularly low. Vulnerability indicators defined for the Great Lakes Region and Ruzizi Plain are presented in Figure 11-1 (next page).

Hydro-meteorological data collected for the study included Ruzizi II inflows, Lake Kivu water levels, Ruzizi I and II turbined flows, minimum and maximum temperatures, ground rainfall data, precipitation data, evapotranspiration, Intensity-Duration-Frequency (IDF) curves, land use and sedimentation rate at Ruzizi II.

Project uncertainties, beside climate change, were noted to be as follows:

Economic	Environmental & Social	Regulatory	Technical
Cost of debt	Requirements for environmental flows	Country and regional constraints on the operation of the project	Hydro-meteorological data uncertainty
Cost of equity	Development limitations identified in the ESIA	Details of the PPA	Geological data uncertainty
Electricity pricing	Regulatory changes	Regulatory constraints on power trading imposed by power pools	
Interest rate	Water use changes	Political instability	
Discount rate	Land use changes		

Precipitation, streamflow and temperature were identified to be key climate stressors.

A number of risks and opportunities were identified for further assessment in subsequent phases.

Hydropower generation, flood security, environmental and social, and economic performance metrics and criteria were defined.

Phase 1 concluded that climate change posed a threat to the Project and therefore the assessment continued to Phase 2 of the IHA guideline.

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Variable	Indicator	Year	Vulnerability level		
			Burundi	DRC	Rwanda
Environmental disasters	Drought	2010	high	high	high
		2030	high	high	high
	Floods and landslides	2010	moderate	moderate	moderate
		2030	high	moderate	moderate
	Storms	2010	low	low	low
		2030	low	low	low
	Wildfires	2010	low	moderate	low
		2030	low	moderate	low
Environmental disasters	Agriculture	2010	acute	high	acute
		2030	acute	severe	acute
	Fisheries	2010	high	severe	moderate
		2030	acute	acute	moderate
Health impact	Hunger	2010	severe	acute	high
		2030	severe	acute	high
Total climate (including the factors above + 15 others)		**2010**	**severe**	**severe**	**high**
		2030	**acute**	**acute**	**severe**

Source: Government of the Netherlands, 2019 (as cited in Tractebel, 2020c)

Figure 11-1 Vulnerability Indicators Defined for the Great Lakes Region and Ruzizi Plain

11.2.3 Phase 2: Initial Analysis

The initial analysis determined an appropriate methodology for the climate stress test conducted under Phase 3. A climate baseline scenario was defined – adopting a 30-year period (from 1976 to 2005) as recommended in the IHA guidelines. A performance baseline for the same period was also established.

Additional data using the future Coupled Model Intercomparison Project Phase 5 (CMIP5) temperature and precipitation projections was collected. Two 30-year time-periods were considered for the analysis of the future in the Ruzizi River basin: 2020-2049 and 2050-2079, for Near-Term and Long-Term future hydro-climatic conditions respectively.

The ranges of changes forming the framework for the sensitivity analysis are summarized in Table 11-1 for each parameter.

Table 11-1 Sensitivity analysis range of changes

Parameter	Sensitivity analysis range
Mean Annual Temperature	From 0°C to +4°C
Mean Annual Precipitation	From -10% to +50%
Inter-Annual Precipitation Variability	From -20% to +90%
Intra-Annual Precipitation Variability	From -20% to +80%

The IHA guidelines were followed in determining the approach to be applied to the climate stress test in Phase 3; a semi-comprehensive approach was chosen.

11.2.4 Phase 3: The Climate Stress Test

Using the outcomes of Phases 1 and 2, projected climate change for the Project area is based on downscaled IPCC CMIP5 data for both Near-Term (2020-2049) and Long-Term (2050-2079) futures for different pathway scenarios (RCP 4.5, RCP 6.0, and RCP 8.5). Projected change

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in mean annual temperature, mean annual precipitation, inter-annual variability of precipitation, and intra-annual variability of precipitation have been assessed and "plausible thresholds/ranges" have been identified, as shown in Table 11-2.

Table 11-2 Climate Change Projections Plausibility Range

Parameter	Classification	2020-2049	2050-2079
Temperature	Most plausible	+1.2°C	+2.2°C
	Plausible	+0.9°C and +1.7°C	+1.5°C and +3.4°C
	Less plausible	+0.5°C and +1.8 °C	+1.2°C and +3.8°C
Precipitation	Most plausible	+2.7%	+5.2%
	Plausible	-2.9% and +11.7%	-2.0% and +19.2%
	Less plausible	-4.8% and +18.3%	-9.0% and +41.1%
Inter-annual variability	Most plausible	+7.4%	+14.9%
	Plausible	-2.8% and +21.5%	-0.1% and +31.6%
	Less plausible	-8.8% and +40.2%	-19.8% and +75.7%
Intra-annual variability	Most plausible	+5.4%	+8.8%
	Plausible	-2.5% and +17.3%	-1.8% and +28.0%
	Less plausible	-5.7% and +29.1%	-16.1% and +64.7%
Source: CIMP5 projection, Tractebel, 2020c			

A Hydropower Generation

Climate stress test results for hydropower generation based on combining climate change plausibility values with the hydrological model (Tractebel, August 2020) are shown in the following tables.

Table 11-3 Plausibility Thresholds for Cascade's Mean Energy with Projected Climate Changes

Classification	2020-2049			2050-2079		
	Original (GWh)	Alt. 1,130m (GWh)	Alt. 1,145m (GWh)	Original (GWh)	Alt. 1,130m (GWh)	Alt. 1,145m (GWh)
Baseline	1,219	1,426	1,542	1,219	1,426	1,542
Most plausible	1,210	1,415	1,530	1,210	1,415	1,530
Plausible	1,137 – 1,289	1,330 – 1,507	1,438 – 1,630	1,096 – 1,378	1,281 – 1,611	1,386 – 1,742
Less plausible	1,064 – 1,437	1,244 – 1,680	1,346 – 1,816	959 – 1,612	1,121 – 1,884	1,213 – 2,037
Source: CIMP5 projection, Tractebel, 2020c						

Table 11-4 Plausibility Thresholds of the Energy Guaranteed at 95% in the Cascade with Projected Climate Changes

Classification	2020-2049			2050-2079		
	Original (GWh)	Alt. 1,130m (GWh)	Alt. 1,145m (GWh)	Original (GWh)	Alt. 1,130m (GWh)	Alt. 1,145m (GWh)
Baseline	993	1,162	1,256	993	1,162	1,256
Most plausible	973	1,138	1,231	971	1,136	1,228
Plausible	904 – 1,041	1,057 – 1,217	1,143 – 1,316	869 – 1,149	1,016 – 1,343	1,099 – 1,452
Less plausible	838 – 1,203	980 – 1,406	1,060 – 1,521	752 – 1,415	880 – 1,655	951 – 1,790
Source: Tractebel, 2020c						

- The most plausible future energy production is comparable to the current baseline: i) projected differences are less than 1% for mean annual energy production; and ii) energy guaranteed at 95% is projected to reduce by approximately 2%.
- The plausible future energy production shows variation from the baseline: i) mean annual energy production is projected to change by between -7% and +6% in the Near-Term and -10% and +13% in the Long-Term; and ii) energy guaranteed at 95% is projected to change by between -9% and +5% in the Near-Term and -13% and +16% in the Long-Term.

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B Sedimentation

Sedimentation of the Ruzizi III dam site is assumed to only depend on precipitation in the inter-catchment between Ruzizi II and Ruzizi III. Climate stress test for sedimentation is shown in the table below.

Table 11-5 Plausibility Thresholds of the Sedimentation Rate with Projected Climate Changes

Classification	2020-2049	2050-2079
	All designs (1,000 m^3/year)	All designs (1,000 m^3/year)
Baseline	204	204
Most plausible	209	214
Plausible	202 – 216	202 – 229
Less plausible	195 - 233	193 - 281
Source: Tractebel, 2020c		

For most of the projections, the Ruzizi III dam will be filled with sediments more quickly than with the sedimentation performance baseline. Efforts to block or remove sediments would need to be intensified in the future, and even more in the long-term compared to the short-term. In addition to increasing sedimentation, more frequent and intense precipitation events are likely to increase soil erosion, which could potentially increase the risk of landslide.

C Flood Security

The climate stress test also addresses flood security. The Clausius-Clapeyron equation has been used to relate projected changes in temperature to water-vapour holding capacity such that a projected 1 °C change in air temperature would lead to an increase of 10.5% in rainfall intensity:

- In the most plausible scenario, the 100-year return period flood is projected to increase by 23% in the Near-Term and 43% in the Long-Term, the check flood is similarly projected to increase by 15% and 28%.
- In the plausible scenario, the 100-year return period flood is projected to change by between 17% and 33% (Near-Term) and between 29% and 68% (Long-Term), and the check flood is projected to change by between 11% and 22% (Near-Term) and between 19% and 44% (Long-Term).

D Environmental Flows

Environmental flows to Ruzizi III are very small compared to the minimum discharge estimated for the baseline period (1976-2005). Inflows are not projected to change much in the future (most plausible scenario).

11.2.5 Climate Change Vulnerability Risks

As guided by the IHA guidelines, risks and opportunities due to identified climate stressors (precipitation and streamflow & temperature) were first identified during Phase 1 and updated in subsequent phases based on additional data collection and taking into account the sensitivity of the system to climate stressors.

Climate change risks are given for high / very high project identified risks:

- Change in precipitation and streamflow results in increased sediment loads that impacts reservoir storage and result in damage to gates and turbines.
- Change in precipitation and streamflow results in more intense floods that results in overtopping of the rockfill dam, and flooding of the powerhouse and access roads.
- Change in temperature results in increased air temperature that results in powerhouse equipment failure due to heat.
- Change in temperature results in increase evaporation from Lake Kivu resulting in reduced water availability for power generation.

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The risk of decreased inflows and impact on energy production is identified as a medium risk and on downstream users as a low / negligible risk.

11.2.6 Phase 4: Climate Risk Management Plan

Design modification measures that have been included in the 2021 Feasibility Study that would increase the resilience of the system are given as:

- Landslide security – the alternative dam site which avoids a landslide risk area has been adopted.
- Hydropower generation – increased equipment design capacity, turbining of environmental flows, increase in the size of power waterways and room made available for an additional turbine if needed.
- Flood security – additional tunnel and gated spillway / increase spillway weir width or lower weir elevation, powerhouse protection, and increase the elevation of the access roads.

Adaptation measures that are to be implemented include 1) structural adaptation measures to update the design of some components and 2) functional adaptation measures to update the operation of the Project. These are:

[M 1] Slope stability shall be monitored and if necessary, dam and reservoir bank protection features shall be constructed to protect structures from landslides.

[M 2] Hydro-meteorological data (temperature, precipitation, river flow) and sedimentation shall be monitored.

[M 3] Consider the use of alternative energy sources such as solar energy.

[M 4] Project infrastructure shall be monitored for damage (gates and turbines) and electrical equipment failures and regular maintenance of facilities undertaken.

[M 5] A sediment management system shall be developed and implemented that includes provision for watershed management to reduce erosion, and dredging of the reservoir, if needed.

[M 6] Revegetation of the river basin should be considered to improve infiltration, reduce sedimentation and minimise flooding of infrastructure.

[M 7] Changes in the energy generation schedule, hourly or seasonally, resulting in a change in grid requirements shall be monitored.

[M 8] A data management system that makes provision for proper storage of data, proper monitoring and formatting of metadata, documenting the full history of the data (e.g., who took the data, when and how) and preservation of raw data shall be implemented and maintained.

[M 9] The Climate Risk Assessment should be updated every 10 years as new data and projections become available, following the IHA Guidelines relevant at the time.

11.2.7 Phase 5: Monitoring, Reporting and Evaluation

In addition to the monitoring measures outlined above, performance monitoring and driver monitoring are recommended as presented in the table below.

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Table 11-6 Recommended Monitoring for Hydropower Generation and Flood Security

Function	Monitoring metric	Reporting frequency
Hydropower generation: performance monitoring	Power outages and availability limitations (days per month)	Daily
	Energy produced (GWh)	Monthly and annual
Hydropower generation: driver monitoring	Precipitation (mm)	Monthly
	Temperature (°C)	Daily (but monthly acceptable)
	Inflows (m^3/s)	Monthly
	Sedimentation rate in the river (m^3/s)	Twice and once a month for the high and low flow season respectively
	Sedimentation in the reservoir (hm^3)	Every 5 to 10 years
Flood security	Precipitation (mm)	Hourly
	Inflows (m^3/s)	Hourly
Landslide security	Risk location and volume (frequency and m^3)	Event based
Source: Tractebel, 2020c		

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11.3 Greenhouse Gas Emissions

11.3.1 Construction GHG Emissions

The Construction GHG emissions have been estimated using an approach that is in alignment with that developed by United Nations Educational, Scientific and Cultural Organization/International Hydropower Association (UNESCO/IHA) (2016).

The manufacture, transportation and installation of Project infrastructure can lead to emissions of GHG. These emissions are a one-off source of GHG that can be attributed to the services that the reservoir provides. The estimate of the construction phase GHG emissions provides an indicative estimate of the construction phase emissions which includes the manufacture of raw materials, transportation of materials to, from and around the site, and the energy use from plant use for installation of Project infrastructure. The assessment provides an order of magnitude level of accuracy, as the emissions are predicted to be small in comparison with the reservoir. The calculation of GHG emissions is based on a simple set of equations that relate the amount of material, plant or unit of transport to a GHG emission factor, along the following logic:

GHG Emissions = Amount of Consumption or Activity x Emission Rate per Unit of Activity

Material consumption is expressed in terms of volume or mass. Construction plant is expressed in terms of energy expressed as electricity use. Construction transport is expressed in terms of tonne-kilometre, which is a unit that combines the amount of material being transported over a distance. The calculation used in this assessment is as follows:

GHG =	Concrete (m^3) x concrete material Emission Factor (EF) ($kgCO2e/m^3$) + mass (tonne) x distance (km) x transport EF (kgCO2e/t.km) + concrete (m^3) x plant EF ($kgCO2e/m^3$)

Each unit of activity is combined with an Emission Factor (EF), which have been sourced from the following references:

- Materials:
  - The Inventory of Carbon and Energy (ICE) V2.0, The University of Bath, 2011
  - The World Bank Carbon Emissions Estimating Tool (CEET), 2014
  - The Civil Engineering Standard of Method and Measurement Fourth Edition (CESMM4), 2012
- Construction Transport
  - The Greenhouse Gas (GHG) Protocol
- Construction Plant
  - The Civil Engineering Standard of Method and Measurement Fourth Edition (CESMM4), 2012

The input data for construction GHG emissions are presented in Table 11-7 and emissions calculation and estimated emissions provided in Table 11-8.

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Table 11-7 Estimated Quantities of Construction Materials

Item	Type	Quantity	Unit
Upstream cofferdam			
Clay core	Earth and Rock	14,701	m^3
Filter/Drain/Transition	Earth and Rock	29,403	m^3
Rockfill	Earth and Rock	30,235	m^3
Rip rap	Earth and Rock	3,920	m^3
Dam			
Excavation - Open air - Soil	Earth and Rock	13,554	m^3
Clay core	Earth and Rock	162,463	m^3
Filter/Drain/Transition	Earth and Rock	64,019	m^3
Rockfill	Earth and Rock	635,620	m^3
Rip rap	Earth and Rock	90,206	m^3
LB platform			
Excavation - Open air - Soil	Earth and Rock	6,520	m^3
Excavation - Open air - Rock	Earth and Rock	58,680	m^3
Shotcrete - Open air	Concrete	94	m^3
Spillway			
Open air spillway - Inlet, weir, chute, energy dissipation			
Excavation - Open air - Soil	Earth and Rock	10,800	m^3
Excavation - Open air - Rock	Earth and Rock	97,200	m^3
Concrete - Open air - structural	Earth and Rock	8,581	m^3
Reinforcement steel	Steel	520	Tonnes
Bottom Outlet			
Inlet			
Excavation - Open air - Rock	Earth and Rock	7,139	m^3
Concrete - Open air - structural	Concrete	3,073	m^3
Reinforcement steel	Steel	292	Tonnes
Shotcrete - Open air (incl. wire mesh)	Concrete	41	m^3
Tunnel			
Excavation - Tunnel - Rock I-III	Earth and Rock	4,756	m^3
Concrete - Underground - Structural (incl. formwork)	Concrete	1,499	m^3
Reinforcement steel	Steel	229	Tonnes
Shotcrete - Underground	Concrete	236	m^3
Energy dissipation			
Excavation - Open air - Rock	Earth and Rock	954	m^3
Concrete - Open air - structural	Concrete	434	m^3
Reinforcement steel	Steel	33	Tonnes
Shotcrete - Open air	Concrete	9	m^3

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Table 11-7 Estimated Quantities of Construction Materials (*Cont.*)

Item	Type	Quantity	Unit
Diversion Tunnel			
Portals			
Excavation - Open air - Rock	Earth and Rock	8,739	m^3
Concrete - Open air - structural	Concrete	600	m^3
Reinforcement steel	Steel	36	Tonnes
Shotcrete - Open air	Concrete	43	m^3
Tunnel			
Excavation - Tunnel - Rock I-III	Earth and Rock	4,756	m^3
Concrete - Underground - Structural	Concrete	1,499	m^3
Reinforcement steel	Steel	229	Tonnes
Shotcrete - Underground	Concrete	236	m^3
Power waterways			
Power intake			
Excavation - Open air - Rock	Earth and Rock	7,258	m^3
Concrete - Open air - structural	Concrete	6,500	m^3
Reinforcement steel	Steel	389	Tonnes
Shotcrete - Open air	Concrete	34	m^3
Headrace tunnel			
Excavation - Tunnel - Rock I-III	Earth and Rock	138,750	m^3
Excavation - Tunnel - Rock IV-V	Earth and Rock	46,250	m^3
Concrete - Underground - Structural	Concrete	40,300	m^3
Reinforcement steel	Steel	1,900	Tonnes
Shotcrete - Underground	Concrete	3,920	m^3
Surge tank			
Excavation - Open air - Soil	Earth and Rock	19,825	m^3
Excavation - Open air - Rock	Earth and Rock	19,825	m^3
Excavation - Shaft - Rock	Earth and Rock	34,265	m^3
Concrete - Underground - Structural	Concrete	8,265	m^3
Reinforcement steel	Steel	248	Tonnes
Shotcrete - Open air	Concrete	145	m^3
Shotcrete - Underground	Concrete	1,011	m^3
Steel-lined tunnel and penstock			
Excavation - Open air - Soil	Earth and Rock	127,400	m^3
Excavation - Open air - Rock	Earth and Rock	54,600	m^3
Excavation - Tunnel - Rock I-III	Earth and Rock	3,848	m^3
Random fill	Earth and Rock	81,478	m^3
Concrete - Open air - structural	Concrete	5,149	m^3
Concrete - Underground - Structural	Concrete	1,558	m^3
Reinforcement steel	Steel	268	Tonnes
Shotcrete - Open air	Concrete	225	m^3

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Table 11-7 Estimated Quantities of Construction Materials (*Cont.*)

Item	Type	Quantity	Unit
Diversion Tunnel			
Shotcrete - Underground	Concrete	148	m^3
Access tunnel			
Excavation - Open air - Soil	Earth and Rock	10,000	m^3
Excavation - Open air - Rock	Earth and Rock	11,600	m^3
Excavation - Tunnel - Rock I-III	Earth and Rock	9,925	m^3
Excavation - Tunnel - Rock IV-V	Earth and Rock	1,080	m^3
Concrete - Underground - Structural	Concrete	3,270	m^3
Concrete - Underground - Backfill	Concrete	165	m^3
Reinforcement steel	Steel	100	Tonnes
Shotcrete - Underground	Concrete	275	m^3
Powerhouse			
Excavation - Open air - Soil	Earth and Rock	81,131	m^3
Excavation - Open air - Rock	Earth and Rock	50,387	m^3
Random fill	Earth and Rock	27,510	m^3
Rockfill	Earth and Rock	13,255	m^3
Rip rap	Earth and Rock	3,128	m^3
Concrete - Open air - backfill	Concrete	300	m^3
Concrete - Open air - structural	Concrete	17,000	m^3
Reinforcement steel	Steel	1,530	Tonnes
Steel - structural	Steel	110	Tonnes
Switchyard			
Random fill	Earth and Rock	48,500	m^3
Concrete - Open air - backfill	Concrete	2,400	m^3
Concrete - Open air - structural	Concrete	2,000	m^3
Reinforcement steel	Steel	100	Tonnes
Roads			
Earthworks	Earth and Rock	75,790	m^3
Excavation - Open air - Soil	Earth and Rock	45,898	m^3
Excavation - Open air - Rock	Earth and Rock	81,693	m^3
Fill	Earth and Rock	185,921	m^3
Subbase	Earth and Rock	31,818	m^3
Roadbase	Earth and Rock	31,565	m^3
Concrete - Lateral drainage channels	Concrete	5,010	m^3
Concrete - Drainage channels on slopes	Concrete	1,953	m^3
Gabions	Earth and Rock	39,024	m^3

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Table 11-7 Estimated Quantities of Construction Materials (*Cont.*)

Item	Type	Quantity	Unit
Diversion Tunnel			
Minihydro Civil Works			
Excavation - Open air - Rock	Earth and Rock	1,072	m^3
Concrete - Open air - backfill	Concrete	195	m^3
Concrete - Open air - structural (incl. formwork)	Concrete	2,955	m^3
Reinforcement steel	Steel	191	Tonnes

Source: TRACTEBEL, 2021a

Table 11-8 Estimated GHG Emissions from Construction

General	Earth and Rock	Concrete	Steel
Unit of Material (UoM)	m^3	m^3	Tonnes
Quantity	2,535,042	110,542	6,175
Material			
kg/UoM	2,300	2,300	7,566
Emission Factor (kgCO2e/UoM)	21.224	342	3,190
Transport			
Distance (km)	5	5	13,000*
Emission Factor (kgCO2e/t.km)	0.2035	0.2035	0.2035
Plant			
Emission Factor (kgCO2e/UoM)	1	5.07	0
kgCO2e	62,271,405	38,625,613	143,290,258
Total CO2e (tonnes)	244,187		
* A conservative estimate is assumed and corresponds to the distance between Rwanda and China			

11.3.2 Reservoir GHG Emissions

Reservoir GHG emissions comprise carbon dioxide (CO_2) and methane (CH_4) released as a result of the biodegradation of the flooded biomass. Emissions of GHGs from the reservoir have been estimated on a yearly basis over the 100-year operating life of the Project. The approach used for the estimation and key assumptions are described as follows:

- It is assumed that all the organic carbon present in the flooded soils is progressively biodegraded through an anaerobic biodegradation process producing CH_4. This is a conservative assumption as it is probable that some of the organic carbon may biodegrade aerobically producing CO_2. However, this assumption is made in order not to underestimate the emissions. It is assumed that carbon content of flooded soils is 12 kg/m^2, this is the high end of typical values recommended by the IHA G-Res tool v2.1 technical documentation (Prairie et al, 2017). It is assumed that all the carbon to a depth of 30 cm is biodegraded, as per IHA technical documentation.
- The is also assumed that all the organic carbon in the flooded above ground biomass biodegrades anaerobically producing CH_4. The quantity of organic carbon in the biomass has been calculated using the carbon content value of tropical mountain savanna vegetation quoted in the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). Mountain savanna has a carbon content of 30 t/ha, but a value of 15 t/ha is used in the calculation to take into account that the vast majority of the reservoir area is cultivated, and that the crops will be harvested before reservoir filling, and that during the time between harvesting and reservoir filling the natural vegetation will only partially grow back. This is considered a conservative assumption.
- A hypothetical 5-year half-life is used as the time constant for the biodegradation of the soft biomass, i.e. 50% of the biomass has biodegraded in the first 5 years following inundation and 75% will have biodegraded after 10 years. A 20-year half-life is used as the

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time constant for the biodegradation of the hard biomass. A 15-year half-life is used as the time constant for the biodegradation of the biomass in soils. The adapted hypothetical time constants are considered as precautionary. This is because when using these values, the theoretical amount of carbon dioxide produced during the operating life of the reservoir is maximised. Use of a faster decay rate would predict the same total amount of carbon dioxide produced during the operating life of the Project – though produced in a shorted time-period, which is probably not realistic. A longer decay rate would assume that not all the carbon was biodegraded in operating life of the Project, and this would minimise the potential amount of carbon dioxide that could be produced.

The evolution of the reservoir GHG emissions over a 100-year period is presented in Figure 11-2.

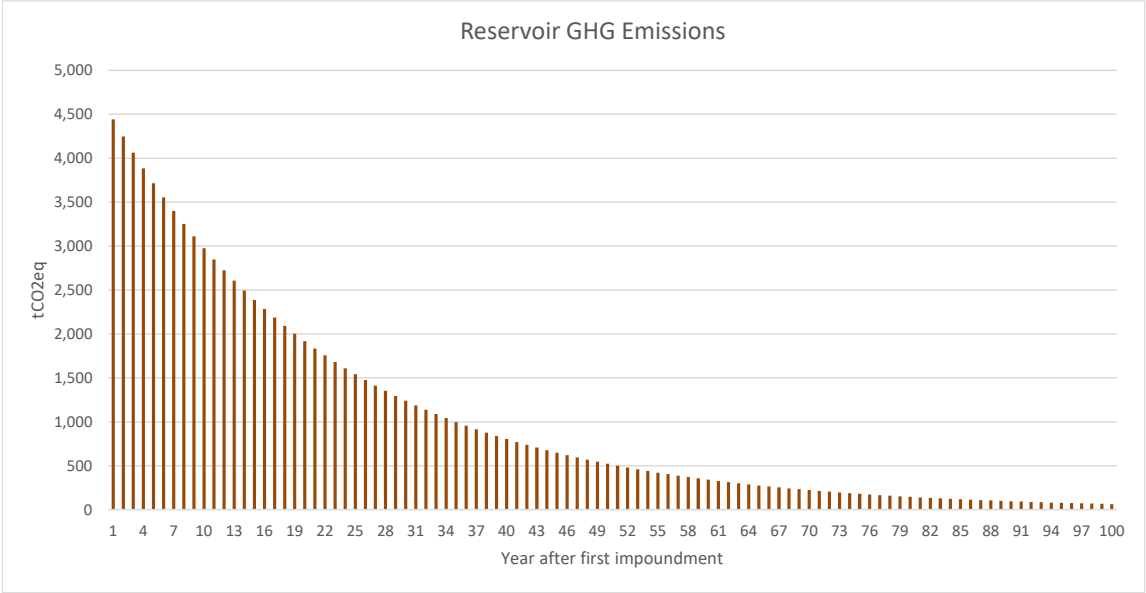


Figure 11-2 Reservoir GHG Emissions

11.3.3 Overall GHG Emissions

The overall GHG emissions covering the construction period and a 100-year operation period represents are presented in Table 11-9.

Table 11-9 – Overall Construction and Reservoir GHG Emissions Averaged over 100 Years

Parameter	Units	Value
Construction GHGs (Over 4 years)	Tonnes	244,187
Reservoir GHGs (over 100 years)	Tonnes	102,217
Combined GHGs	Tonnes	346,403
Average annual emission	Tonnes/year	3,464
Average annual emissions per m^2 of reservoir area	$gCO_2eq/m^2/year$	6,928
Project emissions per unit of energy	gCO2eq/kWh	2.89
Typical Benchmark emissions per unit of energy*	gCO2eq/kWh	Ranging from 4-160
* (Special Report of the Intergovernmental Panel on Climate Change, 2012)		

The total combined emissions from construction and reservoir over the 100-year period are presented in the pie chart Figure 11-3 and a benchmarking comparison provided in Figure 11-4.

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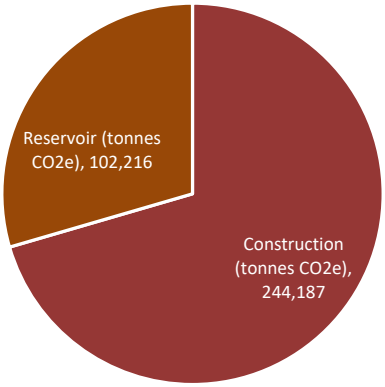
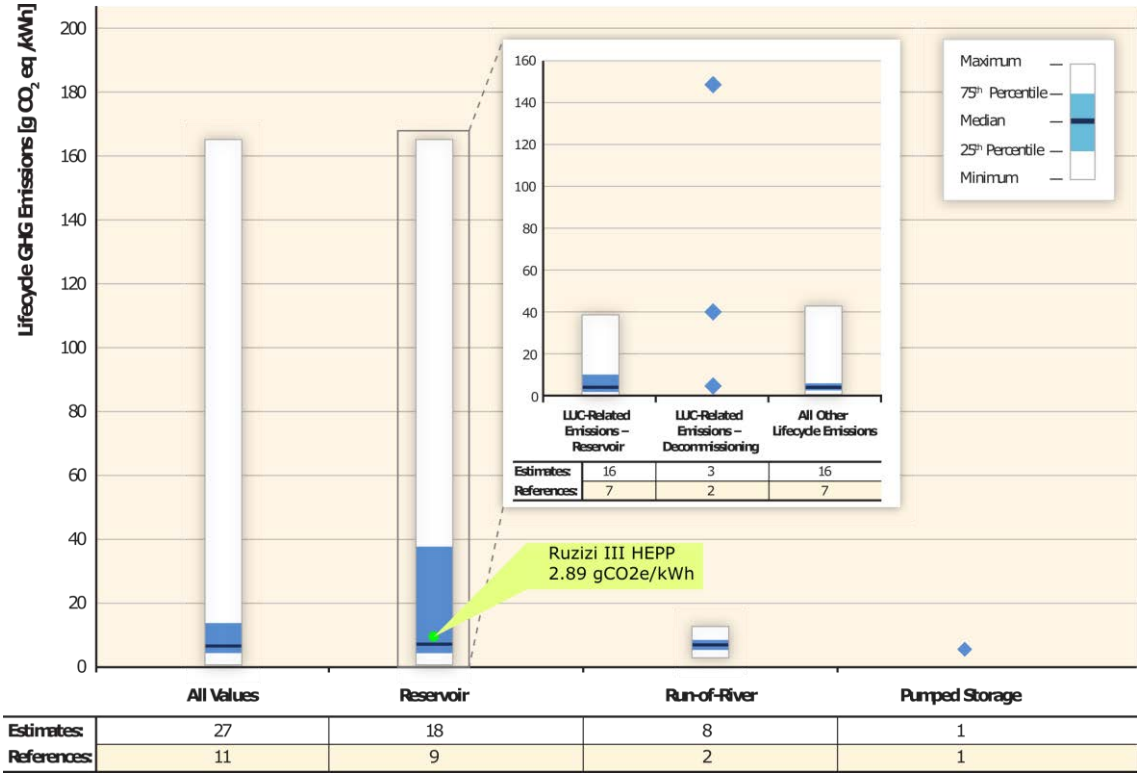


Figure 11-3 Construction and Reservoir GHG Emissions



	All Values	Reservoir	Run-of-River	Pumped Storage
Estimates:	27	18	8	1
References:	11	9	2	1

	LUC-Related Emissions – Reservoir	LUC-Related Emissions – Decommissioning	All Other Lifecycle Emissions
Estimates:	16	3	16
References:	7	2	7

Source: Special Report of the Intergovernmental Panel on Climate Change, 2012

Figure 11-4 Comparison of Project Emissions with Worldwide Benchmark Values

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11.3.4 Comparison with Rwanda's National GHG Emissions and Worldwide Emissions

The Ruzizi III GHG emissions compared with Rwanda's national and worldwide emissions are presented in Table 11-10.

Table 11-10 – Project Emissions Compared with Rwanda's National and Worldwide Emissions

GHG Emissions	Emissions (million tonnes per year)	Percentage Project Emission
Ruzizi III HEPP emissions [a]	0.0035	-
Rwanda's National GHG emissions for the power sector for 2015 [b]	0.159	2.2%
Worldwide GHG Emissions [c]	52,000	0.000007%

Notes:

[a] Average over 100 years and including construction emissions

[b] Rwanda's Nationally Intended Nationally Determined Contributions (Rwanda 2020). The most recent data is from 2015.

[c] IPCC Fifth Assessment Report, 2015 (IPCC, 2021)

11.3.5 GHG Offsets Resulting from Project Implementation

The national GHG emission intensity (tCO2-eq per MWh) has been calculated for the situation when the Project has been implemented. The key figures are presented in Table 11-11 below and it can be seen that the project is expected to result in a 66% reduction in the national emission intensity for electricity production.

Table 11-11 – GHG Offset from Project Implementation

Source	MWh per year	GHG emissions (Mt CO_2-eq / year)	tCO_2-eq / MWh
Rwanda's National electricity production	600,000 [a]	0.159 [b]	0.27
Ruzizi III HEPP	1,197,000	0.0035	0.0029
Rwanda's National electricity production + Ruzizi III Project	1,797,000 [c]	0.16	0.09
Rwanda's National electricity production + Equivalent to Ruzizi III Project using Rwanda's current energy mix	1,797,000	0.48	0.27
Reduction c.f. emissions from Rwanda's energy mix	N/A	0.32[d] (66% reduction)	N/A
Reduction c.f. emissions from energy mix in Burundi, DRC and Rwanda	N/A	0.78	N/A

[a] Source: Rwanda Utilities Regulatory Authority (RURA). The most recent data is from 2016. However, data from 2015 as this is the year when the most recent GHG emission data is available.

[b] Source: Rwanda's Nationally Intended Nationally Determined Contributions (Rwanda 2020). The most recent data is from 2015.

[c] Source: Tractebel; 2021

[d] Equals emissions from Rwanda's electricity production including Ruzizi III power capacity with Rwanda's current energy mix (0.48) minus Rwanda's emissions with Ruzizi III in operation (0.16).

11.3.6 Impact Significance and Mitigation Measures

The total GHG emissions during construction are assessed to be 244,187 tonnes of equivalent carbon dioxide. Construction duration is expected to be 48 and 56 months and consequently, annual GHG emissions during construction are therefore predicted to be on average 61,046 tonnes of equivalent carbon dioxide.

During operation, emissions will be 1,033 tonnes per year on average with emissions decreasing from 4,500 to 3,500 tonnes per year over the first 10 years of operation.

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The GHG emissions are assessed to be below the IFI thresholds of 100,000 tonnes per year which would trigger the need for the developer to publicly disclose GHG emissions on an annual basis and are therefore considered as not significant. However, as a good practice measure it is recommended that Scope 1 and Scope 2 GHG emissions are monitored during construction and included in REL's annual report, in addition the Project will explore the opportunities to benefit from carbon credits, these measures are referred to as:

[M 10] Good Practice measure to monitor Scope 1 and Scope 2 GHG emissions during construction and report the emissions in REL's annual environmental and social performance report and post on the Project's website.

[M 11] The Project undertake a separate study to explore the opportunities to benefit from carbon credits.

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11.4 Air Quality, Dust and Odour

11.4.1 Impact Producing Factors

Potential sources of alteration to ambient air quality during pre-construction and construction are equipment items of activities that emit air pollutant and dust, and which comprise:

- Fuel combustion emissions at worksites and construction accommodation camps from excavation and earth moving equipment and fixed-point sources such as power generators. These emissions typically comprise particulate matter, sulphur dioxide (SO_2) and oxides of nitrogen (NOx).
- Dust arising from land clearing and construction activities at work sites.
- Fuel combustion emissions and dust from construction related traffic.

Potential sources of alteration to ambient air quality during operation comprise the following:

- Fuel combustion emissions from fixed-point sources such as power generators or diesel-fuelled equipment at the dam site, powerhouse or operators' village during the operation.
- Fuel combustion emissions and dust from the road traffic during operation which will comprise vehicles used by employees and services to access the facilities for operational reasons, inspections and maintenance, and occasional deliveries.

11.4.2 Assessment of Receptor Sensitivity

The sensitivity of the air quality is considered to be low and medium, depending on the area affected, as per the criteria set out in the Table 11-12. The project works are undertaken in an area of low terrestrial biodiversity sensitivity and mostly in areas where agriculture is the predominant land use. Some sections or access roads pass through and close to residential areas which have medium sensitivity because the baseline air quality in the villages is probably degraded by the predominant use of wood burning for cooking and heating.

11.4.3 Impacts during Pre-Construction and Construction

The magnitude of the alteration to air quality for the different sources of impact are assessed using the criteria provided in Table 11-13. Air emission modelling has not been undertaken as there is insufficient project information available, so a qualitative approach has been applied. The assessment of the impacts and mitigation measures are provided in Table 11-14 and Table 11-15.

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Table 11-12 Air Quality Sensitivity Criteria

Sensitivity	Sensitivity for human health		Sensitivity for protection of ecosystems/habitats
High	A zone or agglomeration designated as exceeding an air quality limit value; or Undesignated areas where concentrations are 85% or more of an air quality limit value.	And it is within an area where members of the public are regularly present; Or any hospital, school, nursing homes or similar facilities considered to be vulnerable to changes in ambient air quality concentrations.	Within an ecosystem or habitat type which is recognised to be of importance at an international level or is a critical habitat, as defined by the IFC, and where the habitat has the potential to be affected by baseline concentrations close to or above the air quality critical levels.
Medium	Areas not designated as exceeding the limit values and where baseline concentrations are between 50% to 85% of an air quality limit. And it is within an area where members of the public are regularly present;	Or at any hospital, school, nursing homes or similar facilities considered to be vulnerable to changes in ambient air quality concentrations.	Within an ecosystem or habitat type recognised to be of importance at a national scale and where the habitat has the potential to be affected by baseline concentrations close to or above the air quality critical levels.
Low	Areas not designated as exceeding the limit values and where baseline concentrations are between 15% to 50% of an air quality limit.	And is within an area where members of the public are regularly present.	Within an ecosystem or habitat type occurring outside of any designation, but which represent a typical example of the feature under consideration within the context of the ecological resource present within the country and is not likely to be affected by air quality levels.
Negligible	Areas not designated as exceeding the limit values and where baseline concentrations are less than 15% of an air quality limit.	Or is within an area where members of the public are not regularly present.	Within an ecosystem or habitat type which is either appreciably degraded / disturbed by human activity, have low diversity of common and widespread species or have high proportions of invasive / non-native species and would not likely to be affected by air quality levels

Table 11-13 Air Quality Impact Magnitude Criteria

Rank	Description
Major	Impact magnitude is major if the receptor is in the vicinity of the activity and the estimated emissions with respect to background air quality concentrations and likely dispersion may result in long-term elevated concentrations that exceed WHO air quality standards.
Moderate	Impact magnitude is moderate if the receptor is in the vicinity of the activity and the estimated emissions with respect to background air quality concentrations and likely dispersion may result in short-term elevated concentrations that are expected to be between 50% and 100% of WHO air quality standards.
Minor	Impact magnitude is minor if the receptor is in the vicinity of the activity and the estimated emissions with respect to background air quality concentrations and likely dispersion may result in short-term low magnitude concentration that are expected to be between 5% and 50% of WHO air quality standards.
Negligible	Impact magnitude is negligible if no detectable change in air quality is anticipated.

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Table 11-14 Potential Impacts - Air Quality & Odour during Pre-Construction/Construction

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Fuel combustion emissions at worksites and accommodation camps from excavation and earth moving equipment and fixed-point sources such as power generators.	Transient alteration to air quality in the immediate vicinity of the reservoir, dam site and access road between the powerhouse and the work sites over a duration of 56 months. These Areas in the immediate vicinity are predominantly used for agriculture there are no residential areas.	Low	Moderate	Minor (NS)
	Transient alteration to air quality in the immediate vicinity of the powerhouse over a duration of several months. These areas in the immediate vicinity are predominantly used for agriculture. However, there is a village on the opposite side of the river (in DRC) within 170 m of the worksite. Air quality in the village may be considered as degraded from the predominant use of wood burning for cooking.	Medium	Minor	Minor (NS)
Dust arising from land clearing and construction activities at work sites.	Transient alteration to air quality in the immediate vicinity of the reservoir, dam site and access road between the powerhouse and the work sites over a duration of 56 months. These Areas in the immediate vicinity are predominantly used for agriculture there are no residential areas.	Low	Moderate	Minor (NS)
	Transient alteration to air quality in the immediate vicinity of the powerhouse over a duration of several months. These areas in the immediate vicinity are predominantly used for agriculture. However, there is a village on the opposite side of the river (in DRC) within 170 m of the worksite. Air quality in the village may be considered as degraded from the predominant use of wood burning for cooking.	Medium	Moderate	Moderate (S)
Fuel combustion emissions and dust from construction related traffic	Transient alteration to air quality in the immediate vicinity of access roads, some of which are adjacent to villages., where air quality may already be degraded by the predominant use of wood burning for cooking.	Medium	Moderate	Moderate (S)

Proposed mitigation measures for significant impacts are presented in the following table

Table 11-15 Mitigations & Residual Impacts - Air Quality & Odour during Pre-Construction/ Construction

Project Activity	Mitigation	Residual Impact		
		Sensitivity	Magnitude	Significance
Dust arising from land clearing and construction activities at work sites.	[M 12] The Contractor shall prepare and implement an Air Quality and Emissions Management Plan as part of the CESMP, which details measures to manage air emissions and dust. [M 13] The Contractor shall use equipment and adopt construction and transport methods with air emissions that do not exceed threshold emission values specified in Rwanda and DRC regulations or IFC EHS Guidelines, whichever is the most stringent. [M 14] The fleet of vehicles or equipment emitting combustion gases shall be maintained at the intervals and according to the methods specified by the manufacturer. The Contractor shall keep maintenance records.	Medium	Minor	Minor (NS)
Fuel combustion emissions and dust from construction related traffic		Medium	Minor	Minor (NS)

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11.4.4 Predicted Impacts during Operation

The magnitude of the alteration to air quality for the different sources of impact are assessed using the criteria provided in the Table 11-13. Air emission modelling has not been undertaken as there is insufficient project information available, so a qualitative approach has been applied. Assessment of potential impacts is presented in the following table.

Table 11-16 Potential Impacts - Air Quality & Odour during Operation

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Fuel combustion emissions from the fixed-point sources such as power generators at the dam site, powerhouse and operators' village	Minor alteration to the air quality in the immediate vicinity of the operator' village and the dam. These areas in the immediate vicinity are predominantly used for agriculture and there are no nearby residential areas	Low	Negligible - Minor	Minor (NS)
Fuel combustion emissions and dust from traffic along the dam access road and along the transmission line wayleave (for maintenance)	Minor intermittent and transient alteration to the air quality in the immediate vicinity of the access roads. The areas in the immediate vicinity comprise areas predominantly used for agriculture but with some discrete residential areas.	Medium	Negligible - Minor	Minor (NS)

The potential impacts are assessed to be Not Significant (NS) however, as a precautionary measure are proposed.

[M 15] Power generators at the operator's village will be designed to comply with IFC General EHS emission limit values and DRC/Rwanda emission limit values (whichever are the most stringent). Annual monitoring of the emissions will be performed to check conformity.

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11.5 Noise and Vibration

11.5.1 Impact Producing Factors

Potential sources of alteration to ambient noise and vibration levels during pre-construction and construction comprise the following:

- Noise from mobile and stationary machinery equipment at worksites that are for clearing of vegetation, site preparation, earthworks, excavation.
- Noise from temporary construction camps and accommodation camps from vehicles and stationary machinery equipment such as power generators and compressors.
- Noise and vibration from tunnelling activities – which will include some drill and blast operations.
- Noise from construction traffic movement along access roads.

Potential sources of alteration to ambient noise and vibration levels during operation comprise the following:

- Noise from operators' village (generators, compressors, occasional sirens and alarms).
- Noise from the powerhouse
- Noise from 220 kV substation and 220 kV transmission line.
- Noise from Project road traffic which will comprise vehicles used by employees and services to access the facilities for operational reasons, inspections and maintenance, and occasional deliveries.

11.5.2 Assessment of Receptor Sensitivity

The sensitivity of receptors to noise and vibration is primarily dependent upon the activities which take place at the receptor location. Locations where people rest or sleep are considered to be more sensitive. The sensitivity of the areas in the vicinity of the project activities is assessed to be between low and high, depending on the area affected, as per the criteria set out in the Table 11-17.

The project works are undertaken in an area of low terrestrial biodiversity sensitivity and mostly in areas where agriculture is the predominant land use. Some sections of access roads pass through and close to residential areas which have high sensitivity, and the powerhouse is situated 170 m from the village of Bugano in DRC which also has high sensitivity.

Table 11-17 Noise and Vibration Receptor Sensitivity

Sensitivity	Description
High	Locations used for rest, sleep and quiet reflection such as residential areas, hospitals, cemeteries, educational establishments and places of worship.
Medium	Locations used for work requiring concentration, such as offices.
Low	Locations used for recreation, industrial and agricultural activities
Negligible	Locations not regularly utilised

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11.5.3 Predicted Impacts during Pre-Construction and Construction

The magnitude of the alteration to ambient noise and vibration levels for the different sources of impact are assessed using the criteria provided in Table 11-18.

Noise and vibration modelling has not been undertaken and a qualitative approach has been applied. Assessment of potential impacts is presented in Table 11-19.

Table 11-18 Noise Impact Magnitude Criteria

Magnitude	Description		
	Noise		Vibration
	Areas adjacent to worksites	Areas adjacent to access roads	
Major	Ambient noise levels exceed threshold value* by > 3 dB for > 1 month	Major increase in noise level which would be noticeable in the short, medium and long terms	Vibration level >10 mm/s Any exposure other than brief to this level is intolerable.
Moderate	Ambient noise levels exceed threshold value* by > 3 dB for < 1 month	Moderate increase in noise level which would be noticeable in the short and medium terms but possibly not in the long term	Vibration level ranges from 1.0 – 10 mm/s Vibration perceptible at a level sufficient to cause complaint
Minor	Ambient noise levels exceed threshold value* by < 3 dB for > 1 month	Minor increase in noise level which might be noticeable in the short term but possibly not in the medium term and not in the long term after a period of habituation	Vibration level ranges from 0.3 – 1 mm/s Vibration perceptible in residential surroundings
Negligible	Ambient noise levels exceed threshold value* by < 3 dB < 1 month	Negligible increase in noise level considered to be noticeable only when a subject is deliberately listening for a change. Such an impact would result from a 25% increase in traffic volume (assuming no change in speed or composition). May be noticeable in the short-term but not in the medium and long terms.	Vibration level ranges from 0.14 – 0.3 mm/s Vibration perceptible only in most sensitive situations
* The threshold value adopted is 55 dB LAeq, 8 hours during daytime and 45 dB Laeq, 8 hours during night-time (WHO outdoor noise guidance value for residential areas).			

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Table 11-19 Potential Impacts – Noise & Vibration during Pre-Construction/ Construction

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Noise from mobile and stationary machinery equipment at worksites that are for clearing of vegetation, site preparation, earthworks, excavation.	Intermittent increase in ambient noise levels in the immediate vicinity of the reservoir, dam site and access road between the powerhouse and the work sites over a duration of 48-56 months. These areas in the immediate vicinity are predominantly used for agriculture there are no residential areas.	Low	Minor	Minor (NS)
	Intermittent alteration to ambient noise levels in the immediate vicinity of the powerhouse over a duration of several months. These areas in the immediate vicinity are predominantly used for agriculture. However, there is a village on the opposite side of the river (in DRC) within 500-600 m of the worksite, where noise levels could potentially exceed threshold values by >3 dB for short periods of <1 month.	High	Moderate	Major (S)
Noise from temporary construction camps and accommodation camps from vehicles and stationary machinery equipment such as power generators, compressors.	General increase in ambient noise levels in the immediate vicinity of the construction camps over a duration of 48-56 months. These areas in the immediate vicinity are predominantly used for agriculture there are no residential areas. However, noise levels may potentially exceed threshold values by >3 dB but for short periods of <1 month.	Low	Moderate	Minor (NS)
Noise and vibration from tunnelling which will include some drill and blast operations.	The headrace tunnel gallery will be excavated using drill and blast methods and there will be detectable levels of vibration and noise in the immediate vicinity of the tunnel entrance during excavation works. These areas are adjacent to land predominantly used for agriculture but there are no residential areas in immediate vicinity.	Medium	Minor	Moderate (S)
Noise from rock crusher	The use of rock crushers during the construction of access roads which pass close to residential areas can generate noise levels potentially exceeding threshold values by >3 dB but for short periods of <1 month for each noise sensitive location.	High	Moderate	Major (S)
Noise from the concrete batching plant	The batching plant is planned to be situated on the right bank (in DRC) opposite the construction camp. The batching plant is situated about 1.3 km from the nearest residential area (Bugano village of on the right bank in DRC).	Medium	Moderate	Moderate (S)
Noise from construction traffic movement along access roads.	There will be a significant volume of construction traffic moving along the dam access roads to/from the quarry, disposal areas and construction camp. It is expected that during the peak construction period there may be up to 50 trucks travelling along a stretch of road every day. The duration of the civil works is to be just over 3 years. The quarry access roads pass through and adjacent to residential areas and all the roads are adjacent to cultivated land where local people practice labour intensive	High	Moderate	Major (S)

Proposed mitigation measures for Significant (S) impacts are presented in the following table. Specific mitigation measures for impacts that are Not Significant (NS) are not proposed.

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Table 11-20 Mitigations & Residual Impacts – Noise & Vibration during Pre-Construction/ Construction

Project Activity	Mitigation and Monitoring	Residual Impact		
		Sensitivity	Magnitude	Significance
Noise from mobile and stationary machinery equipment at the powerhouse worksite that are for site preparation clearing, earthworks, and construction.	[M 16] The Contractor shall prepare and implement a Noise & Vibration Control and Monitoring Plan as part of the CESMP. [M 17] Regular noise level monitoring will be performed during construction to demonstrate compliance with WHO noise guidelines and DRC and Rwanda noise level regulations. [M 18] The Contractor shall use equipment and adopt construction and transport methods so as minimise noise levels and prevent exceeding threshold values recommended by the DRC/Rwanda regulations and WHO recommendations. [M 19] Where communities are located close to worksites, access roads and public roads affected by construction traffic, the Contractor shall study, propose, implement and monitor the efficiency of all reasonable and practicable measures to minimize noise resulting from the activity and to minimize the acoustic nuisances to adjacent households during day and night. [M 20] Noise barriers or acoustic shields shall be considered if works are close to sensitive receptors and installed if monitoring detects noise levels at residential areas that exceed WHO noise guidelines and DRC and Rwanda noise level regulations. [M 21] Noise-intensive works such as piling, demolition, metalworking, and blasting (in quarries) will not be undertaken at night. [M 22] The Contractor shall monitor the vibration level at buildings nearest to the Works during activities which could generate offset vibration effects. The Contractor shall prepare a pre-construction condition survey for all buildings located within 1 km of any blasting activities (including photographs of existing situation). The condition survey will be used to assess the effect of blasting on structures and the scope of any remediation works necessary to repair the effects of blasting.	High	Negligible	Negligible (NS)
Noise and vibration from tunnelling activities – which will include some drill and blast operations.		High	Negligible	Negligible (NS)
Noise from the rock crushers		High	Minor	Moderate (S)
Noise from the concrete mixing plant		Moderate	Negligible	Negligible (NS)
Noise from construction traffic movement along access roads.		High	Negligible	Negligible (NS)

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11.5.4 Predicted Impacts during Operation

The magnitude of the alteration to ambient noise and vibration levels for the different sources of impact are assessed using the criteria provided in Table 11-18. Noise and vibration modelling has not been undertaken and a qualitative approach has been applied. Assessment of potential impacts is presented in Table 11-21 and mitigation measures and residual impacts are presented in Table 11-22.

Table 11-21 Potential Impacts – Noise and Vibration during Operation

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Noise from operators' village (generators, compressors, occasional sirens and alarms).	The operators' village will accommodate in the order of 50 persons. The camp is planned to be located on the left bank adjacent to the powerhouse. The camp is some 500-600 m from the Bugano village on the right bank (DRC). Equipment at the camp will include noise generating equipment items that without noise minimisation may have the potential to generate noise exceeding regulatory and WHO noise limit values.	High	Major	Major (S)
Noise from powerhouse operation	The above ground powerhouse is planned to be located on the left bank opposite the DRC Bugano village some 500-600 m from the powerhouse. The equipment at the powerhouse will include noise generating equipment items that without noise minimisation can be expected to have the potential to generate noise exceeding regulatory and WHO noise limit values.	High	Major	Major (S)
Corona noise from 220 kV switchyard	The switchyard is situated adjacent to the Bugano village. Equipment items such as transformers and the powerlines are a source of corona noise (an audible hissing sound). The noise will be a nuisance for people.	High	Minor	Moderate (S)
Noise from 220 kV transmission line.	The transmission line is situated adjacent to the Bugano village and crosses 7 km of cultivated land, crossing over the kamanyola-Bugarama road which is lined with residential houses. The noise will be a nuisance for people.	High	Minor	Moderate (S)
Noise from Project road traffic which will comprise vehicles used by employees and services to access the facilities for operational reasons, inspections and maintenance, and occasional deliveries.	During operation there will be only small volumes of traffic that will be mostly between the operators' villages and the dam site and powerhouse. This road is not a public road and does no pass through residential areas. There may be some limited traffic that passes through Bugarama to join the dam and powerhouse access road.	High	Negligible	Negligible (NS)

Proposed mitigation measures for Significant (S) impacts are presented in the following table

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Table 11-22 Mitigations & Residual Impacts – Noise and Vibration during Operation

Project Activity	Mitigation and Monitoring	Residual Impact		
		Sensitivity	Magnitude	Significance
Noise from operators' village (generators, compressors, occasional sirens and alarms).	[M 23] Noise modelling study for the operators' village, powerhouse and substation will be carried out during the design phase and noise prevention measures included in the design as necessary to ensure that noise levels at the site boundary complies with WHO noise guidelines and DRC and Rwanda noise level regulations. [M 24] Noise level monitoring will be performed at the operator's village, powerhouse and substation during commissioning to check compliance with the owner's noise requirements. [M 25] Periodic noise level monitoring will be performed during operation at the powerhouse, operators' camp and substation to check compliance with WHO noise guidelines and DRC and Rwanda noise level regulations.	Low	Negligible	Negligible (NS)
Noise from powerhouse operation		High	Negligible	Negligible (NS)
Noise from the 220 kV switchyard and 220 kV transmission line.	[M 26] The transmission line and switchyard will be designed with features to minimise the corona affect.	High	Negligible	Negligible (NS)

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11.6 Soils, Groundwater and Surface Water

11.6.1 Impact Producing Factors

Potential sources of disturbance to soils during pre-construction and construction comprise the following:

- Worksite preparation works including removal of topsoil, levelling and terracing.
- Removal of topsoil and excavation of material from quarries and borrow areas.
- Excavation and earthworks for the construction of the dam foundations.
- Excavation and earthworks for the headrace tunnel, deviation tunnels, water inlet.
- Topsoil removal, levelling, earthworks for construction of access roads.

Potential sources of alteration to soil, groundwater and surface water quality during pre-construction and construction comprises the following:

- Pollution of soils and groundwater from accidental spills and leaks of hazardous substances stored at worksites and the construction camp.
- Alteration of Ruzizi River water quality from discharge of sanitary wastewater from the construction workers accommodation camp.
- Increased sediment loads in Ruzizi River from runoff from worksites and spoil disposal areas.
- Alteration of the Ruzizi River water quality from filling of the Ruzizi-III reservoir.

Potential sources of alteration to soil, groundwater and surface water quality during operation comprises the following:

- Alteration of the Ruzizi River water quality from operation of the Ruzizi-III reservoir.
- Alteration of Ruzizi River water quality from discharge of sanitary wastewater from the operators' village.
- Pollution of soils and groundwater from accidental spills and leaks of hazardous substances stored at dam site and powerhouse.
- Alteration of Ruzizi River water quality from runoff from areas polluted by accidental spills and leaks of hazardous substances stored at dam site and powerhouse.

11.6.2 Assessment of Receptor Sensitivity

The sensitivity of geology and soils receptors has been assessed as variable in the range negligible to high depending on the location of the Project activities as described by the criteria provided in Table 11-23.

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Table 11-23 Geology and Soils Sensitivity Criteria

Sensitivity	Soils	Groundwater / Surface Water	
		Description	Example
High	Highly vulnerable to physical disturbance, structurally prone to compaction or erosion, and taking >10 years to recover. Highly leachable and amenable to contamination. The soil provides a substrate that has the physical qualities and/or degree of productivity to support the development of important (in terms of nature conservation or concentration of biomass) and/or indigenous species of flora and fauna. The soil is intrinsically linked to the hydrological cycle; water is fundamental to its structure; and the soil plays a key ecosystem role in water regulation.	• Surface water or groundwater body with little or no capacity to absorb proposed changes or minimal opportunities for mitigation. • Receptor at high risk of depletion (surface waters levels falling or drying out; groundwater levels / yields falling) • Receptor at high risk of pollution • Receptor provides vital ecosystem services (fishery, flood conveyance capacity, sediment transport) • Receptor provides urban water supplies, major industrial abstraction or large irrigation supplies	• Pristine reach of river with natural flow, sediment and water quality regime • Spawning areas for important fishery • Springs vital for urban water supply • Water supply serving major industry or irrigation use • River reach receiving wastewater from urban area.
Medium	Vulnerable to physical disturbance but able to recover by mitigation measures within a period of 10 years. Moderately leachable. The soil provides a substrate that has the physical qualities and degree of productivity to support the development of species of flora and fauna in some abundance and levels of diversity. The soil has some capacity for water retention and regulation and plays some role in the hydrological cycle in terms of a degree of water regulation and as a substrate for channelling run-off.	• Surface water or groundwater body with some capacity to absorb proposed changes or limited opportunities for mitigation. • Receptor at medium risk of depletion (surface waters levels falling or drying out; groundwater levels / yields falling) • Receptor at medium risk of pollution • Receptor provides important ecosystem services (fishery, flood conveyance capacity, sediment transport) • Receptor used for local village water supply source, small industrial abstraction or minor irrigation scheme	• River reach or spring/well serving village, local industry or small irrigation user • Village wastewater disposal River reach supporting local fishery.
Low	Resilient to physical disturbance and/or impermeable to contamination. The soil constitutes no particular favourable substrate for the development of floral habitats, invertebrates and other fauna. The soil plays little or no role in the hydrological cycle or regulation of water.	• Surface water or groundwater body with some capacity to absorb proposed changes or moderate opportunities for mitigation. • Receptor already significantly modified from some aspect of natural condition • Receptor provides ecosystem services (fishery, flood conveyance capacity, sediment transport) • Receptor used for water supply to individual dwellings or farms	• River reach in a modified state due to existing use (eg existing dam/weir, gravel extraction) • Minor water use • Isolated wastewater disposal
Negligible	Temporary duration with no detectable impact. No perceptible change to the specific environmental conditions assessed.	> Surface water or groundwater body with considerable capacity to absorb proposed changes and/or good opportunities for mitigation. > Receptor already significantly modified from natural condition	> Aquifer that is confined where project works occur > River reach severely impacted by upstream dam

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11.6.3 Predicted Impacts during Pre-Construction and Construction

The magnitude of the disturbance to geology and soils for the different sources of impact are assessed using the criteria provided in Table 11-24. The assessment of the impacts from disturbance have been undertaken using a qualitative approach. The assessment of potential impact is provided in Table 11-25 and mitigation measures and residual impacts are presented in Table 11-26.

Table 11-24 Soils, Groundwater, Surface Water Impact Magnitude Criteria

Magnitude	Description		
	Soils	Groundwater / Surface Water	
		Typical Characteristics	Example of Features/Areas
Major	The potential for soil quality and/or physical structure to be permanently impacted. The area affected by the activity is predicted to be large (>100 ha).	• Surface water or groundwater body with little or no capacity to absorb proposed changes or minimal opportunities for mitigation. • Receptor at high risk of depletion (surface waters levels falling or drying out; groundwater levels / yields falling). • Receptor at high risk of pollution. • Receptor provides vital ecosystem services (fishery, flood conveyance capacity, sediment transport). • Receptor provides urban water supplies, major industrial abstraction or large irrigation supplies.	• Pristine reach of river with natural flow, sediment and water quality regime. • Spawning areas for important fishery. • Springs vital for urban water • Supply. • Water supply serving major • industry or irrigation use. • River reach receiving • wastewater from urban area. •
Moderate	The impact on soil quality and condition may recover through natural processes and the impact will be medium term (several years). The area affected by the activity is predicted to be a medium extent (>10 ha and < 50 ha)	• Surface water or groundwater body with some capacity to absorb proposed changes or limited opportunities for mitigation. • Receptor at medium risk of depletion (surface waters levels falling or drying out; • groundwater levels / yields falling) • Receptor at medium risk of pollution. • Receptor provides important ecosystem services (fishery, flood conveyance capacity, sediment transport). • Receptor used for local village water supply source, small industrial abstraction or minor irrigation scheme.	• River reach or spring/well serving village, local industry or small irrigation user • Village wastewater disposal • River reach supporting local • fishery.
Minor	The impact on soil quality and condition is predicted to recover rapidly through natural processes and the duration of impact is short (limited to the Construction Phase). The area affected by the activity is predicted to be a minor extent (<10 ha)	• Surface water or groundwater body with some capacity to absorb proposed changes or moderate opportunities for mitigation. • Receptor already significantly modified from some aspect of natural condition. • Receptor provides ecosystem services (fishery, flood conveyance capacity, sediment transport). • Receptor used for water supply to individual dwellings or farms.	• River reach in a modified state due to existing use (eg existing dam/weir, gravel extraction) • Minor water use • Isolated wastewater disposal
Negligible	No changes distinguishable from natural variability.	• Surface water or groundwater body with considerable capacity to absorb proposed changes and/or good opportunities for mitigation. • Receptor already significantly modified from natural condition.	• Aquifer that is confined where project works occur • River reach severely impacted by upstream dam.

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Table 11-25 Potential Impacts – Soils, Groundwater & Surface Water during Pre-Construction/Construction

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Physical Disturbance of Soils				
Worksite preparation works including removal of topsoil, levelling and terracing. Removal of topsoil and excavation of material from quarries and borrow areas.	Worksites, quarries, borrow areas, spoil disposal area and roads are situated mostly on land used for crop cultivation. The impact on livelihoods of the loss of agricultural land is assessed in the social impact (section 11.12). The soils are assessed to be of low sensitivity as they are no longer a substrate for natural floral habitats or other fauna and plays little or no role in the hydrological cycle or regulation of water.	Low	Moderate	Minor (NS)
Excavation and earthworks for the construction of the dam foundations.		Low	Moderate	Minor (NS)
Excavation and earthworks for the headrace tunnel, deviation tunnels, water inlet.		Low	Moderate	Minor (NS)
Topsoil removal, levelling, earthworks for construction of access roads.		Low	Moderate	Minor (NS)
Flooding of soils by reservoir impoundment		Low	Moderate	Minor (NS)
Groundwater, Surface Water and Soil Quality				
Pollution of soils and groundwater from accidental spills and leaks of hazardous substances stored at worksites and the construction camp.	Hazardous substances stored and handled by the Project will include chemical additives for concrete, small quantities of solvents and paints and larger quantities of diesel fuel, hydraulic fluids, lubricating oils (new and used). It can be expected that there will be several diesel storage tanks (typically in the order of 20-30 m^3 volume), vehicle refuelling areas, mobile power generators containing diesel and oils, and areas dedicated to the storage of chemicals and hazards wastes (such as used oils) stored in iso-containers and drums. In the absence of pollution prevention measures, accidental spills and leaks can be expected. The quantities potentially released will be variable and will depend on numerous factors. In the event of accidental leaks and spills the soils at the spill location will be polluted. The area affected will depend on the size of the spill. In the absence of clean-up, during rainfall some of the polluting substances will be carried away with runoff, and some will infiltrate into groundwaters with the rainwaters, leading to a pocket of polluted groundwater in the vicinity of the spill and which will progressively migrate. However, when considering that there will probably not be large inventories of hazardous substances at the project site, there is limited potential for extensive pollution of soils, groundwaters and surface water.	High	Moderate	Major (S)

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Table 11-25 Potential Impacts – Soils, Groundwater & Surface Water during Pre-Construction/Construction (*Cont.*)

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Alteration of Ruzizi River water quality from discharge of sanitary wastewater from the construction workers accommodation camp.	The construction workers camp which will accommodate between 500 and 1,000 workers will generate sanitary wastewater. If the wastewater is not collected in an appropriate manner and is discharged into the Ruzizi River without appropriate treatment there will be alteration to the quality of the river water and exceedance of regulatory and Lender discharge limit values.	High	Moderate	Major (S)
Increased sediment loads in Ruzizi River from runoff from worksites and spoil disposal areas.	Runoff from worksites and disturbed areas will carry sediment into the Ruzizi River, possible increasing the sediment load in the river.	High	Minor	Moderate (S)
Alteration of the Ruzizi River water quality from filling of the Ruzizi-III reservoir.	The duration of reservoir filling is estimated by the feasibility study to be 12 days and during this time there will be release downstream of about 90% of the inflowing water. Once the reservoir is full the outflow will equal the inflow and the residence time of stored water will be less than 24 hours. In this	High	Minor	Moderate (S)

Proposed mitigation measures for significant impacts are presented in the following table.

Table 11-26 Mitigations & Residual Impacts – Geology & Soils during Pre-Construction/Construction

Project Activity	Mitigation and Monitoring	Residual Impact		
		Sensitivity	Magnitude	Significance
Worksite preparation works including removal of topsoil, levelling and terracing and excavation work	[M 27] A soil, slope stability and erosion control plan will be developed and implemented by the EPC Contractor.	Low	Minor	Negligible (NS)
Pollution of soils, groundwater and surface water from accidental spills and leaks of hazardous substances stored at worksites and the construction camp.	[M 28] Construction site pollution prevention and protection plans, and measures will be developed and implemented for all worksites by the EPC Contractor. [M 29] Groundwater at construction worksite will be monitored monthly during construction. [M 30] Construction accommodation camps will be equipped with wastewater treatment facilities to ensure sanitary and domestic wastewater discharges are compliant with Burundi, DRC and Rwanda regulatory	High	Negligible	Negligible (NS)

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Project Activity	Mitigation and Monitoring	Residual Impact		
		Sensitivity	Magnitude	Significance
Worksite preparation works including removal of topsoil, levelling and terracing and excavation work	[M 27] A soil, slope stability and erosion control plan will be developed and implemented by the EPC Contractor.	Low	Minor	Negligible (NS)
Alteration of Ruzizi River water quality from discharge of sanitary wastewater from the construction workers accommodation camp.	discharge limits and IFC EHS guideline emission limit values. [M 31] The quality of wastewater discharges from construction worksites will be monitored to check conformity with discharge limit values. [M 32] During construction, erosion mitigation measures will be employed to prevent soil erosion and fluvial erosion when undertaking works on bare soil and banks and when working in the river (EPC Contractor). [M 33] Cofferdams and diversion tunnels used for construction works in the river will be designed to enable suspended sediment to be carried downstream while construction is taking place. [M 34] During construction, worksite surface erosion and effectiveness of control measures will be monitored by taking weekly fixed-point photos of cleared areas. [M 35] During the reservoir filling phase, bottom sluicing will be undertaken to maintain sediment throughflow as best possible and flows will be sufficient to transport the released sediment downstream to avoid siltation of instream habitats immediately downstream of the dam. [M 36] Environmental performance of the EPC Contractor will be monitored to check conformity with Project standards and non-conformities will be managed through a non-conformity management process.	High	Negligible	Negligible (NS)
Increased sediment loads in Ruzizi River from runoff from worksites and spoil disposal areas.		High	Negligible	Negligible (NS)
Alteration of the Ruzizi River water quality from filling of the Ruzizi-III reservoir.		High	Negligible	Negligible (NS)

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11.6.4 Predicted Impacts during Operation

Table 11-27 Potential Impacts – Soils, Groundwater & Surface Water during Operation

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Alteration of the Ruzizi River water quality from operation of the Ruzizi-III reservoir.	Negligible alteration to reservoir water quality is expected. The progressive biodegradation of flooded biomass releasing nutrients including nitrogen, phosphorus and organic carbon is expected, but because the quantity of flooded biomass is very small compared to the quantity of water flowing through the reservoir, and the short residence time (<1 day) alteration to nutrient concentrations in the reservoir water will be negligible and probably less than intra-annual and inter-annual variations.	High	Negligible	Negligible (NS)
Alteration of Ruzizi River water quality from discharge of sanitary wastewater from the operators' village.	Discharge of untreated sanitary wastewater from the construction camp which accommodates approximately 100 employees could create a measurable alteration to the water quality of the Ruzizi.	High	Minor	Moderate (S)
Pollution of soils, groundwater and surface water from accidental spills and leaks of hazardous substances stored at dam site and powerhouse.	The extent and magnitude of the impacts will depend on the nature of the substance released and the quantity. The largest inventories of hazardous substance will be fuel, oils and used oils. In the event of accidental leaks or spills the soils in the immediate vicinity will be contaminated, but runoff would also be contaminated and could cause the pollution of nearby surface waters.	High	Minor	Moderate (S)

Proposed mitigation measures for significant impacts are presented in the following table

Table 11-28 Mitigations & Residual Impacts – Soils, Groundwater & Surface Water during Operation

Project Activity	Mitigation and Monitoring	Residual Impact		
		Sensitivity	Magnitude	Significance
Alteration of Ruzizi River water quality from discharge of sanitary wastewater from the operators' accommodation camp.	[M 37] The operators' accommodation camp will be equipped with a sanitary and domestic wastewater collection and treatment facilities to ensure discharges comply with regulatory discharge limit values and IFC EHS guideline emission limit values. [M 38] Quality of wastewater discharges from the operators' accommodation camp will be monitored quarterly to check conformity with discharge limit values.	High	Negligible	Negligible (NS)

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Project Activity	Mitigation and Monitoring	Residual Impact		
		Sensitivity	Magnitude	Significance
Pollution of soils and groundwater from accidental spills and leaks of hazardous substances stored at dam site and powerhouse.	[M 39] A Pollution prevention and control plan for the operation phase will developed and implemented. [M 40] Facilities for the storage and handling of hazardous substances at the dam site, powerhouse and switchyard will be designed with spill prevention and protection measures.	High	Negligible	Negligible (NS)

Although significant alteration to reservoir water quality is not expected, monitoring of water quality should be carried out and ant floating waste from Bukavu and carried into the reservoir by the river should be removed and managed in an appropriate manner (see Section 11.9). This measure is referred to elsewhere in the report as:

[M 41] Water quality impacts will be monitored and adaptively managed.

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11.7 Hydrology

The predicted hydrological impacts during pre-construction, construction, and operation have been assessed with reference to the baseline hydrology as described in the Hydrology section of the Environmental Baseline Situation chapter. This includes an assessment of the monthly inflows to Ruzizi II and the study area, an assessment of the study area hydrology including observed water levels and the hydrological and hydraulic characteristics of the study area, and a summary of flood risk at the Ruzizi III dam site. This assessment identified uncertainty / potential non-stationarity in hydrological conditions that would have an associated effect on impacts in the hydropeaking reach.

The main hydrology impacts are further explored in the Environmental Flow Assessment chapter. Particular emphasis is given to the impacts associated with the dewatered reach between Ruzizi III dam wall and the powerhouse tailrace, and the downstream hydropeaking reach extending to the border with Burundi. Consideration is also given to the possible effects of hydropeaking further downstream.

Importantly, the Environmental Flow Assessment related hydrological and hydraulic impacts to ecological and social context. Explicit consideration is given to geomorphology, aquatic ecology, terrestrial ecology, and social reliance. The resultant impacts of hydrological change on these receptors are considered more fully in associated sections of this chapter.

11.7.1 Impact Producing Factors

Potential sources of alteration to hydrology during pre-construction and construction comprise the following:

- Temporary river diversion.
- Reservoir filling.

Potential sources of alteration to hydrology during operation comprise the following:

- Normal powerhouse operation with peak and off-peak discharges.
- Diversion of the river through the headrace tunnel, creating a bypassed reach of the river with only the environmental flow and any flows from dam spillage.
- Sediment flushing operations.
- Bottom outlet testing.
- Reservoir spillage.
- Exception operating conditions.

11.7.2 Assessment of Receptor Sensitivity

The sensitivity of the hydrology receptor has been assessed as low as per the criteria provided in Table 11-23.

Table 11-29 Hydrology Sensitivity Criteria

Sensitivity of receptors	Description
High	• Surface water with little or no capacity to absorb proposed changes or minimal opportunities for mitigation. • At high risk of depletion (surface waters levels falling or drying out). • Provides vital ecosystem services (fishery, flood conveyance capacity, sediment transport). • Provides urban water supplies, major industrial abstraction or large irrigation supplies. • Is a spawning area for important fishery.

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Sensitivity of receptors	Description
Medium	• Surface water with some capacity to absorb proposed changes or limited opportunities for mitigation. • Already experiencing some level of modification from some aspect of natural condition. • At medium risk of depletion (surface waters levels falling or drying out; groundwater levels / yields falling). • Provides important ecosystem services (fishery, flood conveyance capacity, sediment transport). • Used for local village water supply source, small industrial abstraction or minor irrigation scheme. • Serves village, local industry or small irrigation user. • Provides village wastewater disposal. • Supports local fishery.
Low	• Surface water with some capacity to absorb proposed changes or moderate opportunities for mitigation. • Already significantly modified from some aspect of natural condition. • Provides some ecosystem services (fisheries, flood conveyance capacity, sediment transport). • Used for water supply to individual dwellings or farms. • In a modified state due to existing use (e.g. existing dam/weir, gravel extraction). • Provides minor water use. • Provides isolated wastewater disposal.
Negligible	• Surface water with considerable capacity to absorb proposed changes and/or good opportunities for mitigation. • Receptor already significantly modified from natural condition. • River reach severely impacted by upstream dam.

The magnitude of the alteration to hydrology during pre-construction, construction, and operating for the different sources of impact are assessed using the criteria provided in Table 11-30.

Table 11-30 Hydrology Alteration Magnitude Criteria

Magnitude	Description
Major	Fundamental change to the specific environmental conditions assessed, resulting in long term or permanent change, typically widespread in nature. Would require significant intervention to return to baseline.
Moderate	Detectable change to the specific environmental conditions assessed, resulting in non-fundamental temporary or permanent change.
Minor	Detectable but minor change to the specific environmental conditions assessed.
Negligible	No perceptible change to the specific environmental conditions assessed.

11.7.3 Predicted Impacts during Pre-Construction and Construction

The assessment of the impacts during pre-construction and construction from alteration to hydrology disturbance have been undertaken using a quantitative-qualitative approach and are as provided in Table 11-31.

No proposed mitigation measures for pre-construction and construction are required as no significant impacts have been identified.

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Table 11-31 Potential Impacts – Hydrology during Pre-Construction and Construction

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Temporary river diversion	Diversion works undertaken in two-stage process. Stage 1 involves tunnelling through rock spur (no impact on river flows), Stage 2 involves damming the natural river and diverting flows through the diversion tunnels. Short, largely v. steep, reach (circa. 500-600 m) between cofferdam and diversion tunnel outlet will be bypassed. Construction flood (452 m^3/s) defined as combination of Ruzizi I powerhouse maximum flow (154 m^3/s), Ruzizi I spillway operating with one gate open (57 m^3/s) and 20-year return period flood from intervening catchment (241 m^3/s).	Low	Moderate	Minor (NS)
Reservoir clearing	Clearing of the reservoir footprint (46 ha) is required prior to reservoir filling. This activity is likely to result in increased sediment and debris movement in the river but is considered to have no direct impact on hydrology.	Negligible	Negligible	Negligible (NS)
Reservoir filling	Reservoir capacity at Full Supply Level (1145 mASL) is 7.72 Mm^3) which under average flow conditions (110 m^3/s) would take approximately 20 hours to fill. However, due to dam structure stability concerns, the reservoir is expected to take circa. 12 days to fill (an average flow rate of < 8 m^3/s), the remainder of the inflow would be diverted through the diversion tunnel. Short, largely v. steep, reach (circa. 500-600 m) between dam wall and diversion tunnel outlet will be bypassed; reservoir footprint will be progressively inundated. During reservoir filling, the 5.5-km-long dewatered reach downstream of the dam between the reservoir dam wall and powerhouse tailrace is potentially dewatered, in the same way as during operation.	Medium	Moderate	Moderate (S)*
* Mitigation measures are as for during operation, the mitigation measures and assessment of the residual impact are provided in Table 11-32.				

11.7.4 Predicted Impacts during Operation

The assessment of the impacts during operation from alteration to hydrology disturbance have been undertaken using a quantitative-qualitative approach and are presented in Table 11-32. The associated mitigation measures for required significant impacts are as given in Table 11-33.

Table 11-32 Potential Impacts – Hydrology during Operation

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Diversion of the river through the headrace tunnel, creating a dewatered reach (including during reservoir filling)	The circa. 5.5 km river reach between the reservoir dam wall and powerhouse tailrace – currently subject to hydropeaking effects due to the operation of Ruzizi II – is potentially dewatered under normal operating conditions.	Medium	Moderate	Moderate (S)
Normal powerhouse operation with peak and off-peak discharges	River flow and hydraulic conditions in the Ruzizi River downstream of the powerhouse tailrace will be subject to sub-daily fluctuations, that represent an incremental change to the fluctuations caused by the operation of Ruzizi-I and -II.	Medium	Moderate	Moderate (S)

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Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
	The impacts associated with the project are defined as the change in hydraulic conditions relative to the current baseline, i.e., those experienced due to the current hydropeaking operation of Ruzizi II. It is expected that power production ramp-up rates and ramp-down rates could potentially be faster for Ruzizi III than for Ruzizi II, but not exceeding threshold values for public safety and fish stranding. The impacts have been primarily assessed for the reach between the powerhouse tailrace and the Burundi border. Consideration has also been given to the possible impacts in the reach further downstream extending to Lake Tanganyika.. The impacts are more fully described in the Chapter 10 - Environmental Flow Assessment.			
Sediment flushing operations.	Sediment loading in the reservoir will require active sediment management in order to maintain active storage capacity. Any sediment flushing operations will result in a pulse of sediment laden water being released via the bottom outlet into the dewatered reach, with potential impacts on aquatic and terrestrial habitats and biodiversity, and community health and safety.	Medium	Moderate	Moderate (S)
Exception operating conditions.	Under normal operating conditions, the inflows to Ruzizi III reservoir will pass completely through the bottom outlet as environmental flow and, via the headrace, through the powerhouse and tailrace back into the Ruzizi River. Normal operating conditions are considered to be when inflows to Ruzizi III do not exceed circa. 160 m^3/s (equivalent to current 98% June non-exceedence flow). The bottom outlet has been designed to discharge 200 m^3/s at FSL which allows it to release without spill turbined flows in the event of powerhouse shut down. The bottom outlet has also been designed to discharge 110 m^3/s at a reservoir elevation of 1,120 mASL to allow inspection and maintenance of the power intake inlet structure at inflows up to the mean annual flow (110 m^3/s). The spillway has been designed to safely pass a design flood of 986 m^3/s and a safety evaluation flood of 1,420 m^3/s. The head above the spillway weir is estimated to be 3.6 m and 4.4 m respectively under these conditions. Peak flow estimates for floods of lower return periods in the intervening catchment are given by Tractebel[1] as 216-406 m^3/s (RP=10 yrs) and 427- 574 m^3/s (RP=100 yrs). Given an assumed 3 hour storm duration, this results in approximate flood volumes of 3.1-5.8 Mm^3 and 6.1-8.3 Mm^3 respectively. Depending on the timing of the intervening catchment flood events and reservoir levels in Ruzizi III, attenuation of the natural flooding may occur, and associated benefits/disbenefits could occur. Based on simplified 1D hydraulic modelling, flows in excess of circa. 160 m^3/s are expected to lead to floodplain inundation at various locations along the reach downstream of the powerhouse tailrace to the Ruhwa River.	Medium	Moderate	Moderate (S)

[1] Hydrology and Sedimentation Review (Tractebel, February 2020)

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Table 11-33 Mitigations & Residual Impacts – Hydrology during Operation

Project Activity	Mitigation & Monitoring	Residual Impact		
		Sensitivity	Magnitude	Significance
Diversion of the river through the headrace tunnel, creating a dewatered reach.	Maintain a minimum environmental flow release in dewatered reach through reservoir bottom outlet. Sub-daily variation in flow and hydraulic conditions (wetted area, depth, velocity) replaced with conditions associated with environmental flow regime adopted (e.g., 11 m^3/s / approx. 10% MAF). The impacts are as described in the Environmental Flow Assessment chapter. [M 42] Implement monitoring of release from the bottom outlet using flow measurement / video evidence. Provide real-time open web portal to allow for stakeholder assessment of performance. [M 43] Publish annual report of bottom outlet flow release data. [M 44] Implement operational maintenance schedule to ensure full and correct functioning of bottom outlet monitoring & data publishing, to include level of service agreements made with key stakeholders (e.g., ABAKIR) and recommendations for adaptive management variations.	Low	Moderate	Minor (NS)
Normal powerhouse operation with peak and off-peak discharges	Reduce the impact of hydropeaking on sub-daily flow and hydraulic conditions in the hydropeaking reach at source (e.g., incorporate environmental and social constraints into the optimised operating rule curves, and/or incorporate river restoration techniques to increase attenuation, reduce variation of wetted area, depths, and velocities) at ecologically important locations. [M 45] Assess requirements for improved hydrological modelling of upstream and tributary catchments to reduce uncertainty inherent in current broad-scale assessment. [M 46] Assess requirements for improved hydrological and hydraulic characterisation of micro-/meso-scale habitat in hydropeaking reach to reduce uncertainty inherent in current broad-scale assessment. [M 47] Implement monitoring of powerhouse tailrace flow and flow / water levels at selected locations in the hydropeaking reach (between the powerhouse tailrace and the Burundi border) using flow measurement / radar / video evidence.. [M 48] Publish annual report of powerhouse / hydropeaking reach flow data. [M 49] Implement operational maintenance schedule to ensure full and correct functioning of powerhouse tailrace / hydropeaking reach monitoring & data publishing, to include level of service agreements made with key stakeholders (e.g., ABAKIR) and recommendations for adaptive management variations.	Low	Minor	Minor (NS)
Sediment flushing operations.	Sediment management mitigation options are required to minimise the downstream impacts of sediment flushing operations. The measures required are more fully considered in the subsequent Geomorphology and Sediment Transport section of this Impact Assessment & Mitigation chapter. Specifically	Low	Minor	Minor (NS)

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Project Activity	Mitigation & Monitoring	Residual Impact		
		Sensitivity	Magnitude	Significance
	with regards to hydrological impacts, sediment flushing operations should expressly consider their potential for floodplain inundation. Mitigation measures should be implemented to assess the associated impacts of such releases. [M 50] Develop, agree with key stakeholders (e;g., ABAKIR), and implement a Dewatered Reach Sediment Management Plan that explicitly evaluates associated ecological and social functioning in the dewatered and further downstream reaches (including, *inter alia*, sediment transport and floodplain inundation). [M 51] Maintain regular, periodic releases from Ruzizi III reservoir (bottom outlet / spillway) to flush sediment in the dewatered reach. [M 52] Implement monitoring of sedimentation in the dewatered reach (between the powerhouse tailrace and the Burundi border) using periodic sediment sampling / aerial (drone) survey. [M 53] Publish annual report of sediment monitoring in the dewatered reach. [M 54] Implement operational maintenance schedule to ensure full and correct functioning of Dewatered Reach Sediment Management Plan, to include level of service agreements made with key stakeholders (e.g., ABAKIR) and recommendations for adaptive management variations.			
Exception operating conditions.	Powerhouse shutdown and / or power intake inlet structure inspection and maintenance may result in bottom outlet releases that lead to downstream floodplain inundation. Mitigation measures should be implemented to assess the associated impacts of such releases. A Reservoir Operation Plan should be developed that maximises the benefits associated with reservoir attenuation effects on low return period flooding (to be aligned with a Reservoir Sediment Management Plan). [M 55] Develop, agree with key stakeholders (e.g., ABAKIR), and implement a Reservoir Operation Plan (exception operating conditions and flood risk management) that explicitly evaluates associated ecological and social functioning in the dewatered and further downstream reaches (including, *inter alia*, sediment transport and floodplain inundation). [M 56] Publish annual report of Reservoir Operation Plan. [M 57] Implement operational maintenance schedule to ensure full and correct functioning of the Reservoir Operation Plan, to include level of service agreements made with key stakeholders (e.g., ABAKIR) and recommendations for adaptive management variations.	Low	Minor	Minor (NS)

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11.8 Geomorphology and Sediment Transport

11.8.1 Impact Producing Factors

The predicted geomorphology and sediment transport impacts during Ruzizi III pre-construction, construction, and operation have been assessed with reference to the baseline as described in the Geomorphology section of the Environmental Baseline Situation chapter. This includes a general area description and a reach-by-reach assessment of the geomorphological characteristics of: i) the reach from Lake Kivu to Ruzizi II; ii) the reach from Ruzizi II to Ruzizi III; iii) the Ruzizi III inundated area; iv) the reach from Ruzizi III to the powerhouse tailrace (the dewatered reach); v) the reach from the Ruzizi III powerhouse tailrace to the Border with Burundi (the hydropeaking reach); and vi) the reach downstream of the Burundi border. A review of sediment loading into Ruzizi III is also presented.

The main geomorphological and sediment transport impacts are further explored in the Environmental Flow Assessment chapter. Particular emphasis is given to the impacts associated with the dewatered reach between Ruzizi III dam wall and the powerhouse tailrace, and the downstream hydropeaking reach extending to the border with Burundi. The identified impacts are functionally related to the hydrological change drivers.

Potential sources of alteration to river channel geomorphology and sediment transport during pre-construction and construction comprise the following:

- Temporary river diversion.
- Runoff from worksites.
- Reservoir clearing.
- Reservoir filling.

Potential sources of alteration to river channel geomorphology and sediment transport during operation comprise the following:

- Normal powerhouse operation with peak and off-peak discharges.
- Diversion of the river through the headrace tunnel, leaving a bypassed reach of the river.
- Sediment flushing operations.
- Bottom outlet testing.
- Reservoir spillage.
- Exceptional operating conditions.

11.8.2 Assessment of Receptor Sensitivity

The sensitivity of the geomorphology and sediment transport receptor has been assessed as low as per the criteria provided in Table 11-34.

Table 11-34 Geomorphology and Sediment Sensitivity Criteria

Sensitivity of receptors	Description
High	• River channel with little or no capacity to absorb proposed changes or minimal opportunities for mitigation. • Provides vital ecosystem services (fishery, flood conveyance capacity, sediment transport). • Provides urban water supplies, major industrial abstraction or large irrigation supplies. • Is a spawning area for important fishery.
Medium	• River channel with some capacity to absorb proposed changes or limited opportunities for mitigation. • Already experiencing some level of modification from some aspect of natural condition. • At medium risk of depletion (surface waters levels falling or drying out; groundwater levels / yields falling).

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Sensitivity of receptors	Description
	• Provides important ecosystem services (fishery, flood conveyance capacity, sediment transport). • Used for local village water supply source, small industrial abstraction or minor irrigation scheme. • Serves village, local industry or small irrigation user. • Provides village wastewater disposal. • Supports local fishery.
Low	• River channel with some capacity to absorb proposed changes or moderate opportunities for mitigation. • Already significantly modified from some aspect of natural condition. • Provides ecosystem services (fishery, flood conveyance capacity, sediment transport). • Used for water supply to individual dwellings or farms. • In a modified state due to existing use (e.g. existing dam/weir, gravel extraction). • Provides minor water use. • Provides isolated wastewater disposal.
Negligible	• River channel with considerable capacity to absorb proposed changes and/or good opportunities for mitigation. • Receptor already significantly modified from natural condition. • River reach severely impacted by upstream dam.

The magnitude of the alteration to geomorphology and sediment transport for the different sources of impact are assessed using the criteria provided in Table 11-35.

Table 11-35 Geomorphology and Sediment Transport Alteration Magnitude Criteria

Magnitude	Description
Major	Fundamental change to the specific environmental conditions assessed, resulting in long term or permanent change, typically widespread in nature. Would require significant intervention to return to baseline.
Moderate	Detectable change to the specific environmental conditions assessed, resulting in non-fundamental temporary or permanent change.
Minor	Detectable but minor change to the specific environmental conditions assessed.
Negligible	No perceptible change to the specific environmental conditions assessed.

11.8.3 Predicted Impacts during Pre-Construction and Construction

The assessment of the impacts from alteration to geomorphology and sediment transport disturbance have been undertaken using a quantitative-qualitative approach. The assessment of potential impact is provided in Table 11-36.

Table 11-36 Potential Impacts – Geomorphology and Sediment Transport during Pre-Construction/Construction

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Temporary river diversion	Diversion works undertaken in two-stage process. Stage 1 involves tunnelling through rock spur (no impact on river flows), Stage 2 involves damming the natural river and diverting flows through the diversion tunnels. Diversion works are expected to result in increased sediment load to the river. Normal sediment transport into the reservoir area for flows up to the construction flood (452 m^3/s) will occur: this includes sediment transport associated with the operation of the upstream Ruzizi II HEPP.	Medium	Moderate	Moderate (S)
Runoff from worksites	Runoff from worksites and disturbed areas will carry sediment into the Ruzizi River, likely increasing the sediment load in the river.	Medium	Moderate	Moderate (S)

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Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Vegetation clearing and in-channel civil works	Clearing of the vegetation from worksite is required prior to construction works. This activity may result in increased sediment and debris being transported into the river with runoff In-channel civil works may also cause localised increase in river sediment loads.	Medium	Moderate	Moderate (S)
Reservoir filling	Reservoir capacity at Full Supply Level (1,145 mASL) is 7.72 Mm^3) which under average flow conditions (110 m^3/s) would take approximately 20 hours to fill. However, due to dam structure stability concerns, the reservoir is expected to take circa. 12 days to fill (an average flow rate of < 8 m^3/s), the remainder of the inflow would be diverted through the diversion tunnel. Reservoir filling will result in localised reduced flow velocities and associated reduction in suspended sediment transport.	Medium	Moderate	Moderate (S)

Proposed mitigation measures and residual impacts for significant impacts are presented in Table 11-37.

Table 11-37 Mitigations & Residual Impacts – Geomorphology & Sediment Transport during Pre-Construction/Construction

Project Activity	Mitigation	Residual Impact		
		Sensitivity	Magnitude	Significance
Temporary river diversion	See also mitigations & residual impacts associated with Soils, Groundwater and Surface Water: [M 33] Cofferdams and diversion tunnels used for construction works in the river will be designed to enable suspended sediment to be carried downstream while construction is taking place.	Medium	Negligible	Negligible (NS)
Runoff from worksites	See also mitigations & residual impacts associated with Soils, Groundwater and Surface Water: [M 32] During construction, erosion mitigation measures will be employed to prevent soil erosion and fluvial erosion when undertaking works on bare soil and banks and when working in the river (EPC Contractor). [M 34] During construction, worksite surface erosion and effectiveness of control measures will be monitored by taking weekly fixed-point photos of cleared areas.	Medium	Negligible	Negligible (NS)
Vegetation clearing and in-channel civil works	See also mitigations & residual impacts associated with Soils, Groundwater and Surface Water: [M 32] During construction, erosion mitigation measures will be employed to prevent soil erosion and fluvial erosion when undertaking works on bare soil and banks and when working in the river (EPC Contractor).	Medium	Negligible	Negligible (NS)
Reservoir filling	See also mitigations & residual impacts associated with Soils, Groundwater and Surface Water: [M 35] During the reservoir filling phase, bottom sluicing will be undertaken to maintain sediment throughflow as best possible and flows will be sufficient to transport the released sediment downstream to avoid siltation of instream habitats immediately downstream of the dam.	Medium	Negligible	Negligible (NS)

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11.8.4 Predicted Impacts during Operation

The assessment of the impacts during operation from alteration to geomorphological and sediment transport disturbance have been undertaken using a semi quantitative- semi qualitative approach and are presented in Table 11-38. The associated mitigation measures for significant impacts are given in Table 11-39.

Table 11-38 Potential Impacts – Geomorphology and Sediment Transport during Operation

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Normal operating conditions.	The normal operating conditions of Ruzizi III will replace the current conditions (functionally related to the existing hydropeaking operations of Ruzizi II) with conditions functionally related to: i) the reservoir footprint; ii) the dewatered reach between the bottom outlet and the powerhouse tailrace; and iii) the hydropeaking reach downstream of the powerhouse tailrace. These latter two change conditions are considered mor fully in subsequent defined project activities below. The reservoir footprint (the inundated area) will be subject to large variation in surface area, depths, and velocities on a sub-daily basis in response to both variations in seasonal inflows and to operational control of powerhouse releases (peaking and off-peaking conditions). Importantly, without active management, Ruzizi III reservoir will act as a sediment trap for both suspended sediment and bedload, and over time, sedimentation would likely occur, both reducing the live storage of the reservoir and starving downstream reaches of sediment and nutrients.	High	Major	Major (S)
Diversion of the river through the headrace tunnel, leaving a bypassed reach of the river.	The circa. 5.5 km river reach between the reservoir dam wall and powerhouse tailrace – currently subject to hydropeaking effects due to the operation of Ruzizi II – is potentially dewatered under normal operating conditions. This could result in the reach being starved of sediment and nutrients. The environmental flow regime adopted for this reach (see also hydrology predicted operational impacts) is likely to result in a large variation from the current geomorphological and sediment transport regime (that portion driven by the upstream flow regime).	Medium	Moderate	Moderate (S)
Normal powerhouse operation with peak and off-peak discharges.	The geomorphology and sediment transport impacts will be functionally related to the river flow and hydraulic conditions in the Ruzizi River downstream of the powerhouse tailrace, these will be subject to large sub-daily fluctuations, according to the operation of Ruzizi III. The impacts associated with the project are defined as the change relative to the current baseline, i.e., those experienced due to the current hydropeaking operation of Ruzizi II. The current and future operating rules for Ruzizi II and Ruzizi III are assumed to be those provided as optimised rules in the Feasibility Study. It is also assumed that power production ramp-up rates and ramp-down rates will be faster for Ruzizi III than for Ruzizi II (due to local operational conditions). The impacts have been assessed for the reach between the powerhouse tailrace and the Burundi border. The impacts are more fully described in the Environmental Flow Assessment chapter.	Medium	Moderate	Moderate (S)

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Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
	It is also noted that normal powerhouse operation may result in riverbed / bank erosion at the powerhouse tailrace restitution.			
Exceptional operating conditions.	Exceptional operating conditions are taken to occur whenever the reservoir spill is active occurring: i) when over a duration of greater than approx. 24 hours, inflows exceed the powerhouse flow and environmental flow regime releases (i.e., in flood conditions); and ii) during planned or accidental shutdown of the powerhouse intake and/or bottom outlet. Exceptional operating conditions without reservoir spill may also occur during planned or accidental shutdown of the powerhouse, where the bottom outlet is operated to maintain reservoir water levels below FSL. Exceptional operating conditions may result in localised riverbed / bank erosion at i) the spillway restitution and ii) the bottom outlet restitution due to erosional forces associated with the ski jump water jet(s).	Medium	Moderate	Moderate (S)

Table 11-39 Mitigations & Residual Impacts – Geomorphology and Sediment Transport during Operation

Project Activity	Mitigation	Residual Impact		
		Sensitivity	Magnitude	Significance
Normal operating conditions.	Identified mitigation measures include: i) Ensure the sustainable performance of reservoir active storage under normal and exceptional operating conditions, e.g., by sediment flushing and/or sluicing; ii) Provide periodic releases to support aquatic ecological value in the dewatered reach and/or flush sediment accumulation in the dewatered reach; iii) Prevent significant riverbed / bank erosion associated with the spillway, bottom outlet, and powerhouse tailwater restitutions. [M 58] Develop, agree with key stakeholders (e.g., other HEPP operators, ABAKIR), and implement Sediment Management Plan. [M 59] Publish annual report of Sediment Management Plan operations. [M 60] Implement operational maintenance schedule to ensure full and correct functioning of Sediment Management Plan, to include level of service agreements made with key stakeholders (e.g., other HEPP operators, ABAKIR) and recommendations for adaptive management variations.	Low	Minor	Minor (NS)
Diversion of the river through the headrace tunnel, leaving a bypassed reach of the river.		Low	Minor	Minor (NS)
Normal powerhouse operation with peak and off-peak discharges.		Low	Minor	Minor (NS)
Exceptional operating conditions.		Low	Minor	Minor (NS)

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11.9 Wastes

11.9.1 Impact Producing Factors

The following types of waste are expected to be generated during Project construction:

- Spoil from tunnelling (this will be the most significant waste in terms of volume).
- Excavated spoil from creating foundations for the dam and buildings.
- Concrete and concrete washings from concrete batching plants.
- Iron and steel scrap.
- Non-ferrous scrap.
- Waste oil and lubricants from turbine installation and vehicle maintenance/repair.
- Oil contaminated rags from turbine installation and vehicle maintenance/repair.
- Packaging and pallets from deliveries.
- Domestic waste, including glass, plastics, paper and cardboard.
- Batteries.
- Fluorescent tubes.
- Timber.
- Paints and chemicals
- Tyres.

During the operational phase it is envisaged that the following types of waste will be generated:

- Oil contaminated rags from equipment maintenance/repair.
- Cement and concrete generated during maintenance.
- Chemical, paints, oils and fuels.
- Wood and timber.
- Ferrous and non-ferrous metals.
- Fluorescent tubes.
- Batteries.
- Plastic.
- Glass.
- Paper and cardboard.

11.9.2 Assessment of Receptor Sensitivity

In contract to the other types of impacts assessed in this impact assessment chapter, there is no assessment of receptor sensitivity for waste. This is because waste storage, management and disposal is considered as part of the Project design. The significance of impacts is assessed using the impact magnitude criteria provided in Table 11-40.

11.9.3 Predicted Impacts during Pre-Construction and Construction

The assessment of the impacts is presented the tables on the following pages.

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Table 11-40 Waste Impact Significance Criteria

Waste Management Option	Type of Waste		
	Inert	Non-hazardous	Hazardous
Suitable facilities or outlets available with sufficient capacity to manage the quantities of wastes generated	Negligible (Not Significant)	Negligible (Not Significant)	Minor (Not Significant)
Suitable facilities or outlets available but capacity to accept waste from project may be constrained due to size of facility or distance from site	Minor (Not Significant)	Moderate (Significant)	Moderate (Significant)
Facilities are unavailable or unsuitable; or means of management is uncertain.	Moderate (Significant)	Moderate (Significant)	Major (Significant)

Potential impacts are presented in the following table.

Table 11-41 Assessment of Potential Impacts – Wastes during Pre-Construction/Construction

Description of Waste	Potential Impact		
	Waste Type	Availability of Facilities	Significance
Excavation spoil	Inert	Unavailable	Moderate (S)
Concrete	Inert	Available but constrained	Moderate (S)
Concrete washings	Non-Hazardous	Unavailable	Moderate (S)
Iron and steel scrap non-ferrous scrap	Non-Hazardous	Available but constrained	Moderate (S)
General domestic waste, paper and cardboard, packaging, pallets, Glass, plastics and tyres	Non-Hazardous	Available but constrained	Moderate (S)
Oils and lubricants, oil contaminated rags, batteries, fluorescent tubes, paints and chemicals	Hazardous	Availability uncertain	Major (S)

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Table 11-42 Mitigations & Residual Impacts – Wastes during Pre-Construction/Construction

Project Activity	Mitigation	Residual Non-Hazardous Impact		
		Waste Type	Availability of Facilities	Significance
Excavation spoil	[M 61] The EPC Contractor will prepare a Site Waste Management Plan as part of the CESMP in alignment with GIIP and the Employers E&S Requirements. [M 62] The EPC Contractor will ensure that waste is segregated and stored on site according to GIIP, and a register of waste maintained. [M 63] The EPC Contractor will identify accredited third-party waste management facilities for the management of waste, including facilities for reuse and recycling. The facilities will be audited by the EPC Contactor to ensure compliance with GIIP and E&S requirements of the environmental permit. [M 64] Wastes that cannot be managed by offsite contractors will be managed by the EPC Contractor, and this may include construction of a landfill or installation of an incinerator. The design of these facilities will follow GIIP and environmental permits will be obtained. [M 65] The EPC Contractor make all the necessary arrangements for transport of waste that is not managed on-site to accredited offsite waste management facilities. A waste tracking system shall be implemented (waste manifests) and compliance with the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal. [M 66] If quality permits, the EPC Contactors will reuse excavation spoil material, such as for concrete formation, backfilling, foundations and road construction. Excess spoil will be disposed of at designated and specially designed spoil disposal sites and the necessary permits from local authorities obtained by the EPC Contractor. [M 67] The practice of disposing of inert spoil from road construction by side-casting is to be prohibited.	Inert	Available	Negligible (NS)
Concrete		Inert	Available	Negligible (NS)
Iron and steel scrap Non-ferrous scrap		Non-Hazardous	Available	Negligible (NS)
General domestic waste, paper and cardboard, packaging, pallets, Glass, plastics and tyres		Non-Hazardous	Available	Negligible (NS)
Oils and lubricants, oil contaminated rags, batteries, fluorescent tubes, paints and chemicals		Hazardous	Available	Minor (NS)

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11.9.4 Predicted Impacts during Operation

During operation, the types of waste generated will be similar to that generated during the construction, but with smaller quantities. However, domestic trash from Bukavu and Goma which is carried by the Ruzizi River could accumulate in the Ruzizi III reservoir. The baseline situation is that the trash accumulates at the Ruzizi-I and II reservoirs, but similar problems of waste accumulation could occur at Ruzizi III. REL will manage the Project waste generated during operation using the same onsite and offsite facilities as those used by the EPC Contractor during construction. However, additional specific measures will be needed to manage the domestic trash. To this end, the following measures will be implemented:

[M 68] REL will conduct a waste management study to asses how to manage the domestic trash that accumulates in the Ruzizi III reservoir. REL will prepare a Waste Management Plan for the operation phase as part of the ESMP in alignment with GIIP and in coordination with local authorities and the operators of Ruzizi-I and -II.

[M 69] REL will ensure that waste is segregated and stored on site according to GIIP, and a register of waste maintained.

[M 70] REL will establish contracts with accredited third-party waste management facilities for the management of waste, including facilities for reuse and recycling and conduct regular audits to ensure compliance with GIIP and E&S requirements of the environmental permit.

[M 71] REL will make all the necessary arrangements for transport of waste that is not managed on-site to accredited offsite waste management facilities. A waste tracking system shall be implemented (waste manifests) and compliance with the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal.

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11.10 Aquatic Habitats and Biodiversity

11.10.1 Impact Producing Factors

Potential sources of impacts on aquatic habitats and biodiversity during pre-construction and construction comprise the following:

- Temporary river diversion resulting in a bypassed reach of river dry downstream from the site construction site.
- Sedimentation and potential pollution causing alteration to water quality of the Ruzizi River.
- Reservoir filling causing reduction in downstream flow and loss of aquatic habitat and connectivity.

Potential sources of impacts on aquatic habitats and biodiversity during operation comprise the following:

- Physical presence of the dam acting as a barrier to fish migration.
- Trapping of sediment in the reservoir reducing sediment transport downstream.
- Short-term (sub-daily to weekly) changes in river flow conditions caused by peak and off-peak discharges.
- Diversion of the river through the headrace tunnel, reducing flow in the 5.5 km bypassed reach between dam wall and powerhouse outlet.
- Periodic changes in flow conditions in the dewatered reach caused by bottom outlet testing, maintenance, sediment flushes or reservoir spillage.

The high rainfall and steep erodible slopes around the reservoir and dewatered reach increases the risks of high sediment inputs into the river.

The magnitude categories of the impacts on aquatic biodiversity are described in Table 11-43. The assessment of significance for pre-mitigation and residual impacts is presented in Table 11-45 with a summary of mitigation measures.

Table 11-43 Aquatic Habitat and Biodiversity Impact Magnitude Criteria

Magnitude (positive or negative)	Description
Major	Fundamental change to aquatic habitat conditions or biota resulting in long-term or permanent change, typically widespread. Adverse impacts would require significant intervention to return to baseline; and/or exceeds national standards and limits.
Moderate	Detectable change to the aquatic ecosystem or biota assessed resulting in long term or permanent changes at a local scale.
Minor	Detectable but minor change to the specific aquatic habitats or species assessed at a site or local scale and/or with temporary consequences.
Negligible	No perceptible change to the specific aquatic habitat or biota assessed.

11.10.2 Assessment of Receptor Sensitivity / Importance

The sensitivity of aquatic biodiversity receptors (or values) for this project is based primarily on the aquatic health of the ecosystem and presence of threatened, restricted-range or migratory species and/or habitats of high conservation value as categorised in Table 11-44.

In the case of the Project, the Present Ecological State (PES) of the aquatic habitats in the Project AoI were assessed as *Seriously Modified* based on low diversity and abundance of macroinvertebrates. These were mostly dominated by taxa tolerant of poor water quality with a high proportion of air breathers and predators, and indicator species typical of modified habitats. No threatened macroinvertebrates were confirmed or considered likely to occur. In

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addition, the aquatic plant community was dominated by a filamentous algae typical of polluted conditions and diatom composition also indicated elevated concentrations of nutrients and suspended sediments.

In the case of fish, the fish community of the Ruzizi River mainstem was dominated by indigenous species with a few alien species. The species community has undoubtedly changed from natural conditions primarily due to the peaking operation of upstream Ruzizi-I and -II hydropower plants over the last 50 years, pollution inputs, and some inundation of lotic habitats. However, there are several migratory fish species – mostly *Labeo/Labeobarbus* species - that continue to migrate up the Ruzizi River. Evidence for the presence of some fish species recorded historically (in the mid-1950s or until early 1980s) in the middle to upper Ruzizi River have not been confirmed in more recent surveys (e.g. *Acapoeta tanganicae* and *Labeobarbus leleupanus*) in the Project Area. Although the Ruzizi Basin would qualify as critical habitat for several fish species, none of the fish species confirmed in the upper and middle reaches of the Ruzizi River mainstem (i.e. the Project Area of Influence) in the past five years are considered threatened or restricted range or qualify this reach as critical habitat. The highly threatened Chiloglanis species are known predominantly from tributaries of the Ruzizi River outside the Project Area of Influence.

Table 11-44 Aquatic Habitat and Biodiversity Sensitivity Criteria

Conservation value (sensitivity)	Species Criteria	Habitat or Site Criteria
High	Areas or sites of importance for confirmed IUCN Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) species and restricted-range species (<50,000 km^2). Sites with globally, regionally or nationally significant concentrations of migratory or congregatory species.	IUCN Red-listed ecosystems that are classified as CR or EN. Internationally designated biodiversity areas including Nature Reserve and National Parks (IUCN Category I & II), UNESCO World Heritage Sites for biodiversity; recognised Key Biodiversity Areas (KBAs), Important Biodiversity Areas (IBAs), Ramsar Sites, Alliance for Zero Extinction (AZE) sites. Critical habitats of significant international ecological importance.
Medium*	Areas or sites with IUCN Near Threatened (NT) species, or possible but unconfirmed presence of VU, EN or CR species. Biome-restricted endemics (with EOO >50,000 km^2).	IUCN Red-listed ecosystems that are classified as VU. Nationally designated biodiversity areas e.g. Protected Areas, including Natural Monuments or Features (Cat III), Habitat or Species Management Areas (Cat IV), Protected Landscape (Cat V), or Protected area with sustainable use of Natural Resources (Cat VI); nominated or identified Key Biodiversity Areas (KBAs) (or equal status). Natural Habitat of significant ecological importance and/or high biodiversity with limited potential for substitution.
Low	IUCN Least Concern species of local or national importance. Nationally protected species, but not a significant population size and not of national importance.	Modified habitats with some functional ecological value.
Negligible	IUCN Least Concern species of no local or international importance.	IUCN Least Concern species. Species of no national importance.

* The aquatic biodiversity of the Ruzizi River is assessed to be of "medium" sensitivity. This is a precautionary approach because of the historical presence of potential restricted range fish species that could quality for Critical Habitat if they are confirmed to still be present in the project area and because of evidence of fish migration along the Ruzizi River. However, the rating has taken into account that the river has been modified by the hydropeaking operation of Ruzizi-I and -II hydroelectric schemes for the last 50 years.

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11.10.3 Predicted Impacts during Pre-Construction, Construction and Reservoir Filling

11.10.3.1 Predicted Pre-Mitigation Impacts - Construction

The main impacts of the construction phase on aquatic biodiversity are described below and will require mitigation, where feasible. These are summarised in Table 11-45.

A Impact of dewatering of diverted river reach on aquatic habitats and biota

A diversion tunnel will divert the Ruzizi River out of the main river over a distance of ~500-600 m to allow for dam construction. This will result in no flow in this short very steep and turbulent stretch and result in drying and loss of aquatic instream and marginal habitats and desiccation of any macroinvertebrates present. Since the aquatic habitats in the affected reach are considered Modified Habitat and macroinvertebrates exhibit low diversity and abundance this construction phase impact is considered non-significant. Fish will be unable to move through the diverted stretch and their upstream migration will be blocked during the construction period. The impact of the dam wall and reservoir as a permanent barrier to fish migration is covered in more detail in Section 11.10.4.

B Water quality impacts on macroinvertebrates and fish during construction

Construction will cause increased sedimentation and turbidity, and possibly increased contamination from minor hydrocarbon spills at and downstream of the dam and powerhouse construction sites.

- Water Pollution: Pollution events are likely to coincide with high rainfall-runoff events when contaminants will be washed into the river. This will reduce water quality conditions for aquatic biota for several kilometres downstream for the duration of the construction phase, attenuating with increasing distance downstream as contaminants become increasingly diluted, especially downstream of the Rubyiro and Ruhwa confluences located ~13 to 15 km downstream of the Ruzizi III dam site. Most fish guilds are likely to be affected to some degree except for the eurytopic tolerant guild (e.g. *Clarias gariepinus*). The toxicity to fish will depend on the size of any spills that may occur and concentrations in the receiving river. Most pollution events are likely to be sub-lethal. Fish populations are likely to adopt avoidance behaviour by moving away from affected areas and recolonisation from downstream refuges is expected following cessation of the contamination events. The impact is limited in spatial and temporal extent and is considered non-significant.
- Increased sedimentation: Runoff of sediment from construction sites, roads, unstable banks and excavated areas will generate increased sediment loads in the Ruzizi River. The degradation of water quality by high sediments releases into the river may be sporadic and associated with high rainfall-runoff events for the duration of the construction phase activities and until bare slopes may become stabilised through natural revegetation. Higher sediments loads will increase turbidity which may affect primary productivity in aquatic habitats through reduced light penetration, which could affect food availability for grazing macroinvertebrates. It may also impact negatively on predators that rely on sight for feeding such as dragonfly larvae. Deposition of mobilised sediments could also smother benthic habitats further downstream where the river velocity declines, and sediment is able to settle out during construction. However, since the macroinvertebrate community is depauperate, with low diversity and abundance, and few sensitive species (likely due to a long history of peaking operations from upstream HEPPs), construction impacts on macroinvertebrates are considered reversible and non-significant.

Turbidity also impairs prey capture by fish which will impact the invertivore guild of fish (e.g. *Enteromius* spp.) and the larval and juvenile phases of most other fish guilds. Suspended sediment increases abrasion of living tissue, removes mucous coating on gills, and clogs gill

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rakers and filaments. This is likely to be sub-lethal but is expected to result in increase in stress levels and contribute to reduced growth rates and fecundity and fish condition. Fish are likely to move away from the affected areas downstream of the construction site. Recolonisation from downstream refuges is expected following cessation of activities. Avoidance of the construction affected reaches may also interrupt fish migrations for the duration of the elevated suspended sediment loading. Increased sediment deposition along river channel margins may also smother fish habitat and spawning areas possibly reducing fish recruitment. Although the upstream Ruzizi I and II HEPPs trap sediment, the extent of cultivation in the Ruzizi catchment below the Ruzizi II and occasional landslides on the steep slopes already result in increased sediment inputs especially after high rainfall events. Despite the sediment retention in upstream dams, it is likely that the fish community is already impacted by periodic high turbidity and that the fish species present are relatively resilient to seasonal increases in sediment levels. The impact is likely to be limited in spatial and temporal extent (in the order of 5-10 km during construction), and because fish species present are considered relatively tolerant of high suspended sediment loads, the impact is considered non-significant assuming good management practices are implemented to limit sediment inputs.

C **Impacts on Aquatic Habitats and Macroinvertebrates (instream habitats) from Reservoir Filling**

Reservoir inundation will flood ~2.3 km or 13 ha of open river habitat comprising a series of fast flowing rapids and riffles, and a ~1 km section of smooth water, possibly with pools that likely provide a refuge and resting area for fish moving up against high flow velocity. Some portions of the reservoir river reach are anastomosed with small islands separated by riffles. Most of the islands are cultivated and are of low biodiversity value as aquatic habitats. There are no off-channel wetlands or backwaters that serve as fish nursery or feeding areas and aquatic biodiversity (as reflected by macroinvertebrates) is depauperate, and already significantly impacted from upstream hydropeaking flows. Reservoir flooding will permanently inundate the aquatic habitats, and because the aquatic habitats are degraded and macroinvertebrate diversity is low, the impact on the aquatic ecosystem (excluding fish) is considered non-significant. Inundation impacts on rapid and riffle habitats for fish are described below.

D **Impacts on Aquatic Habitats and Fish Species from Reservoir Filling**

The reservoir filling has a duration of less than two weeks, and during this time there will be a reduction in the flow in the dewatered reach (see 11.7.3, Table 11-31). This will negatively influence the availability and suitability of aquatic habitats, due to the decreased water depth and velocity. In order to lower the significance of this impact, an environmental flow will be maintained during this period, in the same way as during operation.

Chiloglanis spp: The presence of threatened *Chiloglanis* species (*C. ruziziensis* and *C. asymetricaudalis*) in the Ruzizi River mainstem has not been confirmed and is likely to be low as a result of peaking flows from upstream hydropower dams. None were caught in mainstem during the 2021/2022 surveys in the Project AoI or during the CRBEC/CRSNE surveys over the past five years (except in tributaries). Since they are small-bodied bottom dwellers, it is considered more likely that they are present in the lower velocity riffles in tributaries to the Ruzizi where they have been recorded (e.g. Sange and Luberizi Rivers (DRC); and Kadjeke River, Burundi as well as the Ntandwe /Rubyiro Rivers (the latter where they were confirmed in 2022). Given the relatively localised loss of rapid and riffle habitat over 2.3 km in the reservoir and reduction in wetted area in the 5.5 km dewatered reach, and the likelihood that *Chiloglanis* are not present or rare in the mainstem, the impact of reservoir inundation on these threatened species is assessed as non-significant.

Migratory species: Several migratory fish of the *Labeo* and *Labeobarbus* genus, (e.g. *Labeobarbus altianalis. L. somereni; Labeo cylindricus*) occur in the Ruzizi River which migrate upstream to rapids spawn. Only one is threatened (*L. leleupanus* (VU) but which has not been confirmed in the Project AoI despite several surveys and was only recorded in main tributaries downstream of the project. Rapid and riffle habitats are considered important for spawning of migratory fish which are believed to move upstream to spawning grounds particularly when river

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levels start to rise in the wet season. Some of the migratory species (e.g. *Labeobarbus / Labeo sp. such L. altianalis*) are relatively long-distance migrators that appear to migrate up to the Ruzizi II HEPP possibly from as far downstream as the Ruzizi floodplains at the northern end of Lake Tanganyika, a distance of approximately 80-100 km. However, migratory behaviour of fish in the Ruzizi is poorly understood and it is unknown the extent to which these species may migrate up other tributaries such as the Rubyiro and Ruhwa Rivers, and others, especially given the higher sediment loads carried by these rivers. It is suspected that the Ruzizi may be a preferential river for migration due to the relatively lower sediment loads carried as a result of sediment trapping in the upstream hydropower dams and presence of multiple rapids in the middle to upper reaches. Several migratory species (e.g. *L. altianalis, L. cylindricus and L. somereni* – all IUCN listed as Least Concern) have been confirmed in the fast flowing reaches of the Ruzizi River near and downstream of the Ruzizi II HEPP. In the context of the available rapid and riffle habitats in the 140 km Ruzizi River (from Lake Tanganyika to Ruzizi II HEPP), the direct inundation of 2.3 km of rapid / riffle habitats by the Ruzizi III HEPP on migratory fish is considered non-significant.

The impact of the barrier effect posed by the dam on fish migration including Critical Habitat qualifying fish is assessed under Operational Impacts in Section 11.10.4.

11.10.3.2 Mitigation Measures for Construction & Reservoir Filling Phase

Mitigation for impacts on aquatic habitats and fish during site preparation, construction and reservoir filling are mainly limited to measures to limit pollution and reduce erosion, water quality impacts and sedimentation and turbidity (see Sections 11.6 and 11.8). There is no mitigation possible for the inundation and loss of aquatic habitats during reservoir filling. Mitigation for impacts arising from construction of the dam wall, diversion tunnel and powerhouse in the river and other project infrastructure are also limited and these activities will inevitably result in increased sedimentation and turbidity of aquatic habitats during the construction period and until such time as bare riverbanks and adjacent construction sites are revegetated. The reduced flow in the dewatered reach during reservoir filling is mitigated by the release of the environmental flow in the dewatered reach, in the same way as during operation. Key construction mitigation measures to protect aquatic habitats and fish are as follows:

Prevention of sedimentation/increased turbidity

Partial mitigation of sedimentation impacts on aquatic habitats during construction can be achieved as follows:

- Discharge of the environmental flow into the dewatered reach downstream from the dam during reservoir filling.
- Riparian Buffer Zones. A riparian buffer zone of 50 m width (measured from the outer edge of the riparian zone) will be implemented within or adjacent to riparian habitats upstream and downstream of the cofferdams within which no vegetation should be removed other than necessary along the construction right of way.
- Clearance for community land uses. Measures to restrict additional clearance of land within at least 10 m of the riverbank for community agriculture shall be enforced around the reservoir and dewatered stretch. This shall form part of other sub-catchment management initiatives to limit erosion and sedimentation impacts on the Ruzizi River.
- Riparian Corridor. Measures will be implemented to prevent bank destabilisation and erosion to minimise sediment transport into rivers and streams. This could include construction of gabions, embankments / berms to limit sheet runoff from adjacent steep slopes in the reservoir catchment and create barriers to prevent landslide material entering the river course.
- Rehabilitation. Rehabilitation of disturbed areas outside (above) the reservoir full supply level will commence as soon as possible after construction work in temporary areas is completed with the aim of re-establishing indigenous vegetation and natural habitats. Seeding of grasses and monitoring and controlling alien plant invasion will be a priority, particularly along drainage lines.

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These measures are referred to elsewhere in this report as:

[M 72] A riparian buffer zone of 50 m around riparian habitats will be maintained in all construction works areas to restrict erosion and sedimentation and rehabilitation, and alien plant control will be applied after construction to re-establish natural vegetation (EPC Contractor).

[M 73] Community land use activities will be regulated within the 50 m buffer zone such that no new agricultural clearance will be permitted whatsoever within 10 m of the riverbank in the project's area of influence (reservoir and dewatered reach).

[M 74]. Protect the riparian corridor through implementing measures to reduce erosion and sediment inputs into river courses through construction of gabions, embankments, and/or berms.

11.10.3.3 Post-mitigation Impacts - Construction

Residual impacts of construction on aquatic habitats and biota are summarised in the following table (Table 11-45).

Construction phase impacts on aquatic habitats and biota will arise primarily from accidental pollution, and increased turbidity / sediment inputs, some of which can be adequately managed through good site practices (e.g. accidental spills), but some such as increased sedimentation / turbidity are inevitable and will be difficult to mitigate effectively. Taking into account the modified condition of the Ruzizi River due to upstream Ruzizi-I and -II hydropower operations and ongoing contamination from large riparian towns (Bukavu), pollution from accidental spills (if mitigated) is predicted to be of minor residual significance. Sedimentation impacts during the approximately 56-month construction phase period may have a moderate significance on downstream aquatic biodiversity but is expected to be ameliorated once construction is completed.

The most obvious direct impact of construction and reservoir filling will be the loss of aquatic and riparian habitats during reservoir filling which will inundate 2.3 km of river reach and cause a reduction in flow in the 5.5 km dewatered downstream reach. This stretch comprises extensive rapids and riffles which are considered of importance to migratory fish, in particular, and for which there is limited mitigation that can be applied. Although the affected river reach is relatively short the loss of these rapids is assessed as potentially significant for fish.

11.10.3.4 Impact Summary

The summary of impacts for pre-construction, construction and reservoir filling is provided in Table 11-45.

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Table 11-45 Summary of Impacts on Aquatic Habitats and Biodiversity during Pre-Construction/Construction & Reservoir Filling

Project Activity	Summary Description of Impact	Potential Impact				Residual Impacts		
		Sensitivity	Magnitude	Significance	Mitigation Measures	Sensitivity	Magnitude	Significance
Temporary river diversion resulting in a bypassed reach of river downstream from the site construction site.	Loss and desiccation of aquatic habitats and biota in a 500-600 m reach from water diversion	Low	Medium	Minor (Not Significant (NS))	Not applicable (impact not significant)	Low	Medium	Minor (NS)
Dam and Powerhouse construction	Pollution of river water from accidental spills on construction sites near the river may have short term localised impacts on aquatic habitats and macroinvertebrates and fish.	Medium	Low	Minor (NS)	See Section 11.6 (Soils, Ground Water and Surface water)	Medium	Low	Minor (NS)
	Increased sedimentation/ turbidity on the Ruzizi River water quality during construction on macroinvertebrates and fish causing smothering of benthic habitats, damage to fish gills and displacement of sensitive fish species to downstream reaches.	Medium	Medium	Moderate (S)	See Section 0 (Geomorphology and Sediment Transport) [M 72] A riparian buffer zone of 50 m around riparian habitats will be maintained in all construction works areas to restrict erosion and sedimentation and rehabilitation, and alien plant control will be applied after construction to re-establish natural vegetation (EPC Contractor). [M 73] Community land use activities will be regulated within the 50 m buffer zone such that no new agricultural clearance will be permitted whatsoever within 10 m of the riverbank in the project's area of influence (reservoir and dewatered reach). [M 74]. Protect the riparian corridor through implementing measures to reduce erosion and sediment inputs into river courses through construction of gabions, embankments, and/or berms.	Medium	Low	Minor (NS)
Reservoir filling	Inundation of aquatic habitats (rapids, riffles and pools) in 2.3 km (13 ha) of fast-flowing river and impact on macroinvertebrates and other non-fish biota.	Low	Medium	Minor (NS)	Not applicable (impact not significant and mitigation not feasible feasible)	Low	Medium	Minor (NS)
	Inundation of 2.3 km of fish habitats (rapid/riffles) of importance for migratory fish (e.g. *Labeo/ Labeobarbus* spp) for spawning.	Medium [a]	Medium	Moderate (S)	No mitigation feasible or possible	Medium	Medium	Moderate (S
	Dewatering of downstream Ruzizi River causing degradation of aquatic habitats and reduction in fish spawning and feeding habitats.	Medium [a]	Low	Minor (NS)	The reservoir filling has a duration of less than 2 weeks, and during this time there will be a small temporary reduction in the flow in the dewatered reach – because of the environmental flow released during reservoir filling. This will precede a greater degree of alteration of flow once operation starts.	Medium [a]	Low	Minor (NS)

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11.10.4 Predicted Impacts during Operation

11.10.4.1 Potential Pre-Mitigation Impacts

A Water Quality Impacts on Aquatic Ecosystem, including Fish

The project impact on water quality during operation is assessed to be not significant (see Section 11.6) because of the short residence time in the reservoir (less than 24 hours) and the small quantity of flooded biomass in relation to the river flow. Lowering of dissolved oxygen levels in the Ruzizi River is not expected. Waste from upstream towns (e.g. Bukavu) is predicted to accumulate in the reservoir and the Project will remove and manage this waste on a routine basis (see Section 11.9). Consequently, it is unlikely that water quality impacts of the project will impact aquatic ecosystems and fish more than occurs under current baseline conditions.

B Impacts on Water Borne Pathogens and Diseases

- Reservoir: The creation of the reservoir is unlikely to increase the risk of spread of bilharzia snails, malarial mosquitos or blackflies which cause waterborne diseases. This is due to the daily fluctuating water levels in the reservoir (in the order of 12 m) which will expose the reservoir margins, causing desiccation of vegetation and any snails or insect larvae that try and establish in this zone. The potential project impact on waterborne diseases is therefore considered non-significant.
- Dewatered Reach: Downstream of the dam in the dewatered reach, reduced sediment and water flow and decreased water depth with higher temperatures may increase the prevalence of benthic algae and water weed which is likely to attract grazers such as bilharzia snails. This may result in an increase in the prevalence of bilharzia in nearby communities / water users, especially as the lower water flow in this reach may facilitate increased water contact with local residents, for fishing, washing, swimming, or water collection (if allowed to use this reach). Currently the rapid flow rate and fluctuating water levels associated with Ruzizi II hydropeaking operations presently precludes establishment of bilharzia snails in the Ruzizi River downstream of the existing HEPPs. This impact is potentially significant for local residents living/working close to or using the dewatered reach unless actively monitored and managed (e.g. through periodic release of freshets to scour accumulated sediment and create temporary conditions unsuitable for snails).

C Impacts on Fish Species from Dam Wall as Barrier to Fish Migration

There is evidence for fish migration through the Project AoI up to Ruzizi II HEPP (located approximately 14 km upstream) which is fitted with a fish pass that has not been operational for over 20 years (but which is due to be rehabilitated). Several migratory fish species were found to be impacted by fish stranding and harvesting by local residents at the spillway when spillage ceased, and more *Labeo/Labeobarbus* species were found in October/November surveys than August in 2021 (Sofreco 2021).

Although there is a fast-flowing cascade just below the proposed Ruzizi III HEPP in what will become the dewatered reach, the presence of increased abundance of migratory fish at Ruzizi II in the wet season survey (mainly *Labeobarbus altianalis*) suggests that the river is generally navigable by some migratory fish. Several of the migratory fish are believed to migrate up from the lower Ruzizi River, possibly from their spawning grounds on the floodplains at its inflow to Lake Tanganyika, ~90-130 km downstream of Ruzizi II HEPP. It is unknown whether fish preferentially migrate up the Ruzizi relative to other tributaries, but this is considered likely due to the lower turbidity and likely higher dissolved oxygen levels which are a key requirement for spawning fish such as *Labeo/Labeobarbus* species.

The Ruzizi III dam wall will stand at a height of 51 m and will prevent fish migration along the upstream 14 km stretch up to Ruzizi II HEPP, which is dominated by a series of rapids and riffles. The fast-flowing rapid cascade located immediately downstream of the dam wall likely already

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restricts migration for some fish, particularly smaller-bodied migratory fish and thus it is likely that mainly the larger adult fish can access this middle-upper reach of the Ruzizi River for spawning. For those that do successfully navigate their way up to Ruzizi II HEPP, many fish are impacted by hydropeaking operations, which leaves fish stranded and subject to harvesting by local residents. In future, the reach upstream of Ruzizi III HEPP is also earmarked for Ruzizi IV HEPP, further negating the potential for fish migration in this reach (see Section 12 Cumulative Impacts).

Overall, the 'loss' of 14 km of river reach upstream of Ruzizi III HEPP as a result of the barrier effect represents a relatively small loss of available fish migration habitat as a result of the project although it comprises multiple rapids and riffles. There are extensive riffle habitats remaining downstream of the Ruzizi III HEPP in the 130 km reach to Lake Tanganyika, as well as alternative tributaries (albeit with higher sediment loads), and therefore the barrier effect of the dam wall on migratory fish is considered non-significant in the context of existing upstream HEPP operations. However, this impact is assessed in combination with the dewatered reach in Section D below.

D Impact of Minimum Flow in Dewatered Reach on Fish

The 5.5 km dewatered reach between the dam and the powerhouse will be subject to a minimum flow of 10 m^3/s (approximately 10% of the Mean Annual Flow (MAF)). While this volume of water is likely to maintain sufficient depth for fish migration (i.e. >0.3 m) over most of the reach, the width of wetted area of river course and water depth will be reduced which may result in some sections becoming more restricted and difficult for fish movement. In addition, some wider and shallower sections with riffles are expected to be subject to higher fishing intensity resulting in reduced migration and spawning success. Should fish migration be restricted in the 5.5 km dewatered reach, this impact when combined with the barrier effect restricting fish migration to the 14 km reach upstream of the reservoir may result in a combined 20 km reduction in accessible river for migratory fish. This reach is already subject to erratic hydropeaking releases and likely has reduced abundance of migratory fish compared to natural conditions. However, although there is still 123 km of Ruzizi River downstream to Lake Tanganyika with several affluent tributaries, the combination of physical reduction in rapid and riffle habitat for migratory fish and reduced survival through expected increased fishing pressures, could have a potentially significant incremental additional impact on fish migration if not mitigated. Monitoring and adaptive management (e.g. through river engineering and periodic release of freshets to reduce sedimentation and increase connectivity) is recommended to optimise conditions and enhance opportunities for fish migration in the dewatered reach. See Section 11.10.4.2 for mitigation requirements.

E Impact of Reservoir on Fish Community

The reservoir will permanently transform 2.3 km of flowing water (lotic) habitat to standing water (lentic) habitat. This transformation will have the following consequences on fish:

- The fish community structure in the reservoir will shift in favour of guilds and species better adapted to lake-like environments as well as to eurytopic (low oxygen) tolerant species such as *Clarias* and *Protopterus* spp. The new reservoir fish community is expected to resemble the upstream wetland-Lake Kivu fish communities more closely.
- The transition from river to a lake-adapted fish community structure is likely to follow a successional pattern with different species dominating at different post-filling stages. Not all rheophilic species (i.e. those adapted to flowing water) are likely to be lost, however; some lotic adapted species may still survive in the transitional reach at the upper end of the reservoir.
- Most indigenous fish are likely to decline in diversity and abundance. Cichlids and the eurytopic tolerant guilds of species may stay the same or increase, while the eupotamonic phytophilic guild of fish (such as some *Labeobarbus* species) are likely to decrease as they will have reduced access to suitable floodplain spawning habitats. Mormyrids and rheophilic species (riffle-adapted) such as some *Labeobarbus* species (and *Chiloglanis*, if present) are also unlikely to persist in the reservoir due to flooding of

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rapids and riffles. An increase in competition and predation by a more diverse and abundant cichlid community may impact the lotic parapotamonic guild (*Enteromius* barb community), which would also be impacted by the reservoir water fluctuations (of 12 m) and associated restrictions in natural establishment of riparian habitats.

Inundation and decomposition of terrestrial vegetation in the reservoir would release nutrients into the reservoir during and after the filling phase for several years and could result in a reduction on dissolved oxygen levels. Overall, inundation may result in an increase fish yield and productivity, at least in the first few months after filling, but low species diversity as the conditions will favour less sensitive fish species. Availability of food items would shift from benthic flow-dependent to zooplanktonic invertebrate taxa (although in relatively low numbers because of the short residence time of water in the reservoir). The higher secondary plankton production would be beneficial to young fish and increase recruitment of those species able to exploit the inshore reservoir habitat. Following filling, nutrient availability may decline as plant nutrients are exhausted and a species succession is likely with a possible 'trough' in productivity before new niches become occupied during the post-filling operational phase.

Given the reduced abundance of fish in the Ruzizi River as a result of the existing hydropower operation, the combined impact of the Ruzizi reservoir on aquatic habitats and the indigenous fish community and food base is considered non-significant.

F Impacts of Sub-daily Hydropeaking Flows on Aquatic Ecology in Downstream River Reaches

Maximum water level

During periods of peak flows there will be negligible incremental alteration to the maximum water level (depth), flow velocity and wetted area of the Ruzizi River downstream from the Project (see Section 11.7 Hydrology and Chapter 10 Environmental Flows Assessment). However, during off peak periods, minimum water levels will be lowered compared to current conditions during off peak flows from Ruzizi I/II. However, the degree of alteration decreases with distance downstream. At the confluence with the Ruhwa tributary (9 km downstream from the Project powerhouse), the minimum water levels will be approximately 20 cm lower than the current conditions, and 20 km and 40 km further downstream, the minimum water level are expected to be lowered by approximately 8 cm and 5 cm respectively. At the Rusizi National Park, the lowering of the minimum water level is expected to be negligible.

Regarding rates of change in water levels, downstream of the Project powerhouse, higher rates of river water level rise and fall (from peak and off-peak flow variations) are expected compared to current conditions, but the effect attenuates with distance downstream. Immediately downstream of the powerhouse, rates may be potentially 25% higher than current conditions. However, rates of change in water level will be negligible at the Rusizi National Park (over 80 km downstream) and less so at the outflow into Lake Tanganyika (130 km downstream). The rate of water level rise and fall in the 14 km immediately downstream from the project powerhouse may be in the order of 25 cm/hour or 0.5 cm per minute, which is lower than the threshold for fish stranding (>15 cm/minute).

Review of satellite imagery suggests that the activation of the floodplain in the Rusizi National Park area is caused by natural flood conditions in tributaries of the Ruzizi River (Ruhwa, Rubyiro and others), rather than elevated flows in the Ruzizi River mainstem. This is evidenced by imagery from December 2019 when there was widespread flooding in the region.

The hydropeaking mode of operation of Ruzizi-I, -II and future operation of Ruzizi-III are not expected to influence floodplain activation, since the maximum flow rate released from the Ruzizi III HEPP (150 m^3/s) is the same as the maximum flow rate currently released by the existing Ruzizi I and II HEPPs. It is noteworthy that the actual observed fluctuations in the Ruzizi River downstream in the Rusizi National Park and Ramsar site area appears to be buffered by a backwater effect from the inflow into Lake Tanganyika into the river.

In terms of determining operational impacts on aquatic biota, including fish, in the downstream reach, two aspects related to the proposed hydropeaking regime for the Project are relevant: (i) the lower than 'normal' minimum flow, and (ii) the rate of water level fall during ramp down.

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Lower minimum flow:

Based on the hydrological modelling done for this study (see Section 10.4), water levels downstream of the powerhouse are predicted to fluctuate approximately 1.66 m daily compared to current fluctuations of approximately 1.33 m as minimum water levels are predicted to be approximately 33 cm lower. This is no lower than water level during a dry year for baseline conditions. However, a lower minimum flow will result in a reduced wetted area of the river. This reduction is expected to affect mostly the wider and shallower riffle sections of the river downstream of Bugarama where fish, including those migrating upstream to spawn, may be restricted in upstream movement during part of the inter-peaking period when the river is at its lowest (i.e. around 4 am, according to the optimised operational scenario). Under this scenario, the reduction in flow and water depth is likely to occur in the middle of the night (from 10pm to 5am) when the scheme is not hydropeaking and the reservoir is filling. During the day, the river levels remain relatively high. Fish that may be constrained to sections of the river with low depth could be subject to increased fishing pressure but because this is likely to occur in the early morning hours this risk is reduced.

Sudden increases in flow associated with hydropeaking causes confusion and disrupts the daily routine movement patterns of fish. During peaking events, fish may seek hydraulic cover in deeper refuge areas, adopt a holding pattern and cease feeding. This will increase energetic costs to individual fish, disrupt normal foraging behaviours and reduce fish condition and readiness to spawn. Hydropeaking typically alters fish migration cues, causing a delay or disruption in seasonal spawning migrations and may lead to fish migrating at suboptimal periods for spawning, leading to reduced fish recruitment. However, although the river is already subject to hydropeaking flow variations and the maximum flow level will not alter with the Project, the incremental flow-related changes from hydropeaking on fish and reduction in baseflow is considered potentially significant and warrants monitoring and if necessary adaptive management. In addition, increased fishing pressure on fish to improve their survival in the shallower downstream reach during minimum flow conditions also warrants mitigation.

Ramp down rates:

Under the optimised scenario, the river levels are predicted to drop dramatically on ramp down, especially in the very dry to normal years, dropping between 6.5 cm/minute downstream of the powerhouse to 1.3 cm/min nearer the Burundi border over a 15-minute duration, coinciding with the duration over which it has been assumed that hydropeaking flow rates change due to changes in turbine operation.

Ramp down rates determine the risk of fish stranding. Fish stranding - the most widely documented hydropeaking impact on fish - is caused by down-ramping i.e., the rapid reduction in river flow following the closure of turbines at the start of off-peak demand periods. The changes in water levels resulting from these pulsed flows can result in fish being stranded on rapidly exposed shorelines (beach stranding), or in pools and depressions after the water has receded (entrapment) (Young *et al*. 2011). Although individual stranding events may not result in high mortality, the cumulative effect of frequent down-ramping can have a significant effect on fish mortalities (Young *et al*. 2011), with mortalities as high as 60% in a single season being estimated (Bauersfeld 1978). Young fish are especially susceptible to stranding because of their selection of shallow water, slow-flowing habitats along channel margins where flow ramping effects are likely to be felt more acutely. However, adult fish are also susceptible since they will move out of the main channel and into flow refugia along channel margins to avoid the high current speeds produced by up-ramping. Here they become vulnerable to stranding during the down-ramping phase (Halleraker *et al.* 2003). The effects of stranding are also likely to be more evident at night when many fish move into shallow water along the channel margins to feed. Down-ramping during the reproductive season and particularly during dry periods is likely to expose spawning nests or beds to drying, causing fish egg and larval mortality. During the up-ramping phase, fish eggs and larvae will be exposed to higher risks of being eroded from nests and spawning areas.

Several factors interact to increase the risk of fish mortality due to stranding (from Young *et al*. 2011):

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- Channel morphology: a river channel with more side channels and depressions presents a higher risk than a steep-sided channel.
- Substrate type: stranding has been observed in all substrate types, but the risks of mortality are deemed higher with large substrate particle sizes.
- Down-ramping rate: an increased down-ramping rate reduces the time fish have available to escape into the main channel.
- Ramping Range: a higher ramping range (amplitude) has been shown to increase risks of stranding.
- Ramping Frequency: a higher frequency of ramping increases the number of times fish are exposed to the risk of stranding.
- Duration: a longer duration between ramping phases increases the risk of mortality, although some fish may be able to survive in pools between ramping phases.

Other factors that influence the risk of stranding and mortality due to stranding include the seasonal timing of hydropeaking, the photophase (day vs night), as well fish body size and species. Saltveit *et al*. (2001) reported that down-ramping rates of 90 cm/hr (1.5 cm/min) resulted in 60% stranding of juvenile fish, whereas Hallerraker *et al*. (2003) that stranding rates were reduced <10 cm/hour (0.15 cm/min). Moreira *et al*. 2019 reported down-ramping thresholds with the most frequently reported rates are those <0.4 cm/min (24 cm/hr), with the exception of European greyling (Auer *et al*. 2014) where rates as high as 3 cm/min (180 cm/hr) were recommended for larger juveniles.

The Ruzizi River in normal flow years is confined to a clearly defined channel with steep banks for considerable distance downstream of the powerhouse until the river widens further downstream of Bugarama. The amplitude of peaking fluctuations under Ruzizi III is predicted to attenuate downstream with the elevation range (i.e. difference between maximum and minimum flow elevations) predicted to drop from 1.66 m below the powerhouse to 1.08 m downstream of the Ruhwa (~15 km downstream of the dam). Ramp down rates over a 15-minute ramp down period are modelled to decline from 6.5 cm/min below the powerhouse to 1.3 cm/min downstream of the Ruhwa, and therefore potentially may remain within the threshold (>1 cm/min) that could cause fish stranding. However, this will need to be monitored to confirm if a 15-minute ramp down period may cause fish stranding (see ESMP).

Because the amplitude of peaking fluctuations in water level and experienced ramp-down rates will be considerably reduced 80 km downstream near the floodplains of the Ruzizi National Park, near Lake Tanganyika, it is highly unlikely that fish stranding will be a significant risk to fish inhabiting the lower floodplains.

The Environmental Flow Assessment (EFA) noted that water levels 60 km downstream of the Burundi/Rwanda border currently vary by up to 0.80 m on a daily basis (taking 4.5 hours to increase and 10 hours to decrease by this amount). It is predicted that downstream water level variation may increase by an additional 20 cm, taking 5 hours to increase, with a similar ramp up rate of 0.3 cm/min, and a slightly faster ramp down rate of 0.17 cm/minute (compared to current rate of 0.13 cm/minute). While these predictions are indicative and based on broad scale modelling with estimated (not measured) cross-sectional profiles, they do suggest that only a small incremental effect in rates of change of water level will be observed in the Rusizi National Park and Ramsar site. The rate of flow-related change will remain well under threshold values for fish stranding (of 1 cm/minute) and as such it is concluded that hydropeaking effects from Ruzizi III HEPP will present no significant transboundary impact. Given the slow incremental change in flow modelled for the downstream reach, the Project is not predicted to have significant impacts on aquatic habitats or fish species downstream within Burundi or affect the Rusizi National Park and Ramsar site (transboundary).

If found to be necessary based on fish monitoring results, impacts of water level fluctuations on fish could potentially be mitigated either by i) reducing the peak flow / off-peak flow ratio (at selected times of the day) and/or extending the duration of the ramp down period or ii) possibly, as a last resort, using river engineering solutions to increase in-river attenuation.

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G Impacts of Sediment Retention in the Reservoir on Fish

A large portion of the baseload sediment and its constituent nutrients carried by the Ruzizi River, much of which enters the river downstream of Ruzizi II HEPP, will be trapped in the Ruzizi III reservoir with mainly some suspended sediment passing through. Consequences of this sediment retention on the downstream river geomorphology is described in Section 11.8. Due to the current daily fluctuations in flow caused by upstream hydropower operations it is expected that bed scouring and armouring has already occurred and the potential for incremental bed and bank erosion will be localised. Some of the loss of sediment and nutrients trapped in the dam will be compensated by lateral inputs from the reservoir edge that are mobilised during daily water level fluctuations as well as inputs from sheet erosion and landslides. It is therefore expected that the impacts of sediment and nutrient retention in the reservoir on fish habitats and fish will be minimal.

It is most likely that sediment-related impacts on aquatic habitats and fish will arise in the dewatered reach as a result of sediment deposition from sheet erosion from agricultural plots or landslides. Depending on the extent of sediment deposition in the dewatered reach, under the proposed minimum flow of 11 m^3/s this may result in creation of gravel and sand bars which could create new aquatic habitats. However, if landslides occur this could result in blockage of the river channel, potentially causing back-flooding of the channel thereby restricting fish migration and smothering of aquatic habitats important for fish feeding and spawning.

Sedimentation inputs and fish use of the dewatered stretch will need to be monitored and adaptively managed, possibly through the release of freshets (mini-flood events) to clear sediment from the dewatered river channel. Overall, the pre-mitigation significance of sediment retention in the reservoir is considered non-significant, although there is a high degree of uncertainty in this due to the unpredictable nature of determining the extent of adverse lateral sediment inputs into the dewatered reach which could cause blockage and smothering of the river course.

H Project Impacts on Priority Fish

Five species of fish two threatened species of non-migratory *Chiloglanis* species (*C. ruziziensis* (CR) and *C. asymetricaudalis* (EN), and three migratory species (*Acapoeta tanganicae* (LC), *Labeo leleupanus* (VU), and *L. caudovittatus* (LC), have been identified as potential critical habitat qualifying species for the Middle Ruzizi River in the Critical Habitat Assessment. *Chiloglanis* species have not been confirmed in the Project Area of Influence (only tributaries e.g. Rubyiro and Ruhwa), but are of stakeholder interest. Of the migratory fish, *L. leleupanus* was recorded 34-km downstream in tributaries to the Ruzizi River, while *L. caudovittatus* has been recorded in the Middle – Upper Ruzizi River. Impacts on these species are described below.

H.1 Chiloglanis

The two *Chiloglanis* species – *C. ruziziensis* (CR) and *C. asymetricaudalis* (EN) are associated with rapid and riffle habitats in flowing rivers where they are adapted to living and grazing on the riverbed substrate for which they are adapted with a suckermouth. They are both range-restricted to the Ruzizi River Basin (although there are also distribution records for *C. asymetricaudalis* in Tanzania in a tributary west of Lake Tanganyika) and historical data records (pre-1990) confirm them to mainly be found in tributaries to the Ruzizi River. Only *C. asymetricaudalis* was found in the Rubyiro River in 2022 and neither species was recorded in the Ruzizi River mainstem either in surveys by Sofreco (2021/2022); CRBEC/CRSNE between 2018 and 2022; or by SLR (2022). However, despite the difficulty in sampling the river for these species in the high velocity flow, their presence in the mainstem Ruzizi River is doubtful especially given the history of hydropeaking over the past 50 years and, if present at all, these species are likely to occur in very low abundance relative to the tributaries.

Adverse impacts on these fish, if present, would potentially occur through i) habitat loss from inundation of 2.3 km of rapid and riffle habitat for the reservoir, and ii) fish stranding from ramp down and possible desiccation of shallow reaches of riffle habitats in dry years during inter-peaking periods when river levels drop to their lowest levels. However, if present, they could

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potentially benefit from habitat improvement in the dewatered reach as a result of releasing a more stable, reduced velocity flow. This would depend on maintaining habitat condition and preventing significant sediment inputs and smothering by sediment and debris from dam construction and during operation.

Overall, since it is considered unlikely that *Chiloglanis* species are present in the Ruzizi mainstem or, if so, not in numbers that constitutes a regularly occurring stable and sustainable population, the potential impact on these threatened and endemic species are assessed as minor and non-significant. In addition, the Project will have no impact on these non-migratory species where they have been confirmed to occur in reasonable abundance in tributaries such as the Rubiyro River.

Mitigation measures for potential impacts on *Chiloglanis* (if present) and for the general fish community include water releases (freshets) from the reservoir to flush sediment out of the dewatered reach post-construction and at regular intervals (e.g. yearly or biannually) to improve habitat condition for fish. As described above, reducing peak / off-peak flow ratios and/or extending ramp down rates will assist with reducing the risk of fish stranding if this is confirmed to occur during monitoring. Fish monitoring is required to validate this prediction and determine additional protection measures for these species (which could include catchment protection measures for the Ribyiro River as an opportunity to achieve a net gain for this species if impacts are confirmed) as outlined in the framework BAP in the ESMMP.

H.2 Migratory fish

Impacts on migratory fish in general are described above and are applicable to the three migratory species considered as potential critical habitat qualifying species (*Acapoeta tanganicae, Labeo leleupanus* and *L. caudovittatus*). There are no recent published or available data for at least the last 20 years to confirm the ongoing occurrence of the first two species in the Ruzizi mainstem in the project AoI and available evidence suggests that they are more likely to be present either in Lake Tanganyika or the lower reaches of the Ruzizi River and its tributaries. Only *L. caudovittatus* (LC) has been confirmed in the Project AoI including near the Bugurama Bridge.

Since there is limited data to suggest that the Project AoI is of primary importance for the survival of these three migratory species and it is likely that that existing hydropower operations have already reduced their abundance and habitat quality, the incremental and direct impact of the Project on these migratory fish species is assessed as non-significant. However, given the presence of migratory fish in the middle to upper Ruzizi River (such as *Labeobarbus altianalis*), and potential for increased fishing pressures due to lower water levels in the dewatered reach and downstream of the powerhouse, mitigation will still need to be applied to minimise project risks on migratory fish. These include monitoring to confirm and identify impacts and potential adaptive management measures if required and appropriate such as applying reduced peak / off-peak flow ratios and/or slower ramp down rates. Measures to reduce fishing pressures on the river reaches where migratory fish are likely to congregate are also required.

I Project Impacts on Rusizi National Park and Ramsar Site

The Rusizi National Park and Ramsar Site is situated in the reach between 88 km and 130 km downstream of the Rusizi III HEPP dam and approximately 83-124 km downstream of the tailrace.

Under current baseline conditions with operation of Rusizi I and II HEPPs, based on recorded measurements taken in March 2023 approximately 120 km downstream of Rusizi III HEPP within the Rusizi National Park flow levels varied by 7-10 cm/day. Modelled predictions for Ruzizi III HEPP indicate that maximum flows levels will not change but that off-peak baseflow will be slightly lower than existing levels. Between the powerhouse and Ruhwa confluence (distance of ~10 km), the baseflow is predicted to decline from 33 cm lower than normal to 14 cm lower than normal. It is estimated that flow levels will decline on average about 1 cm/km with distance downstream (excluding flow contribution from inflowing tributaries). Under Ruzizi III HEPP, it is predicted that by the time the river reaches the Rusizi National Park starting at 80 km

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downstream, daily water level variation due to lower baseflows may be in the order of 10-15 cm/day i.e. slightly higher than current variation of 7-10 cm/day. The rate of rise and fall of the river will be marginally faster than existing baseline conditions but significantly less than the predicted ramp up rate of 6.8 cm/min and ramp down rate of 1.3 cm/min modelled for the Ruhwa confluence located approximately 60 km upstream of the Rusizi National Park.

Since migratory fish are able to swim up the Ruzizi River under the existing flow regime generated by hydropeaking of Ruzizi I and II HEPPs, and Ruzizi III HEPP will not change the maximum flow levels or velocity and will only cause a marginal change in flow variation 80 km downstream, there is no expected impact on the aquatic biodiversity of Rusizi National Park and Ramsar site. This includes the migratory fish such as *Labeobarubs leleupanus* (VU) and *Acapoeta tanganicae* which potentially qualify the lower Ruzizi River as critical habitat (for migratory species) and whose migratory movement patterns are not predicted to be affected as the flow variation rates by the time the water enters the Lower Ruzizi River will be within the threshold of 1 cm/min for fish. Given the natural variability of flow in the Ruzizi River due to seasonal rainfall events in the catchment, and the buffering effect created by backflooding of Lake Tanganyika into the lower Ruzizi River, the predicted change in flow rates in the Rusizi National Park are within the range of natural variation currently experienced by the aquatic biota of the river. This potential transboundary impact is therefore assessed as non-significant.

11.10.4.2 Mitigation Measures for Operation Phase

Mitigation for potential impacts on aquatic habitats and fish will need to be confirmed based on monitoring as outlined in Vol. IV ESMP. These include measures to mitigate water quality alteration (Section 11.6); sediment and geomorphological impacts (Section 11.8) and management of floating waste that accumulates in the reservoir (Section 11.9).

Development of aquatic water weed is not expected to occur in the Ruzizi Reservoir. However, should water weed be found to develop and spread, it will need to be managed and monitored as appropriate as described in Vol. IV ESMP.

Although spread of waterborne diseases is considered a low risk the following measures is proposed during operation. This measure is referred to elsewhere in the report as:

[M 75] Conduct monitoring of bilharzia host snails and blackflies, and prevalence of water borne diseases and identify control and management measures if required.

Box 1 – Fish pass: Although a fish pass was recommended in the earlier Sofreco ESIA (2021), a fish pass is not considered viable for this project. A fish pass, if effective, would enable upstream fish migration in the 14 km reach upstream of the reservoir to Ruzizi II HEPP which although equipped with a fish pass has not been operational for decades. This upstream reach will be further impacted by the Ruzizi IV HEPP if constructed and which would reduce the upstream reach of free-flowing river by an additional 7 km, leaving only 7 km of navigable river for fish migration.

A fish pass (or ladder/elevator) for a dam height of 51 m and for a hydropeaking project with dewatered stretch is not considered viable or feasible. This mitigation option for fish migration to access 7 to 14 km of river reach has not been considered further given the following factors: i) the poor understanding of the biology of migratory fish in Africa, ii) the lack of evidence from other dam projects in Africa that a fish pass or ladder over 50 m is viable, iii) the extensive and costly engineering works required to create a bypass channel given the steep terrain, iv) the peaking operation that will deter upstream fish movement, and v) the minimum flow proposed for the dewatered reach that would not provide sufficient attraction flows to stimulate fish to enter a fish pass, and vi) the river is already highly modified by existing HEPPs creating a cascade of barriers each of which reduce the efficiency of fish migration to a very low level.

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Box 2 – Trap and Haul: 'Trap and haul' is a potential conservation strategy to circumvent barriers to fish migration which are typically used for high value commercial fish species. It involves collecting fish and transferring and transporting fish and water in a transport tank on a truck or trailer, with release at sites above barriers. Trap and haul is considered unviable considering the i) multiple dam barriers upstream and low efficiency of any renovated fish ladders; ii) short distance between the upper most Ruzizi I HPP barrier and Lake Kivu (only 3 km); iii) steep terrain to transport fish upstream, and iv) location on a transboundary river where pressure from fishermen and community members may interfere with fish releases. Given the low potential benefits and viability of successful fish transfer, the 'trap and haul' method is not deemed to be a feasible mitigation strategy.

Minimum flow in dewatered reach

The national guidelines of DRC and Rwanda propose to maintain a constant minimum flow of 11 m^3/s in the 5.5 km dewatered reach during operation, i.e. approx. 10% of MAF. Because the river reach is already impacted by elevated and erratic peaking flows of upstream hydropower dams, this minimum flow is believed to be acceptable as long as the following additional mitigation is implemented:

- Maintain a minimum flow of 11 m^3/s at all times (regardless of the volume of inflow to the reservoir) and document this by means of automated flow monitoring and video evidence to allow transparency with international stakeholders including ABAKIR.
- Implement a minimum of biannual releases of "freshets" for a few consecutive days at a time that shall be timed to coincide with seasonal natural increases in flow with the aim of facilitating migration as well as clearing accumulated sediment from the dewatered reach. The volume of freshets required should be determined through a further modelling study but are assumed to be a minimum of 50 m^3/s for a few days.
- Conduct fish and fish habitat monitoring (i.e. sampling of gravel/riffle habitats) in the dewatered reach (commencing pre-construction) on a quarterly basis for the first three years after commencement of operation, and thereafter decreasing to biannual depending on results. This will be focussed on low flow periods (between peaking of upstream dams) to confirm ongoing presence of fish; document changes in fish community/structure and abundance, and to understand fish migration patterns. Data and monitoring reports shall be disclosed and made available to relevant institutions and lenders on a biannual basis and should not be considered confidential.
- Implement adaptive management depending on fish monitoring results which may include confirming timing and size of freshet releases and possible increased seasonal releases in the dewatered stretch; and feasible engineering solutions to improve river channel morphology for fish habitats and movement.

Due to the reduction of flow in the dewatered reach and potential for increased fishing pressures in the shallower pools that is expected to cause additional threats to fish, the following is proposed:

- Fence the powerhouse outlet area to restrict access by fishermen
- Enforce a no fishing exclusion zone in the dewatered reach and for 1 km downstream of the powerhouse outlet to improve fish spawning and dispersal ability
- Employ fish monitors / guards to enforce no fishing zones and to work with communities to improve use of sustainable fishing methods between Bugarama and the Ruhwa confluence.

These measures are summarised in this report as:

[M 76] Maintain a minimum flow of at least 11 m^3/s at all times (including during reservoir filling) with video evidence shared with ABAKIR and other stakeholders; and release freshets of at least 50 m^3/s over a few days on a biannual basis timed with rising river levels (volume to be confirmed through further modelling).

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[M 77] Conduct fish monitoring and implement adaptive management based on results and disclose results to relevant institutions and lenders on a biannual basis.

[M 78] Implement and enforce a no fishing zone in dewatered reach and 1 km downstream of powerhouse and work with communities to improve sustainable fishing practices downstream of Bugarama.

Fish stranding in hydropeaking reach

[M 79] Implement fish monitoring to determine whether fish stranding occurs and determine additional mitigation if required (e.g. extended ramp down rates after each sub-daily peaking event to achieve a rate of water level drop of max. 3 cm/minute downstream of the powerhouse; or river engineering solutions to moderate flow fluctuations.

11.10.4.3 Potential Post Mitigation Impacts

Potential pre-mitigation and post-mitigation impacts of operation on aquatic habitats and biodiversity are summarised in Table 11-46.

Operation phase impacts on aquatic habitats and biota will arise primarily from

i) reduction of flow to 11 m^3/s in the dewatered reach which will reduce available aquatic habitats (through reduced wetted area) and may restrict fish movement, and which will increase fishing pressures in the shallower pools;
ii) daily fluctuations in water levels in the hydropeaking reach and lowered baseflow level which will result in an incremental increased disruption to fish behaviour and ecology, and
iii) the dam creating a barrier to fish migration and reservoir resulting in an altered fish community.

Although no formal hydrological modelling with measurements of bathymetric cross-sectional profiles was done for the downstream reach in Burundi, analysis performed for the EFA suggest that there will be very minor flow alteration extending into the floodplains of the Ruzizi National Park, and these fluctuations will be within baseline intra and inter-annual variations. Currently, water levels 60 km downstream of the Burundi/Rwanda border vary by 0.80 m on a daily basis, while under Ruzizi III HEPP operation they are predicted to increase to 1 m variation (5 hours to increase and 10 hours to decrease) (i.e. increase of approximately 20 cm). Here, ramp down rates would increase slightly from 0.13 cm/min to 0.17 cm/min (remaining well below rates that could cause fish stranding), while ramp down rates remain similar to baseline at about 0.3 cm/min. Maximum flow during peaking will be similar to current levels while minimum flow during off-peak periods may be slightly lower than current and compensated by inflows from other tributaries with increasing distance downstream.

All the residual impacts are rated as either Minor or Moderate Significance with none rated as High Significance. However, given the uncertainty regarding the hydrological modelling predictions for water levels and wetted area in the downstream reach combined with uncertainty on the extent and importance of fish migration fish monitoring will be required to confirm impacts and identify options for adaptive management. This will be particularly important for impacts related to sediment changes in the dewatered reach and fluctuating water levels in the hydropeaking reach. Other recommendations for more detailed hydrological modelling to confirm predictions are made in Section 11.7.

11.10.4.4 Impact Summary – Operational Phase

Proposed mitigation measures for significant impacts are presented in the following table (Table 11-46).

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Table 11-46 Mitigations & Residual Impacts – Aquatic Habitat & Biodiversity during Operation.

Project Activity	Summary Description of Impact	Potential Pre-Mitigation Impact			Mitigation Measures	Residual Impacts		
		Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
Alteration of the Ruzizi River water quality.	Water quality impacts on aquatic ecosystem and fish: Water entering the reservoir will have a short residence time of <24 hours under hydropeaking operation, and therefore anoxic conditions are unlikely to develop so water quality impacts on fish in the reservoir or in the dewatered reach downstream are predicted to be minor.	Medium	Low	Minor	See Section 11.6.	Medium	Medium	Minor
Creation of reservoir with still water body and dewatered reach with reduced water flow.	Impact on water borne pathogens (e.g. malaria, bilharzia, sleeping sickness): Reservoir and dewatered reach will provide some improved habitat conditions for host vectors of water borne diseases, especially if water hyacinth is allowed to spread on the surface. The reservoir water level will fluctuate sub-daily by up to 20 m so this will to some extent discourage the establishment of bilharzia host snails on fringing vegetation. However, the low water level and slower velocity in the dewatered reach may promote malaria and bilharzia vectors to spread which may cause increased prevalence of these diseases in local communities using this river reach.	Low	Low	Minor	As for water quality above. [M 76] Maintain a minimum flow of at least 11 m3/s at all times (including during reservoir filling) with video evidence shared with ABAKIR and other stakeholders; and release freshets of at least 50 m3/s over a few days on a biannual basis timed with rising river levels (volume to be confirmed through further modelling).	Low	Low	Minor
Physical presence of the dam acting as a barrier to fish migration.	Impacts on Fish Species from Dam Wall as Barrier to Fish Migration: The dam wall of 55 m height will pose a barrier to fish migration of *Labeo/ Labeobarbus* species mainly, and will restrict access to flowing water rapids and riffles over a distance of ~14 km between the dam wall and Ruzizi II HEPP. This stretch appears to comprise potentially important rapids and pools for fish spawning but data to confirm its importance for migratory fish in comparison to lower reaches of the Ruzizi is limited.	Medium*	Medium	Moderate See Important Note* and boxes 1 & 2 in Section 11.10.4.2	No mitigation possible. Fish pass/ ladder is not considered viable for a dam of 55 m with low flow dewatered reach and peaking operation. Fish monitoring	Medium*	Medium	Moderate See Important Note* and boxes 1 & 2 in Section 11.10.4.2

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Project Activity	Summary Description of Impact	Potential Pre-Mitigation Impact			Mitigation Measures	Residual Impacts		
		Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
Presence of reservoir with still water	Impact of Reservoir on Fish Community: The fish community in the reservoir will favour fish adapted to a lake-like environment and will lead to a reduction in fish adapted to flowing water. More common and hardy fish will displace more sensitive fish species, and these are likely to include a higher abundance of alien fish species such as XX which may predate and outcompete smaller indigenous fish (especially if artificially introduced for aquaculture).	Medium*	Medium	Moderate See Important Note*	No mitigation possible. Monitoring is required to confirm change in fish community composition, including increase in alien fish species, and identify adaptive management measures if required.	Medium*	Medium	Moderate See Important Note*
Reduced water flow in dewatered stretch (5.5 km)	Impact of Reduced Flows in Dewatered Reach on Fish: Implementation of a minimum flow of 10 m^3/s in the 5.5 km dewatered reach will reduce available river wetted area and depth for fish, and possibly improve opportunities for increased fishing pressure in shallow reaches, resulting in reduced fish abundance and migration.	Medium*	Medium	Moderate See Important Note*	[M 76] Maintain a minimum flow of at least 11 m3/s at all times (including during reservoir filling) with video evidence shared with ABAKIR and other stakeholders; and release freshets of at least 50 m3/s over a few days on a biannual basis timed with rising river levels (volume to be confirmed through further modelling). [M 77] Conduct fish monitoring and implement adaptive management based on results and disclose results to relevant institutions and lenders on a biannual basis. This could include engineering solutions to improve fish habitat and continuity to assist movement, and confirm size and frequency of freshets. [M 80] Implement and enforce a no fishing zone in dewatered reach and 1 km downstream of powerhouse and work with communities to improve sustainable fishing practices downstream of Bugarama.	Medium*	Medium	Moderate See Important Note*
Sediment retention in reservoir and lateral sedimentation inputs in dewatered reach	Impact of Sediment and Nutrient Retention and Sediment Deposition in dewatered reach on fish: reduction of sediment in the dewatered reach will have a minimal incremental impact on aquatic habitats and fish from riverbed armouring and bank erosion. However, lateral sediment inputs from sheet erosion or landslides if severe and not managed may result in blockage and back-flooding in the river course, preventing fish migration and smothering habitats for fish feeding and spawning.	Medium*	Medium	Moderate See Important Note*	[M 76] Maintain a minimum flow of at least 11 m3/s at all times (including during reservoir filling) with video evidence shared with ABAKIR and other stakeholders; and release freshets of at least 50 m3/s over a few days on a biannual basis timed with rising river levels (volume to be confirmed through further modelling).	Medium*	Low	Minor

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Project Activity	Summary Description of Impact	Potential Pre-Mitigation Impact			Mitigation Measures	Residual Impacts		
		Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
Daily flow variations caused by peak and off-peak discharges and sediment related changes.	Impact of geomorphological changes from daily flow fluctuations on aquatic habitats and fish: frequent and high amplitude changes in flow may drive some localised erosion of mobile gravel and sandbars and possible slumping of riverbanks downstream of the powerhouse possibly leading to some sediment deposition in slackwater habitats. However, this is not expected to be severe as the banks are low angled and low in height and appear relatively stable, possibly having stabilised over time under the current hydropeaking regime from upstream HEPPs.	Medium*	Low	Minor	Monitoring is required to assess erosion and sediment changes induced by hydropeaking with adaptive management as required.	Medium	Low	Minor
Daily flow variations caused by peak and off-peak discharges	Impact of Sub-daily Hydropeaking Flows on Fish: Peaking operation will continue to have an incremental impact on fish through alteration of fish migration cues, but this is an ongoing impact of Ruzizi I and II HEPPs. There is some potential for fish stranding as a result of rapid ramp down rates although this is mitigated as the river is generally confined to the main river course with steep banks.	Medium*	Medium	Moderate See Important Note*	[M 79] Implement fish monitoring to determine whether fish stranding occurs and determine additional mitigation if required (e.g. extended ramp down rates after each sub-daily peaking event to achieve a rate of water level drop of max. 3 cm/minute downstream of the powerhouse; or river engineering solutions to moderate flow fluctuations.	Medium*	Low	Minor
Sediment flushing from bottom outlet of reservoir	Impact of Sediment Flushing on Fish: Sediment venting/sluicing from the dam via the bottom outlet will be done periodically (frequency to be determined) to reduce sediment build-up in the reservoir. This will result in a discharge of sediment rich and partially anoxic mud and water to the dewatered reach which may smother aquatic habitats unless managed correctly with sufficient water releases.	Medium*	Medium	Moderate See Important Note*	See Section 11.8	Medium*	Low	Minor

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Project Activity	Summary Description of Impact	Potential Pre-Mitigation Impact			Mitigation Measures	Residual Impacts		
		Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
Creation of reservoir & dewatered reach with minimum flow, and release of hydropeaking flows downstream	Project Impacts on Fish: Fish will be impacted by direct inundation of rapid/riffle habitats for the reservoir; reduced flow and possible increased sedimentation in the dewatered reach from lateral inflows possibly causing blockage and smothering of habitats; and ongoing but increased daily variability of flows in the downstream reaches, including sudden ramp down rates which could cause fish stranding. These impacts are incremental to the existing peaking regime of the Ruzizi River. In addition, lower baseflow in the dewatered reach and downstream of the powerhouse will increase fishing pressures on fish that may be unsustainable.	Medium*	Medium	Moderate See Important Note*	All the management measures in this table to mitigate impacts on water quality, sediment and geomorphology, and aquatic habitats are applicable to fish. [M 80] Implement and enforce a no fishing zone in dewatered reach and 1 km downstream of powerhouse and work with communities to improve sustainable fishing practices downstream of Bugarama	Medium*	Low	Minor
Altered flows on downstream	Project impacts on Rusizi National Park and Ramsar site: Hydrological changes in the lower reaches of the Rusizi River where it flows through the national park and Ramsar site and potential influences on the aquatic ecology were assessed to have little to no incremental impact relative to existing baseline conditions. Flows will remain within the range of normal variability 80-120 km downstream of the Ruzizi III HEPP and fish and other biota will continue to maintain lifecycles and migratory behaviour similar to current conditions.	High	Low	Minor	All the management measures in this table to mitigate impacts on water quality, sediment and geomorphology, and aquatic habitats are applicable to protection of the lower Ruzizi River and the ecology of the Rusizi National Park.	High	Low	Minor

***Important Note**

*Although the Ruzizi River in the Project AoI is considered 'modified habitat based on the aquatic status its sensitivity is rated as Medium due to the confirmed presence of several non-threatened but restricted range migratory fish that use the Ruzizi River to access upstream spawning grounds in rapids and riffles, although none are assessed to qualify as critical habitat in the Project AoI. The lower Ruzizi River in the National Park and Ramsar site is considered High sensitivity and likely to qualify for critical habitat.

Several impacts are assessed as moderate significance mainly due to the presence of migratory fish species. but many of these could be considered as non-significant in the context of the impacts caused by the existing hydropower projects (i.e. not all Moderate Impacts are considered 'Significant'). In addition, although the middle to upper Ruzizi River is not assessed as Critical Habitat a precautionary approach has been adopted in the assessment of fish impacts because of the uncertainty in fish migration and historic presence of threatened fish species.

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11.11 Terrestrial Habitats and Biodiversity

11.11.1 Impact Producing Factors

Potential sources of disturbance to terrestrial habitat and biodiversity during pre-construction and construction are caused by land use changes required for:

- Site preparation.
- Construction of the dam wall and installation of permanent and temporary project facilities.
- Construction of access roads.
- Creation of the 220 kV Transmission Line wayleave.
- Reservoir impoundment.
- Creation of spoil disposal areas.
- Development of quarries and borrow areas.

Note: no quarries and borrow areas have been determined and assessed as part of this ESIA and will be assessed under a separate ESIA.

During the operation phase the primary source of impacts on terrestrial biodiversity will be i) the presence of the 220 kV Transmission Line and the maintenance of the Transmission Line wayleave, mainly through collision risk to birds, and ii) the presence of the dam infrastructure and flow-related impacts on terrestrial fauna dependent on the river course such as hippopotamus and birds.

The different levels of magnitude of the impacts on terrestrial biodiversity are described in Table 11-47 and different categories of sensitivity in Table 11-48. The assessment of impact significance and mitigation measures is presented in Table 11-49.

Table 11-47 Terrestrial Habitat and Biodiversity Impact Magnitude Criteria

Magnitude (positive or negative)	Description
Major	Fundamental change to terrestrial habitat or biota resulting in long term or permanent change, typically widespread (regional, national and international or transboundary in scale). Adverse impacts would require significant intervention to return to baseline; and/or exceeds national standards and limits.
Moderate	Detectable change to the specific environmental conditions assessed resulting in non-fundamental temporary or permanent change.
Minor	Detectable but minor change to the specific environmental conditions assessed.
Negligible	No perceptible change to the specific environmental conditions assessed.

11.11.2 Assessment of Receptor Sensitivity

The sensitivity of terrestrial biodiversity receptors (or values) is linked to the Ecological Importance (EI) of the receptor, e.g. habitats that have a high EI are considered to have higher sensitivity to construction and operational impacts of the Project than habitats with low EI (see Section 7 Environmental Baseline Situation).

Species of Conservation Concern (SCC) are also by default considered to have higher sensitivity than non-SCC. The sensitivity of the terrestrial ecology receptors is assessed to be between low and high, depending on species and habitat criteria (see Table 11-48).

The Project construction works will be undertaken in a mosaic of areas of low and medium terrestrial biodiversity sensitivity, with small patches of high sensitivity habitat (Hillslope

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Grassland / Savannah) likely to be impacted. However, most of the construction phase impacts will take place in areas of low sensitivity where agriculture is the predominant land use.

Table 11-48 Terrestrial Habitat and Biodiversity Sensitivity Criteria

Conservation value (sensitivity)	Species Criteria	Habitat or Site Criteria
High	Areas or sites of importance for confirmed IUCN Critically Endangered, Endangered and Vulnerable species and restricted-range species (<50,000 km^2). Sites with globally, regionally or nationally significant concentrations of migratory or congregatory species.	IUCN Red-listed ecosystems that are classified as CR or EN. Internationally designated biodiversity areas including Nature Reserve and National Parks (IUCN Category I & II), UNESCO World Heritage Sites for biodiversity; recognised Key Biodiversity Areas (KBAs), Important Biodiversity Areas (IBAs), Ramsar Sites, Alliance for Zero Extinction (AZE) sites. Critical habitats of significant international ecological importance.
Medium	Areas or sites with IUCN Near Threatened (NT) species, or possible but unconfirmed presence of VU, EN or CR species. Biome-restricted endemics (with EOO >50,000 km^2).	IUCN Red-listed ecosystems that are classified as VU. Nationally designated biodiversity areas e.g. Protected Areas, including Natural Monuments or Features (Cat III), Habitat or Species Management Areas (Cat IV), Protected Landscape (Cat V), or Protected area with sustainable use of Natural Resources (Cat VI); nominated or identified Key Biodiversity Areas (KBAs) (or equal status). Natural Habitat of significant ecological importance and/or high biodiversity value.
Low	IUCN Least Concern species of local or national importance. Nationally protected species, but not of significant population size and not of particular national importance.	Modified habitats with some functional ecological value (e.g. fallow cultivated lands, degraded early-stage secondary shrublands).
Negligible	IUCN Least Concern species of no particular local or international biodiversity importance.	Habitats of no/little national biodiversity importance.

11.11.3 Potential Impacts during Pre-Construction, Construction & Reservoir Filling

11.11.3.1 Potential Impacts

Six impacts on terrestrial biodiversity were identified for the construction phase and are assessed in Table 11-49. The large proportion of Modified Habitat and associated faunal assemblages resulted in some impacts having a minor or negligible impact and thus requiring only limited or no mitigation actions besides standard good construction practice. A summary of the expected habitat losses for different project components is summarised in Table 4-21 in Chapter 4.7 (Habitat Status Assessment). The following impacts have Moderate significance and will require mitigation:

A Loss of Natural Habitat

A total of approximately 18 ha of largely Natural Habitat will be impacted by the Project infrastructure and construction works. Of this, 1.7 ha of High EI comprising Hillslope Grassland/Savannah occurs within the reservoir area. While Natural Habitat will be lost within the inundation zone, this is only a minor portion of the remaining habitat, and no threatened or restricted range flora species have been confirmed. The loss of this largely Natural Habitat is assessed as non-significant . The portions of habitats classed as Largely Natural Habitat in the Project AoI are generally small, fragmented areas which have been degraded through land use activities, but which still retain their native species composition and are not invaded by alien invasive species. They are typically surrounded by a mosaic of agricultural land or more degraded shrubland. No protected or internationally recognised areas are in the Project AoI with

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the nearest formally protected area being the Nyungwe Forest National Park (approximately 20 km upstream).

Of the 53.5 ha flooded by the reservoir, 32 ha or 60% comprises Cultivated /Secondary Shrubland mosaic, which when combined with the habitat losses from other project activities totals 154 ha, and which is assessed as non-significant from a biodiversity perspective.

B Loss of Species of Conservation Concern

The main habitat that is likely to support species of conservation concern (SCC) is Hillslope Grassland / Savannah, which potentially supports several highly threatened and restricted-range species, although none were confirmed despite targeted surveys in May 2024. A total of 18 ha of this habitat is located in the project infrastructure and reservoir areas including 1.7 ha in reservoir; 5.5 ha in transmission line RoW; 6.2 ha in access road corridors; and 4.8 ha in other project infrastructure sites. The main project activities with potential to impact flora SCC are aspects that will impact on Hillslope Grassland/Savannah: inundation of the reservoir would flood 1.7 ha while site clearance of the transmission line wayleave may impact 5.5 ha. While no SCC were confirmed during the five-day field survey in 2022 it is possible that some plant species, such as *Emilia subscaposa* and *Chlorophytum hirsutum*, may not have been flowering and thus overlooked. The supplementary survey undertaken during May 2024 confirmed the absence of flora SCC from the powerline route. If present within the landscape, the flora SCC are likely to be located within the inaccessible cliffs and slopes, and will therefore not be impacted by project infrastructure and activities. Given the fragmented nature of the habitats and the lack of SCC, this impact is assessed as non-significant.

C Introduction of invasive terrestrial alien plant species

The presence of a large number of invasive terrestrial alien plant species throughout the project area indicates that there is a significant seed bank of these species in the topsoil, increasing the risk of these species becoming established on ground cleared of vegetation during construction. Particularly aggressive invaders such as *Tithonia diversifolia, Lantana camara* and *Parthenium hysterophorus* will be the most likely species to become established. The project activities most likely to result in this impact are site preparation for construction of infrastructure, and transport of excavated material from quarries hosting these species, clearing of the access road and transmission line corridors, and creation of topsoil and spoil disposal areas. The potential impact of alien invasive species is considered significant and requires mitigation and monitoring to achieve a minor residual impact. This is especially pertinent to areas of Hillslope Grassland along the transmission line corridor, wherein invasive species encroachment will severely negatively impact the biodiversity value.

D Disturbance to fauna from Transmission Line Construction

The Transmission Line is routed mostly through modified habitat comprising cultivated fields, with only approximately 5.5 ha potentially affected within a 30 m wide wayleave. The number of fauna SCC potentially occurring in the entire Project area is low, but construction activities (e.g. blasting, if required) may impact on sensitive species including breeding birds of prey, some of which are still present in the project area. During 2022 a breeding pair of Rock Kestrels (*Falco rupicolus*) (listed as Least Concern by IUCN) was observed attending a nest on a cliff within the transmission line wayleave, and was confirmed again in 2024. This pair (or any others present) may abandon nest sites during construction activities depending on the seasonality of construction and type of noisy activities, especially blasting.

Construction impacts for the TL and associated access roads on such fauna is likely to have a Moderate impact pre-mitigation but will be non-significant with mitigation. The vulnerable areas for this impact along the TL route will be potential breeding habitat for birds of prey, which comprises mostly cliffs since there are few large trees on the slopes for raptors to breed in. Note: operation phase impacts of the TL are addressed below.

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E **Direct Mortality and Disturbance to Fauna from Increased Human Presence**

Responses to human-caused disturbances follow the same pattern that is used to evaluate a change in animal response to the risk of predation (Frid & Dill 2002). Consequently, prey may choose areas where there is less risk of being taken by a predator, thereby selecting certain habitats that are perceived as more secure. Essentially, this drives prey species displacement and alters species movement dynamics, essentially creating what is called a landscape of fear (Ripple & Beschta 2004, Brown & Kotler 2007). Furtive species are likely to be displaced with increased human presence.

Poaching is presently an impact within the region, specifically within the DRC territory of the PAOI, and an increase in the local human population may drive an increase in the demand for bushmeat. Poaching of mesocarnivores and primates that are important in maintaining ecosystem functioning by predating on potential pest species and dispersing seeds, respectively, will potentially have broader regional effects.

11.11.3.2 Mitigation Measures for Construction Phase

Proposed mitigation measures are presented in Table 11-49. Key mitigation measures for priority impacts are discussed in more detail below.

A **Loss of Natural Habitat**

The loss of any Natural Habitat, particularly Hillslope Grassland / Savannah, which has high EI, requires mitigation to minimise habitat losses and to achieve no net loss. This impact will mainly arise from reservoir inundation and site clearance for infrastructure, including the erection of pylons along the transmission line (TL) wayleave.

- Transmission Line: for the TL, avoidance of impacts on portions of remaining Natural Habitat can be achieved by locating pylons or towers and routing access tracks in degraded habitat where possible, and avoiding or minimising loss of Hillslope Grassland.
- Reservoir & Other Infrastructure: Where impacts on high EI habitat is unavoidable, such as the inundation zone (which contains only 1.7 ha of Hillslope Grassland Savannah), then habitat restoration in other areas of the reservoir sub-catchment should be prioritised to improve habitat condition and aid catchment management to minimise soil erosion and reservoir sedimentation. This could include restoration of overgrazed grassland and associated hillslope thickets in the reservoir catchment above the full supply level (especially in the 50 m buffer zone that will be acquired for the project), and removal of invasive alien plants from riparian thickets and wetlands. Such restoration of habitats in the reservoir sub-catchment will be sufficient to compensate for loss of the 18 ha of largely Natural Habitat. The specific measures and actions to be taken should be detailed in a restoration and monitoring plan prior to reservoir inundation. Measures could also include protecting riparian vegetation from agriculture and charcoal production by enforcing buffer zones (e.g. 50 m buffer from river margins and wetlands), thereby assisting with bank stability and biodiversity enhancement. The detailed design of project infrastructure within the project footprint shall aim to minimise loss of portions of largely Natural Habitat by prioritising use of degraded habitats where possible. Appropriate siting in more degraded areas will likely reduce the residual impact on Natural Habitat in terms of total hectares quantified, which is currently estimated at approximately 18 ha.

B **Loss of Species of Conservation Concern**

A walk-through of the transmission line route was undertaken during the May 2024 to determine the location of any threatened and/or restricted-range flora species, if any, to inform on micro-siting of pylons or the access roads. The priority species, *Emilia subscaposa, Chlorophytum hirsutum* and *Blepharis burundiensis* and *Bulbostylis longiradiata* were not located within the transmission line route. Note that although the entirety of the route could not be traversed due to these portions being inaccessible on foot due to the steep and unstable terrain, based on the

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observations made where access was possible, these species are unlikely to occur. Nevertheless, the Hillslope Grassland habitat should be impacted as minimally as possible, and if possible, the placement of pylons should not occur within it.

C Alien Plant Control

One of the most significant project-related impacts is alien plant invasion, which can be relatively easily mitigated. The first action should be the compilation of a Terrestrial Alien Invasive Plant Management, Monitoring and Control Plan (which should include an overview of key invasive species, description of control methods to be used and a schedule for plant monitoring and control actions). This should be followed by the training and equipping of a small team of staff to identify and eradicate any established populations of alien species throughout the construction phase and early operation phase. Import of material from quarries and borrow pits will be a key source of introduction of alien invasive plants and will be difficult to manage. Hence it will be important to monitor and control alien invasive plants on a continual basis where imported material is stockpiled and used. Note: quarries and borrow pits have not been assessed in this ESIA and will require separate assessment. Implementation of these measures should reduce the impact to non-significant.

D Transmission Line Construction Timing

Potential project impacts from transmission line construction on breeding raptors, especially cliff-breeding species, such as Rock Kestrels and Lanner Falcons (which were confirmed nesting on the cliffs in the TL corridor) can be minimised by confining as many noisy construction activities such as blasting to the period when raptors are least likely to be breeding, (i.e. Dec-May). The supplementary survey undertaken in May 2024 did not locate any specific nest sites. Nevertheless, construction activities that generate considerable noise and vibration should be prioritised outside of the raptor breeding season.

E Managing Human Presence

In order to reduce the impact of increased human presence from the potential 500-1,000 construction workers, Environmental Awareness Training is the primary mitigation measure. Staff must be made aware of 'no-go' areas (areas external to the working area) and that entering these areas will be considered a punishable offence. Staff are to be made aware of the importance of local biodiversity and that poaching and persecution (example killing of animals out of fear or superstition) or purchase of bushmeat is not permitted and will be made a punishable offence.

11.11.3.3 Residual Impacts

All terrestrial ecology impacts during construction are evaluated as negligible or minor post mitigation (i.e. non-significant).

The majority of terrestrial impacts can be mitigated through minimising habitat losses through optimised site design/layout and implementing good construction practice to minimise footprints, control alien invasion, and revegetate damaged areas. To achieve this pre-construction walk-through surveys are required for the transmission line to verify tower and access road locations in grassland habitat and near bird nesting cliffs, and for other infrastructure in the reservoir and powerhouse vicinity. It is expected that detailed design and infrastructure siting will reduce the size of the habitat losses calculated in this ESIA.

Compensation to achieve no net loss of the estimated hectarage of largely natural habitat for terrestrial biodiversity can be done through restoration of habitats around the reservoir and along the river course, and removal of alien species from wetlands and riparian zones. This will also yield benefits for reducing erosion and sedimentation in the reservoir.

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11.11.3.4 Impact Summary – Construction Phase

Note: since mitigation measures are applicable to several project activities these are defined for loss of natural habitat and species of concern and not by each project activity.

Table 11-49 Summary of Impact on Terrestrial Habitat & Biodiversity during Pre-Construction/Construction and Reservoir Filling

Project Activity	Summary Description of Impact	Potential Impact			Mitigation Measures	Residual Impact		
		Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
Site preparation	Loss of natural habitat (riparian and hillslope habitat).	Medium	Low	Minor	Loss of Natural Habitat – Ruzizi III HEPP • [M 81] Construction work site planning shall seek to minimise impacts on vegetation and an Environmental Compliance Officer with ecological experience will oversee site clearance and ensure control measures are implemented (EPC Contractor). • [M 82] Construction site clearance activities will be implemented in a manner to minimise loss of vegetation by restricting footprints of vegetation removal, stockpiling and vehicle access (EPC Contractor). • [M 83] During construction, topsoil management will be implemented in accordance with a Topsoil Management Plan that defines the location, storage, size/shape and protection measures for topsoil stockpiles (EPC Contractor). • [M 84] Prepare and implement a Restoration and Rehabilitation Plan aimed at achieving no net loss of natural habitat in the reservoir sub-catchment area. Collect seed from native plants & propagate key species identified in the restoration plan in an off-site project nursery and implement progressive re-establishment of Natural Habitat wherever possible (EPC Contractor). Loss of Species of Conservation Concern [M 85] Conduct walk-through of construction area footprints prior to clearance to ensure no SCC present (low likelihood) (EPC Contractor) and micro-site infrastructure where possible if any SCC are found. Disturbance to fauna from blasting, particularly during breeding periods • [M 86] Although few breeding raptors are likely to be present, conduct a walk-through bird survey in breeding season to confirm presence of breeding birds, especially raptors and restrict blasting to periods outside of breeding season (Dec-May) where possible (EPC Contractor). Introduction of invasive alien plant species	Medium	Low	Minor
	Loss of Species of Conservation Concern.	Medium	Low	Minor		Medium	Low	Minor
	Introduction of invasive alien plant species.	Medium	Medium	Moderate		Medium	Low	Minor
	Increased human presence leading to displacement and mortality	Medium	Medium	Moderate		Medium	Low	Minor
Construction of the dam wall and installation of permanent and temporary project facilities	Loss of natural habitat (riparian and hillslope habitat).	Medium	Low	Minor		Medium	Low	Minor
	Loss of Species of Conservation Concern.	Medium	Low	Minor		Medium	Low	Minor
	Introduction of invasive alien plant species	Medium	Medium	Moderate		Medium	Low	Minor
	Disturbance to fauna (especially due to noise disturbance during blasting)	Medium	Low	Minor		Medium	Low	Minor
Development of quarries and borrow areas and spoil disposal areas	Loss of natural habitat (riparian and hillslope habitat).	Medium	Low	Minor		Medium	Low	Minor
	Introduction of invasive alien plant species	Medium	Medium	Moderate		Medium	Low	Minor
	Disturbance to fauna, particularly during breeding periods.	Medium	Low	Minor		Medium	Low	Minor
Construction of access roads	Loss of natural habitat (riparian and hillslope habitat).	Medium	Low	Minor		Medium	Low	Minor
	Introduction of invasive alien plant species	Medium	Medium	Moderate		Medium	Low	Minor
	Disturbance to fauna, particularly during breeding periods.	Medium	Low	Minor		Medium	Low	Minor

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Project Activity	Summary Description of Impact	Potential Impact			Mitigation Measures	Residual Impact		
		Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
					• [M 87] Develop and implement a Terrestrial Alien Invasive Plant Management, Monitoring and Control Plan for the HEPP and TL construction activities (EPC Contractor).			
Creation of the 220 kV Transmission Line wayleave	Loss of natural habitat (riparian and hillslope habitat)	High	Negligible	Negligible	Loss of Natural Habitat - Transmission Line • [M 88] Plan the location of pylons in degraded habitat wherever possible. • [M 89] Collect seed of typical natural grassland species for revegetating any cleared or damaged areas of Hillslope Grassland post-construction & propagate key species in off-site project nursery. • [M 90] Implement progressive re-establishment of Natural Habitat wherever possible in construction footprints. Loss of SCC - Transmission Line • [M 91] Conduct walk-through of the final confirmed pylon sites in Hillslope Grassland habitats to confirm presence of SCC to enable micro-siting of pylons or plant rescue if required. Introduction of invasive alien plant species - TL • [M 92] Implement terrestrial alien invasive plant management, monitoring and control measures along the TL wayleave and access routes during construction (EPC Contractor). Disturbance to birds, particularly during breeding periods. • [M 93] If possible, erect pylons and fit transmission lines between December and May, when few raptors are likely to be breeding.	High	Negligible	Negligible
	Loss of Species of Conservation Concern	High	Low	Moderate		Medium	Low	Minor
	Introduction of invasive alien plant species	Medium	Medium	Moderate		Medium	Low	Minor
	Disturbance to fauna, particularly during breeding periods	Medium	Medium	Moderate		Medium	Low	Minor
Reservoir impoundment	Loss of natural habitat (riparian and hillslope habitat)	Medium	Medium	Moderate	Loss of Natural Habitat • [M 94] Compile a Revegetation and Rehabilitation Plan aimed at achieving No Net Loss for the 41.8 ha of Largely Natural Habitat impacted by the Project. This should include restoration of degraded habitats in the reservoir sub-catchment above the full supply level and along the river course.. • [M 95] Implement restoration of priority habitats (Hillslope Grassland / Savannah) adjacent to the full supply level. Loss of SCC in Reservoir Impoundment • [M 96] Conduct walk-through of areas of Hillslope Grassland / Savannah, Riparian Thicket and Hillslope Thicket that will be inundated by reservoir to confirm presence, and rescue any threatened or restricted-range species that are found and can be translocated	Medium	Low	Minor
	Loss of riparian corridors for movement of fauna species	Low	Low	Minor		Low	Low	Minor
	Introduction of invasive alien plant species	Medium	Medium	Moderate		Medium	Low	Minor
	Loss of Species of Conservation Concern	Medium	Medium	Moderate		Medium	Low	Minor
	Loss of fauna through drownings	Low	Low	Minor		Low	Low	Minor

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Project Activity	Summary Description of Impact	Potential Impact			Mitigation Measures	Residual Impact		
		Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
					to similar habitat adjacent to the full supply level (i.e. buffer zone). Loss of fauna through drowning during reservoir inundation [M 97] Implement reservoir filling during lower flow, dry season periods or by regulating peaking flows from upstream hydropower plants in such a way to enable fauna (including smaller animals (e.g. snakes and other reptiles, rodents) to escape to higher ground.			

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11.11.4 Predicted Impacts during Operation

11.11.4.1 Predicted Pre-Mitigation Impacts

The assessment of impact significance and mitigation measures for operational impacts on terrestrial ecology are provided below, with mitigation measures provided in Section 11.11.4.2.

A Mortality of birds in association with overhead transmission lines

Large birds such as birds of prey or waterbirds are relatively scarce in the project area, although a few species were observed during fieldwork, such as the migratory common buzzard (*Buteo buteo*), Wahlberg's Eagle (*Hieraaetus wahlbergi*) and Long-crested Eagle (*Lophaetus occipitalis*).. These species are perch-and-wait predators that will utilise the transmission line as a perching site. This will especially be prevalent within planar agricultural areas where prey is expected to be abundant. This increases the potential for electrocution by non-insulated energised components. This is due to contact with wing tips or streamers. In addition, these species as well as other raptor species recorded such as Lanner Falcons (*Falco biarmicus*) and Rock Kestrels (*F. rupicolus*) that are known to breed in the area, will potentially use the transmission line as a nesting site, thereby also causing the risk of electrocution.

A number of migratory non-raptor species as white stork (*Ciconia ciconia*) also potentially occur and could be impacted. These species are known to be vulnerable to collisions with overhead transmission lines (especially the narrower earth line) and to electrocution when perched on pylons. The area of highest risk will be where the transmission lines cross Natural Habitat in the hills in the western part of the route and this is where mitigation actions will be most needed, comprising approximately 7 km of the alignment.

B Degradation of Natural Habitat along the transmission line wayleave

Most degradation or loss of Natural Habitat will have taken place during the construction phase. However, ongoing vegetation clearance and maintenance of the transmission line wayleave could result in species composition and structural changes to vegetation communities, which would be most significant in the Hillslope Grassland / Savannah community. Further loss of biodiversity will occur if herbicides are used to maintain the RoW as a result of impacts on insect pollinators and other biota.

C Introduction of Alien Plant Species

The construction phase poses the highest risk for terrestrial alien species becoming established in and around the project area, including vegetation clearance of the transmission wayleave unless adequately mitigated throughout construction. Following construction and staff demobilisation, failure to monitor and control alien plants may result in ongoing spread of aliens that may have been introduced into the project area or through spread across cleared areas from adjacent land. Alien plant encroachment invades and displaces native species, and some species can be toxic to wildlife and other grazers (including domestic livestock).

D Impacts of Reservoir on Wildlife

Creation of a lacustrine (lake like) dam in place of a flowing river will change the faunal diversity and abundance in the future reservoir. Currently there are few water birds using the fast-flowing rapids along the river which is likely linked to low prey availability (macroinvertebrates and fish). Hippopotamuses are resident further downstream below Bugarama with crocodiles also present further down river, especially in Burundi. The reservoir water level is predicted to fluctuate by up to 9 m a day during operation which will restrict establishment of marginal vegetation along the edge of the water body. However, water birds may be attracted to the improved fishing in the reservoir and foraging habitat in the exposed muddy shoreline during drawdown. It is also possible that hippopotamus and crocodiles could move upstream of Bugarama and become established in the reservoir if they are not exposed to human risk (and

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this may lead to social consequences through damage to crops on riverbanks and could restrict future fishing activities). These wildlife changes in the reservoir are considered a non-significant adverse impact on biodiversity.

E Impacts of Altered Flows on Downstream Wildlife

Flow alterations described in Section 11.7 and the EFA (in Chapter 10) will cause: i) significantly reduced flow in the 5.5 km dewatered reach during normal operations (non-flood periods) resulting in a shallower river with rapids and pools compared to the existing fast-flowing rapids, ii) similar maximum flow rates as existing but reduced off-peak baseflow elevation and velocity, and reduction in wetted bank area in downstream hydropeaking reaches, (which will mainly occur at night), and iii) increased rate of water level rise (ramp up) from around 7cm/min (existing) to 12 cm/min (future), and fall (ramp down) from around 0.8 cm/min (existing) to 6.5 cm/min (future, downstream the powerhouse). These hydrological effects will attenuate (decrease) with increasing distance downstream, buffered by inflows from other tributaries, and causing a minor change in water level downstream of the Ruhwa River. By the time the river reaches the Rusizi National Park and Ramsar site modelled results predict that the water level will be in the order of around 10 cm lower during off peak periods than current baseline conditions. Overall daily water levels are predicted to vary by a total of 1 m a day compared to the current conditions modelled prediction of 80 cm per day, 60 km downstream of the Burundi border. However, this modelled variation is further dampened by backflooding of Lake Tanganyika into the Ruzizi River which appears to account for the observed 7-10 cm variation measured 14 km upstream of the Ruzizi River mouth (where it enters the lake). This level of variation is within the elevation range typically experienced under existing conditions with the addition of variable seasonal rainfall.

Under these predicted flow conditions, there will be no or minimal observable impact on wildlife dependent on the downstream reaches in Burundi including the Rusizi National Park and Ramsar site and therefore no transboundary effects on wildlife are predicted. While minimum water levels will be lower, there will remain sufficient water depth and pools for hippopotamus and crocodiles, and therefore these water-dependent wildlife and waterbirds should be unaffected by the variation. The fact that the minimum water levels will occur at night when hippo are often out of the water on the banks or foraging further mitigates any potential impact of lower water levels during off peak periods. Therefore, this impact is evaluated as non-significant and no specific mitigation is required.

F Impacts of Altered Flows on Downstream Riparian Vegetation

The structural and compositional dynamics of riparian vegetation are dependent on the hydrological characteristics of a given system. The two types of riparian vegetation currently present in the downstream reach, namely Riparian Thicket and Riparian Wetland, will be impacted in different ways by the project-related changes to the river that are likely to occur. This is attributed to the differing ecological characteristics of the species in each habitat, such as the proportion of species requiring a constant wet bank or flow-dependent species. Riparian Wetlands have the higher proportion of these species and are thus more likely to be impacted as changes in depth and area of the river result in changes to the availability of a wet bank and accessibility of riparian species to flowing water. However, most of the alluvium within the downstream reach has been converted into agricultural areas. The remaining Riparian Wetlands are dominated by *Phragmites mauritiana*, and therefore this habitat type can rapidly recolonise new areas. Accordingly, the impacts to downstream riparian vegetation have been assessed as non-significant (Minor).

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11.11.4.2 Mitigation Measures for Operation

Proposed mitigation measures for significant impacts during operation are presented in Table 11-50.

A **Prevent mortality of large birds along transmission lines**

In order to lower the risk of large birds (e.g. raptors, waterbirds) colliding with overhead lines, purpose-designed bird flapper devices should be placed along the section of the route crossing ridges or elevated areas or in close proximity to cliffs or rocky outcrops where raptors are confirmed. Where feasible, another way of minimising the collision risk is to route the alignment along the side of hillslopes rather than along crests, since migrating and foraging raptors frequently follow ridge lines. In order to minimise the risk of electrocution, all pylons crossing these areas should be fitted with anti-perching devices (e.g. metal spikes) to discourage use of pylons by nesting or perching birds.

Figure 11-5 provides examples effective console designs that discourages birds from perching and nesting. In addition, a horizontal bar provides an alternative perching site away from energised components.

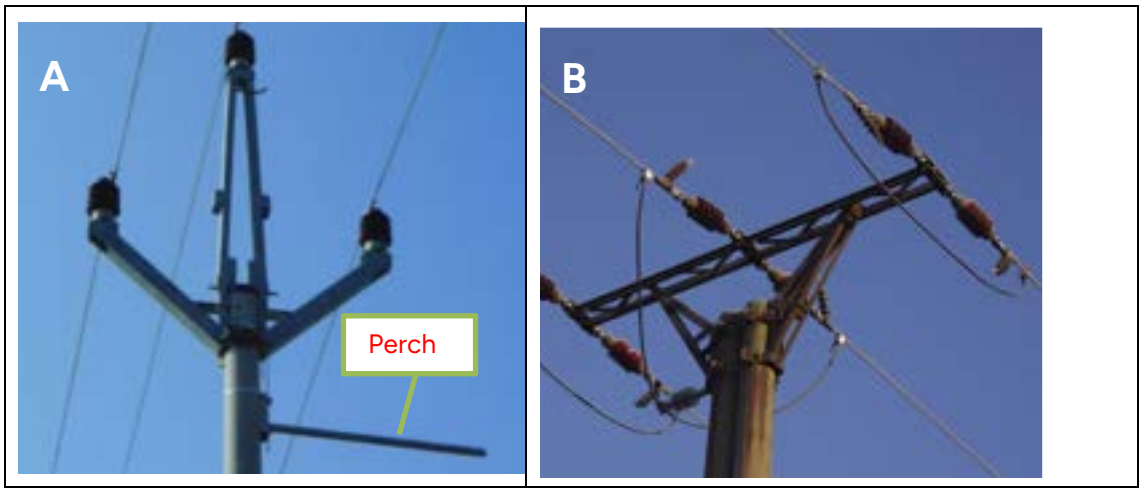


Figure 11-5 Photographs illustrating effective console designs for reducing the risk of electrocution. Source – RPS (2021).
A) The shape discourages birds from perching and nesting. The horizontal bar provides an alternative perching area away from energised components. B) Jumper wires placed under the cross-arm with fully insulated phase conductors.

The transmission line should be marked with bird diverters every 10 m along the westernmost section from the powerhouse across the ridges and slpes with Hillslope Grassland (approximately 4 km) to make the lines as visible as possible to collision-susceptible species. Shaw *et al.* (2021) demonstrated that large bird mortality was reduced by 51% (95% CI: 23–68%). Recommended bird diverters such as flapping devices (dynamic device) (Figure 11-6) and thickened wire spirals (static device) (Figure 11-6) that increase the visibility of the lines should be fitted along the transmission in priority areas, i.e., in areas of Natural Habitat. Static devices although considered less effective than dynamic devices are the preferred option due to reduced maintenance requirements.

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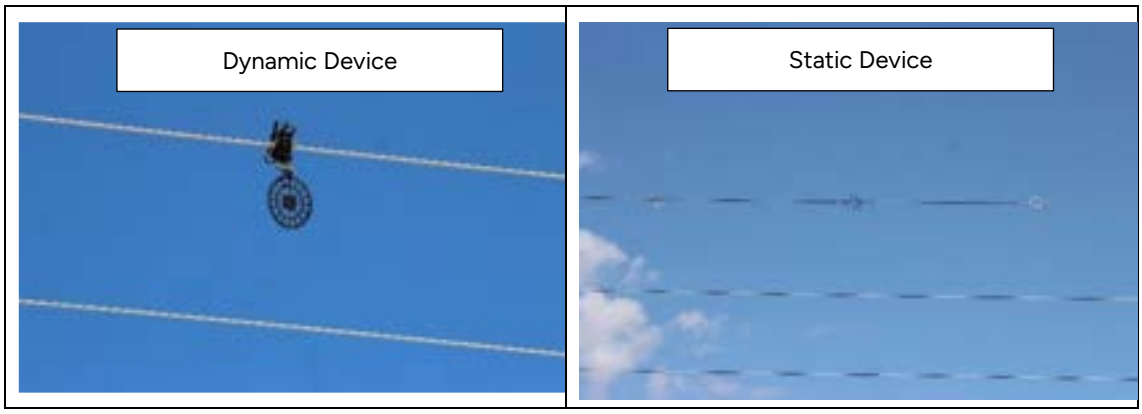


Figure 11-6 Photographs illustrating the various types of bird diverters that can be fitted on the transmission line to mitigate against bird collisions

B **Alien Plant Control**

As for the Construction Phase, a Terrestrial Alien Invasive Plant Management, Monitoring and Control Plan should be implemented during Operation – especially seasonally for the first two years or until such time as bare areas are revegetated and alien spread linked to project activities is effectively managed. This is expected to reduce the impact to non-significant.

C **Avoid habitat clearance for parts of transmission line wayleave**

Natural Habitat along the transmission line, especially Hillslope Grassland / Savannah habitat on steep slopes, should not be cleared in the wayleave but left as natural habitat as although these areas were not confirmed during the supplementary survey to contain plant SCC, these areas support an array of indigenous flora species not located in other habitats.

D **Protection of Reservoir Wildlife**

Local communities should be informed of the potential for hippopotamus and crocodiles to move into the reservoir and the associated increased risk of crop raiding and safety risks when working or fishing in the Project Area. They should be informed of the need to avoid harming wildlife and encouraged to protect them. Dam operational staff and security shall also be informed of the need to monitor for presence of wildlife and inform communities of the safety risks and requirement to protect wildlife.

11.11.4.3 Post-Mitigation Impacts

Post-mitigation impacts of operation on terrestrial ecology and their mitigation requirements are summarised in Table 11-50.

Project operation is predicted to have non-significant impacts on terrestrial fauna of negligible to minor residual significance following implementation of the mitigation measures, comprising alien invasive plant control and monitoring, erosion protection and revegetation, and mitigation for bird collision with powerlines.

11.11.4.4 Impact Summary – Operation Phase

The summary of impacts and mitigation measures for the operation phase are provided in the table overleaf.

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Table 11-50 Summary of Impacts on Terrestrial Habitats & Biodiversity during Operation

Project Activity	Summary Description of Impact	Potential Impact			Mitigation Measures	Residual Impact		
		Sensitivity	Magnitude	Significance		Sensitivity	Magnitude	Significance
Operation of the 220 kV Transmission Line	Mortality of large birds through collisions with overhead lines or electrocution while perching on pylons	Medium	Medium	Moderate	Bird collision and electrocution: • [M 98] Plan the TL route along the hillslopes rather than along the hill crests, which are often followed by raptors on migration and where collision risk is higher. • [M 99] Install bird diverters and anti-perching devices (e.g. metal spikes) along the section of the TL route crossing Natural Habitat and where bird collisions with the conductors can occur.	Medium	Low	Minor
Maintenance of the 220 kV Transmission Line wayleave	Degradation of habitat through clearance of vegetation along wayleave	High	Low	Moderate	Vegetation maintenance of transmission line wayleave [M 100] Avoid ongoing clearance of Natural Habitat along the wayleave, especially Hillslope Grassland / Savannah habitat on steep slopes unless necessary for safety reasons.	High	Negligible	Negligible
Restoration of Construction Areas	Introduction or spread of invasive alien species	Medium	Medium	Moderate	Spread of invasive alien species • [M 101] Implement a Terrestrial Alien Invasive Plant Management, Monitoring and Control Plan for the Operation Phase. • [M 102] Implement monitoring of erosion and rehabilitation / restoration success and implement additional measures if required to facilitate recovery of construction areas.	Medium	Low	Minor
Reservoir presence and operation	Attraction of increased waterbirds to fish and possible presence of hippopotamus and crocodiles in the new waterbody which may be at risk from local community members.	Medium	Low	Minor	Awareness of community members and wildlife monitoring [M 103]Inform local communities of potential for increased risk of hippopotams and crocodiles in the reservoir and related safety concerns and need to protect wildlife, and monitor and record wildife presence in the reservoir. This should be done by community liaision officers and environmental staff of REL or outsourced to external ecological consultants or reserarchers.	Medium	Low	Minor
Alteration in flows	Impacts of Altered Flows on Downstream Wildlife (including Rusizi National Park	Medium	Low	Minor	No mitigation required	Medium	Low	Minor
Alteration in flows	Impacts of Altered Flows on downstream riparian habitats	Medium	Low	Minor	Maintenance of EFlows as per Section 11.7	Medium	Low	Minor

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11.12 Impacts on Local Communities' Livelihoods

This section focuses on the Project's impacts on local communities' means of livelihoods and economic activities. Data on economic and physical impacts is based on a preliminary census and asset inventory carried out in 2022. The figures provided in this section are therefore provisional and will be updated as part of the census and asset inventory update, which will be undertaken during the preparation of a Resettlement Action Plan.

Other social impacts are assessed in the following sections:

- Impacts on community Health and Safety, including risks related to the Project's vehicles traffic, are assessed in section 11.14.
- Impacts on occupational health and safety and labour conditions are assessed in section 11.13.3.
- Impacts on Cultural Heritage elements are assessed in Section 11.17.
- Impacts on ecosystems are assessed in Section 11.18.
- Jobs creation and associated indirect business opportunities during construction and operation are considered positive impacts. They are described in section 11.20.

11.12.1 Impact Producing Factors

As described in Section 8 – Social Baseline, the local communities' means of livelihood are predominantly based on crop farming. Fishing activities do occur but are not a main source of livelihood for the local communities. The impact producing factors for local communities' livelihoods are therefore mostly limited to the land acquisition process during pre-construction and construction, and to changes in the river flow during operation.

- During pre-construction: the land acquisition process and the involuntary resettlement process will occur before the start of any construction activity and will be limited to the Project's footprints.
- During construction, no construction activity will occur outside the Project's footprints. No new land acquisition is expected to occur. No impact on fishing activities or fish farming are expected during construction.
- During operation, the changes of the river flow are not expected to cause any discernible change for agricultural activities along the riverbanks, for fishing activities or for fish farming activities downstream of the powerhouse release.

11.12.2 Overview of Land Acquisition and Involuntary Resettlement Impacts

This section gives an overview of the impacts from land acquisition, including involuntary resettlement. These impacts are estimated in the Resettlement Policy Framework (Volume V of the ESIA). They are summarised hereafter for the readers convenience. It must be noted that these impacts are estimated at this stage, as some elements of the Project are yet to be defined (quarries). The Resettlement Policy Framework estimated the impacts based on a preliminary census of the affected persons. A census will be performed when Resettlement Action Plans are prepared. The impacts and the number of affected persons will then be updated.

Table 11-51 below presents an overview of the estimated impacts of the Project's land requirements. No community or collective properties are affected.

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Table 11-51 Overview of Estimated Involuntary Resettlement Impacts

Country	Affected Households			
	All affected households (Physically and economically displaced)		Physically Displaced Only	
	Households	People*	Households	People*
DRC	1,546	13,928	50	485
Rwanda	703	4,015	0	0
Total both countries	2,249	17,943	50	485
* The number of individuals affected is an estimate, as some households did not declare how many members they had.				

A Physical Displacement

Physically displaced people are defined as people who will lose the residential structure (house) there are residing in on a permanent basis. During the preliminary census of 2022, 50 households were identified as affected by physical displacement (485[2] people or household's members), all in DRC. No physically displaced household has been identified in the future reservoir or the dam site. Table 11-52 below disaggregates the physically displaced people by Project component and gender of household's head.

Table 11-52 – Estimated Number of Physically Displaced People (2022 Preliminary Census)

Country	Project Components	All physically displaced households		Physically displaced women-headed households	
		Number of households	Number of physically displaced people*	Number of households	Number of physically displaced people*
DRC	LA X - Switchyard works, Disposal area 5 (DA5), Operator houses + REL sub office	11	93	3	25
	LA XI - Access Road	39	392	14	125
	Total DRC	*50*	*485*	*17*	*150*
Total Both Countries		*50*	*485*	17	150
** The number of individuals affected is an estimate, as some households did not declare how many members they had.*					

B Economic displacement

Economically displaced households are those affected by loss of land, assets or access to land or assets, leading to loss of income sources or other means of livelihood. Table 11-53 below gives their distribution by country and Sector or *Groupement* according to the preliminary census in 2022. No institutional stakeholder was identified as affected in 2022.

Overall, the Project will affect 207.51 ha of land. Table 11-53 gives summary of the number of households affected by economic displacement.

[2] The number of individuals affected is an estimate, as some households did not declare how many members they had.

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Table 11-53 – Estimated Economic Displacement, Disaggregated by Country and Sector/Groupement (2022 Preliminary Census)

Country	Sector / Groupement	Number of economically displaced households	Number of economically displaced people*
Rwanda	Bugarama	367	1,952
	Nzahaha	336	2,760
Sub-total Rwanda		703	4,015
DRC	Kamanyola	599	5,597
	Karhongo	947	8,331
Sub-total DRC		1,546	13,928
Total both countries		2,249	17,943
* The number of people is only an estimate, as some households did not provide the number of households members			

An estimated number of 127 structures are affected, as indicated in Table 11-54. These structures include residential structure (houses) either occupied or abandoned, as well as non-residential structures (small barns or shelters used in fields). The occupied residential structures (houses) are those considered as physical displacement impact. One of the structures affected in a Church (in DRC). This impact is further described in Section 11.17 on Cultural Heritage.

Table 11-54 – Estimated Loss of Structures (Residential and Non-Residential)

Country	Sector / Groupement	Number of structures lost	Households losing structures*	
			Number	% of affected households
Rwanda	Bugarama	3	3	0.8%
	Nzahaha	5	3	0.9%
Sub-total Rwanda		8	6	0.9%
DRC	Kamanyola	116	51	8.5%
	Karhongo	3	3	0.3%
Sub-total DRC		119	54	3.5%
Total both countries		127	60	2.7%
* Some households own more than one structure				

The estimated loss of crops and trees are summarised in Table 11-55 below.

Table 11-55 Estimated Loss of Crops and Trees

Categories of crops or trees lost	Number of households losing crops or trees		Total area lost in ha (annual crops) Total number of perennial crops or trees lost	Average area lost in ha (annual crops) or number lost by households
	Number	% of affected households		
Annual crops	1,844	73%	154.1	0.08
Perennial crops	1,341	60%	240,895	180
Fruit trees	1,614	72%	167,384	104
Medicinal trees	1,454	61%	45,099	76
Timber trees	1,013	42%	94,930	191

11.12.3 Assessment of Receptor Sensitivity

The sensitivity of receptors is related to their socio-economic vulnerability. Vulnerability is measured by their capacity to cope with social impacts that affect their access to or control over additional or alternative social resources, ultimately affecting their wellbeing. Sensitive or vulnerable receptors generally have less means to absorb adverse changes, or to replicate beneficial changes to their resource base than non-sensitive or non-vulnerable receptors.

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A community's vulnerability might be measured in terms of its resilience to loss of community facilities, whereas an individual's vulnerability can be considered as their resilience to deprivation, loss of livelihood assets and/or opportunities (their job).

Impoverishment risks include landlessness, joblessness, homelessness, marginalisation, increased morbidity and mortality, food insecurity, loss of access to common property resources, and social de-structuring. The table below presents the guideline criteria used to categorise the sensitivity of receptors.

Table 11-56 Criteria for Determining Sensitivity

Sensitivity of receptors	Description
High	A highly vulnerable receptor with very little capacity and means to absorb socio-economic shocks and take advantage of opportunities.
Medium	A vulnerable receptor with some capacity and means to absorb socio-economic shocks and take advantage of opportunities.
Low	A non-vulnerable receptor with limited capacity and means to absorb socio-economic shocks and take advantage of opportunities.
Negligible	A non-vulnerable receptor with plentiful capacity and means to absorb socio-economic shocks and take advantage of opportunities.

As described in the baseline section and in the Resettlement Action Plan, all affected households are relying on farming activities for their subsistence, and 90% of them are also relying on crop farming as an income generating activity. Given the level of dependence on these resources, the sensitivity of these households to the impact of land acquisition is assessed as medium to high.

According to the information gathered during qualitative consultations, the Project selected the following five categories of vulnerability amongst the physically and economically displaced population:

- Women-headed households, defined as any household headed by a woman.
- Elder-headed households, defined as any household headed by a person over 65 years old living without any 18 to 64-year-old non-disabled household member.
- Disabled-headed households, defined as any household headed by a mentally or physically disabled person living without any 18 to 64-year-old non-disabled household member.
- Landless households, defined as any household without any land title, customary ownership right or customary usage right over the land plots cultivated by the household members (relying solely on sharecropping and renting).
- Historically Marginalised Households, defined as households including at least one person from the Historically Marginalised (Rwanda) / Batwa (DRC) Community (see Social Baseline).

As Table 11-57 illustrates, according to these criteria 38% of the surveyed households are vulnerable, with a percentage of vulnerability which is higher in DRC (47%) than in Rwanda (22%). Notably, 8% of surveyed households (11% in DRC and 2% in Rwanda) fall into more than one category of vulnerability. The two categories that tend to overlap the most are women-headed households and landless households: in DRC, where this trend is most evident, 9% of women-headed households are landless. Table 11-57 breaks the total percentage of vulnerable households down by category. As can be observed, the majority of the vulnerable population is made up of (i) women-headed households, the percentage of which is considerably higher in DRC than it is in Rwanda, and (ii) landless people, who are exclusively found in DRC.

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Table 11-57 Percentage of Households per Vulnerability Category

Vulnerability Category	Vulnerable Population out of all Surveyed Households (%)		
	Rwanda	Congo	All Households
Total Vulnerable Households	22%	47%	38%
Women-headed Households	13%	31%	25%
Elder-headed Households	1%	1%	1%
Disabled-headed Households	9%	3%	5%
Landless Households	0%	22%	15%
Historically Marginalised / Batwa Households	2%	1%	1%

All vulnerable households are considered of high sensitivity.

11.12.4 Predicted Impacts during Pre-Construction and Construction

The magnitude of an impact and its effects is the extent to which the impact results in a social receptor gaining or losing access to or control over socio-economic resources resulting in a beneficial or adverse effect on their wellbeing. Wellbeing refers to the financial, physical and emotional conditions.

The assessment of magnitude has been undertaken in two steps: (i) the impacts associated with the Project land acquisition have been identified; (ii), the magnitude of impacts and effects have been categorised based on consideration of the parameters listed below along with professional judgement:

- Duration of the impact
- Spatial extent of the impact
- Number of people or groups affected
- Likelihood

Table 11-58 Criteria for Determining Magnitude

Magnitude (positive or negative)	Description
Major adverse/beneficial	• A probable impact that affects the wellbeing of groups of many people or business entities within a widespread area and beyond the project life.
Moderate adverse/beneficial	• A possible impact that will likely affect either the wellbeing of a group of people or business entities beyond the local area of influence into the wider area of influence or continue beyond the project life.
Minor adverse/beneficial	• An impact that may affect the wellbeing of a small number of people and/or households or businesses, or occurs exceptionally, mostly within the project area of influence and does not extend beyond the life of the project.
Negligible	• An impact that is localised within the project's site boundary and is temporary or unlikely to occur with no detectable effects on the wellbeing of people or a business entity so that the socio-economic baseline remains consistent.

All land acquisition impacts will be permanent, as all lands will be acquired permanently. In the Transmission Line Right of way, the land will be cleared during construction, restriction of use will be applied during operation, and the affected households will continue their economic activities under the line during operation. The number of households to be affected is significant (2,249).

Therefore, the magnitude of land acquisition impacts is moderate to major adverse.

Potential impacts are presented in the following table.

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Table 11-59 Potential Impacts – Physical & Economic Displacement during Pre-Construction/Construction

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Land Acquisition (all Project's footprints)	2,249 households (17,943 people) economically displaced, including 50 households (485 people) physically displaced, losing means of livelihoods (lands, crops and trees)	Medium / High	Moderate to major adverse	Major (Significant)

Proposed mitigation measures for significant impacts are presented in the following table. The specific impacts which land acquisition may have on women's land tenure security are described in Section 11.16.1, including mitigation measures. Similarly, the impacts which land acquisition may have on rates of gender-based violence and harassment are described in Section 11.16.2.

Table 11-60 Mitigations & Residual Impacts – Physical & Economic Displacement during Pre-Construction/Construction

Project Activity	Mitigation	Residual Impact		
		Sensitivity	Magnitude	Significance
Land Acquisition (all Project's footprints)	[M 104] Implementation of the Resettlement Action Plan [M 105] Compensation of all affected lands and assets at full replacement costs [M 106] Assistance to physical resettlement [M 107] Livelihood Restoration Programme, including a transitional allowance. [M 108] Specific assistance for affected vulnerable households. [M 109] Local Area Development Plan Compensation or moving of the graves and church located in the Project acquired land plots, as defined in the Resettlement Action Plan.	Medium / High	Minor to Moderate	Minor See Note
Note: The significance is assessed as "Minor" based on the assumption that the mitigation measures will be effective. The REL E&S team has established a good relationship with PAPs through a continued consultation process. The land valuation process has confirmed a relatively low number of physically displaced households. These households have already been informed of the fact that they will be given the option to choose between replacement housing and cash compensation. Several PAPs have already expressed a preference for cash compensation, as this allows them flexibility and independence in designing their new home. Despite higher numbers of economically affected households, the number of grievances which have come out of the land valuation process are low and almost all have been resolved, except 1-2 which have been sent to the court.				

11.12.5 Predicted Impacts during Operation

No impact from Land acquisition is expected during the operation. Other potential impacts on the local communities' livelihoods could be related to the changes in the river flow.

No impact on agricultural activities are expected during operation (i) in the reservoir area, (ii) in the dewatered reach between the future dam and the powerhouse or (iii) downstream of the powerhouse.

- The creation of the reservoir at the start of operation is not expected to affect agricultural activities on its banks. There is no permanent irrigation system in this section of the Ruzizi River. Most farmers fetch water directly in the river with buckets.
- The reduction of the river flow in the dewatered reach is not expected to affect agricultural activities. There is no permanent irrigation system in this section of the river. Most farmers fetch water directly in the river with buckets. A small minority use mobile pumps with flexible pipes to water their crops during the summer period. These mobile pumps can be moved. These 2 ways of abstracting water from the river will not be affected.

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- Downstream of the Powerhouse, the river flow is not expected to change significantly compared to the existing situation. There is no permanent irrigation system in this section of the Ruzizi River.

No specific fisheries survey was performed in the Study Area. Based on the quantitative and qualitative socioeconomic information collected, fishing activities are not a primary source of income or livelihoods amongst the local communities. However, the households surveyed reported practising this activity regularly in the Ruzizi river: 39% of households in DRC and 13% in Rwanda declared that at least one of their members was fishing regularly. During operation, the lower and more regular flow in the dewatered stretch is likely to be more favourable for fishing activities. Downstream of the powerhouse release, as the changes in the river flow are not expected to be discernible fishing activities from current conditions, fishing activities are not likely to be affected in the short term. On the long term, as it should be easier to catch fishes, fishing activities may deplete the fish population. However, this is difficult to assess.

Fish Farming activities exist downstream of the powerhouse (one fish farm in Gatebe village in Rwanda, and several in DRC, close to the confluence with the Ruhwa River). As for fishing activities, these fish farms are not expected to be affected by a discernible deviation from current conditions during operation.

Potential impacts are assessed in Table 11-61below.

Table 11-61 Potential Impacts – Local Communities' Livelihoods during Operation

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Land Acquisition (all Project's footprints)	No impact anticipated during operation	Medium / High	No impact	No impact
Changes in the river flow downstream of the dam	Change in the availability of water used for irrigation of the agricultural fields along the banks of the Ruzizi.	Medium / High	negligible	Negligible (Not Significant)
	Change in the fish stocks, hence on fish catch be fishermen downstream of the dam.	Medium	Likely to be negligible	Likely to be Negligible (Not Significant)
	Change in the availability of water used for the fish farms downstream of the powerhouse in DRC and Rwanda.	Medium	negligible	Negligible (Not Significant)

No significant impact is anticipated during operation. As no data on local fisheries activity has been collected during the ESIA, the Project will monitor the fisheries activities downstream of the dam to confirm that no significant change occurs, and detect any unexpected impact, as defined in the table below

Table 11-62 Mitigations & Residual Impacts – Local Communities' Livelihoods during Operation

Project Activity	Mitigation	Residual Impact		
		Sensitivity	Magnitude	Significance
Land Acquisition (all Project's footprints)	[M 110] Monitoring of fisheries activities downstream of the dam to confirm the absence of any discernible change in fish catch because of the Project	Medium	Likely to be Negligible	Likely to be Negligible (Not Significant)

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11.13 Labour and Working Conditions

This section provides information on how REL will manage the following:

- Working conditions and management of worker relationships.
- Protecting the workforce.
- Occupational health and safety.
- Workers engaged by third parties.
- Supply chain.

Information on the management of labour and working conditions during the construction phase is provided in the subsection dealing with workers engaged by third parties.

11.13.1 Working Conditions and Management of Worker Relationships

11.13.1.1 Human Resources Policies and Procedures

REL has developed human resources policy for management of its employees. The policy is available for staff in English.

The policy includes the labour management principles that will be adopted and will include a commitment to comply with the following:

- Labour laws of Burundi, DRC and Rwanda.
- Lenders' policies on labour and working condition.

The accommodation camps for the Project's workers will be built and operated in line with the IFC-EBRD Guidance note on Workers' Accommodation. These commitments are referred to elsewhere in the E&S studies as:

[M 111] The Project's HR policy and labour management principles will align with Lenders' Policies and the labour laws of Burundi, DRC and Rwanda and be available in Kinyarwanda, English and French.

11.13.1.2 Employment

A Local Employment Objectives and Targets

REL requires that the EPC Contractor shall recruit construction workers from Burundi, DRC and Rwanda, with preference given to recruitment of workers from Project affected communities. Around 75% of workers will be unskilled. The Contractor shall use its best efforts to ensure that a minimum of 25% of these workers are from Burundi, 25% from DRC and 25% from Rwanda. Additionally, 15% of all employees (skilled and unskilled) will be women. These commitments are referred to elsewhere in the E&S studies as:

[M 112] The Project will set local employment objectives and targets.

[M 113] The Project's local employment objectives will include specific targets for the employment of women. According to these targets, at least 15% of the total workforce (skilled and unskilled) will be female.

B Communication of the Local Employment Objectives, Targets and Recruitment Process

The local employment objectives, targets and process will be communicated to local people by REL. The EPC Contractor's Recruitment Policy shall comply with the labour laws of Burundi, DRC and Rwanda and Lenders' Policies, and based on principles related to transparency, non-discrimination, fair treatment and equal opportunity. The content of the Recruitment Policy shall include, but not necessarily be limited to, the following:

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- Statement of commitment to meeting Labour Laws of Burundi, DRC and Rwanda, ILO conventions and international guidelines with regards to recruitment and labour management, including non-discrimination and equal opportunities.
- Description of measures to be implemented by the Contractor to enhance employment opportunities for people for Project affected communities.
- Description of local recruitment process and job application procedure to be disclosed in French and English.
- Description of measures to ensure transparency of recruitment process and measures to ensure equal opportunities for all local people subject to appropriate skills.
- Description of measures to encourage women to participate in recruitment opportunities.
- Description of the disciplinary and dismissal process.
- The Contractor shall advertise all job vacancies locally.

The Contractor shall require their Subcontractors to adhere to their Recruitment Policy via the use of contractual clauses. These commitments are referred to elsewhere in this report as:

[M 114] The local Recruitment Policy will be communicated widely.

C Training

The EPC Contractor shall prepare and implement a program to provide skills training to employees recruited from Burundi, DRC and Rwanda with the objective of improving the productivity and skills of personnel. The programme shall be open to personnel designated by the Contractor but shall not involve fewer than 250 people. This commitment is referred to elsewhere in this report as:

[M 115] Construction phase training programme will be implemented by the EPC Contractor.

11.13.1.3 Workers' Organisations

The HR policies and labour management procedures developed by REL will include provisions to ensure the following:

- The Project will not seek to prevent by any means whatsoever the formation of worker organisations or any other legally-established worker group(s).
- The Project will comply with Labour Laws of Burundi, DRC and Rwanda and ILO convention concerning relations with authorised labour organisations and workers representatives.
- In the case of a stoppage of work or strike, REL will ensure that relevant managers, contractors, and other parties including Lenders are informed promptly so that appropriate engagement and action can be undertaken to resolve the issue and will arrange meetings with interest parties to resolve issues.

Additional information on the contents of the policies and procedures is provided in Vol. 3 – ESMMP. This commitment is referred to elsewhere in the E&S studies as:

[M 116] Provisions regarding allowance of workers' organizations and collective bargaining will be included in the Project's HR policy.

11.13.1.4 Non-Discrimination and Equal Opportunities

The Project's HR policy, labour management principles and labour management procedures will include provisions to ensure adherence to the principles of equal opportunities and fair treatment. There will be no discrimination with respect to employment, promotion, training, compensations, dismissal, wage and retirement on the basis of race, religion, language, ethnic identity, sexual orientation, faith, civil, social or economic status, disability, political opinion, participation in and membership in unions, pregnancy or military service. To promote the employment of women, the HR policy will include a target to recruit women for at least 15% of

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all staff positions. The project will monitor the number of positions offered to local community members and to women, throughout construction and operation. These commitments are referred to elsewhere in the E&S studies as:

[M 117] Provisions regarding non-discrimination and equal opportunities will be included in the Project's HR Policy.

11.13.1.5 Retrenchment

A workers' demobilisation plan will be prepared and implemented to mitigate the negative impacts of the decrease of jobs offered by the project at the end of the construction period (see section 11.13.4).

11.13.1.6 Workers Grievance Mechanism

REL will develop and implement a formal workers' Grievance Mechanism for all direct and sub-contracted employees that will follow legal requirements of Burundi, DRC and Rwanda and align with good international practice.

The grievance mechanism will allow workers to raise reasonable workplace concerns—including options for making anonymous grievances. The workers will be informed of the existence and functioning of the grievance mechanism at the time of hiring. REL will monitor the effectiveness of the employee grievance mechanism on regular basis.

The mechanism will involve an appropriate level of management and enable concerns to be addressed promptly in a transparent manner, and providing feedback to those concerned, without any retribution. The mechanism will not impede access to other judicial or administrative remedies that might be available under law or through existing arbitration procedures, or substitute for grievance mechanisms provided through collective agreements.

Employee grievances will be registered and tracked by the HR management. Effective resolution of the employee grievances will also be monitored during labour audits. These commitments are referred to elsewhere in the E&S studies as:

[M 118] Workers' grievance mechanism will be implemented and monitored during labour audits.

11.13.2 Protecting the Work Force

11.13.2.1 Forced Labour and Child Labour

REL's HR policy and labour management principles will include a clear statement that there will be no forced labour and child labour. Measures to ensure that the EPC Contractor and its subcontractors adhere to the policy and principles are provided in section 5.6.4. This measure is referred to elsewhere in this report as:

[M 119] Project's HR Policy and labour management principles will clearly state that there will be no forced labour and child labour.

11.13.2.2 Labour Audits

During the construction phase, every 6 months an Independent Integrated Environmental, Social, Health and Safety Audit by an independent auditor will be organised and financed by REL. This audit includes labour issues. The audits will be conducted by certified external auditors. The labour component of the audit will include labour issues such as the use of local workforce, and a specific attention will be given to migrant workers and labour agents. In addition, the EPC contractor will need to provide REL with documentation demonstrating how subcontractors will be managed and how subcontractors will be required to comply with the EPC contractor's labour management commitments. This measure is referred to later in this report as:

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[M 120] REL will review the EPC contractor's subcontractors' management procedures prior to the start of construction and organise and finance 6-monthly Integrated Environmental, Social, Health and Safey audits by an independent auditor of the EPC Contractor and its subcontractors' working practices to check compliance with the Project's HR Policy, Labour laws of Burundi, DRC and Rwanda, and Lenders' labour management requirements.

11.13.2.3 Gender Based Violence and Harassment

The risk that the Project may contribute to Gender-based violence and harassment is envisaged in both Rwanda and DRC. Specific mitigation measures to deal with this risk are described in detail in Section 11.16.2.

[M 113] The Project's local employment objectives will include specific targets for the employment of women. According to these targets, at least 15% of the total workforce (skilled and unskilled) will be female.

[M 117] Provisions regarding non-discrimination and equal opportunities will be included in the Project's HR Policy.

[M 121] The EPC will develop a gender-sensitive recruitment strategy and communicate it to the local communities.

[M 122] REL will recruit two trained female Gender Officers (1 in Rwanda and 1 in DRC) to define and implement GBVH protocols. These protocols will apply to all Project workers, including contractors and sub-contractors. Communities will be made aware and trained regarding GBV aspects and the Workers' Code of Conduct, so that they know their rights and how to complain of needed.

[M 123] The EPC will develop and implement a workers' code of conduct, including GBVH policies, and mandatory training of all workers on sexual harassment and GBVH protocols

[M 124] The EPC contractor will develop an Occupational Health and Safety Management Plan which will gender and GBVH aspects, such as: gender-separate accommodation on camp, gender-separate lockable latrines and WASH facilities that are well-lit, conveniently located and easily accessible.

[M 125] The EPC will establish workers' safety committee which will include at least one trained female worker representative.

[M 126] The Workers' grievance mechanism and Community grievance mechanism will channel all GBVH complaints and store them on a separate database. REL's Gender Officers will be responsible for handling and solving these complaints.

[M 127] [M 145] REL's Gender officers will prepare and implement a Community Outreach Programme on Gender-based violence and harassment, to disclose the Project's GBVH protocols and reporting processes.

11.13.3 Occupational Health and Safety

The hazards to which workers may be exposed to during construction are expected to be as follows:

- Hazardous materials.
- Noise, dust and vibrations.
- Potential fire and explosion.
- Other general worksite hazards.
- Natural hazard events including seismic activity, volcanic activity and flood events.

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The EPC Contractor will prepare and implement a Construction Health and Safety Plan, as well as a Community Health and Safety Plan in compliance with ISO 45001:2018 or equivalent. For this purpose, the EPC Contractor will recruit a very experienced and ISO 45001:2018 or equivalent Health and Safety Specialist. The Owner's Engineer will be responsible for the quality and adequate implementation of this Construction Health and Safety Plan will also hire for this purpose a very experienced and ISO 45001:2018 or equivalent Health and Safety Specialist (not a junior).

11.13.4 Workers Engaged by Third Parties

The workforce for the construction work will be recruited and managed by the EPC Contractor and their subcontractors. REL will ensure that the management of the labour and working conditions of these workers is implemented in alignment with labour laws of Burundi, DRC and Rwanda and Lenders' labour management requirements. The contractual labour management requirements reflect all the commitments listed in the previous section regarding:

- HR policies.
- Workers' organisations and collective bargaining.
- Workers' grievance mechanism.
- Non-discrimination and equal opportunities.
- Communication of the local employment objectives, targets and recruitment process.
- Training.
- Forced labour and child labour.

Management measures for occupational health and safety during construction under responsibility of the EPC contractor are presented in Table 11-63.

A workers' demobilisation plan will be prepared and implemented to mitigate the negative impacts of the decrease of jobs offered by the project at the end of the construction period. The key aspects of the scope are provided in Vol. IV ESMP.

Twenty-four months prior to the end of operations, the EPC Contractor shall prepare a Demobilisation Plan to anticipate significant job losses resulting from the Project's transition from construction to operation. The plan will be prepared and implemented in line with national law and good industry practice and based on the principles of non-discrimination and will reflect the Project's consultation with employees and their organizations, and eventually with the appropriate governmental agencies. This is referred to later in the report as:

[M 128] The EPC Contractor will prepare a detailed Demobilisation Plan and implement the plan at the end of the construction.

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Table 11-63 Potential Impacts – Occupational Health & Safety during Construction

Hazard	Description of the hazard	Management measures	Reference to ESMP
1. General	All hazards in general	> The EPC Contractor will establish and implement an appropriate Environmental and Social Management System (ESMS) in alignment with ISO 14001. The system will include occupational health & safety related plans, in compliance with ISO 45001:2018 or equivalent, that are included in the ESMP. > The EPC Contractor will prepare and implements a Construction Health and Safety Plan, as well as a Community Health and Safety Plan in compliance with ISO 45001:2018 or equivalent. > The EPC Contractor will recruit an experienced and ISO 45001:2018 or equivalent Health and Safety Specialist. > The Owner's Engineer should hire an experienced and ISO 45001:2018 or equivalent Health and Safety Specialist. > The occupational health and safety aspects of all work by the EPC Contractor will be in alignment with the requirements of EBRD's PR4, IFC's Performance Standards and the IFC General EHS guidelines. > The EPC Contractor will establish a workers' safety committee including worker representatives. > REL will recruit a health and safety team that is responsible for the supervision of the EPC Contractor and monitor health and safety performance.	[M 129] General construction phase occupational health and safety management measures.
2. Hazardous substances	The hazardous substances transported, stored and handled are expected to include (but not limited to) the following: > Diesel fuel for construction vehicles and machinery > Explosives for tunnelling and localised road widening work and access road construction > Lubricating oils > Used oils > Small amounts of diverse paints, solvent & chemicals > Transformer oil > Hazardous waste	> The EPC Contractor will prepare and implement a hazardous substances management plan, which will include (but not be limited to) the following: • Handling and storage conditions • Emergency procedures in case of a spill • Pollution control equipment to be installed at the storage sites: anti-pollution kits, extinguishers • Training of employees in charge of handling chemical substances and hazardous materials • Use of Personal Protective Equipment (PPE) and emergency measures in case of an incident > Hazardous substances will be transported to the site by licensed transport contractors in compliance with DRC, Rwanda and EU transport regulations. > Hazardous substances storage facilities will be designed by the EPC Contractor in alignment with national health and safety regulations of DRC and Rwanda and GIIP. > REL's health and safety team will review and validate the design of facilities from a health and safety perspective, and check the conformity of facilities and transport during construction.	[M 130] Construction phase hazardous substances management plan.

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Table 11-63 Potential Impacts – Occupational Health & Safety during Construction (*Cont.)*

Hazard	Description of the hazard	Management measures	Reference to ESMP
3. Noise, dust and vibrations	Dust, noise and vibration may be caused by the following: > Traffic > General construction work > Blasting Inappropriately managed construction work may generate dust, noise and vibration at levels exceeding occupation health and safety threshold values. The blasting is carried out as part of the tunnelling work and for the new road construction.	> General measures listed under item [1] above. > The EPC Contractor will design facilities and develop execution plans, procedures and monitoring programmes to ensure that workers are not exposed to levels of noise, dust and vibrations that exceed DRC and Rwanda Occupational Health and Safety limit values and which are in alignment with IFC General EHS guidelines. > The EPC Contractor will provide workers with adequate PPE. > The EPC Contractor will develop and implement the following plans in compliance with DRC and Rwanda health and safety regulations and IFC General EHS guidelines: • Explosives management plan – included in the hazardous substances management plan • Air and dust control management plan • Noise and vibration control plan > The REL Health and Safety Team will review and validate the plans. > The REL health and safety team will check compliance with requirements during the construction work.	[M 131] Construction phase noise, dust and vibration management measures.
4. Fire and explosion	The fire and explosion hazard is represented by the transport, storage and handling of combustible, inflammable or explosive material. The principal combustible material is diesel fuel and the principle explosive material is the explosive used for blasting. Both these materials will be transported to worksite by road and stored in dedicated facilities. In the case of an accidental event workers may be affected by the consequences of the fire and/or explosion causing injury to people.	> General measures listed under item [1] above. > The EPC Contractor will implement measures to ensure that the fire and explosion risks are at acceptable levels in accordance with DRC and Rwanda health and safety regulations and IFC General EHS guidelines. These are expected to include (but not be limited to) the following: • Facilities will be designed in alignment with DRC and Rwanda safety standards and IFC General EHS guidelines • A risk assessment will be carried out in alignment with GIIP • Accidental event consequence calculation will be undertaken to confirm adequacy of safety distances • Facilities will be equipped with high integrity safety prevention and protection systems • Facilities will be equipped with emergency alarm systems • Facilities will be equipped with human and material resources for emergency response – including mobile and fixed fire-fighting equipment, ambulances, medical facilities, and medical staff • An emergency response to fire and explosion events will be included in the construction work's Emergency Preparedness Plan • Regular emergency response exercises will be organised > Regular fire & explosion safety audits will be undertaken by REL as part of the works supervision	[M 132] Construction phase fire and explosion management measures.

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Table 11-63 Potential Impacts – Occupational Health & Safety during Construction (*Cont.)*

Hazard	Description of the hazard	Management measures	Reference to ESMP
4. Other general worksite hazards	> Electrical hazards: use of mobile power generators, electrical equipment > Mechanical hazards: present with (but not limited to) the use of fixed and mobile mechanical equipment for the construction of dam, buildings, infrastructure and mechanical hydraulic systems > Confined spaces: Workers involved in tunnelling will be working in confined spaces where there are risks of asphyxiation and rock falls > Deep and fast flowing water: there are risks associated with working on or near water such as the rivers or reservoirs for the workers constructing dams, weirs, other headworks facilities and tunnel outlet structures > Trips and falls: a general hazard that is present in general terms during construction work > Working at heights: this is a general hazard that is present in general terms during construction work > Extreme temperatures: the project area is subject to hot weather and heavy rain	> The EPC Contractor will establish and implement an appropriate Environmental and Social Management System (ESMS) in alignment with OHSAS 18001. The system will include occupational health & safety related plans that are included in the ESMP. > The occupational health and safety aspects of all work by the EPC Contractor will be in alignment with the requirements of lenders' health and safety requirements, and the IFC General EHS guidelines. > The EPC Contractor will establish a workers' safety committee including worker representatives. > REL will recruit a health and safety team that is responsible for the supervision of the EPC Contractor and monitor health and safety performance.	[M 129] General construction phase occupational health and safety management measures.
Natural hazards risks to workers during construction	> Risks of rock fall at the accommodation camps or at the worksites > Landslips whilst working in proximity to / operating quarries or disposal areas in the vicinity of areas of potential land instability	> Conduct a risk assessment for natural hazards for workers during construction, on all worksites, including construction camps: • Identification of natural hazards to workers during construction, for each worksite, including the construction camps • Definition of natural hazards mitigation measures for each worksite, including the construction camps	[M 133] Conduct a risk assessment for natural hazards for workers during construction.

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Table 11-64 Potential Impacts – Occupational Health & Safety during Operation

Project Activity	Description of the Hazard	Management Measures	Reference to ESMP
1. General	All hazards in general	> The facilities will be designed and constructed in compliance with DRC and Rwanda health and safety regulations, GIIP and IFC General EHS Guidelines. > The facilities will be operated and maintained by REL in accordance with procedures developed in alignment with GIIP and IFC General EHS Guidelines. > REL will establish and implement an appropriate Environmental and Social Management System (ESMS) in alignment with OHSAS 18001 for the operation of the scheme. > REL will develop and implement a Health and Safety Plan addressing the health and safety hazards at the site and which are expected to encompass the same type of hazards as those addressed in construction. > REL will undertake regular health and safety risk assessments, monitor the implementation of the Health and Safety Plan and provide health and safety trainings to its employees during operation.	[M 134] General operation occupational health and safety measures: ESMS aligned with OSHAS 18001, Health and Safety Plan, Employee training.
2. Hazardous substances	Hazardous substances transported to and stored on the site are expected to include (but not limited to) the following: > Diesel fuel for diverse diesel-powered machinery such as cranes or small mobile back-up generators > Lubricating oils and hydraulic fluid > Used oils > Small amounts of diverse paints, solvent & chemicals > Hazardous waste	> General measures listed under item [1] above. > Hazardous substances will be transported to the site by licensed transport contractors in compliance with DRC and Rwanda transport regulations. > The site Health and Safety Plan (see item 1 above) will include management measures for chemicals and hazardous substances. It will be similar to the construction phase hazardous substances management plan, though adapted for smaller inventories and fewer materials.	[M 135] Operation phase hazardous substances management measures.
3. Noise	At the dam site, the main sources of noise are expected to be from mobile machinery such as cranes, motors for opening/closing gates, small mobile generators and compressors used for maintenance works, and equipment housed in machine rooms. These noise sources are of concern from an occupational health and safety perspective. At the powerhouse, the noise sources at the source are expected to include the following: > Turbines and generators > Transformers > Aeration conduit > Tailrace channel	> General measures listed under item [1] above. > Noise levels in work areas will comply with DRC and Rwanda Occupational Health and Safety limit values and which are in alignment with IFC General EHS guidelines. > For work in noisy areas, operators will be provided with suitable high-performance hearing protection devices. > Operator health checks will include checking of hearing. > Procedures will be prepared that make the use of hearing protection mandatory in areas with high noise. > Regular equipment noise monitoring will be undertaken. > Equipment will be regularly inspected and maintained to ensure that noise levels are minimised.	[M 136] Operation phase occupational noise exposure management measures.

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Table 11-64 Potential Impacts – Occupational Health & Safety during Operation (*Cont.*)

Project Activity	Description of the Hazard	Management Measures	Reference to ESMP
4. Fire and explosion	The fire and explosion hazard is represented by the transport, storage and handling of combustible and inflammable substances. The principal combustible material is diesel fuel. This material will be transported to the site by road and stored in dedicated facilities. In case of an accidental event workers and communities may be affected by the consequences of the fire and/or explosion causing damage to property and/or injury to people.	> General measures listed under item [1] above. > EPC Contractor is required to implement measures to ensure that the facilities are designed fire and explosion risks are at acceptable levels in accordance with DRC and Rwanda regulations and IFC General EHS guidelines. > REL will maintain and operate the facilities in accordance with the recommendations of the designers.	[M 137] Operation phase fire and explosion management measures in compliance with NFPA.
5. Other general worksite hazards	> Electrical hazards: present in relation to (but not limited to) the electrical equipment at the dam site, powerhouse and switchyard. > Mechanical hazards: present with (but not limited to) the use of fixed and mobile mechanical equipment at the dam and powerhouse. > Confined spaces: Workers involved in inspection and maintenance may need to enter tunnels, inspection galleries within the dam structure, where there are risks of asphyxiation and rock falls. > Deep and fast flowing water: there are risks associated with working on or near water such as the rivers or reservoirs for the operating staff and maintenance workers. > Trips, falls: this is a general hazard that is present in many areas. > Working at heights: this is a general hazard that is present in some areas.	> The facilities will be designed and constructed in compliance with DRC and Rwanda health and safety regulations, GIIP and IFC General EHS Guidelines. > The facilities will be operated and maintained by REL in accordance with procedures developed in alignment with GIIP and IFC General EHS Guidelines. > REL will establish and implement an appropriate Environmental and Social Management System (ESMS) in alignment with OHSAS 18001 for the operation of the scheme. > REL will develop and implement a Health and Safety Plan addressing the health and safety hazards at the site and which are expected to encompass the same type of hazards as those addressed in construction. > REL will undertake regular health and safety risk assessments, monitor the implementation of the Health and Safety Plan and provide health and safety trainings to its employees during operation.	[M 134] General operation occupational health and safety measures: ESMS aligned with OHSAS 18001, Health and Safety Plan, Employee training.

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11.14 Community Health and Safety

11.14.1 Health and Safety Hazards

Project facilities and activities that represent or could cause a community health and safety hazard during **pre-construction and construction** are described in Table 11-65.

Table 11-65 Hazards for Community Health and Safety during Construction

Hazard	Unwanted event	Communities / people potentially affected
Project structures and equipment – coffer dam in particular	Structural failure of the coffer dam may be caused by a natural hazard (seismic event, extreme flood), design error, or construction error	Downstream communities
Noise, dust, vibration generated by project activities	Offsite noise and dust levels exceed human health threshold values (defined by World Health Organization – WHO). Vibration may trigger landslides or damage houses	Communities situated near roads used by project traffic and project worksites
Hazardous substances transported, stored and handled by the project	Accidental loss of containment (leak, spillage, accident event) causing offsite effects such as overpressure, thermal or toxic effects	People in the immediate vicinity of the facilities where hazardous substance stored or handled and where the accident occurs
Worksites in general	Unauthorised entry by member of community, accident such as trip, fall, electrocution	Person(s) who made the unauthorised entry
Project traffic on public roads	Traffic accident	Road users or pedestrians
Communicable diseases present in the communities or brought by workers	Increased incidence of communicable diseases linked to the arrival of construction workers	Communities of villages in the Project area
Project impacts on water quality	Pollution from wastewater discharges, or accidental spillage or leaks of hazardous substances	Communities of villages in the Project area
Natural hazards	Project causes increased frequency or magnitude of naturally occurring events	Communities of villages in the Project area
	Natural hazard event impacts project structures / facilities causing a technological accident with offsite consequences	Communities situated near roads used by project traffic and project worksites
Security and human rights	Inappropriate behaviour with regard to local communities by contractor and/or security personnel	Community members employed by the project Communities in the Project area
Population influx	Pressure on existing health systems and community health and safety in general as a result of influx of opportunity seekers to the Project area	Communities of towns and villages in the Project area

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Project facilities and activities that represent or could cause a community health and safety hazard during **operation** are described in the Table 11-66.

Table 11-66 Hazards for Community Health and Safety during Operation

Hazard	Unwanted event	Communities / people potentially affected
Dam structure	Structural failure of the Ruzizi-III. May be caused by natural hazards (seismic event, extreme flood), design error, or construction error. The dam break analysis is provided in Vol. III Annexes	Downstream communities
Hazardous substances transported, stored and handled by the project	Accidental loss of containment (leak, spillage, accident event) causing offsite overpressure, thermal or toxic effects	People in the immediate vicinity of the facilities where hazardous substance stored or handled
Noise from powerhouse	Exceedance of human health threshold values (defined by World Health Organization – WHO)	Communities situated near powerhouse
General hazards at project facilities (dam and powerhouse areas)	Unauthorised entry by member of community, accident such as trip, fall, electrocution…	Person(s) who made the unauthorised entry
Project traffic on public roads	Traffic accident	Road users or pedestrians
Waterborne diseases	No issues are expected	Communities of villages in the Project area
Impacts on water resources representing public health hazards	Pollution from wastewater discharges, or accidental spillage or leaks of hazardous substances	Communities of villages in the Project area
Natural floods	No increase in frequency or magnitude of natural flood flow expected	Downstream communities
Peak and off peak flows downstream from the Ruzizi-III powerhouse	Drowning	Person(s) who have ventured into the riverbed for recreational or other purposes
Periodic testing of the bottom outlet – releasing water into the Ruzizi from the dam causing a rapid change in river flow conditions.	Drowning	Person(s) who have ventured into the riverbed for recreational or other purposes
Influence of project on natural hazards	Triggering of landslide events Reservoir triggered seismicity	Communities of villages in the Project area
Influence of natural hazards on the project	Dam break	Downstream communities
Climate change	Increased frequency and magnitude of flood events, mudflows, debris flows, landslides – which impact the dam structure	Downstream communities
Electrical hazards represented by the physical presence of the 220 kV Transmission Line, 30 kV power line and the 220 kV substation.	Electrocution	Communities of villages in the Project area
Electromagnetic Radiation from the 220 kV Transmission Line.	Health effects of exposure to EMR The Electro Magnetic Frequencies (EMF) levels under the transmission line have been estimated and they are below the recommended threshold for community exposure considered by international standards[3]. In the Right of way, the Magnetic field values are expected to be	Communities living/working close to the transmission line

[3] The International Committee on Non-ionizing Radiation Protection (ICNIRP), in cooperation with the World Health Organization (WHO), has developed guidelines for the public and workers exposed to electromagnetic fields (ICNIRP, 1998). For the public, ICNIRP recommends exposure limits of 5.0kV/m for electric fields and 100μT (50Hz) for magnetic fields.
See International Commission on Non-Ionizing Radiation Protection. « Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 ghz) ». Health Physics 74, nº 4 (1998): 494-522.

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Hazard	Unwanted event	Communities / people potentially affected
	below 15 µT (for a threshold value of 100 µT), and the electric fields are expected to be below 4 kV/m (between 0.5 kV: M and 4 kV/m, for a threshold value of 5 kV/m) *	
Presence of the reservoir and alteration to downstream hydrology	Increased prevalence of water-related diseases	Communities living/working close to the reservoir dewatered reach of the river
* Source: Studio Pietrangeli, 2019		

11.14.2 Health and Safety Management Measures

Health and safety management measures are described in Table 11-67.

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Table 11-67 Community Health and Safety Management Measures – Construction and Operation

Hazard	Description of the hazard	Management measures	Reference to ESMP
1. Project structures and equipment – the coffer dam in particular	Risks to the community linked to the safety of the coffer dams, and the hydraulic and seismic loads caused by flood events and seismic activity. In the event of a flood event or seismic event with loads exceeding the coffer design criteria, there may be a failure of the structure causing a flood event affecting downstream communities.	The Project will define the detailed coffer dam safety measures which should include as a minimum the following: > Coffer dam design criteria for seismic and hydraulic loading in alignment with the recommendations of the International Committee On Large Dams (ICOLD). > Landslide risk reduction measures – protection or avoidance measures. > Coffer dam construction methods will follow GIIP, quality assurance procedures will be followed to ensure that the dam is constructed as designed. > The stability of the coffer dam will be monitored. Regular visual inspections will be carried out. > The Emergency Preparedness Plan will include coffer dam emergency situations. The plan includes the results flood levels of the area in the event of the coffer dam break.	[M 138] Coffer dam design criteria for seismic and hydraulic loading will follow ICOLD guidelines and take into account findings of detailed natural hazard risk assessments. See measures listed for natural hazards [8].
2. Noise dust and vibration	Dust, noise and vibration potentially affecting communities may be caused by: > Road traffic > General construction work > Blasting and tunnelling Inappropriately managed general construction work may generate offsite dust, noise and vibration at levels exceeding public health and safety threshold values. The blasting is carried out as part of the tunnelling work and for some localized road construction works. Inappropriately managed blasting may cause rockfall that may cause damage to public or private property and may cause injury.	See section on Air Quality and Noise (section 11.4)	See section 11.4
3. Hazardous materials	The hazardous substances transported and stored at worksite are expected to include (but not limited to) the following: > Diesel fuel > Explosives > Lubricating / used oils / transformer oil > Small amounts of diverse paints, solvent & chemicals > Hazardous waste Accidental leaks or spills during transport, or during onsite handling and storage may have offsite consequences affecting communities. In the event of fire or explosion, there may be offsite consequences affecting local communities.	The offsite effects of accidental spills or leaks of hazardous materials or consequence of accidental events caused by hazardous substances – such as fire and explosion – are prevented through the same measures that are adopted for occupational health and safety (see Table 11-63 item [2]). In addition, a suitable safety distance will be adopted between onsite areas for storage and handling of hazardous substances and offsite residential areas. > Hazardous substance areas will have suitable safety signage > Fuels storage will have secondary containment with 110% capacity > Refuelling tanks will have double a skin > Fuels will be transported is designated vehicles only > Hazardous waste areas will be separated from other waste areas and secured	[M 139] Safety distances between onsite areas for storage and handling of hazardous substances and offsite residential areas.

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Table 11-67 Community Health and Safety Management Measures – Construction and Operation (*Cont.*)

Hazard	Description of the hazard	Management measures	Reference to ESMP
4. Other hazards at worksites	Members of the community who enter construction sites without authorization or appropriate induction, safety equipment or site knowledge will be exposed to (i) electrical hazards (power supply service line, mobile power generators, electrical equipment), (ii) mechanical hazards (fixed and mobile mechanical equipment), (iii) chemical hazards (storage of hazardous materials), and (iv) physical hazards such as trips and falls.	The hazard is managed through the establishment of site a perimeter fence to prevent unauthorised entry. > The worksites will be guarded by a licenced security contractor. > All high voltage circuits will be secured to prevent unauthorised access > Camp areas will be well illuminated > All visitors and workers have a specific health and safety induction upon arrival to site > Work areas and offices will be maintained in a safe condition in accordance with the Project Health and safety Plan	[M 140] Control of access to worksites.
5. Traffic and road safety	Construction traffic will be using the roads passing through villages and residential areas and adjacent to cultivated lands. There will consequently be a significant increase in traffic. Local communities and especially children may not be familiar with such heavy traffic driving through their villages.	The EPC contractor will develop a Traffic Management Plan. The key aspects are listed below: > Best practice will be implemented speed limits, signage, driving rules, traffic marshals at key locations, drivers will be trained, alcohol and drug tests will be carried out and vehicle speed monitored using GPS devices. > Project-related traffic will be limited through residential areas at night, after agreement with the local authorities. > Specific attention will be made for schools, traffic marshals will be stationed at schools, project traffic will not travel in front of schools at school start and finish times. > The Traffic Management Plan will be communicated to the head of local communities and will be disclosed in local villages. > Road safety awareness and information will be provided to communities. > Local authorities will be informed prior to the movement of heavy exceptional convoys through residential areas. During operation the dam access road will be maintained by by REL	[M 141] Construction phase traffic management plan. [M 142] Public disclosure of the construction phase traffic management plan. [M 143] Local authorities given prior warning of the programmed arrival of heavy convoys. [M 144] Traffic hazard awareness campaigns organised for communities including school children. [M 145] The dam access road will be maintained for the duration of the HEPP's operating life.
6. Security and human rights	Inappropriate behaviour with regard to local communities by contractor and/or security personnel and/or public security forces.	A private security provider for the construction phase will be engaged by the EPC Contractor. When construction is completed, a smaller security force will be required and the Project Company will either engage a new security provider or extend the services of the service provider contracted for the construction. The main role of the security provider will be to guard the facilities – which will be fenced – and to control all people and vehicles entering and leaving the controlled areas. The management of the private security provider engaged to guard the facilities during construction and operation will follow the recommendations of the Voluntary Principles for	[M 146] Adherence to the Voluntary Principles on Security and Human Rights - and the International Code of Conduct for Private Security Service Providers including contractors and their subcontractors [M 147] Security services providers personnel to be

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Hazard	Description of the hazard	Management measures	Reference to ESMP
		Security and Human Rights and the International Code of Conduct for Private Security Service Providers[4] The Project will ensure that security guards are trained with regard to the Project's goals to establish good relationships with local stakeholders. A training specific to security personnel will be developed and implemented I, which outlines appropriate conduct, engagement and appropriate use of force, ensure that security personnel receive and remain up to date on human rights and cultural sensitivity, as well as the Voluntary Principles on Security and Human Rights. In order to manage the interactions between the Project Company and the public security providers (local police forces), RAL is committed to adhering to the Voluntary Principles for Security and Human Rights. To this end it will liaise regularly with public security providers to ensure that they are informed about the Project and the Project Company's policy on human rights, in particular that force should be used only when strictly necessary and to an extent proportional to the threat and that the rights of individuals should not be violated. In the event of a national security situation, the Project will follow instructions given by the public security providers.	trained to comply with the Voluntary Principles on Human Rights and the International Code of Conduct for Private Security Service Providers [M 148] Cooperation with local police forces

[4] The EIB Standard 9 on Health, Safety and Security requires that the provision of private security to protect project workers, assets, communities and suppliers is consistent wit international human rights standards and principles, including include the Voluntary Principles on Security and Human Rights and the International Code of Conduct on Private Security Providers.
The Voluntary Principles on Security and Human Rights is a collaborative effort by governments, major multinational extractive companies, and NGOs to provide guidance to companies on tangible steps that they can take to minimize the risk of human rights abuses in communities. The principles documents provide guidance to companies in developing practices that maintain the safety and security of their operations while respecting the human rights of those who come into contact with security forces related to those operations. https://www.voluntaryprinciples.org/the-principles/
The International Code of Conduct for Private Security Service Providers (ICoC) is a set of principles for private military and security providers, created through a multi-stakeholder initiative convened by the Swiss government. This process involved and continuously involves representatives from private security companies, states, and civil society organizations. The code reinforces and articulates the obligations of private security providers particularly with regard to international humanitarian law and human rights law.

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Table 11-67 Community Health and Safety Management Measures – Construction and Operation (*Cont.*)

Hazard	Description of the hazard	Management measures	Reference to ESMP
7. Community exposure to communicable disease	About 500-1,000 construction workers will be employed during peak, out of which at least 50% unskilled workers. Some workers may come from outside the region. However, some expatriated foreign workers can be expected. The presence of the temporary workers may potentially increase the incidence of communicable diseases, including STI/HIV and COVID-19.	The EPC Contractors will prepare and implement a health and safety plan which will include measures regarding the management of communicable diseases and management of community health. Key measures are listed below and more detail provided in Vol. IV ESMP. > Recruitment target of 25% from Burundi 25% from DRC and 25% from Rwanda for unskilled positions to reduce the number of workers from outside the region. > Construction workers will be accommodated in a worker accommodation camp, with controlled access. > In coordination with local health authorities, health awareness campaigns will be organised for those communities situated close to worker accommodation camps. > Construction workers (including subcontractors) will be subject to health screening. During induction, workers will be provided with health awareness training including with regard to sexually transmitted diseases. Periodic refresher training will be provided. > Free condoms will be available at the project's first aid and medical centres at the construction sites and construction camps. > REL will monitor the implementation of these measures by the EPC Contractor.	[M 149] Community health management measures included in the construction phase health and safety plan. [M 150] Monitoring by REL of the implementation of the community health management measures by the EPC Contractor.
8. Impacts on availability and quality of water resources representing health hazards	Water resources may be affected by the following: > Increased sediment loading in the Ruzizi River from earthworks and dewatering of tunnels. > Accidental spills and leaks from the storage and handling of hazardous materials may contaminate surface and groundwater. > Discharge of sanitary and domestic wastewater. If tunnelling spoil material contains sulphur bearing rock, there may be a risk of acid rock drainage and heavy metal leaching causing a change of river water pH and increased concentration of some heavy metals in the river water.	The EPC Contractor will prepare and implement a Construction ESMP that will include measures to prevent impacts on water resources availability and quality. Key measures are listed below and more detail provided in Vol. IV ESMP. > Sanitary and domestic wastewater will be collected and treated prior to discharges. All discharges will comply with Burundi, DRC and Rwanda discharge limits and limits defined by IFC General EHS guidelines. > Sediment traps will be used to prevent runoff with high sediment load draining from worksites to surface water. > Spoils from tunnelling will undergo geochemical testing to assess the risk of acid rick drainage and heavy metal leaching. If such risks are present, the spoil will be stored in a facility equipped to prevent contaminated runoff and seepage water from contaminating water resources. > Monitoring of wastewater discharges will be undertaken by the EPC Contractor – and periodic controlled by REL. > Monitoring of ambient surface and groundwater quality will be undertaken by REL and starting before construction work starts. Monitoring by the EPC Contractor will be undertaken during construction work and REL will make periodic controls. > The EPC Contractor will provide alternative sources of household potable water if wells or springs used by a household are affected by the Project.	[M 151] Technical measures to avoid impacts on water quality including from wastewater discharges, runoff and tunnelling spoils. [M 152] Disclosure of water monitoring results.

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Table 11-67 Community Health and Safety Management Measures – Construction and Operation (*Cont.*)

Hazard	Description of the hazard	Management measures	Reference to ESMP
9. Natural hazards	The construction phase of the project is not expected to trigger natural hazard events such as seismic events, extreme flood events, mudflow or debris flow events. However, natural hazards events could potentially trigger technological accidents such as coffer dam break or loss of containment of hazardous substances causing explosion, fire or pollution that could affect local communities.	> Seismic studies have been undertaken to characterise magnitude and frequency of seismic events (see Section 7). Seismic criteria for the coffer dam have been defined. Additional seismic studies will be undertaken and seismic loading criteria for the coffer dam and other temporary structures will be revised if necessary. > Hydraulic studies have been undertaken to characterise frequency and magnitude of extreme flood events. Hydraulic loading and flood evacuation design criteria for the coffer dam have been defined. > Landslide risk assessment studies have been performed (see section 7. Additional studies will be undertaken and which will include assessment of the risk to temporary construction facilities, and definition of risk reduction measures. > The risk assessment for natural hazards for workers during construction will define the natural hazards mitigation measures for each worksite, including construction camps.	[M 153] Detailed design to include detailed seismic studies to complement the preliminary studies already performed and to confirm dam and coffer dam design criteria. [M 154] Coffer dam and diversion tunnel flood management criteria and procedure in detailed design. [M 155] Assessment of reservoir rim stability and analysis of hydraulic consequences. [M 156] Carry out detailed landslide risk assessment and include dam, coffer dam and temporary construction facilities in the assessment and include the findings into the Project design.

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11.14.3 Project Induced In-Migration Health & Safety Risks

Large construction projects can attract new in-migrants. Depending on how it is managed and the baseline conditions, project-induced in-migration can have an adverse or a beneficial impact on local communities and the Project's performance. Potential new migrant stakeholder groups for this Project include:

- Returning family, extended family members and former residents – seeking improved living conditions and employment or opportunities to provide goods and services to the Project or local population.
- Camp followers - who are entrepreneurs arriving to capture business opportunities associated with the construction labour of the Project.
- Opportunistic migrants, Unskilled, semi-skilled or skilled people seeking direct or indirect employment or entrepreneurial opportunities.

To assess the risk and magnitude of (i) the project-induced in-migration and (ii) its potential impacts, the methodologies used are those defined in:

- The IFC handbook on Project-induced in-migration (IFC 2009).
- The World Bank Guidance Note on Managing the Risks of Adverse Impacts on Communities from Temporary Project Induced Labor Influx (World Bank 2016).

The significance of the potential impacts from Project-induced in-migration depends on:

- The likelihood and anticipated magnitude of the influx.
- The absorption capacity or resilience of the host communities.
- The capacity of the project to manage the risks related to project-induced in-migration.

11.14.3.1 Assessment of Project-Induced In-Migration Magnitude

The importance of influx usually depends on several factors (IFC, 2009) depending on the Project characteristics as well as socioeconomics conditions of the area:

- The number of unskilled jobs offered locally by the Project.
- Accommodation strategy of Project's workforce.
- Accessibility of the Project area and its possible enhancement by the Project.
- Perceived opportunities to speculate on compensation during the Project's land acquisition process.
- Proximity with international borders and existence of transnational migrations.
- Level to employment in the area without the Project.
- Existing local patterns of migration.
- Proximity with important urban centres.

The table overleaf describes the assessment of each of the above factors, the likelihood and potential magnitude of influx in the Project's area.

Table 11-68 Assessment of Risks and Magnitude of Project Related In-Migration

Factors	Description of situation	Risk / Magnitude of influx
Number of unskilled jobs offered by the Project (jobs seekers moving to projects hoping to be hired are almost exclusively unskilled workers)	The Project will, at peak construction period, require between 500 and 1,000 workers. The whole construction period is estimated at between 48 and 56 months. Assuming a total of 1,000 workers is required, it is estimated that in the order of 120 will work as managers, 700 will be semi-skilled or skilled workers and 180 will be hired as unskilled workers. The EPC Contractor will largely communicate on the local employment targets and objectives to avoid a massive influx of job-seekers. The EPC Contractor will be required to have recruit local people for 100% of the unskilled workers. This will minimize employment opportunities for outsiders as scale of job-seeker influx depends on	Low risk / Low magnitude

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Factors	Description of situation	Risk / Magnitude of influx
	perceived employment opportunities. There will be few opportunities for potential migrants as local people will be prioritised for skills development and employment and this may deter potential in-migrants.	
Accommodation of workforce (no accommodation means higher in-migration)	The construction camp will be designed by the EPC Contractor to accommodate the required peak number of workers (in the order of 500 to 1,000 workers), but possible that unskilled workers from Rwanda and DRC may be accommodated at the own homes.	Low risk / low magnitude
Accessibility of Project area (New accessibility means high in-migration)	The Project's sites are located in areas that are already accessible: they are close to national roads, both in Rwanda and DRC. The Project will upgrade existing roads and create new roads to access the dam.	Low risk / low magnitude
Perceived opportunities of speculation (high perceived opportunities result in high in-migration)	The land tenure is well established in the Project area (legal land tenure in Rwanda and customary land tenure in DRC). Few opportunities for potential migrants as local people are being prioritised for skills development and employment and this may deter potential in-migrants.	Low risk / low magnitude
Proximity with international borders (proximity can potentially result in higher risk of in-migration)	The Project is situated on the international border between DRC and Rwanda, and the border with Burundi is close. However, the borders are well monitored and controlled by the local police forces.	Medium risk / medium magnitude
Level of employment in the area (high level means less in-migration)	The large majority of the population is engaged in agriculture in the Project area (both in Rwanda and DRC). Very few formal employment opportunities are available outside the urban areas.	Medium risk / medium magnitude
Existing patterns of migration (tendencies to mobility means high risk of in-migration)	There is an existing tendency to mobility within the population both in Rwanda and DRC. However, people are usually moving mostly from rural areas to urban centres. The Project area has been subject to several refugees' population movements over the past 30 years.	Medium risk / medium magnitude
Proximity with urban centres (close means less risk of in-migration)	There are 2 urban centres close to the Project: - Bugarama Sector in Rwanda and - Kamanyola town in DRC	Low risk / low magnitude

Source: adapted from IFC 2009: "Projects and People: A Handbook for Addressing Project-Induced In-Migration"

The probability of project-induced in-migration is low to medium, and the possible magnitude of such influx would unlikely be significant.

Based on documentation collected on a wide array of Projects worldwide, the IFC (IFC, 2009) estimates that a Project's related in-migration could range between 3 to 10 times the number of people employed by the Project.

Given the fact that population movements have happened in the region, and as the risk is low to medium, it is estimated that potential in-migration should not exceed two to five times the number of unskilled workers. The number of these unskilled workers during construction would be about 180 at peak. Hence the order of magnitude of the influx could range from about 300 to 900 people, including the unskilled workers coming from outside the Project area employed by the Project.

11.14.3.2 Absorption Capacity of Local Communities

The impacts of Project-induced in-migration will depend on the absorption capacity of the communities where the influx would be located. These communities are likely to be those where the Project construction camp will be located. Only one construction camp is planned, in Rwanda. Its location is given in Figure 11-7 below. The villages or settlement which could

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potentially be affected by the Project-induced in-migration are the closest to the Construction Camp (on both sides of the border):

- In Rwanda: Gatebe and/or Kabuzunzu villages in Bugarama Sector, which are located along the access road leading to the Construction Camp, and Nyagahanga village in Nzahaha Sector, from which an existing track is leading to the reservoir site, and then to the construction Camp,
- In DRC, Bugano, Kafunda and Nachihembe villages, which are either crossed by the access road leading to the bridge in front of the Construction Camp, or with an access to this access road.

Even if the predicted risk of in-migration is low, in the event of such influx happens, and given the conditions of public utilities, specifically health facilities, education, transports, water utilities, in the Project area and the local demography, it may have high impacts on the local communities. The communities potentially receiving the influx are considered to have a medium to high sensitivity:

- in Rwanda Gatebe and Kabuzunu villages are part of the urban setting of Bugarama sector, their sensitivity is assessed as medium,
- Nyagahanga village in Rwanda and Bugano, Kafunda and Nachihembe villages in DRC are located in rural areas, their sensitivity is assessed as high.

Table 11-69 below presents the comparison of the existing population in the 6 villages which are likely to receive the potential influx with the size of the influx. Two scenarios are considered: a low Project-induced in-migration (about 300 in-migrants) and a high Project-induced in-migration (about 900 in-migrants). Assuming the influx would be spread regularly within these 6 villages, it would represent:

- between 5 and 26% of the existing population in each village with a low in-migration, and
- between 13 and 65 % of the existing population in each village with a high in-migration.

Table 11-69 Influx Scenario Compared to the Existing Population in the Villages close to the Construction Camp

Settlements or villages closest to the Construction Camp		Estimated exiting population in 2021	Potential influx (low scenario - 300 migrants)		Potential influx (high scenario - 900 migrants)	
			Number of in-migrants	% of existing population	Number of in-migrants	% of existing population
Rwanda	Nyagahanga	648	50	8%	150	23%
	Gatebe	920	50	5%	150	16%
	Kabuzunzu	1,117	50	4%	150	13%
Total in Rwanda		2,685	150	6%	450	17%
DRC	Kafunda	300	50	17%	150	50%
	Bugano	230	50	22%	150	65%
	Nachihembe	900	50	6%	150	17%
Total in DRC		1,430	150	10%	450	31%
Total both countries		4,115	300	7%	900	22%

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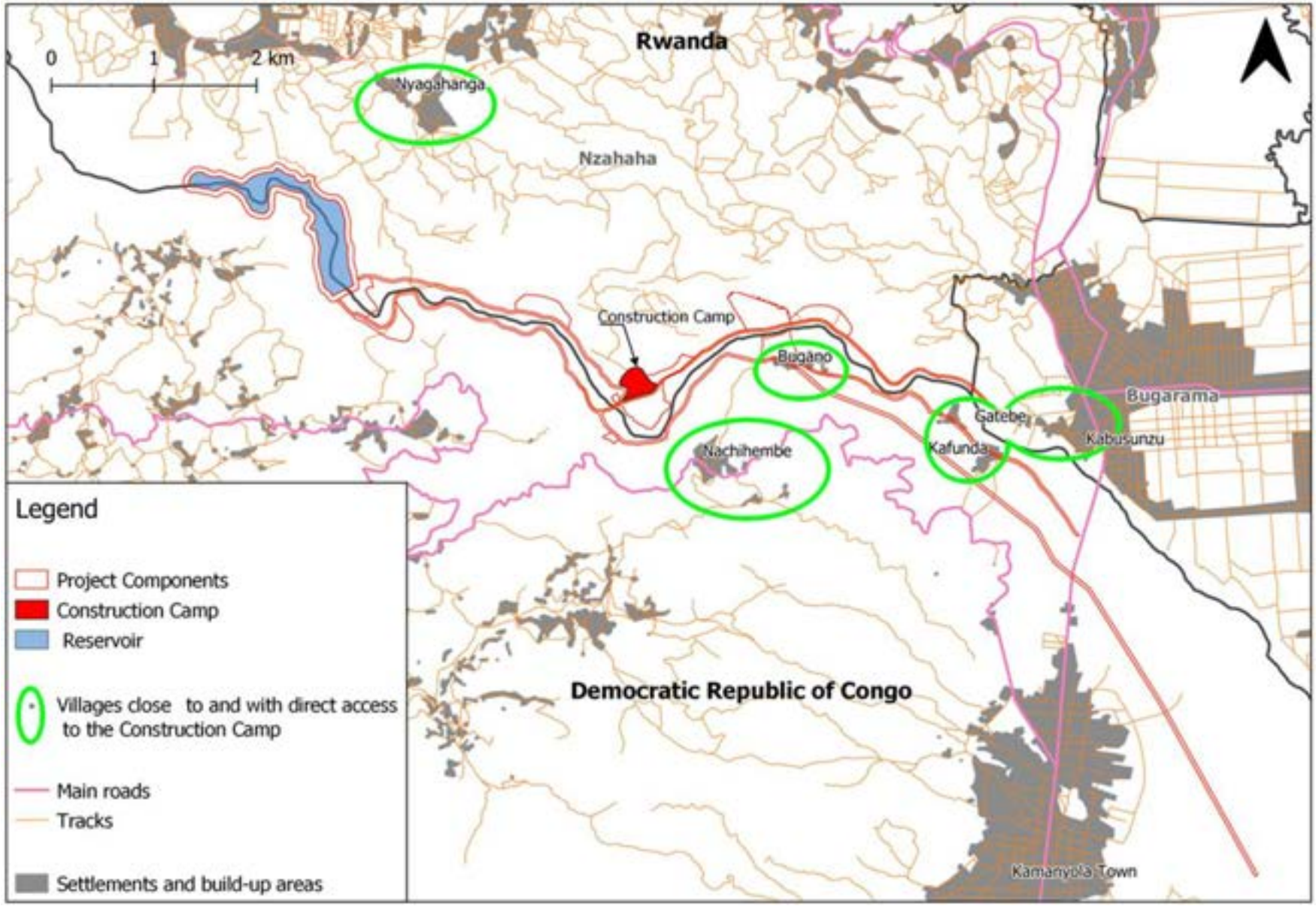


Figure 11-7 – Construction Camp and Potential Areas Targeted by Project-Induced In-Migration

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11.14.3.3 Potential Impacts

Implications associated with Project's related in-migration could be serious if that risk would materialize. The potential impacts could be:

- Various types of anti-social behaviour (e.g. public drunkenness) or illicit behaviour.
- Pressure on social services, especially health facilities.
- Increase in sexually transmitted diseases.
- Local inflation of prices, including pressure on accommodation and rents.
- Gender-based violence.
- Increase in traffic and related accidents.

Given the estimated importance of the influx, the magnitude of these impacts would be minor to moderate. As the local social environment is considered of medium to high sensitivity, any of the impacts above is likely to be moderate.

11.14.3.4 Risks Factors Related to Influx Management

The World Bank Guidance Note on "Managing the risks of adverse impacts on communities from temporary project induced labour influx" (World Bank 2016) suggests that the potential impacts from Project-induced in-migration could be further exacerbated by the local social, institutional and organisational Project implementation situation. A high-risk situation required more stringent management measures than a low-risk one. The following criteria must be considered to assess if the Project's implementation situation increases the risks related to influx management or not:

- Institutional capacity of the implementing agency.
- Capacities of contractors regarding workers management and health and safety policies.
- Pre-existing social conflicts or tensions.
- Situation of local law enforcement.
- Prevalence of gender-based violence and social norms towards it in the community.
- Local prevalence of child and forced labour.

Table 11-70 below assesses the level of risk of the social, institutional and organisational context of the Project, in regard to the factors listed above.

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Table 11-70 Factors Increasing the Risks Related to Influx Management

Risk Factors	Description of situation	Importance of risk
Institutional capacity of the implementing agency	REL and the EPC contractor have a strong institutional capacity and are used to manage this magnitude of workforce.	Low risk
Capacities of contractors regarding workers management and health and safety policies	The EPC contractor applies the international standards regarding workers management and health and safety policies.	Low risk
Pre-existing social conflicts or tensions	As described in the socioeconomic baseline: - Rwanda currently enjoys high levels of political stability and general security. - The Project area in DRC, as well as the broader Sud-Kivu region, is characterized by the presence of armed groups. Over the past 30 years, a succession of armed conflicts took place in this region. The area around Kamanyola town, and the immediate vicinity of the Project appears to be less touched by the armed groups than other parts of the region.	Medium risk
Situation of local law enforcement	The situation of local law enforcement differs between Rwanda and DRC. In Rwanda, the public order is maintained through local security arrangements in the local communities, producing what has been described by scholars as a "*remarkably efficient information-gathering apparatus*"[5] coordinated with the authorities and police forces. In the Project area in DRC, there is limited law enforcement from Police forces outside Kamanyola town. Most low-level conflicts are managed and solved by the traditional authorities.	Medium to high risk
Prevalence of gender-based violence and social norms towards it in the community	As described in the socioeconomic baseline, gender-based violence is widespread both in Rwanda and DRC. Several example of gender-based violence and gender impacts from previous Projects' construction workforce have been reported (including unwanted pregnancies)	High risk
Local prevalence of child labour.	Increased opportunities for the host communities to sell goods and services to the incoming workers can lead to child labour to produce and deliver these goods and services, which in turn can lead to enhanced school dropout. School dropout and child labour are already occurring in the affected communities.	High risk
Source: adapted from World Bank 2016, "*Managing the Risks of Adverse Impacts on Communities from Temporary Project Induced Labor Influx*"		

Based on the above criteria, the social, institutional and organisational context of the project does constitute a medium to high-risk environment for the management of Project-induced in-migration.

[5] Lamarque Hugh, "Policing small communities: Rwandan law enforcement and the co-production of security", Politique africaine, 2020/4 (No 160), p. 113-138. URL: https://www.cairn-int.info/journal-politique-africaine-2020-4-page-113.htm

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11.14.3.5 Mitigation strategy

A **During construction**

Some of the mitigation measures already defined in previous sections will help to reduce and mitigate the risks and magnitude of the Project-induced in-migration and which are as follows:

[M 111] The Project's HR policy and labour management principles will align with Lenders' Policies and the labour laws of Burundi, DRC and Rwanda

[M 112] The Project will set local employment objectives and targets.

[M 113] The Project's local employment objectives will include specific targets for the employment of women. According to these targets, at least 15% of the total workforce (skilled and unskilled) will be female.

[M 114] The local Recruitment Policy will be communicated widely.

[M 119] Project's HR Policy and labour management principles will clearly state that there will be no forced labour and child labour.

[M 122] REL will recruit two trained female Gender Officers (1 in Rwanda and 1 in DRC) to define and implement GBVH protocols. These protocols will apply to all Project workers, including contractors and sub-contractors.

[M 123] The EPC will develop and implement a workers' code of conduct, including GBVH policies, and mandatory training of all workers on sexual harassment and GBVH protocols

[M 141] Construction phase traffic management plan.

[M 142] Public disclosure of the construction phase traffic management plan.

[M 149] Community health management measures included in the construction phase health and safety plan.

[M 150] Monitoring by REL of the implementation of the community health management measures by the EPC Contractor.

[M 146] Adherence to the Voluntary Principles on Security and Human Rights - and the International Code of Conduct for Private Security Service Providers including contractors and their subcontractors

[M 147] Security services providers personnel to be trained to comply with the Voluntary Principles on Human Rights and the International Code of Conduct for Private Security Service Providers

[M 148] Cooperation with local police forces

The Project will also prepare an Influx Management Strategy with the following objectives:

- Review of the existing operational responsibilities and management plans.
- Integration of selected influx management interventions into existing management plans.
- Monitoring and evaluation to assess their effectiveness.

This measure is referred later in this report as:

[M 157] Preparation and implementation of an Influx Management Strategy.

In addition of the measures already listed above, to mitigate risks of gender-based violence from the in-migrant workers amongst the local communities, the following measure will be implemented:

[M 158] REL Gender officers will prepare and implement a Community Outreach Programme on Gender-based violence and harassment, to disclose the Project's GBVH protocols and reporting processes.

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B **During operation**

All the measures listed above are related to the construction period. Project-induced in-migration could potentially happen during the operation, as fishers attracted by the fishing potential of the newly created reservoir would settle in the villages around the reservoir. This is however difficult to anticipate. This will have to be monitored by the Project. Should any significant influx around the reservoir happen during operation, measures to address potential negative impacts will be defined to update the Influx Management strategy during operation.

These measures are:

[M 159] Monitoring on Project-induced in-migration around the reservoir during operation during the first years of operation

[M 160] Addressing potential negative social impacts of continued presence of project-induced influx during the first years of operation

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11.15 Human Rights

No standalone Human Rights Impact Assessment has been performed. The Lenders E&S policies do address impact on Human Rights, as a key topic mainstreamed throughout their E&S standards. Potential human rights impacts have been considered and mainstreamed throughout the impact assessment process. The Table 11-71 below provides an overview of the sections of the ESIA where the human rights have been considered. The human rights listed in this table are the international human rights provided under the International Bill of Human Rights[6], including the International Covenant on Economic, Social and Cultural Rights and the International Covenant on Civil and Political Rights (the ICESCR and ICCPR) and the Core ILO Conventions[7]. Human rights which are considered relevant for the Project activities are listed in Table 11-71.

Table 11-71 Human Rights in the ESIA

Human Rights	ESIA section(s) where these aspects are covered
Right to self-determination (ICESR) (*It includes the rights to pursue economic, social and cultural development, to dispose of a land's natural resources and not to be deprived of the means of subsistence.)*	Impacts on local communities' livelihoods Cultural heritage Ecosystem services
Right to life (ICCPR)	Labour and working conditions Communities health and safety Impacts on local communities' livelihoods
Right not to be subjected to torture, cruel, inhuman and/or degrading treatment or punishment (ICCPR)	Labour and working conditions Communities health and safety Impacts on local communities' livelihoods
Right not to be subjected to slavery, servitude or forced labour (ICCPR & ILO Conventions)	Labour and working conditions
Right to liberty and security of the person (ICCPR)	Labour and working conditions Communities health and safety
Right to liberty of movement (ICCPR)	Labour and working conditions Impacts on local communities' livelihoods

[6] The International Bill of Human Rights was the name given to United Nations General Assembly Resolution 217 (III) and two international treaties established by the United Nations. It consists of the Universal Declaration of Human Rights (adopted in 1948), the International Covenant on Civil and Political Rights (ICCPR, 1966) with its two Optional Protocols and the International Covenant on Economic, Social and Cultural Rights (ICESCR, 1966). The two covenants entered into force in 1976, after a sufficient number of countries had ratified them.

[7] The Core ILO Conventions are:
C29 Forced Labour Convention (1930)
C87 Freedom of Association and Protection of the Right to Organise Convention, 1948
C98 Right to Organise and Collective Bargaining Convention, 1949
C100 Equal Remuneration Convention, 1951
C105 Abolition of Forced Labour Convention, 1957
C111 Discrimination (Employment and Occupation) Convention, 1958
C138 Minimum Age Convention, 1973
C182 Worst Forms of Child Labour Convention, 1999

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Human Rights	ESIA section(s) where these aspects are covered
Right to a fair trial (ICCPR) Right to recognition as a person before the law (ICCPR) Right to freedom of arbitrary or unlawful interference with a person's privacy (ICCPR)	Labour and working conditions The Project has prepared a Stakeholder Engagement Plan and a Grievance Redress Mechanism, see Chapter 6 Public Participation
Rights to freedom of opinion without interference and the right to freedom of expression (ICCPR)	Labour and working conditions The Project has prepared a Stakeholder Engagement Plan and a Grievance Redress Mechanism, see Chapter 6 Public Participation
Right to freedom of assembly (ICCPR) Right to freedom of association (ICCPR and ILO Conventions) Rights of protection for the child (ICCPR, ICESCR and ILO Conventions) Right to work (ICESCR) Right to enjoy just and favourable conditions of work (ICESCR and ILO Conventions) Right to form and join trade unions and the right to strike (ICESCR and ILO Conventions) Right to social security, including social insurance (ICESCR) Right of aliens to due process when facing expulsion (ICCPR)	Labour and working conditions
Right to participate in public life (ICCPR)	The Project has prepared a Stakeholder Engagement Plan, see Chapter 6 Public Participation
Right to equality before the law, equal protection of the law, and rights of non-discrimination (ICCPR, ICESCR and ILO Conventions)	Labour and working conditions Community health and safety Impacts on local communities' livelihoods
Right to an adequate standard of living (ICESCR)	Labour and working conditions Community health and safety Impacts on local communities' livelihoods
Right to health (ICESCR)	Labour and working conditions Community health and safety
Right to education (ICESCR)	Impacts on local communities' livelihoods Positive impacts and benefits
Rights to take part in cultural life, to benefit from scientific progress, and to protection of the material and moral rights of authors and inventors (ICESCR) Rights to freedom of thought, conscience and religion (ICCPR)	Cultural heritage

ICCPR = International Covenant on Civil and Political Rights; ICESCR = International Covenant on Economic, Social, and Cultural Rights; ILO = International Labour Organisation

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11.16 Gender-related Risks and Impacts

The Social Baseline data collection activities carried out in January 2022 revealed widespread manifestations of gender-based inequality and discrimination across the Study Area. Gender-specific issues observed on field can be summarised in the following key points:

- **Land** – in both Rwanda and DRC, women face serious constraints to land tenure security. In Rwanda, the only way for women to access land ownership titles is through marriage. In fact, land is so scarce that inheritance tends to be passed on to male children only and the land market is generally dominated by men. In DRC, customary rights do not allow women to own land through at all. Women generally access land only through getting informal usage rights from their father, brother or husband. Due to these difficulties, unmarried women and widows are likely to remain landless or homeless unless their family can support them.
- **Domestic Life** – All across the Study Area in Rwanda and DRC, women usually are socially expected to take care of their house and children.
- reported being more likely than men to perform unpaid work for their family rather than receive a salary. Even the women that do earn a salary are financially dependent on male family members and have little control over their own salary and spending power. All women and while they reported having access to services and resources as well as men, they felt that men had the ultimate control of these resources and the benefits coming out of it. Women reported participating actively to the life of the village and feeling represented by all collective institutions. Women are using microcredit institutions at village level to gain control over their own financial resources. In DRC, women reported often experiencing restrictions in their control of agricultural activities and revenues.
- **Livelihoods** – Alongside their domestic duties, women in both Rwanda and DRC worked within the family's field and are responsible for selling produce at markets. Fewer women reported also supporting their husband's business or shop, especially in the larger centres of Bugarama (Rwanda) and Kamanyola (DRC).
- **Health** - Women face constraints accessing maternity and gynaecological services for themselves and child health services for their children. Constraints in accessing healthcare is mostly due to lack of transport, high cost of health centres, bad quality of roads and failing to receive support or agreement from their husband to seek treatment. Some cases of at-home abortions and births have been reported in Rwanda and in DRC alike.
- **Divorce and Marriage** – In Rwanda as well as DRC, polygamy has been reported as a common practice threatening women's reputation and land tenure stability. Since legal polygamy is not allowed, illegal wives often remain stuck in landless conditions working on plots which belong to their husband but might be taken away at the termination of the relationship. In both countries, divorced women and widows face
- **Gender-based Violence** - Cases of physical and sexual gender-based violence have been mentioned in Rwanda as well as DRC. There are no specific networks or platforms available to support victims of GBV, apart from referrals to hospitals from the local health centres. Sexually transmitted diseases and cases of sexual assault were reported in all of the health centres visited. Episodes of unwanted pregnancies caused by immigrant workers due to projects around the Study Area were also reported in Rwanda (Bugarama to Gisheke Road Project and Gishoma Geothermal Power Plant).

Due to the manifestations of gender inequality described above, there is a risk that the Project may negatively affect women.

Two categories of risks could materialise, having a significant impact on women's livelihood and land tenure security and potentially leading to an increase in GBVH. These two categories of impacts are described in detail and mitigated in Section 11.12, which deals with livelihood-related impacts and Section 11.16.2, which covers GBVH impacts.

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11.16.1 Land Tenure and Livelihood Security Impacts

As outlined in Section 11.12.4, the preliminary census of 2022 identified that 25% of all physically and economically displaced households was headed by a woman. The potential negative impacts that the Project may have on women's land tenure and livelihood security are:

- Within the land acquisition process, female land users may struggle to prove their eligibility to compensation measures, resulting into some women being unable to receive compensation for their loss of revenue. This is likely to be the case for the following categories of women:
  - Widows that have been using the land of their deceased husband without ever acquiring a title in their name.
  - Unmarried women with land use rights gifted or inherited from their family without a title or customary right attached to it.
  - Married women working exclusively on their husband's land without their name figuring on the land title.
  - Women engaging in an extra-legal polygamous relationship and working exclusively on their partner's land, on which they do not have rights.
- If physically and economically displaced, women-headed households may struggle more than men to find alternative sources of revenue, re-establish their livelihoods or find new land for their homes.
- If married men receive compensation for their family's land, there is a possibility that they might claim control over the compensation money and use it for expenses that their wives do not prioritise.

The sensitivity of the receptive environment for gender-based violence is considered high because, as described in the Section 11.12.3, in the Project area women have little access to land use and ownership rights in practice, although they may be allowed to these rights in paper. Since all land acquisition for the Project will be permanent, with PAPs still being able to cultivate under the transmission line during operation, and the percentage of women-headed households is not negligible (25%), the magnitude of land acquisition impacts on women's land tenure security is moderate. The significance of the potential impact before mitigation is Major (Significant).

Specific mitigation measures will be implemented to (i) reduce the likelihood that the risk may materialise and (ii) reduce the impact's magnitude, should its avoidance be inevitable. In addition to the mitigation measures established in Table 11-60 for all physically and economically displaced households, specific mitigation measures will be put in place in the RAP to reduce the risk and mitigate the potential impact on women's land tenure and livelihood security:

- REL will carry out specific consultations with women all throughout the RAP process, to inform them of their rights and present to them the compensation process.
- Gender-separate consultations will be carried out with both men and women to educate them about how to manage the compensation money fairly for the benefit of the household.
- For married couples, compensations will be paid on shared bank accounts.
- Specific measures to support women by restoring their livelihoods and assisting them in their displacement will be proposed in the RAP.

11.16.2 Gender-based Violence Impacts

The Project may contribute to the rise of gender-based violence and harassment (GBVH) cases. GBVH cases included sexual exploitation and abuse (SEA) and sexual harassment (SH), including physical, sexual, emotional and financial control and violence. As outlined in the GBV World Bank

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Good Practice Note on GBV (2019), GBVH can be exacerbated by (i) resettlement and land redistribution processes and (ii) a large influx of male workers. Consequently, the project may contribute to rise in SEA and SH cases due to the following causes:

- Women may experience GBVH during the compensation and resettlement process, due to the following factors:
  - When trying to prove their right to affected land that they were gifted or inherited, women may face violence or threats from male relatives trying to claim the land for themselves.
  - If physically of economically displaced, financial stresses and the loss of livelihoods may lead to additional instability within homes where women are already affected by domestic violence.
- Women may be negatively affected by the predominantly male labour influx into the Project area, due to the following factors:
  - Men are more likely to benefit from local employment opportunities, which may lead to a higher workload for women on family farms with a potentially exploitative surcharge of domestic and agricultural work, to make up for the loss of male workers.
  - If the labour force is predominantly male, the few women hired by the Project may face discrimination, violence or harassment by male workers.
  - As more workers move or commute to the Study Area to seek employment in the Project, spending time living with and / or engaging with local communities, women may face additional risks of physical and sexual harassment and abuse within their communities.

The sensitivity of the receptive environment for gender-based violence is considered high for two main reasons:

- As outlined in the Social Baseline, discrimination and harassment against women are not uncommon across the study area.
- According to methodologies used to assess the risks of gender-based violence and harassment[8], being a green-field project, recruiting a large workforce, engaging local communities, employing private security staff and operating in an isolated area are all risk factors for gender-based violence.

Although the sensitivity of the receptive environment is high, the potential impact on GBVH is considered moderate in magnitude, since it may only be experienced during the 56-month construction period.

As the receptor's sensitivity is high and the magnitude of the risk is moderate, the significance of the potential impact before mitigation is Major (Significant).

To reduce the risk of women facing GBVH as part of the resettlement and compensation process, the RAP's grievance mechanism will include a tool to report and treat grievances related to GBVH risks within the framework of land acquisition and compensation. Specific indicators to assess the nature of GBVH incidents and the demographics of victims will be added to the monitoring arrangements of the grievance mechanism, to ensure that GBVH cases are adequately monitored and that corrective measures can be put in place in a timely manner. The RAP explains in detail how this system will function.

To reduce the risk of women facing GBVH in the context of labour influx and construction works, several mitigation measures will be implemented to (i) reduce the likelihood that the risk may materialise and (ii) reduce the impact's magnitude, should its avoidance be inevitable. The mitigation measures to reduce the risk and mitigate the potential impact on GBVH during construction are outlined as follows::

[8] See Social Development Direct (2020) *Addressing Gender-Based Violence and Harassment. Good Practice Note for the Private Sector*. Good Practice Note produced with the assistance of the European Bank for Reconstruction and Development (EBRD), the International Finance Corporation (IFC) and CDC Group plc (CDC). The content of this publication has been developed by Social Development Direct.

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[M 113] The Project's local employment objectives will include specific targets for the employment of women. According to these targets, at least 15% of the total workforce (skilled and unskilled) will be female.

[M 117] Provisions regarding non-discrimination and equal opportunities will be included in the Project's HR Policy.

[M 120] REL will review the EPC contractor's subcontractors' management procedures prior to the start of construction and organise and finance 6-monthly Integrated Environmental, Social, Health and Safey audits by an independent auditor of the EPC Contractor and its subcontractors' working practices to check compliance with the Project's HR Policy, Labour laws of Burundi, DRC and Rwanda, and Lenders' labour management requirements.

[M 121] The EPC will develop a gender-sensitive recruitment strategy and communicate it to the local communities.

[M 122] REL will recruit two trained female Gender Officers (1 in Rwanda and 1 in DRC) to define and implement GBVH protocols. These protocols will apply to all Project workers, including contractors and sub-contractors.

[M 123] The EPC will develop and implement a workers' code of conduct, including GBVH policies, and mandatory training of all workers on sexual harassment and GBVH protocols.

[M 124] The EPC contractor will develop an Occupational Health and Safety Management Plan which will gender and GBVH aspects, such as: gender-separate accommodation on camp, gender-separate lockable latrines and WASH facilities that are well-lit, conveniently located and easily accessible..

[M 125] The EPC will establish workers' safety committee which will include at least one trained female worker representative.

[M 126] The Workers' grievance mechanism and Community grievance mechanism will channel all GBVH complaints and store them on a separate database. REL's Gender Officers will be responsible for handling and solving these complaints.

[M 158] REL Gender officers will prepare and implement a Community Outreach Programme on Gender-based violence and harassment, to disclose the Project's GBVH protocols and reporting processes.

After implementation of these mitigation measures, the risks are considered Minor (Not Significant).

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11.17 Cultural Heritage

11.17.1 Impact Producing Factors

The factors which could potentially affected elements of cultural heritage are threefold:

- During pre-construction and construction: Land acquisition, earthworks and construction of the physical component of the Project, which can destroy material elements of cultural heritage, including potential archaeological artefacts.
- During construction and operation: disturbances from construction activities (such as noise, dust or vibrations), which may affect either the tangible elements of cultural heritable or disturb the social, religious or cultural practices occurring at the sites of the cultural heritage elements.
  - During construction, this will be from the following activities: clearing of vegetation, site preparation, earthworks, excavations, temporary construction camps and accommodation camps from vehicles and stationary machinery equipment such as power generators and compressors, tunnelling activities – which will include some drill and blast operations, construction traffic movement along access roads.
  - During operation, this will be around the operators' village (generators, compressors, occasional sirens and alarms), the powerhouse, the 220 kV substation and 220 kV transmission line and the Project road traffic (vehicles to access the facilities for operational reasons, inspections and maintenance, and occasional deliveries.)
- During construction and operation: potential restriction of access or impairment of access to sites where cultural heritage practices occur (such as baptism sites along the riverbanks, or grotto where local communities are praying), for safety reasons or because of the physical presence of the Project elements.

11.17.2 Assessment of Receptors Sensitivity

The sensitivity of Cultural Heritage elements to impacts from the Project's activities is primarily dependent upon the nature of the cultural heritage elements. The sensitivity criteria are set out in the Table 11-72 below.

Among those identified in the baseline section, the cultural Heritage elements which may experience impacts are those:

- Located inside the Project footprints,
- Located in the immediate vicinity of the Project's sites (less than 50m from the Project's sites boundaries), and potentially affected by the disturbances from construction activities, and
- Which access to could be impaired.

These cultural heritage elements are listed in Table 11-73 and Figure 11-8 illustrates their location. The assessment of the potential impacts is given in the next sections.

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Table 11-72 Cultural Heritage Receptor Sensitivity

Sensitivity	Description
High	Internationally recognized heritage of communities who use, or have used within living memory the cultural heritage for long-standing cultural purposes; or protected by local, national and international laws or treaties, including those proposed by host governments for such designation. It has substantial value to local, national, and international stakeholders; and / or it has exceptional scientific value and similar types of resources are rare or non-existent. The Cultural heritage element cannot be moved or replaced. The religious or cultural practices attached to it cannot be done somewhere else. It meets the IFC PS8 criteria for non-replicable cultural heritage[9] *Examples: Regional pilgrimage sites; multi-community or regional cemeteries or sacred sites; Large, complex archaeological sites spanning various periods*
Medium	The Cultural heritage element is specifically or generically protected by local or national laws but laws allow for mitigated impacts. It has considerable cultural value for local and/or national stakeholders. It can be moved or replaced, or the religious or cultural practices attached to it can be done somewhere else, or data and artefacts recovered in consultation with stakeholders. It has substantial scientific value, but similar information can be obtained at a limited number of other resources. It meets the IFC PS8 criteria for non-replicable cultural heritage *Examples: Small to medium sized, complex archaeological sites with intact, surface or subsurface features (mounds, pits, burials, etc.); location where ancestral spirits are housed or important sacrifices are made; small rock art sites; multi-family or village cemeteries; sacred groves or sites used by a community*
Low	The Cultural Heritage element has cultural value to local stakeholders but limited value to national or international stakeholders (it is not recognised by the local or national authorities) The Cultural heritage element can be moved or replaced, or the cultural practices attached to it can be done somewhere else without any difficulty. It is of a type that is common in the surrounding region. It has limited scientific value or similar information can be obtained at numerous other resources. It meets the IFC PS8 criteria for replicable cultural heritage[10]. *Examples: Small, surface scatters of archaeological artefacts; stone axes or cutting tools; location used by the community for medicinal treatment, sites used for community gathering or cultural, ritual or religious events; family shrines; impacted or heavily modified historic buildings; isolated graves*
Negligible	The Cultural Heritage element has limited or no cultural or scientific value to local, national, or international stakeholders, and/or it has been substantially impacted and has lost all or most of its scientific or cultural value. The Cultural heritage element can be moved or replaced, or the cultural practices attached to it can be done somewhere else without any difficulty. It is of a type that is common in the surrounding region. It meets the IFC PS8 criteria for replicable cultural heritage *Examples: previously disturbed small archaeological sites; abandoned single-use ritual or medicinal sites; small sites used by families or community members for social, non-ritual events.*

[9] Nonreplicable cultural heritage may relate to the social, economic, cultural, environmental, and climatic conditions of past peoples, their evolving ecologies, adaptive strategies, and early forms of environmental management, where the (i) cultural heritage is unique or relatively unique for the period it represents, or (ii) cultural heritage is unique or relatively unique in linking several periods in the same site. (IFC PS8 §12 note 5)

[10] Replicable cultural heritage is defined as *tangible* forms of cultural heritage that can themselves be moved to another location or that can be replaced by a similar structure or natural features to which the cultural values can be transferred by appropriate measures. Archeological or historical sites may be considered replicable where the particular eras and cultural values they represent are well represented by other sites and/or structures. (IFC PS8 §11 note 3)

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Table 11-73 List of Potential Cultural Heritage Receptors

Country	Cultural heritage element	Category	Potential impact producing factor
Rwanda	[R1] Nyagahanga Baptism spot	Intangible	Potential restriction of access and effects from changes in river flow.
Congo	9 private graves	Tangible	The graves are located inside the Project land acquisition areas
	[C4] Bugano's CEV Catholic Church	Tangible	Located inside the Project land acquisition area.
	[C14] Kafunda 's Praying Spot	Tangible	Praying spot located about 10m from the Project land acquisition area for the access road. May be affected by disturbances from Project's vehicles traffic.
	[C1] Bugano's Baptism Site	Intangible	Located along the riverbank, about 10m from the Project land acquisition area for the access road. Potential restriction of access and/or may be affected by disturbances from Project's vehicles traffic.
	[C3] Bugano Protestant Church	Tangible	Located less about 50m from the access road which will be used by the Project. May be affected by disturbances from Project's vehicles traffic.
	[C2] Paying spot in a grotto	Intangible	*Located in the Transmission Line Right-of-Way*
	[C4] Prayer place on an island	Intangible	Potential restriction of access and effects from changes in river flow.

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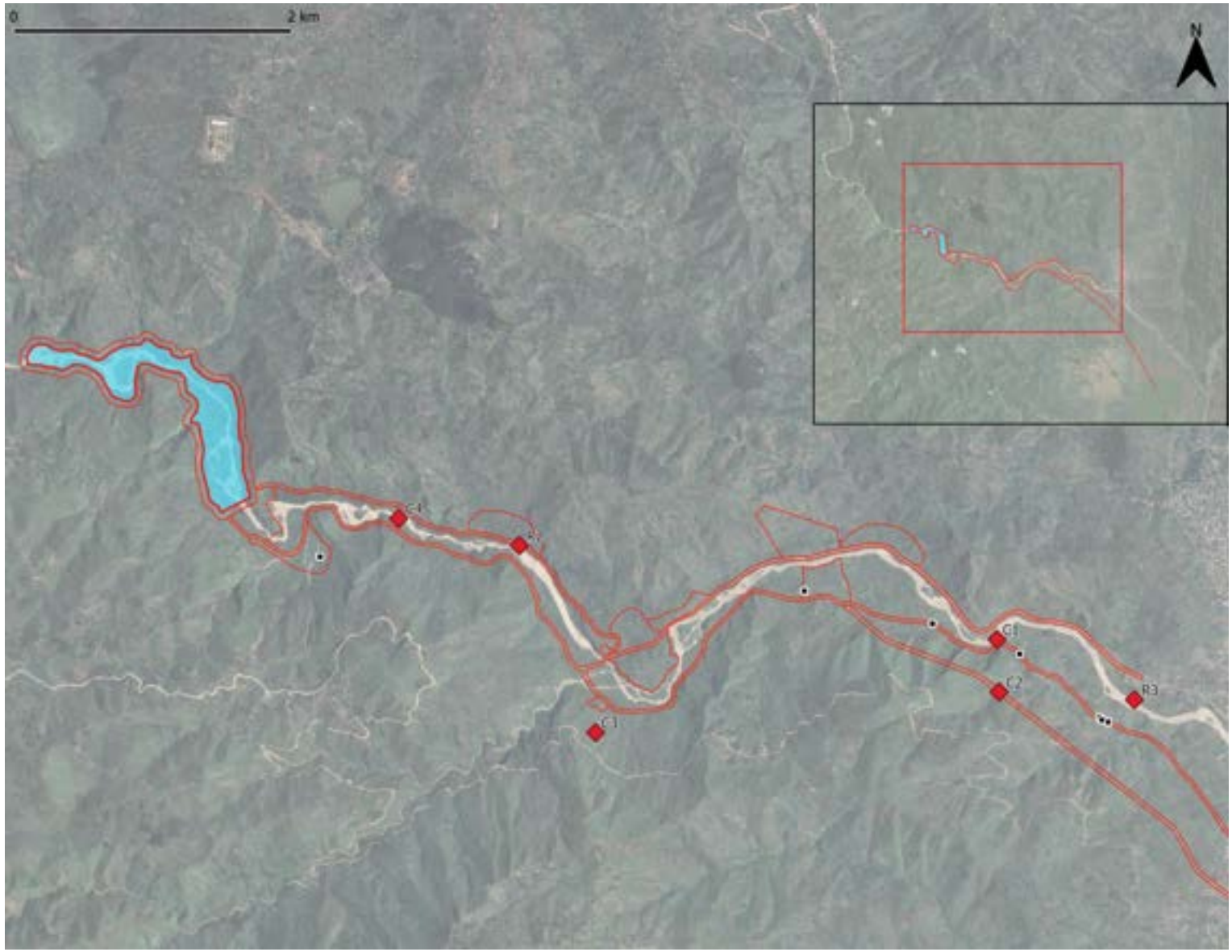


Figure 11-8 – Location of Cultural Heritage Elements Receptors of Potential Impacts

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11.17.3 Predicted Impacts during Pre-Construction and Construction

The magnitude of potential impacts on Cultural Heritage elements are assessed using the criteria provided in Table 11-74 below. The significance of potential impacts during pre-construction and construction is assessed in Table 11-75. Proposed mitigation measures for significant impacts are presented in Table 11-76.

Table 11-74 Cultural Heritage Impacts Magnitude Criteria

Magnitude	Description		
	Earthworks and physical construction of Project's Components	Disturbances from Project's activities (dust, noise or vibration from construction activities)	Restriction of access or impaired access to the Cultural Heritage element for local communities
Major	The cultural heritage elements are located in the Project footprint, and if the CH element cannot be moved, the construction of the Project will cause the complete destruction of the cultural heritage element	The disturbances are preventing the local communities from having any cultural, religious, or social practice with or in the cultural heritage element at all time. Or the disturbances (vibration) are causing heavy damages to the cultural heritage element, rendering it unsafe or destroying it	Access to the cultural heritage element is blocked or impaired permanently. The local communities cannot access the cultural heritage elements anymore.
Moderate	The cultural heritage elements are located in the Project footprint, and if the CH element cannot be moved, the construction of the Project will cause some partial damages to the cultural heritage element	The disturbances are preventing the local communities from having any cultural, religious, or social practice with or in the cultural heritage element during certain periods of time. Or the disturbances (vibration) are causing some damages to the cultural heritage element, without threatening it	Access to the cultural heritage element is blocked or impaired during certain periods of time, but not permanently.
Minor	The cultural heritage elements is located in the Project footprint, but the physical state of the Cultural heritage elements will not be affected by the Project.	The disturbances require the local communities to adapt their use of the cultural heritage element, but they can continue their social, cultural or religious practices. The disturbances do not affect the physical state of the cultural heritage element	The access to the cultural heritage element has to be modified or adapted but can be maintained.
Negligible	The cultural heritage elements are not located in the Project footprint	The disturbances do not require any change from the local communities in their social, cultural or religious practices attached to the cultural heritage element. The disturbances do not affect the physical state of the cultural heritage element	No change in the access to the cultural heritage element

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Table 11-75 Potential Impacts on Cultural Heritage during Pre-Construction/ Construction

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Earth works and physical construction of project components	7 private graves and 1 church (see Figure 11-10) are located in the Project affected land plots.	Low	Major	Moderate (S)
	1 praying site in a grotto is located in the Transmission line right of way	Low	Minor	Major (S)
	Archaeological artefacts could potentially be discovered during earthworks	Negligible to Low	Major	Minor (NS) to Moderate (S)
Construction activities creating disturbances (noise, dust and vibration)	1 church and 1 prying site are located less than 50 m from the Project access roads. 2 baptism sites are located less than 50 m from the Project access roads 1 praying site in a grotto is located in the Transmission line right of way Prayer Island is located about 50 m from the access roads in Congo and Rwanda. They may be affected by dust, noise and vibration during construction. While it is not expected that the disturbances will prevent any permanent use of the cultural heritage elements or sites, it is possible that the vibrations from the Project's vehicles traffic could cause some damage to the churches. Noise and dust from construction activities may disturb the social or religious practices of the local communities for the sites closest to the Project's sites.	Low	Moderate to Major	Minor (NS) To Moderate (S)
Restriction of access	For safety reasons, the access to the cultural heritage elements closest to the Project's site may be restricted either during periods of time or permanently throughout the construction period. This could be the case for (i) the 2 baptism sites on the riverbanks which are less than 10 m from the access roads and (ii) the island used as a prayer site (see Figure 11-10)	Low	Minor to Major	Minor (NS) To Moderate (S)

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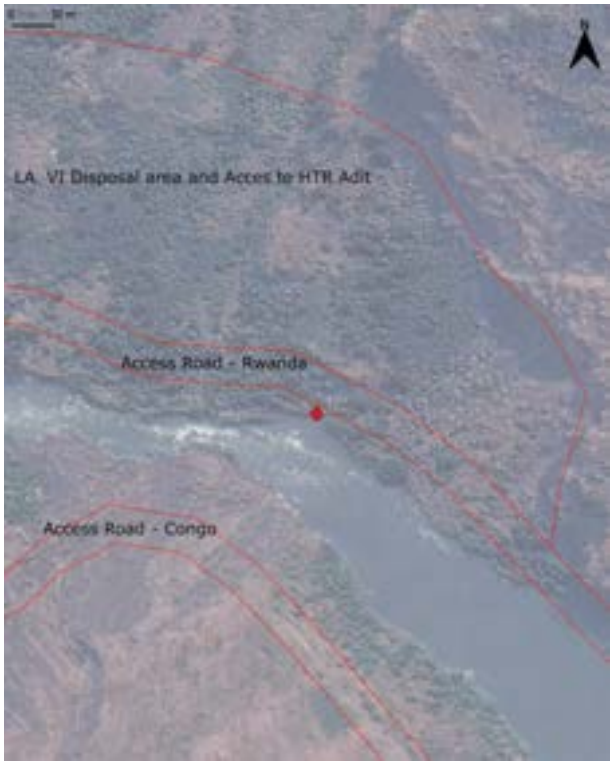
Figure 11-9 – Church affected by the Access Road in DRC

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Site C4 in Figure 11-8



Site R2 in Figure 11-8



Site C1 in Figure 11-8

Figure 11-10 – Baptism sites and island used as a praying site, close to the Access Roads

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Table 11-76 Mitigations & Residual Impacts – Impacts on Cultural Heritage during Pre-Construction/ Construction

Project Activity	Mitigation	Residual Impact		
		Sensitivity	Magnitude	Significance
Earth works and physical construction of project components	[M 161] Compensation or moving of the graves and church located in the Project acquired land plots, as defined in the Resettlement Action Plan.	Low	Minor	Minor (NS)
	[M 162] Define and implement a Chance Find Procedure	Negligible to Low	Minor	Negligible to Minor (NS)
Construction activities creating disturbances (noise, dust and vibration)	All measures to control noise, dust and vibration. Measures to repair or correct the effects and compensate if needed will also be implemented [M 163] All cultural heritage elements located adjacent to a construction site or the external boundaries of the future reservoir (within 30 m), will be protected from potential damages due to construction methods.	Low	Low	Negligible (NS)
Restriction of access	[M 164] Consultation with communities using the 2 baptism sites and prayer site on the island close to the Project's sites and the payer site under the Transmission Line Right of way to assess if access to these sites could be impaired by the Project activities [M 165] Commitment to not block accesses to places of worship throughout the construction phase as much as possible, taking into consideration safety issues. [M 166] Where existing access cannot be maintained, provision of an alternative access route, subject to overriding health, safety, and security considerations	Low	Minor	Minor (NS)

11.17.4 Predicted Impacts during Operation

The significance of potential impacts during operation is assessed in Table 11-77. Proposed mitigation measures for significant impacts are presented in Table 11-78.

It must be noted that the payer site under the Transmission Line right of way in DRC (site [C2]) should not be affected, as it is located in the valley between to hills. The towers are likely to be located at the top of these hills, and access to the prayer site should not be impaired during operation. The Electro Magnetic Frequencies (EMF) levels under the transmission line have been estimated and they are below the recommended threshold for community exposure considered by international standards[11]. No restriction of access to this site for safety reason should be established during operation.

[11] The International Committee on Non-ionizing Radiation Protection (ICNIRP), in cooperation with the World Health Organization (WHO), has developed guidelines for the public and workers exposed to electromagnetic fields (ICNIRP, 1998). For the public, ICNIRP recommends exposure limits of 5.0kV/m for electric fields and 100µT (50Hz) for magnetic fields.
See International Commission on Non-Ionizing Radiation Protection. « Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 ghz) ». Health Physics 74, nº 4 (1998): 494-522.

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Table 11-77 Potential Impacts on Cultural Heritage during Operation

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Operation activities creating disturbances (noise, dust and vibration)	During operation, the elements of cultural heritage potentially affected by noise, dust or vibrations are located close to the access roads. It is not expected that the traffic during operation will cause important disturbance.	Low	Negligible	Negligible (NS)
Restriction of access for safety reasons	During operation, it is not expected that any restriction of access will be established on the cultural heritage sites located in the river (praying site on an island), along the riverbank in DRC (baptism site in Bugano – [C1]) or access to the payer site under the Transmission Line will be impaired (site [C2]) However, the baptism site along the riverbank in Rwanda (in Nyagahanga – [R2]) will be located just next to a disposal area. It is unlikely that the disposal area will create any safety risk, but the potential consequences could be important (fatalities). The safety risks from this disposal area should be studied and integrated in the design.	Low	Minor to Major	Minor (NS) To Moderate (S)

Proposed mitigation measures for significant impacts are presented in the following table

Table 11-78 Mitigations & Residual Impacts on Cultural Heritage during Operation

Project Activity	Mitigation	Residual Impact		
		Sensitivity	Magnitude	Significance
Restriction of access for safety reasons	[M 167] Implement GIP for ensuring the disposal area do not represent any safety risk for the general public.	Low	Negligible to Minor	Negligible (Not Significant)

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11.18 Ecosystem Services

The approach for the assessment of impacts on ecosystem services follows the method defined by the World Resource Institute (2013).

11.18.1 Ecosystems Services the Project Could Impact

Ecosystems and habitats that could be impacted by the Project are presented in Table 11-79. See also Chater 8 - Social Baseline, Section 8.13 Ecosystem services: Provisioning and Cultural Services, which provides a more detailed analysis of these services.

Table 11-79 Ecosystems and Habitats

Ecosystem	Habitat
Lotic ecosystem (river)	River
Riparian ecosystem	Riparian thicket
	Riparian wetland
Hillslope ecosystem	Bare rock
	Hillslope Grassland / Open savanna
	Hillslope Thicket
	Riparian Thicket (Bamboo)
Anthropized ecosystem	Cultivated land
	Tree plantations
	Settlements

11.18.2 Ecosystem Services Screening

The screening exercise uses a generic ecosystem services classification list and Project-specific information on the habitats, communities and Project activities. The outputs of the screening assessment are summarized in Table 11-80.

Table 11-80 Ecosystem Services Potentially Present in the Study Area

Service category	Ecosystem service	Resource/Examples
Provisioning	Food: game meat	Animals hunted primarily for food or sale (recreational hunting is covered under cultural services)
	Food: wild plants, nuts, mushrooms, fruits, honey	Fruit, wild plants, nuts, etc. collected in natural areas for consumption or sale
	Food: cultivated crops	Annual and permanent crops grown for subsistence use and commercial sale
	Food: livestock farming	Sedentary livestock farming
	Food: wild-caught fish	Fish caught for subsistence or commercial sale
	Food: Aquaculture	Fish that are bred and reared in ponds for purposes of harvesting
	Freshwater	Freshwater for bathing, drinking, irrigation, laundry, household sanitation, cattle, and husbandry
	Timber and wood products	Wood collected for local use or for sale as timber.
	Biomass fuel	Wood
	Biochemicals, natural medicines, pharmaceuticals	Natural medicines, biocides, food additives, pharmaceuticals and other biological material for commercial or domestic use
	Ornamental resources	For example, pelts, carved or decorative animal products, live animal trade
Cultural	Spiritual or religious value	Natural spaces or species with spiritual or religious importance

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Service category	Ecosystem service	Resource/Examples
	Traditional practices	Cultural value placed on traditional practices such as hunting, fishing, crafts and use of natural resources
	Recreation and tourism	Use of natural spaces and resources for tourism and recreation (e.g. fishing, kayaking, hiking, hunting)
	Aesthetic value	Cultural value placed on the aesthetic value provided by landscapes, natural landmarks
	Intrinsic value of biodiversity	Species or specimens valued for their mere existence, regardless of their utilitarian value to humans (e.g., 'each species has an intrinsic right to exist')
Regulating	Regulation of air quality	The influence ecosystems have on air quality by extracting chemicals and dust from the atmosphere (i.e., serving as a 'sink') or emitting chemicals to the atmosphere (i.e., serving as a 'source')
	Climate regulation: local regional and global	Vegetated areas sequester carbon dioxide, with implications for global climate change, regulation of temperature, shade, and quality of vegetated areas
	Regulation of water timing and flows	Influence ecosystems have on the timing and magnitude of water runoff, flooding, and aquifer recharge
	Erosion regulation	Role of vegetation in regulating erosion on slopes and riparian areas
	Pollination	Birds, insects and some small mammals pollinate certain flora species, including some agricultural crops
	Natural hazard regulation	Regulation of hydrological (e.g. flood) and meteorological (e.g. drought) frequency and intensity (e.g. dense forest can limit floods, droughts and provide firebreaks)
	Pest regulation	Regulation of the presence/abundance of pests (animal or plant) including invasive species
	Disease regulation	Influence ecosystems have on the incidence and abundance of human pathogens
Supporting	Nutrient cycling	Flow of nutrients (e.g., nitrogen, sulphur, phosphorus) through ecosystems
	Water cycling	Flow of water through ecosystems in its solid, liquid, or gaseous forms
	Soil formation	Contribution to natural soil-forming processes
	Habitat Provision	Natural spaces that maintain species populations and protect the capacity of ecological communities to recover from disturbances

11.18.3 Ecosystem Services Scoping

Ecosystem services potentially present in the study area have been first scoped in or out, based on the findings of site visits in December 2021 and January 2022, including interviews and focus groups. The scoping was performed by identifying potential impacts that may affect the provision of services by ecosystem and the impacts that may prevent the beneficiaries from obtaining the services provided by the ecosystems. When a potential impact is linked to a beneficiary the ecosystem service is scoped in, when there is a potential impact on an ecosystem service but no beneficiary that ecosystem service is scoped out and not assessed further. The results of the scoping process are found in Annex F.

11.18.4 Types and Value of Ecosystem Services

Table 11-81 describes the prioritized ecosystem services identified in the Project area and their values, based on the importance of ecosystem services for their beneficiaries and the replaceability of the ecosystem services.

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Table 11-81 Values of Ecosystem Services in the Study Area

Service	Ecosystem providing the service	Description/beneficiaries	Importance to beneficiaries / dependency of beneficiaries to this ecosystem service	Replaceability	Value
Provisioning services					
Cultivated crops	• Anthropized ecosystem	Subsistence farming is a major source of income and means of livelihood in the study area. All the villagers have cultivated plots of land located on the slopes and banks along the Ruzizi River.	Agriculture is vital for communities as it is the primarily subsistence activity, providing food for household consumption and surplus sold for additional income.	Not replaceable	High
Livestock farming	• Hillslope ecosystem • Anthropized ecosystem	Livestock farming is not an important activity within the project area. Livestock farming is mainly for subsistence purposes. The most common types of animal farming are small scale goat farming and domestic farming of chickens for both commercial and subsistence purposes. Cattle are mainly using hillslopes (including grassland) ecosystem as grazing land.	Livestock farming is not a significant activity in the Project study area. It punctually provides food for household consumption	Not replaceable	High
Fishing	• Lotic Ecosystem	Fishing is practiced all throughout the study area, although it is not a primary activity for local communities (see social baseline). Fishing is mostly for own consumption although some is traded by fishermen.	Fishing activities are an economic activity for some households but is not essential for the communities living near the river.	Not replaceable	Low
Aquaculture	• Lotic Ecosystem	Fish farming activities are occurring downstream the powerhouse, in Bugarama, and in DRC, close to the Burundi border.	Fishponds are filled with water by a gravity filling system. Fish farming is a significant economic activity in the area. FAO is sponsoring a fish farming program in RDC with the aim of distributing fish to farmers to increase fishing activities and fish commercialisation	Not replaceable	High
Freshwater for domestic purposes, and farming activities	• Lotic Ecosystem • Riparian ecosystem	Communities living along the Ruzizi River use water for domestic purposes. Main uses include recreational purposes, washing, drinking, bathing, and irrigation. Ruzizi River is also used to water the cattle.	People who are using Ruzizi River have sometimes no other access to water for domestic purposes. Ruzizi river is essential to several communities as it provide water points for cattle. Communities who grow vegetable along the river also depends on it for irrigation.	Not replaceable	High
Biomass fuel	• Riparian ecosystem • Hillslope ecosystem	Walking to collect firewood around settlements and crops is a routine activity for local communities in the project area. Charcoal fabrication is not a significant activity within the project area.	Firewood is essential for communities to cook, as charcoal is expensive. People use firewood on a daily basis.	Replaceable – firewood could be replaced by charcoal and/or gas but is not affordable for local communities as they use it on a daily basis.	High

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Service	Ecosystem providing the service	Description/beneficiaries	Importance to beneficiaries / dependency of beneficiaries to this ecosystem service	Replaceability	Value
Medicinal plants, natural medicines	• Hillslope ecosystem • Riparian ecosystem • Anthropized ecosystem	Collecting medicinal plants is common in the project area but is not a regular activity and varies depending on necessity.	Medicinal plants collection is a punctual activity that is important for local communities. According to local communities, medicinal plants are very common and can be found in all types of ecosystems, even in cultivated crops.	Replaceable – medicinal plants could be replaced by conventional medicine. This type of medicine is however not easily accessible in the area.	High
Regulating services					
Air quality & carbon emissions regulation	• Hillslope ecosystem • Riparian ecosystem • Anthropized ecosystem	Natural vegetated habitats play an important role in air quality & carbon emissions regulation.	The mosaic of largely modified habitats along the Ruzizi River play a relatively minor role in air emission and climate change regulation.	Not replaceable	Low
Water and flood regulation	• Lotic Ecosystem • Riparian ecosystem	The riparian fringing and floodplain vegetation can play a role in flows regulation. Such regulation benefits to the communities that live and cultivate along the Ruzizi River.	The Ruzizi River has limited fringing riparian and floodplain habitat and therefore plays a limited role in attenuating or regulating flows between Lake Kivu and Lake Tanganyika. The extensive habitat clearance in the Ruzizi catchment for cultivation further exacerbates flood runoff into the Ruzizi River which may result in more extreme flood events over time.	Not replaceable	High
Water purification and waste treatment	• Lotic Ecosystem • Riparian ecosystem	Vegetation can play an important role in water purification, mainly in swamp habitats. This can directly benefit to local communities who are using the river water for domestic purposes.	Wetland, swamp and floodplain habitats are limited along the Ruzizi River and therefore play a minor role in water purification arising from pollution from upstream settlements. The most abundant aquatic plant observed during the field survey in January 2022 was the filamentous alga *Cladophora glomerata*, and this could serve to remove nutrients, but the roles of this species in water purification and waste treatment is likely to be small because of the fast current speeds and short contact time. Generally, river flow is high velocity with limited time for filtration through instream habitats.	Not replaceable	Low

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Service	Ecosystem providing the service	Description/beneficiaries	Importance to beneficiaries / dependency of beneficiaries to this ecosystem service	Replaceability	Value
Erosion regulation	• Hillslope ecosystem • Lotic Ecosystem • Riparian ecosystem	Sediment transported by the Ruzizi River and the fringing riparian vegetation reduces the erosional effect of the river flow, thereby maintaining riverbanks and providing land for riverbank cultivation. The steep cultivated slopes on shallow soils adjacent to the Ruzizi III HPP are prone to landslides and resultant erosion and sedimentation. The riparian woodland/thicket occupies a narrow strip along the river and helps to stabilise riverbanks and protect against sedimentation to some extent.	The narrow strip that is cultivated (mainly vegetables as it is close to the river and crops can be easily watered) along the river is vital for communities as it is the primarily subsistence activity, providing food for household consumption and surplus sold for additional income.	Not replaceable – available agricultural land along the Ruzizi River is scarce in the gorge section between the reservoir area and the powerhouse site.	High
Natural Hazard regulation	• Riparian Ecosystem • Lotic Ecosystem	The attenuation of flow in the lower Ruzizi River due to the low gradient and extensive floodplain systems helps to protect local communities and infrastructure along the river from sudden or rapid fluctuations of flow during flooding. This reduces community safety risks, and floodplain cultivation or harvesting. River level changes occur at a rate that communities can adapt to and predict.	Floodplain and riverbank farming is important for food security and livelihoods of communities living along the Ruzizi River.	Not replaceable – available agricultural land along the lower Ruzizi River is scarce.	High
Disease regulation	• Riparian ecosystem • Lotic Ecosystem	Many communities in the study area are reliant on close contact with the river water for bathing/washing, watering crops, livestock watering and fishing. High river velocity and flooding serves to flush pathogens more rapidly downstream preventing the establishment of bilharzia snails and reducing habitat for mosquitoes and other water borne vectors of disease.	The Ruzizi River provides potential habitat for the pest Blackfly *Simulium damnosum* complex (*Diptera: Simuliidae*). This species complex could transmit the nematodes that cause river blindness (Onchocerciasis) among humans, but none were recorded during the field surveys in January and February 2022. Snails that are intermediate hosts of the parasites that cause liver fluke disease among livestock, and bilharzia among humans, are present in the Study Area, but these do not appear to be problematic. Fast river flow may be important for keeping numbers of snails down.	Not replaceable – role of natural hydrological cycle of the Ruzizi River in disease regulation cannot be adequately replaced by other disease prevention or curative measures.	High

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Service	Ecosystem providing the service	Description/beneficiaries	Importance to beneficiaries / dependency of beneficiaries to this ecosystem service	Replaceability	Value
Supporting services					
Nutrient cycling	• Riparian ecosystem • Lotic Ecosystem • Anthropized ecosystem (crops)	Riparian vegetation, especially in swampy areas downstream Bugarama where water moves slowly through reeds (*Phragmites mauritianus*) and tall grasses (*Hyparrhenia* species) grass, plays a water quality purification role through filtering out high nitrogen and other contaminants entering the river from settlements/industry upstream. Because the riparian vegetation is very degraded and represent very low surfaces, the efficiency of this function is probably relatively low.	As for disease regulation above, many communities are reliant on close contact with water for livelihoods.	Not replaceable – filtering role of Ruzizi River floodplain vegetation plays an important role in filtering nutrients and water quality maintenance. There is limited treated water supply to communities along the river that can provide an alternative to river water use for multiple purposes.	High
Soil formation	• Riparian Ecosystem • Lotic Ecosystem • Anthropized ecosystem (crops)	The large sediment volume carried by the river serves to buffer potential erosional effects of the river and thereby maintain riverbanks and sediment delivery to floodplains to support the aquatic ecosystem, and particularly fisheries downstream, as well as supply of sediment to support riverbank cultivation.	Floodplain and riverbank farming is important for food security and livelihoods of communities living along the river, while fishing is a marginal subsistence activity. Fishing increases in importance downstream of the planned dam site.	Replaceable – sediment inputs from the catchment can balance that trapped by the reservoir	Low

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Service	Ecosystem providing the service	Description/beneficiaries	Importance to beneficiaries / dependency of beneficiaries to this ecosystem service	Replaceability	Value
Habitat provision	• Riparian Ecosystem • Lotic Ecosystem • Hillslope ecosystem	Local communities especially fishers benefit from the lotic and riparian ecosystem that provide suitable habitat for fish species. Hillslope ecosystems provide habitat for terrestrial biodiversity species (e.g. birds, insects) that are involved in the pollination process that benefit to the local communities.	The fisheries productivity supported by the flowing Ruzizi River and its fringing floodplain habitats provide a subsistence food source for local residents, primarily downstream of Bugarama where the river velocity is slower and there is easier access to the riverbanks near settlements.	Not replaceable – habitat provision role and fisheries provided by the Ruzizi River is not replaceable although aquaculture (that already exists upstream in Lake Kivu and in downstream fish ponds) can potentially provide an alternative fishery resource (depending on support and training provided), although may have adverse effects on indigenous fish.	High
Cultural services					
Traditional practices	• Riparian habitat • Hillslope ecosystem	Special sites can be considered as cultural sites by the communities for various reasons. Several intangible cultural heritage sites have been identified in the project area and include several praying spots.	Cultural value of praying and/or use of sacred sites is considered to be of high importance for the local communities.	Not replaceable but alternative sites may be identified by communities.	High

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11.18.5 Ecosystem Services Assessment

The ecosystem services assessment considers the following 3 key criteria:

- Does the Project change the quality or quantity of the service?
- If yes, whether the change would adversely affect users significantly, for example by tipping them over a threshold, or making demand outstrip supply, or changing perceptions about availability?
- If yes, whether the service is important for livelihoods?

When all 3 criteria are met, the impact on the service can be characterised as an affected 'priority' ecosystem service. The assessment is presented in the following table.

Table 82 – Mitigation Measures for impacted Ecosystem Services

Service	Ecosystem providing the service	Source and description of potential impact on biophysical receptor	Vol./Section of the ESIA where mitigation measures are identified
Provisioning services			
Cultivated crops	Anthropized ecosystem	Reduced area available for crop cultivation caused by Project land take (e.g. physical and economical displacements). Land plots that will be lost will be compensated as part of the RAP.	Vol. V RAP
Livestock farming	Hillslope ecosystem Anthropized ecosystem	Reduced area available for livestock farming caused by Project land take. The reduction of pasture area availability from land take for the Project is not anticipated to be significant and will be compensated through the RAP.	Vol. V RAP
Fishing	Lotic ecosystem Riparian ecosystem	Overall, fishing is not an important economic in the Project area of influence even though more fishers have been identified downstream of the dam. During construction, the main impacts caused by the dam will affect fish habitats in the 5.5 km dewatered stretch, through flow alteration and increased sedimentation but where few fishing activities occur. The Project operation will alter the aquatic ecology and river hydrology upstream and downstream, affecting water quality, quantity and fish breeding grounds, and likely leading to a reduction in fish abundance in some river reaches. However, most fish species are expected to continue to use the river course in the same way and to aggregate downstream of the new dam and powerhouse where they may be easier to harvest due to lower off-peak baseflows. Unsustainable fishing practices could however impact on the long term catch rates if insufficient fish numbers are unable to spawn and recruit and reach maturity. . the impact of the project on community fishing is not considered significant.	Vol. IV ESMP - Fisheries Management Programme
Aquaculture	Lotic ecosystem Riparian ecosystem	Fish farming is not expected to be affected by the Project, as changes in river flows are not expected to prevent the periodic filling of fishponds.	N/A
Freshwater for domestic purposes, industrial / farming activities	Lotic ecosystem Riparian ecosystem	Cattles and villagers will continue to have access to the river during construction and operation. People will continue to be able to fetch water. Water resources may be affected by the following: Increased sediment loading in the Ruzizi River from earthworks. Accidental spills and leaks from the storage and handling of hazardous materials may contaminate surface and groundwater. Discharge of sanitary and domestic wastewater.	Vol. II / Section11.6

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Service	Ecosystem providing the service	Source and description of potential impact on biophysical receptor	Vol./Section of the ESIA where mitigation measures are identified
Regulating services			
Erosion regulation	Lotic ecosystem	Retention of sediment in the reservoir will lead to increased riverbank and bed erosion downstream with implications for fisheries productivity and floodplain crop cultivation.	Vol. II / Section 11.8
Disease regulation	Lotic ecosystem Riparian ecosystem	The flow velocity of the Ruzizi River minimises the availability of still water areas where water borne disease vectors can proliferate thereby minimising prevalence of diseases such as bilharzia.	Vol. IV ESMP – section 4.8 – Alien Invasive species Management
Supporting services			
Soil formation	Lotic ecosystem Riparian ecosystem	Trapping of suspended sediment and nutrients in dam will cause riverbank erosion and loss of floodplain area for cultivation. Bank and bed erosion may lead to deposition of sediment and smothering of floodplains with negative effects on fisheries.	
Habitat provision	Lotic ecosystem Riparian ecosystem Hillslope ecosystem	Trapping of suspended sediment and nutrients in reservoir will cause negligible riverbank erosion. Impacts on fish species typically caught by fishers is predicted to be minimal.	N/A
Cultural services			
Cultural services	Ruzizi River	In DRC the river is perceived as carrying a particular cultural and spiritual value. Project will create a 5.5 km dewatered stretch modifying the river's hydrology.	Vol. II / Section 11.7 Hydrology

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11.19 Landscape and Visual Amenity

11.19.1 Impact Producing Factors

The landscape and visual impacts that may arise from the construction of the Project include works at the proposed infrastructures sites, and any associated works such as:

- Temporary accommodation camp for construction workers.
- Spoil disposal areas.
- Access roads.
- River diversion works (tunnels and coffer dam).

Landscape-visual permanent impacts will be connected to the existence of permanent HPP buildings during the operational phase.

Project facilities that might affect the landscape and visual amenity will be the permanent infrastructures:

- Rockfill embankment dam
- Reservoir
- Access roads
- Power waterway (including water intake, headrace tunnel, surge shaft, penstock and powerhouse)
- Switchyard
- Transmission line
- Permanent camps

11.19.2 Assessment of Landscape Value and Visual Sensitivity

11.19.2.1 Landscape Value

The existing landscape within the project area can be divided into two categories:

- Ruzizi deep gorge
- Ruzizi floodplain

The first category consists of a deep gorge (Ruzizi River gorge) with steep cultivated slopes running down to the Ruzizi River. This basic terrain varies in terms of slope steepness, extent of farming and vegetation types. When going further down (South), the gorge opens to the Ruzizi floodplain. Almost the entire project area, apart from some small portions of largely natural habitat, is under anthropic influence – mostly cultivation and degraded secondary shrubland - classified as modified habitat.

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Figure 11-11 View on the Ruzizi gorge from the Plateau (Rwanda) toward Southeast

The second category consists of a large, opened floodplain that starts at the end of the Ruzizi gorge, in Bugarama, and goes along the Ruzizi River toward Burundi. Houses, roads and small power lines are much more frequent than in the upstream areas especially. Most of the floodplain is flat and cultivated.

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Figure 11-12 View on the Ruzizi floodplain (from Rwanda) toward North West

11.19.2.2 Visual Receptors

Visual receptors are the components of the landscape that are likely to be affected by the scheme and can include individual elements (such as rivers or buildings), aesthetic characteristics (for example tranquillity or openness), or, at a larger scale, the character of a defined character area or landscape type.

The sensitivity of visual receptors affected by a project is generally defined by the views of the people who may be affected by a proposed project proposals. They generally include users of public rights of way or other recreational facilities; travellers who may pass through the study area because they are visiting, living or working there; residents living in the study area, either as individuals or, more often, as a community; and people at their place of work.

As part of the Ruzizi 3 project development, affected people will be:

- Local permanent residents of settlements and land users.
- Road users using the road from Bugarama toward the Ruzizi gorge (road going to the future powerhouse site).
- Road users using the road going from Kamanyola toward Bukavu (Road N5).

The people affected by visual impacts. The will be residents living in the Project area of influence. Village's receptors are mainly located on the plateau and most of them do not have a direct view down the Ruzizi River Gorge where the dam will be located. Due to the winding of the valley, the dam will not be visible from the floodplain (e.g. Bugarama area).

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11.19.2.3 Assessment of Sensitivity

The assessment criteria of Landscape character and visual amenity are described in Table 11-83 below.

Table 11-83 Landscape and Visual Amenity Receptor Sensitivity Classification

Sensitivity	Description of Landscape Character	Description of Visual Amenity
High	Landscape of distinctive components and characteristics, or a relatively undisturbed, pristine landscape, where changes or disruptions to the existing landscape would be noticeable and difficult to mitigate or restore; a small change is likely to be prominent or even dominant; a change to the landscape could alter the classification and integrity of the landscape character or quality and its perceived value relative to the scale and openness.	High Receptors with a key interest and expectation of enjoying the view (e.g. residential receptors, tourists or people engaged in outdoor recreation whose attention is focused on the landscape) and/or a greatly valued existing view (e.g. a designated landscape, unspoilt countryside, recognised viewpoint or conservation area).
Moderate	Landscape of relatively widespread, featureless, common components and characteristics, able to tolerate some changes or modifications without altering the classification of landscape character or quality. Landscape lacking in structural landform would also be considered of medium sensitivity.	Moderate Receptors at locations where the view is valued but not fundamental to the location or activity (e.g. people engaged in outdoor recreation that does not focus on an appreciation of the landscape). Visual receptors are less sensitive to changes to their view if the quality, condition and extent of the existing view is unexceptional (e.g. some high density suburban townscapes).
Low	Landscape of relatively indiscernible components and characteristics, the nature of which is likely to be tolerant of substantial change, where modifications are unlikely to alter its character or quality classification. Landscape of poor condition, and low perceived value relative to their scale and form. Where a landscape holds a high potential for mitigation it would also be considered to be of low sensitivity.	Low Receptors engaged in activities that either distract from the view or require concentration on the foreground, resulting in a minimal interest or appreciation of the view (e.g. people at work or motorists travelling through the area with the sole purpose of getting from one place to another and not for the specific enjoyment of the scenery). Receptors might very well appreciate the view if they chose to, but visual amenity is not the principal reason for them to be present. Visual receptors are less sensitive to changes to their view if the quality of the existing view is poor (e.g. industrial areas or derelict land).
Negligible	N/A – it is not considered appropriate to include this category since no landscape is considered so unimportant that it may safely be disregarded.	Negligible N/A – it is not considered appropriate to include this category since no visual receptor is considered so unimportant that it may safely be disregarded

The landscape character sensitivity is assessed in Table 11-84.

Table 11-84 Assessment of Sensitivity of Landscape Character

Receptors	Description	Sensitivity
Ruzizi deep gorge	This high value is a function of the relative lack of development, unbuilt area (even if cultivated) and dramatic terrain.	High
Ruzizi floodplain	This is a function of the flat terrain and relative density of development.	Low

The social baseline study identified a number of settlements that could be potential visual receptors (people with a view of one or several Project component(s)). Due to (i) the winding nature of the valley, (ii) the rugged terrain and (iii) the distribution of the project components over a large area, the number of Project components visible to people from a single location will be limited. Potential receptors are listed with an assessment of sensitivity in Table 11-85.

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Table 11-85 Assessment of Sensitivity of Visual Receptors

Receptors	Description	Sensitivity
Residents of the plateau's edge (on both sides of the Ruzizi valley)	The largest components that might change the most the landscape is the dam and reservoir, which will be located in a remote area, not visible from the main settlements. However, permanent resident of settlements located within the zone of visual influence might be affected daily by the changes in the landscape and visual amenity.	Medium
Land users of the valley and floodplain (e.g. farmers, fishermen)	Land user of the area will be affected by the changes in the landscape and visual amenity. However, visual amenity is not the principal reason for them to be present <as they are working in the area.	Low
Road travellers through the area, especially on Road N5 in DRC	The users of the main roads and passengers of public transport that are not resident of the settlements within have transport as their primary interest. They will witness the landscape changes during the time needed to drive through the zone of visual impact.	Low

11.19.3 Predicted Impacts

The effects are likely to include:

- Removal of the existing vegetation
- Temporary construction camps and associated equipment.
- Localised light pollution
- Excavation and cuts in hillsides from development of tunnel and access roads
- New quarries which at the worst scenario could leave a permanent scar on the hillsides especially since, once opened, they are likely to continue in use
- Change in tranquillity of the surrounding landscape

Table 11-86 Landscape and Visual Amenity Receptor Sensitivity Classification

Magnitude	Description of Impact on Landscape	Description of Impact on Visual Amenity
High	High Extensive change to existing view, loss of key characteristic features; introduction of anomalous and highly prominent or dominant new elements. Impact is more likely to be high if change is long-term or permanent.	High Ranging from a limited change in landscape and seascape characteristics over an extensive geographical area, to an intensive or pronounced change over a more limited area. Impact is more likely to be high if change is long-term or permanent.
Moderate	Moderate Notable change to existing view (e.g. partial loss of key characteristic features); introduction of prominent, but essentially localised new features or elements; could include high impact change of a short-term or temporary nature.	Moderate change in a localised area (e.g. limited woodland clearance without compromising the overall integrity of the wider woodland area). Could include high impact change of a short-term or temporary nature.
Low	Low Minor change to existing view (e.g. limited loss of characteristic features), changes are evident, but not especially prominent and are generally localised impact is more likely to be low if change is short-term or temporary.	Low Minor change in scale and geographical extent (e.g. loss of small areas of vegetation or indirect impact resulting from intervisibility with development in adjoining character type). Impact is more likely to be low if change is short-term or temporary.
Negligible	Negligible Barely perceptible change to existing view and/or very brief exposure to view	Negligible Virtually imperceptible change to the baseline context.

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11.19.3.1 Dam

A Landscape

During the construction phase, there would be considerable disturbance to the landscape:

- The clearance of land and removal of vegetation would result in direct effects on the fabric of the landscape over a wide area.
- Construction traffic, compounds and working areas would result in a large increase in activity levels. Noise and lighting associated with both traffic and construction areas would influence landscape character, notably through effects on perceptual qualities, particularly tranquillity.
- The creation of the quarries and deposit areas would result in recurring disturbance. Assuming the working areas are restored following construction, elements of these deposit areas and quarry works will be temporary and reversible. However, the removal of vegetation and creation of new landforms will take time to restore to the extent that they blend with the adjacent landscape.

Some the elements that form part of the construction phase would be temporary and reversible e.g. construction areas would be removed, and the land restored following the completion of works. Many structures, such as the dams and the powerhouse would remain following the construction phase. During operation, the main element that will modify significantly the landscape is the reservoir.

B Visual Effects

The most transformative elements in the area of visual influence will be the dam and the reservoir. These would become the largest scale elements within the area. However, the dam site is located in a deep gorge, not in a populated area and, therefore, will not be seen by many receptors.

The multiple areas of disturbance associated with quarries and deposit areas would also result in effects that extend into the operational phase. It will take time for new planting to replace vegetation that is removed. The changes in landform would also be permanent. However, providing effective restoration of these areas take place, the land should gradually blend with the local context.

All permanent and temporary facilities at the dam site (i.e. the dam, the powerhouse, the construction camp, the switchyard, the quarry and disposal areas) will not be visible from one single location.

11.19.3.2 Transmission Line

A Landscape

The construction of the TL will also necessitate clearance of land and removal of vegetation beneath the line and at the pylon's construction location. New temporary access tracks would be likely to be required to provide suitable access for the delivery of materials, plant and the workforce to the working areas.

Vegetation clearance and the traffic will influence landscape character and change the undisturbed nature of the area.

B Visual Effects

The transmission line will be visible from several settlements, including Bugarama and Kamanyola. However, as it will be located on the hill slope and not on the skyline, the contrast will allow not to be too visible. As the line will cross the N5 asphalted road, the TL will also be seen by any road user.

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11.19.3.3 Access Roads

A Landscape

The construction of new access road (16.4 km) might affect the landscape, whether improvement of existing dirt roads (12.7 km) is not likely to have significant changes on it. The clearance of land and removal of vegetation will mainly occur fir the new access roads construction. However, the area is already degraded and mainly covered with crops and thickets. Construction traffic will also result in a large increase in activity levels that will influence landscape character.

B Visual effects

The access roads will be visible from several settlements as roads will be spread out in several location over a total of 29.1 km (both for new and improved roads).

11.19.3.4 Assessment of Visual Impacts

Potential impacts are presented in the following tables.

Table 11-87 Potential Impacts – Landscape & Visual Amenity during Pre-Construction/Construction

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Dam	Local residents People living in settlements nearby construction sites will experience a range of changes and effects.	Medium	Negligible	Negligible (NS)
	Land users People working on the valley slopes will experience a range of changes and effects.	Low	Negligible	Negligible (NS)
	Road users The dam infrastructures construction sites will not be visible from most parts of the road. However, it could be briefly visible from specific point of view.	Low	Negligible	Negligible (NS)
Transmission Line	Local residents The transmission line construction sites will be visible from Bugarama and Kamanyola, the main two cities in the area.	Medium	Negligible	Negligible (NS)
	Land users People working on the valley slopes (downstream from the dam site) and in the floodplain will experience a range of changes and effects.	Low	Negligible	Negligible (NS)
	Road users Locals using the asphalted road N5 from Bugarama to Kamanyola and then toward Bukavu will notice landscape change due to the construction of the power line and the pylons which are crossing the road.	Low	Negligible	Negligible (NS)
New access road	Local residents People living in the area will experience a range of changes and effects. It is however anticipated that, due to the relief, only few hundred meters sections of access road(s) will be visible from one single location.	Medium	Minor	Minor (NS)
	Land users As per the local residents, people working in the area (farmers within the valley and the floodplain) will experience a range of changes and effects.	Low	Negligible	Negligible (NS)
	Road users Locals using the asphalted road N5 will experience a permanent change in the landscape due to the presence of access roads, from a few specific points of view.	Low	Negligible	Negligible (NS)

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Table 11-88 Potential Impacts – Landscape & Visual Amenity during Operation

Project Activity	Summary Description of Impact	Potential Impact		
		Sensitivity	Magnitude	Significance
Dam	Local residents Number of settlements from which dam infrastructures will be visible will be very limited. People living in those settlements will experience a range of changes and effects.	Medium	Minor	Minor (NS)
	Land users People working on the valley slopes will experience a range of changes and effects.	Low	Minor	Minor (NS)
	Road users The dam infrastructures will not be visible from most parts of the road. However, it could be briefly visible from specific point of view.	Low	Negligible	Negligible (NS)
Transmission Line	Local residents The transmission line will be permanently visible from Bugarama and Kamanyola, the main two cities in the area.	Medium	Minor	Minor (NS)
	Land users People working on the valley slopes (downstream from the dam site) and in the floodplain will experience a range of changes and effects.	Low	Negligible	Negligible (NS)
	Road users Locals using the asphalted road N5 from Bugarama to Kamanyola and then toward Bukavu will notice landscape change due to the construction of the power line and the pylons which are crossing the road.	Low	Negligible	Negligible (NS)
New access road	Local residents See construction phase.	Medium	Minor	Minor (NS)
	Land users See Construction phase.	Low	Minor	Minor (NS)
	Road users See Construction phase.	Low	Negligible	Negligible (NS)

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11.20 Positive Impacts and Benefits

11.20.1 Impact Producing Factors

During pre-construction and construction, the creation of job opportunities and business opportunities for the Project's supply chain will produce positive impacts.

During operation, the generation of electricity will be the main positive impact of the Project.

11.20.2 Predicted Impacts during Pre-Construction and Construction

The construction activities will generate temporary employment opportunities. Construction duration is estimated at 56 months, requiring an estimated workforce of 500-1,000 workers during the period of peak activities (Tractebel, 2021). A key positive impact will be the provision of an income source for workers and their families contributing to their well-being.

Based on comparison with similar projects in the region, it is estimated that about 180 unskilled jobs[12] could be available during the construction period.

The supply of goods and services along the Project's supply chain will also create economic opportunities.

To enhance these positive impacts and ensure they benefit as much as possible to the local communities in the vicinity of the Project, the following measures already defined in the previous sections will be implemented:

[M 112] The Project will set local employment objectives and targets.

[M 114] The local Recruitment Policy will be communicated widely.

[M 115] Construction phase training programme will be implemented by the EPC Contractor.

11.20.3 Predicted Impacts during Operation

The main positive impact during operation is the objective justifying the Project: electricity production

The Project will generate clean and renewable power, reducing the region's reliance on expensive thermal generation. The estimated energy production for the Ruzizi-III powerplant[13] is between 1,153 and 1,197 GWh (mean annual energy) or between 945 and 989 GWh (firm energy).

Availability of the renewable power will support efforts to extend electrification to the region. It is currently projected that the Project will benefit a population of 30 million people, 54% of whom are living under the poverty line and averaging a 24% electricity access rate. Once commissioned, Ruzizi III will almost double Burundi's current capacity, increase Rwanda's installed capacity by nearly 30% and provide much needed baseload power in Eastern DRC, a region that is otherwise isolated from DRC's interconnected grid.

Permanent employment opportunities during operation will be more limited than during construction. The operation of the scheme will require only a small number of staff, probably in the order of 50 people.

[12] 6 Unskilled occupations correspond to International Standard Classification of Occupation (ISCO-08) Skill Level 1 See International Labour Office – ISCO-08 "Volume I - International Standard Classification of Occupation – Structure, group definitions and correspondence tables"
[13] Source: Project's feasibility Study (Tractebel, 2021)

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The measures to enhance the positive impacts during operation are described in the next section.

11.20.4 Local Area Development Plan

The Project recognizes that the economic benefit at the national level will be produced using the natural resources of the Ruzizi River and that communities have a right to share in that benefit – and that this is not compensation for negative impacts. For that purpose, a Local Area Development Plan has been prepared and will be implemented by the Contracting States to ensure that the local population in the area of the Project can also benefit from the Project. The Local Area Development Plan sometimes has different names and abbreviations in other projects, such as Corporate Social Responsibility (CSR) Plan or Community Investment Plan (CIP), but for Ruzizi-III Project, LADP will be the name of the support program towards the wider community. It is a tool proposed by the Project to support the local communities to improve their living conditions, address development challenges and to take advantage of emerging opportunities.

The Project intends to fund local development activities during the construction period and the operation phase to achieve sustained sharing of benefits with the project-affected communities. The Local Area Development Plan initiatives will be implemented in 2 phases: a first phase of 5 years, (year 1 to year 5) followed by a second phase of 5 years (year 6 to year 10). The first phase has been budgeted as part of the RAP. It will start as soon as the construction activities start. The second phase will be funded after evaluation of the activities implemented during the first phase.

This Plan will not be limited to the households affected by the Project's land acquisition process: *it will target all villages in the immediate vicinity of the Project footprints*.

The Project will screen investment options and prioritize shared areas of interest, mainly between communities, the local authorities and the Contracting States. This screening will be undertaken based on criteria that will be discussed and agreed with the communities and the local authorities. Criteria that would be applied are:

- Sustainability factors, i.e. viable handover strategy and clear set-up for the ownership, operation and maintenance arrangements to avoid creating dependency and to ensure that the initiative can become self-sustaining once REL withdraws its support. This includes consideration of the local government's interest, and the availability of local implementing partners to deliver the initiatives and services.
- Alignment with existing government or municipal plans for local developments.
- When possible, rehabilitate or complete existing infrastructure before investing in new construction.
- Cost-benefit considerations, i.e. the number of people benefiting from the initiative compared to the cost for the Project.

The Local Area Development Plan initiatives could include the following components:

- Electrification of villages or improvement of access to electricity,
- Support to the development of fish farming and fisheries activities in the future reservoir,
- Support to the development of sustainable water supply systems in the villages,
- Support to roads improvement,
- Support to health centres, by provision of medicines and medical equipment,
- Flour mills and small processing installation in the villages,
- Support to improve schools (construction of new rooms and provision of schooling equipment and access to electricity).

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11.21 Impacts on Historically Marginalised People

The presence of Historically Marginalised People (HMP) in the Project area was identified during the qualitative survey carried out in 2022. In 2022, a stand-alone anthropological study was conducted to further explore the socioeconomic characteristics of the community. Based on the outcome of this study, the Project has concluded that the 'Twa' social group, known as 'Batwa' in DRC and 'Historically Marginalised People (HMP)' in Rwanda, qualifies as Indigenous according to SP 7, WB ESS 7, AfDB OS 1 and EIB ESS 7.

The socioeconomic characteristics of this community are outlined in detail in the Social Baseline. In summary, this community is known as Batwa in DRC and as *Abasigajwinyuma Namatekas*, or Historically HMP, in Rwanda, where identification with ethnic labels has been outlawed in 2003. In both Rwanda and DRC, this community self-identifies and is perceived as descending from a hunter-gatherer community which historically lived in the region's forests. HMP faced marginalization, land grabbing, violence and forced displacement from their ancestral lands throughout the 20th century. In the Project area, they currently live in extreme poverty as tenants or squatters, occasionally engaging in daily agricultural labor. They still experience discrimination and struggle to access healthcare and education. Many of their cultural traditions and practices have been lost after their displacement from ancestral lands.

While the anthropological study produced in 2022 concludes that the Project is not expected to have a significant impact on the livelihoods, culture and lifestyle of HMP, a robust stand-alone impact assessment is required to adequately assess impacts. To adequately assess impacts on the HM community in the Project area, the Project will develop an Historically Marginalized People Development Plan (HMPDP), which will assess and mitigate adverse impacts on the community, as well as develop a timebound plan to ensure informed participation and consultation of indigenous people and create positive opportunities for the sustainable development of the communities.

11.22 Recap of Impacts and Mitigation Measures

A recap of all impacts and mitigations that are assessed in this Section 11 is provided in Table 11-89.

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Table 11-89 Summary of Potential Impact and Risks and Mitigation Measures

	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Climate Change Vulnerability	C / Op		R	N/A	[M 1] Slope stability shall be monitored and if necessary, dam and reservoir bank protection features shall be constructed to protect structures from landslides. [M 2] Hydro-meteorological data (temperature, precipitation, river flow) and sedimentation shall be monitored. [M 10] Good Practice measure to monitor Scope 1 and Scope 2 GHG emissions during construction and report the emissions in REL's annual environmental and social performance report and post on the Project's website. [M 3] Consider the use of alternative energy sources such as solar energy. [M 4] Project infrastructure shall be monitored for damage (gates and turbines) and electrical equipment failures and regular maintenance of facilities undertaken. [M 5] A sediment management system shall be developed and implemented that includes provision for watershed management to reduce erosion, and dredging of the reservoir, if needed. [M 6] Revegetation of the river basin should be considered to improve infiltration, reduce sedimentation and minimise flooding of infrastructure. [M 7] Changes in the energy generation schedule, hourly or seasonally, resulting in a change in grid requirements shall be monitored. [M 8] A data management system that makes provision for proper storage of data, proper monitoring and formatting of metadata, documenting the full history of the data (e.g., who took the data, when and how) and preservation of raw data shall be implemented and maintained. [M 9] The Climate Risk Assessment should be updated every 10 years as new data and projections become available, following the IHA Guidelines relevant at the time.
Greenhouse Gas Emissions	C	GHG emissions from construction <IFI threshold of 100,000 tonnes CO2e per annum which triggers need to monitor and publicly disclose GHG emissions	I	NS	[M 10] Good Practice measure to monitor Scope 1 and Scope 2 GHG emissions during construction and report the emissions in REL's annual environmental and social performance report and post on the Project's website. [M 11] The Project undertake a separate study to explore the opportunities to benefit from carbon credits.
	Op	GHG emissions from reservoir operation	I	NS	No measures proposed as the impact is not significant
Air quality, Dust and Odour	C	Emissions of air quality pollutants from fuel combustion at worksites	I	NS	[M 12] The Contractor shall prepare and implement an Air Quality and Emissions Management Plan as part of the CESMP, which details measures to manage air emissions and dust. [M 13] The Contractor shall use equipment and adopt construction and transport methods with air emissions that do not exceed threshold emission values specified in Rwanda and DRC regulations or IFC EHS Guidelines, whichever is the most stringent. [M 14] The fleet of vehicles or equipment emitting combustion gases shall be maintained at the intervals and according to the methods specified by the manufacturer. The Contractor shall keep maintenance records.
	C	Dust emissions from land clearing and site preparation		S	
	C	Emissions of air quality pollutants and dust from construction related traffic		S	
	Op	Emissions of air quality pollutants from fixed point sources at the dam, powerhouse and operators' village	I	NS	[M 15] Power generators at the operator's village will be designed to comply with IFC General EHS emission limit values and DRC/Rwanda emission limit values (whichever are the most stringent). Annual monitoring of the emissions will be performed to check conformity.

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	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Noise and Vibration	C	Noise from vegetation clearing and site preparation at worksites	I	S	[M 16] The Contractor shall prepare and implement a Noise & Vibration Control and Monitoring Plan as part of the CESMP. [M 17] Regular noise level monitoring will be performed during construction to demonstrate compliance with WHO noise guidelines and DRC and Rwanda noise level regulations. [M 18] The Contractor shall use equipment and adopt construction and transport methods so as minimise noise levels and prevent exceeding threshold values recommended by the DRC/Rwanda regulations and WHO recommendations. [M 19] Where communities are located close to worksites, access roads and public roads affected by construction traffic, the Contractor shall study, propose, implement and monitor the efficiency of all reasonable and practicable measures to minimize noise resulting from the activity and to minimize the acoustic nuisances to adjacent households during day and night. [M 20] Noise barriers or acoustic shields shall be considered if works are close to sensitive receptors and installed if monitoring detects noise levels at residential areas that exceed WHO noise guidelines and DRC and Rwanda noise level regulations. [M 21] Noise-intensive works such as piling, demolition, metalworking, and blasting (in quarries) will not be undertaken at night. [M 22] The Contractor shall monitor the vibration level at buildings nearest to the Works during activities which could generate offset vibration effects. The Contractor shall prepare a pre-construction condition survey for all buildings located within 1 km of any blasting activities (including photographs of existing situation). The condition survey will be used to assess the effect of blasting on structures and the scope of any remediation works necessary to repair the effects of blasting.
		Noise from machinery at construction sites,	I	S	
		Noise from rock crushers at quarries	I	S	
		Noise from cement batching plant	I	S	
		Noise and vibration from tunnelling (includes blasting)	I	S	
		~~Noise and vibration from blasting at quarries~~	~~I~~	~~S~~	
		Noise and vibration from construction traffic movements along dam and quarry access roads	I	S	
	Op	Noise from operators' village (generators, compressors, sirens, alarms)	I	S	[M 23] Noise modelling study for the operators' village, powerhouse and substation will be carried out during the design phase and noise prevention measures included in the design as necessary to ensure that noise levels at the site boundary complies with WHO noise guidelines and DRC and Rwanda noise level regulations. [M 24] Noise level monitoring will be performed at the operator's village, powerhouse and substation during commissioning to check compliance with the owner's noise requirements. [M 25] Periodic noise level monitoring will be performed during operation at the powerhouse, operators' camp and substation to check compliance with WHO noise guidelines and DRC and Rwanda noise level regulations. [M 26] The transmission line and switchyard will be designed with features to minimise the corona affect.
		Noise from powerhouse operation	I	S	
		Noise from the 220 kV switchyard and 220 kV transmission line	I	S	
		Noise from Project road traffic	I	NS	
Soils, Groundwater and Surface Water	C	Topsoil removal and excavation during site preparation of worksites and roads	I	NS	[M 27] A soil, slope stability and erosion control plan will be developed and implemented by the EPC Contract [M 28] Construction site pollution prevention and protection plans, and measures will be developed and implemented for all worksites by the EPC Contractor. [M 29] Groundwater at construction worksite will be monitored monthly during construction. [M 30] Construction accommodation camps will be equipped with wastewater treatment facilities to ensure sanitary and domestic wastewater discharges are compliant with Burundi, DRC and Rwanda regulatory discharge limits and IFC EHS guideline emission limit values.
	C	Pollution of soils, groundwater and surface water from accidental spill and leaks of hazardous substances	I	S	

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	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Soils, Groundwater and Surface Water (cont.)	C	Alteration of Ruzizi River water quality from discharge of effluents and wastewaters from the construction workers' accommodation camp	I	S	[M 31] The quality of wastewater discharges from construction worksites will be monitored to check conformity with discharge limit values. [M 32] During construction, erosion mitigation measures will be employed to prevent soil erosion and fluvial erosion when undertaking works on bare soil and banks and when working in the river (EPC Contractor). [M 33] Cofferdams and diversion tunnels used for construction works in the river will be designed to enable suspended sediment to be carried downstream while construction is taking place. [M 34] During construction, worksite surface erosion and effectiveness of control measures will be monitored by taking weekly fixed-point photos of cleared areas. [M 35] During the reservoir filling phase, bottom sluicing will be undertaken to maintain sediment throughflow as best possible and flows will be sufficient to transport the released sediment downstream to avoid siltation of instream habitats immediately downstream of the dam. [M 36] Environmental performance of the EPC Contractor will be monitored to check conformity with Project standards and non-conformities will be managed through a non-conformity management process.
	C	Increased sediment loads in the Ruzizi River from runoff from worksites and spoil disposal areas	I	S	
	C	Alteration of the Ruzizi River from filling of the Ruzizi-III reservoir	I	S	
	Op	Alteration of the Ruzizi River water quality from discharge of wastewaters from the operators' village	I	S	[M 37] The operators' accommodation camp will be equipped with a sanitary and domestic wastewater collection and treatment facilities to ensure discharges comply with regulatory discharge limit values and IFC EHS guideline emission limit values. [M 38] Quality of wastewater discharges from the operators' accommodation camp will be monitored quarterly to check conformity with discharge limit values. [M 39] A Pollution prevention and control plan for the operation phase will developed and implemented. [M 40] Facilities for the storage and handling of hazardous substances at the dam site, powerhouse and switchyard will be designed with spill prevention and protection measures.
	Op	Alteration of reservoir water quality and consequently	I	S	[M 41] Water quality impacts will be monitored and adaptively managed.
Hydrology	C	Temporary river diversion	I	NS	Measures included in the Project design
	C	Reservoir clearing	I	NS	Measures included in the Project design
	C	Reservoir filling	I	NS	Measures included in the Project design
	Op	Diversion of the river through the headrace tunnel, leaving a bypassed reach of river.	I	S	[M 42] Implement monitoring of release from the bottom outlet using flow measurement / video evidence. Provide real-time open web portal to allow for stakeholder assessment of performance. [M 43] Publish annual report of bottom outlet flow release data. [M 44] Implement operational maintenance schedule to ensure full and correct functioning of bottom outlet monitoring & data publishing, to include level of service agreements made with key stakeholders (e.g., ABAKIR) and recommendations for adaptive management variations.
		Normal powerhouse operation with peak and off-peak discharges	I	S	[M 45] Assess requirements for improved hydrological modelling of upstream and tributary catchments to reduce uncertainty inherent in current broad-scale assessment. [M 46] Assess requirements for improved hydrological and hydraulic characterisation of micro-/meso-scale habitat in hydropeaking reach to reduce uncertainty inherent in current broad-scale assessment. [M 47] Implement monitoring of powerhouse tailrace flow and flow / water levels at selected locations in the hydropeaking reach (between the powerhouse tailrace and the Burundi border) using flow measurement / radar / video evidence.. [M 48] Publish annual report of powerhouse / hydropeaking reach flow data. [M 49] Implement operational maintenance schedule to ensure full and correct functioning of powerhouse tailrace / hydropeaking reach monitoring & data publishing, to include level of service agreements made with key stakeholders (e.g., ABAKIR) and recommendations for adaptive management variations.

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	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Hydrology (cont.)		Sediment flushing operations	I	S	[M 50] Develop, agree with key stakeholders (e;g., ABAKIR), and implement a Dewatered Reach Sediment Management Plan that explicitly evaluates associated ecological and social functioning in the dewatered and further downstream reaches (including, *inter alia*, sediment transport and floodplain inundation). [M 51] Maintain regular, periodic releases from Ruzizi III reservoir (bottom outlet / spillway) to flush sediment in the dewatered reach. [M 52] Implement monitoring of sedimentation in the dewatered reach (between the powerhouse tailrace and the Burundi border) using periodic sediment sampling / aerial (drone) survey. [M 53] Publish annual report of sediment monitoring in the dewatered reach. [M 54] Implement operational maintenance schedule to ensure full and correct functioning of Dewatered Reach Sediment Management Plan, to include level of service agreements made with key stakeholders (e.g., ABAKIR) and recommendations for adaptive management variations.
		Exceptional operating conditions	I	S	[M 55] Develop, agree with key stakeholders (e.g., ABAKIR), and implement a Reservoir Operation Plan (exception operating conditions and flood risk management) that explicitly evaluates associated ecological and social functioning in the dewatered and further downstream reaches (including, *inter alia*, sediment transport and floodplain inundation). [M 56] Publish annual report of Reservoir Operation Plan. [M 57] Implement operational maintenance schedule to ensure full and correct functioning of the Reservoir Operation Plan, to include level of service agreements made with key stakeholders (e.g., ABAKIR) and recommendations for adaptive management variations.
Geomorphology and Sediment Transport	C	Cofferdam and temporary river diversion causing reduced sediment loads in the downstream reach	I	S	[M 33] Cofferdams and diversion tunnels used for construction works in the river will be designed to enable suspended sediment to be carried downstream while construction is taking place.
	C	Runoff from worksites increasing sediment loads in the river	I	S	[M 32] During construction, erosion mitigation measures will be employed to prevent soil erosion and fluvial erosion when undertaking works on bare soil and banks and when working in the river (EPC Contractor). [M 34] During construction, worksite surface erosion and effectiveness of control measures will be monitored by taking weekly fixed-point photos of cleared areas.
	C	Reservoir clearing causing increased sediment loads in the river	I	S	[M 32] During construction, erosion mitigation measures will be employed to prevent soil erosion and fluvial erosion when undertaking works on bare soil and banks and when working in the river (EPC Contractor).
	Op	Normal and exceptional operating conditions with diversion of the river through the headrace tunnel, leaving a reach of the river left dry and peak and off-peak discharges. Causing trapping sediment in the reservoir and reduced sediment loads in the reach downstream from the dam	I	S	[M 58] Develop, agree with key stakeholders (e.g., other HEPP operators, ABAKIR), and implement Sediment Management Plan. [M 59] Publish annual report of Sediment Management Plan operations. [M 60] Implement operational maintenance schedule to ensure full and correct functioning of Sediment Management Plan, to include level of service agreements made with key stakeholders (e.g., other HEPP operators, ABAKIR) and recommendations for adaptive management variations.
Wastes	C	Excavation spoil (Inert waste)	R	N/A	[M 61] The EPC Contractor will prepare a Site Waste Management Plan as part of the CESMP in alignment with GIIP and the Employers E&S Requirements. [M 62] The EPC Contractor will ensure that waste is segregated and stored on site according to GIIP, and a register of waste maintained.

ORIZED

PUBLIC DISCLOSURE AUTHORIZED

	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Wastes (cont.)	C	Waste concrete (inert waste)	R	N/A	[M 63] The EPC Contractor will identify accredited third-party waste management facilities for the management of waste, including facilities for reuse and recycling. The facilities will be audited by the EPC Contactor to ensure compliance with GIIP and E&S requirements of the environmental permit. [M 64] Wastes that cannot be managed by offsite contractors will be managed by the EPC Contractor, and this may include construction of a landfill or installation of an incinerator. The design of these facilities will follow GIIP and environmental permits will be obtained. [M 65] The EPC Contractor make all the necessary arrangements for transport of waste that is not managed on-site to accredited offsite waste management facilities. A waste tracking system shall be implemented (waste manifests) and compliance with the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal. [M 66] If quality permits, the EPC Contactors will reuse excavation spoil material, such as for concrete formation, backfilling, foundations and road construction. Excess spoil will be disposed of at designated and specially designed spoil disposal sites and the necessary permits from local authorities obtained by the EPC Contractor. [M 67] The practice of disposing of inert spoil from road construction by side-casting is to be prohibited.
	C	Iron and steel scrap and non-ferrous scrap (Non-hazardous waste)	R	N/A	
	C	General domestic waste, paper and cardboard, packaging, pallets, glass, plastic, tires (Non-hazardous waste)	R	N/A	
	C	Oils and lubricants, oil contaminated rags, batteries, fluorescent tubes, paints and chemicals (Hazardous waste)	R	N/A	
	Op	Iron and steel scrap and non-ferrous scrap (Non-hazardous waste)	R	N/A	[M 68] REL will conduct a waste management study to asses how to manage the domestic trash that accumulates in the Ruzizi III reservoir. REL will prepare a Waste Management Plan for the operation phase as part of the ESMP in alignment with GIIP and in coordination with local authorities and the operators of Ruzizi-I and -II. [M 69] REL will ensure that waste is segregated and stored on site according to GIIP, and a register of waste maintained. [M 70] REL will establish contracts with accredited third-party waste management facilities for the management of waste, including facilities for reuse and recycling and conduct regular audits to ensure compliance with GIIP and E&S requirements of the environmental permit. [M 71] REL will make all the necessary arrangements for transport of waste that is not managed on-site to accredited offsite waste management facilities. A waste tracking system shall be implemented (waste manifests) and compliance with the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal.
	Op	General domestic waste, paper and cardboard, packaging, pallets, glass, plastic, tires (Non-hazardous waste)	R	N/A	
	Op	Oils and lubricants, oil contaminated rags, batteries, fluorescent tubes, paints and chemicals (Hazardous waste)	R	N/A	
Aquatic Habitats and Biodiversity	C	Increased sedimentation/ turbidity affecting fish and fish habitat	I	S	[M 72] A riparian buffer zone of 50 m around riparian habitats will be maintained in all construction works areas to restrict erosion and sedimentation and rehabilitation, and alien plant control will be applied after construction to re-establish natural vegetation (EPC Contractor). [M 73] Community land use activities will be regulated within the 50 m buffer zone such that no new agricultural clearance will be permitted whatsoever within 10 m of the riverbank in the project's area of influence (reservoir and dewatered reach). [M 74]. Protect the riparian corridor through implementing measures to reduce erosion and sediment inputs into river courses through construction of gabions, embankments, and/or berms.
	Op	Development of bilharzia snails and blackflies and increased risk of development of waterborne diseases	R	N/A	[M 75] Conduct monitoring of bilharzia host snails and blackflies, and prevalence of water borne diseases and identify control and management measures if required.

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PUBLIC DISCLOSURE AUTHORIZED

	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Aquatic Habitats and Biodiversity (cont.)	Op	Project impacts on fish from altered flows and barrier to migration	I	S	[M 76] Maintain a minimum flow of at least 11 m3/s at all times (including during reservoir filling) with video evidence shared with ABAKIR and other stakeholders; and release freshets of at least 50 m3/s over a few days on a biannual basis timed with rising river levels (volume to be confirmed through further modelling). [M 77] Conduct fish monitoring and implement adaptive management based on results and disclose results to relevant institutions and lenders on a biannual basis. [M 78] Implement and enforce a no fishing zone in dewatered reach and 1 km downstream of powerhouse and work with communities to improve sustainable fishing practices downstream of Bugarama. [M 79] Implement fish monitoring to determine whether fish stranding occurs and determine additional mitigation if required (e.g. extended ramp down rates after each sub-daily peaking event to achieve a rate of water level drop of max. 3 cm/minute downstream of the powerhouse; or river engineering solutions to moderate flow fluctuations.
	Op	Impact of altered flows on Rusizi National Park and Ramsar site	R	NS	Mitigation and monitoring of flows, water quality and wastes are applicable to the lower Ruzizi River. Fish monitoring is required for the Rusizi River reaches within Rwanda but should be extended into Burundi should results indicate the potential for fish impacts downstream of the confluence of the Ruhwa River. No additional mitigation measures are specifically required for the Rusizi National Park.
Terrestrial Habitats and Biodiversity	C	Loss of natural habitat (dam, reservoir, powerplant, roads)	I	S	[M 81] Construction work site planning shall seek to minimise impacts on vegetation and an Environmental Compliance Officer with ecological experience will oversee site clearance and ensure control measures are implemented (EPC Contractor). [M 82] Construction site clearance activities will be implemented in a manner to minimise loss of vegetation by restricting footprints of vegetation removal, stockpiling and vehicle access (EPC Contractor). [M 83] During construction, topsoil management will be implemented in accordance with a Topsoil Management Plan that defines the location, storage, size/shape and protection measures for topsoil stockpiles (EPC Contractor). [M 84] Prepare and implement a Restoration and Rehabilitation Plan aimed at achieving no net loss of natural habitat in the reservoir sub-catchment area. Collect seed from native plants & propagate key species identified in the restoration plan in an off-site project nursery and implement progressive re-establishment of Natural Habitat wherever possible (EPC Contractor).
	C	Loss of species of conservation concern (dam, reservoir, powerplant, roads)	I	S	[M 85] Conduct walk-through of construction area footprints prior to clearance to ensure no SCC present (low likelihood) (EPC Contractor) and micro-site infrastructure where possible if any SCC are found
	C	Disturbance of fauna from blasting (especially during breeding periods) (dam, reservoir, powerplant, roads)	I	S	[M 86] Although few breeding raptors are likely to be present, conduct a walk-through bird survey in breeding season to confirm presence of breeding birds, especially raptors and restrict blasting to periods outside of breeding season (Dec-May) where possible (EPC Contractor).
	C	Introduction of invasive alien species (dam, reservoir, powerplant, roads)	I	NS	[M 87] Develop and implement a Terrestrial Alien Invasive Plant Management, Monitoring and Control Plan for the HEPP and TL construction activities (EPC Contractor).
	C	Loss of natural habitat (transmission line)	I	S	[M 88] Plan the location of pylons in degraded habitat wherever possible. [M 89] Collect seed of typical natural grassland species for revegetating any cleared or damaged areas of Hillslope Grassland post-construction & propagate key species in off-site project nursery. [M 90] Implement progressive re-establishment of Natural Habitat wherever possible in construction footprints.
	C	Loss of species of conservation concern (transmission line)	I	S	[M 91] Conduct walk-through of the final confirmed pylon sites in Hillslope Grassland habitats to confirm presence of SCC to enable micro-siting of pylons or plant rescue if required.

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	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Terrestrial Habitats and Biodiversity (cont.)	C	Introduction of invasive alien plan species (transmission line)	I	S	[M 92] Implement terrestrial alien invasive plant management, monitoring and control measures along the TL wayleave and access routes during construction (EPC Contractor).
	C	Disturbance to birds (transmission line)	I	S	[M 93] If possible, erect pylons and fit transmission lines between December and May, when few raptors are likely to be breeding.
	C	Loss of natural habitat during reservoir impoundment	I	S	[M 94] Compile a Revegetation and Rehabilitation Plan aimed at achieving No Net Loss for the 41.8 ha of Largely Natural Habitat impacted by the Project. This should include restoration of degraded habitats in the reservoir sub-catchment above the full supply level and along the river course.. [M 95] Implement restoration of priority habitats (Hillslope Grassland / Savannah) adjacent to the full supply level.
	C	Loss of species of conservation concern during reservoir impoundment	I	S	[M 96] Conduct walk-through of areas of Hillslope Grassland / Savannah, Riparian Thicket and Hillslope Thicket that will be inundated by reservoir to confirm presence, and rescue any threatened or restricted-range species that are found and can be translocated to similar habitat adjacent to the full supply level (i.e. buffer zone).
	C	Loss of fauna through drowning during reservoir impoundment	I	S	[M 97] Implement reservoir filling during lower flow, dry season periods or by regulating peaking flows from upstream hydropower plants in such a way to enable fauna (including smaller animals (e.g. snakes and other reptiles, rodents) to escape to higher ground.
	Op	Mortality of large birds during operation of the 220 kV transmission line	I	S	[M 98] Plan the TL route along the hillslopes rather than along the hill crests, which are often followed by raptors on migration and where collision risk is higher. [M 99] Install bird diverters and anti-perching devices (e.g. metal spikes) along the section of the TL route crossing Natural Habitat and where bird collisions with the conductors can occur.
	Op	Degradation of habitat through clearance of vegetation along wayleave	I	S	[M 100] Avoid ongoing clearance of Natural Habitat along the wayleave, especially Hillslope Grassland / Savannah habitat on steep slopes unless necessary for safety reasons.
	Op	Introduction or spread of invasive alien species	I	S	[M 101] Implement a Terrestrial Alien Invasive Plant Management, Monitoring and Control Plan for the Operation Phase. [M 102] Implement monitoring of erosion and rehabilitation / restoration success and implement additional measures if required to facilitate recovery of construction areas.
	Op	Impacts of Reservoir on Wildlife	R	NS	[M 103]Inform local communities of potential for increased risk of hippopotams and crocodiles in the reservoir and related safety concerns and need to protect wildlife, and monitor and record wildlife presence in the reservoir. This should be done by community liaision officers and environmental staff of REL or outsourced to external ecological consultants or reserarchers.
	Op	Impacts of Altered Flows on Downstream Wildlife (including Rusizi National Park)	R	NS	No specific mitigation required.
Impacts on local communities' livelihoods	C	Land acquisition	I	S	[M 104] Implementation of the Resettlement Action Plan [M 105] Compensation of all affected lands and assets at full replacement costs [M 106] Assistance to physical resettlement [M 107] Livelihood Restoration Programme, including a transitional [M 108] Specific assistance for affected vulnerable [M 109] Local Area Development Plan
	Op	Impact of alteration to flow conditions on fishing	I	NS	[M 110] Monitoring of fisheries activities downstream of the dam to confirm the absence of any discernible change in fish catch because of the Project

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	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Labour and Working Conditions	Op	Compliance with lender policies with regard to human resources policies and procedures	R	N/A	[M 111] The Project's HR policy and labour management principles will align with Lenders' Policies and the labour laws of Burundi, DRC and Rwanda and be available in Kinyarwanda, English and French.
	Op	Compliance with lender policies with regard to employment	R	N/A	[M 112] The Project will set local employment objectives and targets. [M 113] The Project's local employment objectives will include specific targets for the employment of women. According to these targets, at least 15% of the total workforce (skilled and unskilled) will be female. [M 114] The local Recruitment Policy will be communicated widely. [M 115] Construction phase training programme will be implemented by the EPC Contractor.
	Op	Compliance with lender policies with regard to workers' organisations	R	N/A	[M 116] Provisions regarding allowance of workers' organizations and collective bargaining will be included in the Project's HR policy.
	Op	Compliance with lender policies with regard to non-discrimination and equal opportunities	R	N/A	[M 117] Provisions regarding non-discrimination and equal opportunities will be included in the Project's HR Policy.
	Op	Compliance with lender policies with regard to retrenchment	R	N/A	[M 128] The EPC Contractor will prepare a detailed Demobilisation Plan and implement the plan at the end of the construction.
	Op	Compliance with lender policies with regard to workers grievance mechanism	R	N/A	[M 118] Workers' grievance mechanism will be implemented and monitored during labour audits.
	Op	Compliance with lender policies with regard to protecting the workforce	R	N/A	[M 119] Project's HR Policy and labour management principles will clearly state that there will be no forced labour and child labour.
	Op	Compliance with lender policies with regard to occupational health and safety	R	N/A	[M 136] Operation phase occupational noise exposure management measures. [M 137] Operation phase fire and explosion management measures in compliance with NFPA. [M 134] General operation occupational health and safety measures: ESMS aligned with OSHAS 18001, Health and Safety Plan, Employee training. [M 135] Operation phase hazardous substances management measures. [M 136] Operation phase occupational noise exposure management measures. [M 137] Operation phase fire and explosion management measures in compliance with NFPA.
	C	Compliance with lender policies with regard to workers engaged by third-parties	R	N/A	[M 120] REL will review the EPC contractor's subcontractors' management procedures prior to the start of construction and organise and finance 6-monthly Integrated Environmental, Social, Health and Safey audits by an independent auditor of the EPC Contractor and its subcontractors' working practices to check compliance with the Project's HR Policy, Labour laws of Burundi, DRC and Rwanda, and Lenders' labour management requirements. [M 129] General construction phase occupational health and safety management measures. [M 130] Construction phase hazardous substances management plan. [M 131] Construction phase noise, dust and vibration management measures. [M 132] Construction phase fire and explosion management measures. [M 133] Conduct a risk assessment for natural hazards for workers during construction.
	C/Op	Risk of gender-based violence for the project as a whole	R	N/A	[M 113] The Project's local employment objectives will include specific targets for the employment of women. According to these targets, at least 15% of the total workforce (skilled and unskilled) will be female.

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	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
					[M 117] Provisions regarding non-discrimination and equal opportunities will be included in the Project's HR Policy. [M 121] The EPC will develop a gender-sensitive recruitment strategy and communicate it to the local communities [M 122] REL will recruit two trained female Gender Officers (1 in Rwanda and 1 in DRC) to define and implement GBVH protocols. These protocols will apply to all Project workers, including contractors and sub-contractors. [M 123] The EPC will develop and implement a workers' code of conduct, including GBVH policies, and mandatory training of all workers on sexual harassment and GBVH protocols [M 124] The EPC contractor will develop an Occupational Health and Safety Management Plan which will gender and GBVH aspects, such as: gender-separate accommodation on camp, gender-separate lockable latrines and WASH facilities that are well-lit, conveniently located and easily accessible. [M 125] The EPC will establish workers' safety committee which will include at least one trained female worker representative [M 126] The Workers' grievance mechanism and Community grievance mechanism will channel all GBVH complaints and store them on a separate database. REL's Gender Officers will be responsible for handling and solving these complaints.
Community Health and Safety	C/Op	Community health and safety risks as a whole	R	N/A	[M 130] Construction phase hazardous substances management plan. [M 131] Construction phase noise, dust and vibration management measures. [M 132] Construction phase fire and explosion management measures. [M 133] Conduct a risk assessment for natural hazards for workers during construction. [M 134] General operation occupational health and safety measures: ESMS aligned with OSHAS 18001, Health and Safety Plan, Employee training. [M 135] Operation phase hazardous substances management measures. [M 136] Operation phase occupational noise exposure management measures. [M 137] Operation phase fire and explosion management measures in compliance with NFPA. [M 138] Coffer dam design criteria for seismic and hydraulic loading will follow ICOLD guidelines and take into account findings of detailed natural hazard risk assessments. [M 139] Safety distances between onsite areas for storage and handling of hazardous substances and offsite residential areas. [M 140] Control of access to worksites. [M 141] Construction phase traffic management plan. [M 142] Public disclosure of the construction phase traffic management plan. [M 143] Local authorities given prior warning of the programmed arrival of heavy convoys. [M 144] Traffic hazard awareness campaigns organised for communities including school children. [M 146] Adherence to the Voluntary Principles on Security and Human Rights - and the International Code of Conduct for Private Security Service Providers including contractors and their subcontractors [M 147] Security services providers personnel to be trained to comply with the Voluntary Principles on Human Rights and the International Code of Conduct for Private Security Service Providers [M 148] Cooperation with local police forces [M 149] Community health management measures included in the construction phase health and safety plan. [M 150] Monitoring by REL of the implementation of the community health management measures by the EPC Contractor.

ORIZED

PUBLIC DISCLOSURE AUTHORIZED

	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
					[M 151] Technical measures to avoid impacts on water quality including from wastewater discharges, runoff and tunnelling spoils. [M 152] Disclosure of water monitoring results. [M 153] Detailed design to include detailed seismic studies to complement the preliminary studies already performed and to confirm dam and coffer dam design criteria. [M 154] Coffer dam and diversion tunnel flood management criteria and procedure in detailed design. [M 155] Assessment of reservoir rim stability and analysis of hydraulic consequences. [M 156] Carry out detailed landslide risk assessment and include dam, coffer dam and temporary construction facilities in the assessment and include the findings into the Project design.
Community Health and Safety (cont.)		Community health and safety risks associated with Project induced in-migration	R	N/A	[M 111] The Project's HR policy and labour management principles will align with Lenders' Policies and the labour laws of Burundi, DRC and Rwanda and be available in Kinyarwanda, English and French. [M 112] The Project will set local employment objectives and targets. [M 113] The Project's local employment objectives will include specific targets for the employment of women. According to these targets, at least 15% of the total workforce (skilled and unskilled) will be female. [M 114] The local Recruitment Policy will be communicated widely. [M 119] Project's HR Policy and labour management principles will clearly state that there will be no forced labour and child labour. [M 122] REL will recruit two trained female Gender Officers (1 in Rwanda and 1 in DRC) to define and implement GBVH protocols. These protocols will apply to all Project workers, including contractors and sub-contractors. [M 123] The EPC will develop and implement a workers' code of conduct, including GBVH policies, and mandatory training of all workers on sexual harassment and GBVH protocols [M 141] Construction phase traffic management plan. [M 142] Public disclosure of the construction phase traffic management plan.[M 149] Community health management measures included in the construction phase health and safety plan. [M 150] Monitoring by REL of the implementation of the community health management measures by the EPC Contractor. [M 146] Adherence to the Voluntary Principles on Security and Human Rights - and the International Code of Conduct for Private Security Service Providers including contractors and their subcontractors [M 147] Security services providers personnel to be trained to comply with the Voluntary Principles on Human Rights and the International Code of Conduct for Private Security Service Providers [M 148] Cooperation with local police forces [M 157] Preparation and implementation of an Influx Management Strategy. [M 158] REL Gender officers will prepare and implement a Community Outreach Programme on Gender-based violence and harassment, to disclose the Project's GBVH protocols and reporting processes. [M 159] Monitoring on Project-induced in-migration around the reservoir during operation during the first years of operation [M 160] Addressing potential negative social impacts of continued presence of project-induced influx during the first years of operation
Human rights	C/Op		R	N/A	Addressed through measures under separate headings as explained in the main text

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PUBLIC DISCLOSURE AUTHORIZED

	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Gender-specific risks and impacts	C/Op	Gender-specific risks and impacts	R	N/A	[M 113] The Project's local employment objectives will include specific targets for the employment of women. According to these targets, at least 15% of the total workforce (skilled and unskilled) will be female. [M 117] Provisions regarding non-discrimination and equal opportunities will be included in the Project's HR Policy. [M 120] REL will review the EPC contractor's subcontractors' management procedures prior to the start of construction and organise and finance 6-monthly Integrated Environmental, Social, Health and Safey audits by an independent auditor of the EPC Contractor and its subcontractors' working practices to check compliance with the Project's HR Policy, Labour laws of Burundi, DRC and Rwanda, and Lenders' labour management requirements. [M 121] The EPC will develop a gender-sensitive recruitment strategy and communicate it to the local communities [M 122] REL will recruit two trained female Gender Officers (1 in Rwanda and 1 in DRC) to define and implement GBVH protocols. These protocols will apply to all Project workers, including contractors and sub-contractors. [M 123] The EPC will develop and implement a workers' code of conduct, including GBVH policies, and mandatory training of all workers on sexual harassment and GBVH protocols [M 124] The EPC contractor will develop an Occupational Health and Safety Management Plan which will gender and GBVH aspects, such as: gender-separate accommodation on camp, gender-separate lockable latrines and WASH facilities that are well-lit, conveniently located and easily accessible. [M 125] The EPC will establish workers' safety committee which will include at least one trained female worker representative [M 126] The Workers' grievance mechanism and Community grievance mechanism will channel all GBVH complaints and store them on a separate database. REL's Gender Officers will be responsible for handling and solving these complaints. [M 158] REL Gender officers will prepare and implement a Community Outreach Programme on Gender-based violence and harassment, to disclose the Project's GBVH protocols and reporting processes.
Cultural Heritage	C	Impacts from earthworks and physical construction	I	S	[M 161] Compensation or moving of the graves and church located in the Project acquired land plots, as defined in the Resettlement Action Plan. [M 162] Define and implement a Chance Find Procedure
	C	Construction activities generating noise, dust vibration	I	S	See measures above for noise, dust and vibration [M 163] All cultural heritage elements located adjacent to a construction site or the external boundaries of the future reservoir (within 30 m), will be protected from potential damages due to construction methods.
	C	Restriction of access	I	S	[M 164] Consultation with communities using the 2 baptism sites and prayer site on the island close to the Project's sites and the payer site under the Transmission Line Right of way to assess if access to these sites could be impaired by the Project activities [M 165] Commitment to not block accesses to places of worship throughout the construction phase as much as possible, taking into consideration safety issues. [M 166] Where existing access cannot be maintained, provision of an alternative access route, subject to overriding health, safety, and security considerations
	Op	Restriction of access for safety reasons	I	S	[M 167] Implement GIP for ensuring the disposal area do not represent any safety risk for the general public.
Ecosystem Services	C/Op	Ecosystem Services	I	S	Addressed through measures under separate headings as explained in the main text

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PUBLIC DISCLOSURE AUTHORIZED

	Phase [a]	Impact / Risk [b]		Significance [c]	Mitigation
Landscape and Visual Amenity	C/Op	Physical presence of structures represent a degradation of the land scape and visual amenity	I	NS	No measures proposed because the impact is not significant
Positive Impacts and benefits	C	Employment opportunities	I	S	[M 112] The Project will set local employment objectives and targets. [M 114] The local Recruitment Policy will be communicated widely. [M 115] Construction phase training programme will be implemented by the EPC Contractor.
	Op	Enhancement of benefits	I	S	Local Area Development Plan

Notes

[a] C = Construction, Op = Operation

[b] I = Impact, R = Risk

[C] S = Significant, NS = Not Significant, N/A = Not Applicable (the case for risks)

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12 Cumulative Impact Assessment

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Contents

12.1 Introduction 12-1

12.1.1 Objective 12-1
12.1.2 Methodology 12-1

12.2 Study Area Context 12-4

12.2.1 Administrative and Socioeconomic Setting 12-4
12.2.2 Physical Setting 12-4
12.2.3 Surface Water 12-4
12.2.4 Groundwater 12-4
12.2.5 Land Use 12-6
12.2.6 Main Uses of the Basin Water Resources 12-6
12.2.7 Soil Degradation 12-6
12.2.8 Potential Sources of Pollution 12-6
12.2.9 Physical-Chemical Quality of Water 12-6
12.2.10 Natural Hazards 12-7
12.2.11 Flood Events 12-7

12.3 Projects and Regional Development 12-8

12.3.1 Existing and Future Hydropower Developments 12-8
12.3.2 Existing and Future Transmission Lines (Associated Facilities) 12-10
12.3.3 Ruzizi-III Quarries and Borrow Areas 12-11
12.3.4 Master Plan for the Development of the Ruzizi Plain 12-14
12.3.5 Water Abstraction for Use as Potable Water 12-16
12.3.6 Gishoma Peat-Fuelled Power Plant 12-16
12.3.7 Other Anthropogenic Activities 12-16

12.4 Environmental Stressors and External Factors .. 12-19

12.4.1 Demographic Changes 12-19
12.4.2 Land Cover / Land Use Changes 12-19
12.4.3 Climate Change 12-19
12.4.4 Anthropogenic Pollution 12-20
12.4.5 Soil Degradation 12-20
12.4.6 Natural Hazards 12-20

12.5 CIA Temporal & Spatial Boundaries 12-21

12.5.1 Spatial Boundaries 12-21
12.5.2 Temporal Boundaries 12-21

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

12.6 Identification of VECs 12-22

12.6.1 Initial VEC Identification 12-22
12.6.2 Stakeholder Participation 12-22
12.6.3 Screening of Initial VECs 12-27
12.6.4 VECs Selected for Assessment 12-31

12.7 Assessment of Cumulative Impacts on Ruzizi River Hydrology VEC 12-32

12.7.1 Metric for Assessment of VEC 12-32
12.7.2 Spatial and Temporal Boundaries 12-32
12.7.3 Baseline Conditions 12-32
12.7.4 Projects, Stressors & External Factors Contributing to the Cumulative Impact 12-33
12.7.5 Assessment of Significance of Cumulative Impact on Hydrology 12-34

12.8 Assessment of Cumulative Impacts on Ruzizi River Geomorphology VEC 12-37

12.8.1 Metric for Assessment of VEC 12-37
12.8.2 Spatial and Temporal Boundaries 12-37
12.8.3 Projects, Stressors & External Factors Contributing to the Cumulative Impact 12-37
12.8.4 Assessment of Significance of Cumulative Impacts on Geomorphology 12-39

12.9 Assessment of Cumulative Impacts on Fish & Aquatic Habitat VEC 12-42

12.9.1 Metrics for Assessment of Impacts on VEC 12-42
12.9.2 Spatial and Temporal Boundaries 12-42
12.9.3 Projects, Stressors & External Factors Contributing to the Cumulative Impact 12-42
12.9.4 Assessment of Significance of Cumulative Impacts on Fish & Aquatic Habitat 12-43

12.10 Conclusions and Mitigation & Monitoring Framework 12-48

12.10.1 Conclusions 12-48
12.10.2 Mitigation and Monitoring Framework 12-49

PUBLIC DISCLOSURE AUTHORIZED

PUBLIC DISCLOSURE AUTHORIZED

List of Tables

Table 12-1 Hydropower Projects on the Ruzizi River 12-8
Table 12-2 Potential Quarries and Borrow Areas for the Ruzizi III HEPP 12-11
Table 12-3 Summary of Irrigation Area Categories 12-14
Table 12-4 Engagement with Institutional Stakeholders 12-22
Table 12-5 List of FGDs with Communities 12-24
Table 12-6 Questions, Responses and VECs Identified during FGDs with Communities 12-24
Table 12-7 Initial VECs and Outcomes of the VEC Screening Process 12-28
Table 12-8 VECs Selected for Assessment 12-31
Table 12-9 Summary of Ruzizi River Flow Conditions Prior to Start of Ruzizi-I Hydropower Scheme 12-32
Table 12-10 Ruzizi-I and -II HEPP Peak and Off Peak Flow Characteristics 12-33
Table 12-11 Alteration to Natural Conditions Minimum Water Level vs River Length 12-35
Table 12-12 Sediment Accumulation in Ruzizi-I and -II Hydropower Scheme Reservoirs 12-37
Table 12-13 Ruzizi River Sediment Budget for Natural, Current and Future Conditions 12-41
Table 12-14 Alteration to Minimum Water Levels and Fish Migration 12-44
Table 12-15 Roles and Responsibilities for Mitigation and Monitoring of Cumulative Impacts 12-51

List of Figures

Figure 12-1 Six-Step Approach for CIA 12-2
Figure 12-2 Schematic Illustrating VEC-Centred Approach 12-3
Figure 12-3 CIA Study Area Map 12-5
Figure 12-4 Map Showing Locations of Ruzizi-I, -II, -III and -IV HEPPs 12-9
Figure 12-5 Regional Transmission Line Network (Associated Facilities) 12-12
Figure 12-6 Locations of Potential Quarry Sites 12-13
Figure 12-7 Irrigated Perimeters in the Ruzizi Plain 12-15
Figure 12-8 Location of Gishoma thermal PP and peatland 12-17
Figure 12-9 Map Showing Location of Focus Groups Discussion (FGD) Meetings with Communities 12-26
Figure 12-10 VEC Screening Process 12-27
Figure 12-11 Monthly Distribution of Ruzizi River Flows at the Lake Kivu Outlet 12-32
Figure 12-12 Ruzizi River Hydrographs for Natural Conditions (Prior to Start of Ruzizi I HPP) 12-33
Figure 12-13 Percentage Alteration to Natural Conditions Minimum Water Level vs River Length (Illustrative) 12-36

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12.1 Introduction

12.1.1 Objective

The objective of the Cumulative Impact Assessment (CIA) is to assess the incremental increase of Project impacts that result from temporal and spatial overlap with impacts of past, present and probable future anthropogenic activities and evolving natural processes. The spatial area considered is the geographical zone that encompasses the Ruzizi hydrographic network starting from the outflow of the Lake Kivu and extending to the river's outflow into Lake Tanganyika.

The overall goal is to identify E&S impacts and risks that, in the context of existing, planned, and reasonable predictable developments, may generate cumulative impacts that could jeopardize the overall long-term environmental, social and economic sustainability of the Project and the Ruzizi watershed. The assessment has the following objectives:

- Assess the potential impacts and risks of the Project over time, in the context of potential effects from other developments and external environmental and social factors.
- Verify that the Project's cumulative impacts and risks will not compromise the sustainability or viability of the social and natural environment.
- Mitigate potential cumulative impacts when applicable.
- Confirm that the Project's value and feasibility are not limited by cumulative effects.
- Ensure that the concerns of affected communities about the cumulative impacts are identified, documented and addressed.
- Manage potential reputation risks.

The assessment outcomes are as follows:

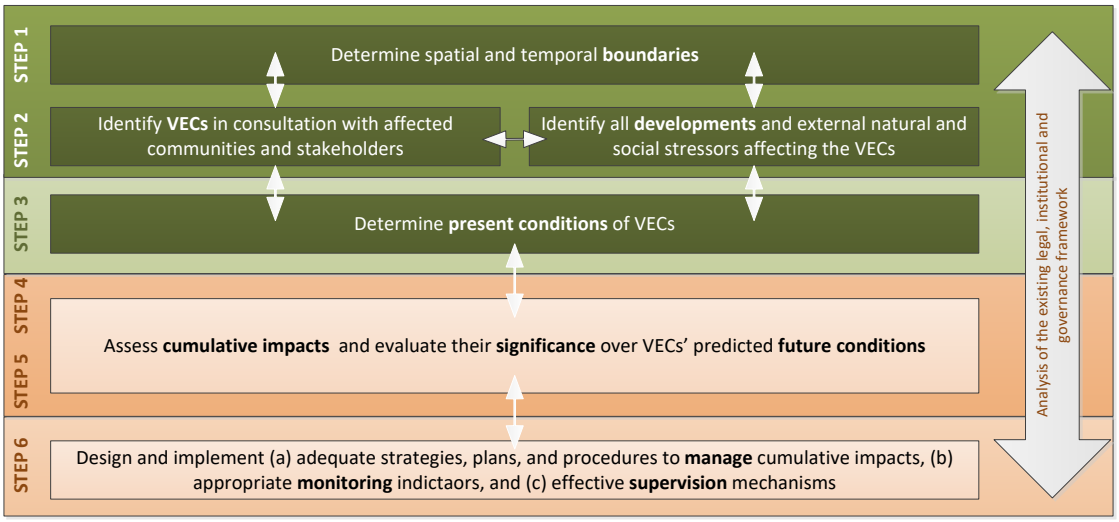
- Identification of selected aspects of the social and natural environment (Valued Environmental Components (VECs)) that are likely to be affected by cumulative impacts.
- Identification of other existing and reasonably anticipated and/or planned hydropower, irrigation and other projects in the Ruzizi watershed that may contribute to cumulative impacts on identified VECs.
- Identification of external environmental and social stressors that could contribute to cumulative impacts.
- Assessment of the future condition of the selected VECs, as the result of the Project's cumulative impacts combined with those of other developments and external stressors.
- Identification of cumulative impact avoidance and minimization measures.
- Definition of monitoring and management of cumulative environmental and social risks.

12.1.2 Methodology

The methodology follows the approach and steps set out in the Good Practice Handbook on Cumulative Impact Assessment and Management for the Private Sector in Emerging Markets (IFC, 2013). The assessment focuses on the environmental and social aspects of the receiving environment that are considered important for assessing risk and which are referred to collectively as "Valued Environmental and Social Components" (VECs). A 6-step approach has been used for the assessment as illustrated in Figure 12-1.

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Source: (IFC, 2013)

Figure 12-1 Six-Step Approach for CIA

12.1.2.1 Steps 1 and 2 – Scoping

The scoping steps 1 and 2 comprise the identification of the VECs to be studied and determination of the spatial and temporal boundaries of each VEC. The VECs were identified by the CIA team based on their experience with hydropower project ESIAs. External activities and natural and social stressors were identified through review of secondary data and from environmental and social baseline survey work conducted in the frame of this ESIA.

12.1.2.2 Step 3 - Determination of the Present Condition of VECs

Baseline conditions of VECs were characterised as part of this ESIA and are documented in Chapters 7 and 8.

12.1.2.3 Steps 4 and 5 – Assess Cumulative Impacts and Evaluate Significance

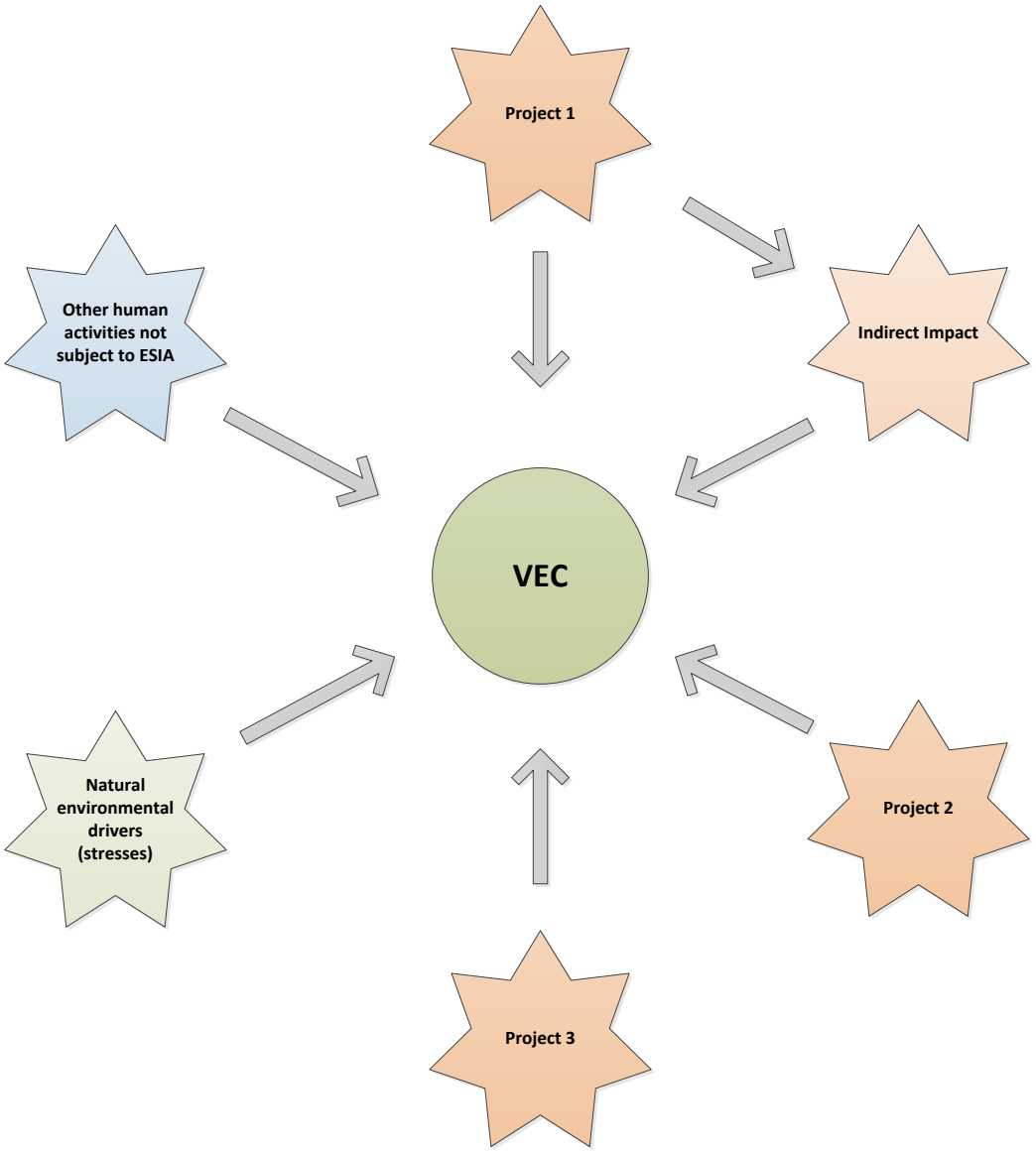
The assessment uses a VEC-centres approach as illustrated in Figure 12-2. Cumulative impacts are assessed quantitatively by considering the relative magnitude of alterations to current and future environmental conditions caused by projects, anthropogenic activities, external factors and environmental stressors.

12.1.2.4 Step 6 - Preparation of a Framework for the Management of Cumulative Impacts

The framework for the management of significant cumulative impacts identified in Step 5 are managed through a set of specific mitigation and monitoring measures that address cumulative impacts and which are different from measures that are specific to the Ruzizi-III impacts assessed elsewhere in this ESIA.

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Source: (IFC, 2013)

Figure 12-2 Schematic Illustrating VEC-Centred Approach

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12.2 Study Area Context

The information provided in the following paragraphs is reproduced from the *Baseline Study of the Basin of Lake Kivu and the Ruzizi River*, prepared for Lake Kivu and Ruzizi River Basin Authority (ABAKIR) by SHER Consult (Groupe Artelia), (SHER, 2020). The information has been redacted to focus on the Ruzizi River Basin.

12.2.1 Administrative and Socioeconomic Setting

The population of the Lake Kivu and Ruzizi River basin is estimated at 11 million inhabitants for the year 2020, distributed as 6.8 million inhabitants in DRC (62%), 2.5 million inhabitants in Rwanda (23%) and 1.7 million inhabitants in Burundi (15%). The rural population of the basin is estimated at 8.5 million (77%), while the urban population is estimated at 2.5 million (23%). The cities of Goma and Bukavu, which dominate the urban population of the basin, each have more than one million inhabitants in 2020. Based on a hypothesis of maintaining the current annual population growth rates for the three countries, the population of the basin should reach 27.5 million inhabitants by 2050, an increase of almost 150% over 30 years. Throughout the basin, the population is characterised by a high level of poverty, especially in areas where insecurity and the presence of armed groups are still prevalent, as well as in rural areas affected by political disturbances.

12.2.2 Physical Setting

The altitude of the Ruzizi River basin is between 770 and 3,400 m. The Ruzizi plain, extends over approximately 1,345 km² at an altitude of between 770 and 950 m. The map of the study area is provided in Figure 12-3.

12.2.3 Surface Water

The watershed of the Ruzizi River occupies 6,057 km² and comprises 31 sub-basins which are tributaries of the Ruzizi River. The Ruzizi River has a total length of 168 km. The Ruzizi River drains water from Lake Kivu to Lake Tanganyika and forms a natural border between Rwanda, DRC and Burundi. On the first 50 km long section from Lake Kivu to the locality of Kamanyola (upper river), the river is embedded between the steep, heavily deforested and bare watersheds of South Kivu in DRC and the District of Rusizi in Rwanda. The Ruzizi-III HEPP is located on this reach. The river crosses an escarpment, and the altitude decreases from 1,450 m to 962 m with numerous waterfalls (gorges). After the escarpment zone, the Ruzizi River extends over a length of 130 km in the plain, gradually falling from an altitude of 962 m to 770 m with a low average slope, before flowing into Lake Tanganyika.

12.2.4 Groundwater

Four main types of aquifers can be defined in the Lake Kivu and Ruzizi River basin, based on their hydrodynamic properties and aquifer potential: (i) Quaternary sedimentary aquifers corresponding to alluvial (fluvio-lacustrine) deposits, mainly found in the alluvial plain of the Middle and Lower Ruzizi, (ii) superficial aquifers located in the alteration zones of metamorphic and crystalline Precambrian bedrock, (iii) deeper discontinuous aquifers located in the fissured zones of Precambrian metamorphic and crystalline bedrock, and finally (iv) complex aquifers located in volcanic terrains (basalt, pyroclastic deposits) of the Cenozoic. The aquifers with one of the highest groundwater capacities are found in the alluvial aquifer of the Ruzizi plain. Groundwater in the basin is mainly exploited from natural springs, primarily for drinking water supply in rural areas.

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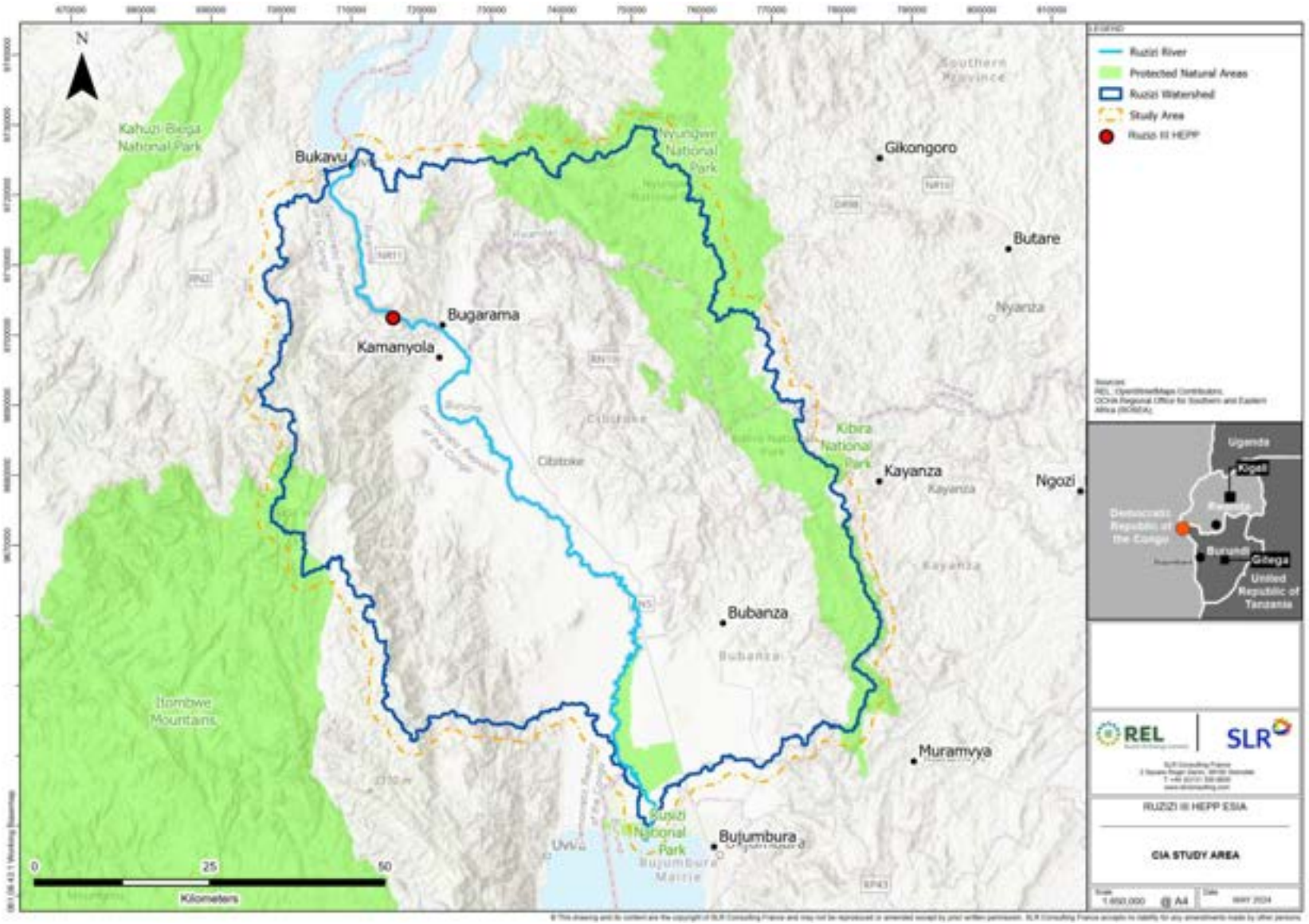


Figure 12-3 CIA Study Area Map

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12.2.5 Land Use

The Lake Kivu and Ruzizi River basin land use/cover comprises 45% agricultural land, 30% forest land, 20% grassland, 3% shrub land and 1% urban areas (in 2020). Agricultural areas thus occupy almost half of the basin area. They are located on steep slopes, with the exception of those located in the Ruzizi plain.

Forest areas with a particularly interesting biodiversity are also present in the basin particularly in the upper reaches of the watershed (such as the Nyungwe and Kibira National Parks that are the source of several tributaries that drain into the Ruzizi River). They play an important role in soil conservation, water resources and biodiversity. They account for 30% of the catchment area's land cover.

Land use in the basin has changed significantly in recent decades. In a quarter of a century, the area devoted to agriculture has increased by 29%, to the detriment of forests and grasslands. The urban area of the basin has increased by 43% in the last ten years, due to the rapid development of the main cities of the basin, notably Bukavu and Bujumbura.

12.2.6 Main Uses of the Basin Water Resources

Drinking water in the Ruzizi River basin is mainly supplied from spring catchments. Agricultural development in the upper catchment of the Ruzizi River based is based almost entirely on rain-fed and subsistence agriculture; it is widely practised on steep slopes that are highly exposed to erosion, and is associated with animal husbandry in stalls, particularly in Burundi and Rwanda. Irrigated agriculture is mainly found in the Ruzizi plain downstream of the Ruzizi III project extending from Bugarama to Lake Tanganyika. There are a large number of irrigated areas with a total surface area of 59,287 ha, mostly split between Burundi and DRC, of which the part corresponding to agricultural areas is only 12,500 ha. However, the agricultural potential of the entire plain is estimated at 125,713 ha.

12.2.7 Soil Degradation

The basin is characterised by very high soil loss from erosion. Canopy reduction, removal or alteration of understorey vegetation, mining, forest destruction, human-induced fires and soil compaction through grazing by domestic animals has greatly increased the risk of soil erosion.

12.2.8 Potential Sources of Pollution

The potential sources of pollution are diverse. Throughout the Lake Kivu and Ruzizi River basin, there is little collective sanitation infrastructure and little solid waste collection.

Bacteriological and chemical contamination due to inadequately treated, poorly treated or untreated domestic and industrial wastewater from the rapidly growing urban agglomerations on the shores of Lake Kivu constitutes a significant risk of degradation of the quality of the lake water near these areas.

As far as solid waste is concerned, large urban agglomerations have led to an accumulation of waste, including non-degradable plastic packaging that ends up in lake and river waters.

12.2.9 Physical-Chemical Quality of Water

The major problem encountered in relation to surface water quality is the massive erosion observed in the basin. This erosion generates extremely high and widespread turbidity in most of the basin's watercourses. The phenomena of sediment transport in the rivers and sediment

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accumulation, with the extreme turbidity observed, is one of the main environmental challenges facing the basin.

The waters of Lake Kivu are influenced by the salt content of the volcanic lava in the region and show consistent concentrations of soluble cations and anions that increase with depth. Electrical conductivity and concentrations of major elements are relatively high at the surface of the lake, with electrical conductivity values of the order of 1,000 to 1,500 µS/cm and a salinity of the order of 1 g/l. A basic pH level of between 8 and 9 is generally observed in the lake.

In its upper course, in addition to the waters of the lake, the Ruzizi River collects the high salinity waters from the volcanic regions of South Kivu and the waters of the thermal springs. The Ruzizi River retains in its upper course many of the physicochemical characteristics of the water of Lake Kivu: pH close to 9, electrical conductivity of around 1,000 µS/cm, and high ionic concentrations (above 1 g/l). After crossing the volcanic zones and entering the plain, the salinity decreases from upstream to downstream, under the effect of dilution by the tributaries of the low salinity Moyenne Ruzizi. In fact, the tributaries of the Ruzizi show, overall, pH values close to neutrality, and very low electrical conductivity (rarely exceeding 200 µS/cm). The major ions are also present in low concentrations compared to the Ruzizi.

12.2.10 Natural Hazards

The most likely natural hazards in the basin are landslides, volcanic eruptions and earthquakes. Landslides are directly related to steep slopes, geology and heavy rainfall.

Floods are directly linked to a rainy event but also depend on the size and shape of the catchment area, its land use and topography. These floods, known as "flash floods", will potentially be more numerous in the future due to climate change, increasing urbanisation and the context of soil degradation linked in particular to land pressure.

The Lake Kivu and Ruzizi River basin is located in the Albertine Rift, the western branch of the East African Rift composed of divergent tectonic plates moving apart at a rate of 6 to 7 mm per year. Numerous earthquakes occur every year. In the last 15 years, more than 28 earthquakes of magnitude greater than 4 on the Richter scale have occurred in the basin. The most powerful of these was recorded in August 2015 with a magnitude of 5.8 in the locality of Kabare in DRC.

In the north of the Lake Kivu and Ruzizi River basin, there are several volcanoes including Nyamulagira and Nyiragongo. The latter is an active volcano located at an altitude of 3,470 m, north of the city of Goma and is particularly well known for containing the largest lava lake in the world. It poses a real danger to the cities of Goma and Gisenyi, which during the eruptions of 1976 and 2002 saw tens of people perish and thousands of others displaced.

12.2.11 Flood Events

Flooding has occurred in recent years in Bujumbura, caused by the overflowing of Lake Tanganyika. Lake Tanganyika water levels reached a record high of 777.2 m in April 2024, breaking its previous record from 1964. Bujumbura, and other coastal towns and cities, were badly affected, hundreds of buildings, including hospitals and schools, were abandoned, and roads and bridges destroyed. The recent flooding is attributed to factors like heavy rainfall associated with the El Niño phenomenon and soil degradation caused by agricultural activities and deforestation. On April 16, 2024, the Burundian government and the UN issued a joint statement appealing for financial aid. The statement reported that over 200,000 people in Burundi had been affected by torrential rains, with nearly 100,000 people displaced. It also stated that relentless rainfall has destroyed 40,000 ha of crops. Similar flooding has occurred in previous years due to heavy rainfall and rising water levels in Lake Tanganyika, including events in 2019, 2020 and 2021. The damages were worsened by flash floods, mudslides, and landslides.

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12.3 Projects and Regional Development

12.3.1 Existing and Future Hydropower Developments

12.3.1.1 Overview

In addition to the Ruzizi-III HEPP, there are 2 existing hydropower schemes and one HEPP under development on the Ruzizi River, key information on these projects is summarised in Table 12-1. Locations of the HEPPs are shown in Figure 12-4.

Table 12-1 Hydropower Projects on the Ruzizi River

Hydropower Scheme (Operator)	Capacity (MW)	Turbining Capacity (m^3/s)	Concept	River length distance upstream from Ruzizi-III HEPP (km)	Status
Existing					
Ruzizi I (SNEL)	29.8	150	Daily regulation (hydropeaking)	28	In operation since 1959
Ruzizi II (SINELAC)	36	150	Daily regulation (hydropeaking)	12	In operation since 1989
Future					
Ruzizi IV	287	150	Run-of-River No reservoir	11 km (water intake) 5.5 (powerhouse)	Feasibility Study ongoing

The Ruzizi-I and -II HEPPs have been in operation with hydropeaking since 1959 and 1989 respectively. This has resulted in alteration of the Ruzizi River hydrology for over 50 years. The current hydrology conditions with the operation of Ruzizi-I and -II are described in the environmental baseline (Chapter 7). The impacts on hydrology described in the assessment of impacts and mitigation (Chapter 11) and the environmental flow assessment (Chapter 10), is in effect an assessment of the cumulative impact of the operation of Ruzizi-I, -II and -III.

The current degree of alteration to the Ruzizi River flow downstream extending from Ruzizi-II to the inflow in Lake Tanganyika decreases with distance. The amplitude of fluctuations in river water level (caused by hydropeaking of Ruzizi-II) decreases with distance from Ruzizi-II. At the Rusizi National Park close to the Lake Tanganyika inflow, the fluctuations in water level are not noticeable. Park authorities, when met by ESIA team, informed that they were not aware of the hydropeaking mode of operation of Ruzizi-I and -II and had not observed any effects on river water levels at the park.

The operation of Ruzizi-III has been designed to align with the operation of Ruzizi-I and -II in a coordinated manner. The Ruzizi-III peak and off peak flow rates will be identical to those of the current operation of Ruzizi-II, and the effects of the pulses of peak and off peak flows in effect shift downstream to a certain extent, but no significant changes in river hydrology downstream from Rwanda-Burundi border are expected (see Chapter 10).

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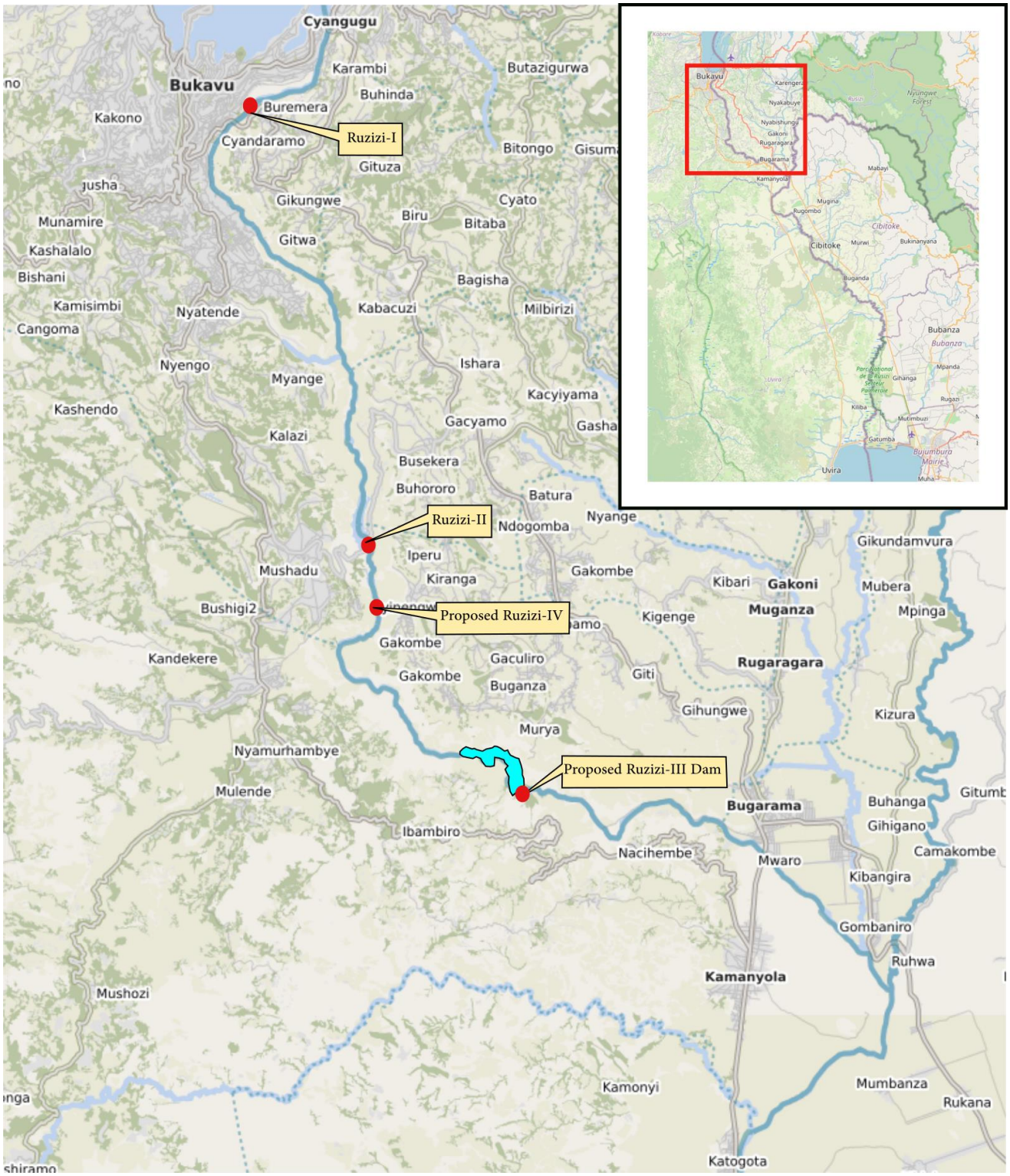


Figure 12-4 Map Showing Locations of Ruzizi-I, -II, -III and -IV HEPPs

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12.3.1.2 Sediment Accumulation

The storage capacity of the Ruzizi-I and -II reservoirs have been significantly reduced by the accumulation of sediment. The origin of the accumulated sediment is soil erosion and landslides within the reservoir rim boundary, partly caused by deforestation from demographic pressure. On the right bank (DRC side) of the Ruzizi River within the reservoir rim boundaries of both Ruzizi-I and -II falls with the extensive dense urban development of the city of Bukavu, which has a population in the order of 2 million inhabitants.

The Ruzizi-III HEPP will be affected by the sediment management of the upstream Ruzizi-I and -II hydropower schemes. At the time of writing, the sediment that has accumulated in the Ruzizi-I and -II reservoirs cannot be flushed downstream because the bottom outlet gates of the two HEPPs are blocked with sediment and cannot be opened.

The operators of Ruzizi-I and -II are currently dredging the reservoirs in an attempt to increase the live storage capacity. For the purpose of this study, it is assumed that the dredged sediment will be returned to the Ruzizi River downstream from Ruzizi-II. If the dredging is successful, it can be expected that additional sediment management measures such as sluicing and flushing may be possible in the future. This would result in enabling the passage downstream of inflowing sediment in the future. However, if the sediment management measures are not successful, the quantities of sediment trapped will continuously increase until the reservoir is completely filled with sediment. If this were to happen, the schemes would not be able to operate with hydropeaking but should be able to continue to operate as run-of-river schemes if the turbines can be protected. In this case the inflowing sediment would overflow downstream.

The Ruzizi-III HEPP, which has a large water storage capacity will be able to accommodate the changes in operation of Ruzizi-I and -II because of overall quantity of water released downstream during the Ruzizi-III reservoir filling time interval will be unchanged, and no consequences on the Project power production capacity are expected.

12.3.1.3 Accumulation of Domestic Waste

There are significant quantities of domestic waste that accumulates in the Ruzizi-I and -II reservoirs. The waste is removed by the operators and because of the lack of suitable municipal waste management facilities and the cost associated with offsite management, the waste is burnt at sites adjacent to the reservoir shores.

12.3.1.4 Fish Ladders

It is also noteworthy that the fish passage systems on Ruzizi-I and -II have been non-functional for decades, and therefore, this has likely affected the population and distribution of migratory fish species in the Ruzizi River. KfW is financing the rehabilitation of the fish ladders and the works are at the planning stage. The rehabilitation of the Ruzizi-I and -II fish ladders would mean that the Ruzizi-III Project will prevent fish from reaching 31 km of river upstream, i.e. reducing the benefits of the fish ladder rehabilitation. However, it needs to be considered that the rehabilitated fish ladders may be totally effective and could be an ideal location for local people to harvest the fish (which is already the case at the pool at the base of Ruzizi II's (inoperable) fish ladder.

12.3.2 Existing and Future Transmission Lines (Associated Facilities)

Electrical power generated by the Ruzizi-III HEPP is transported via the project's 200 kV transmisison line to the Kamanyola substation in DRC (an associated facility). The Kamanyola substation is developed by EGL and will be operated by SINELAC, who will manage the equal sharing of the power with Burundi, DRC and Rwanda.

Transmission lines (associated facilities) that will connect to the Kamanyola substation as listed below. All these transmisison lines are currenty at the planning stage – feasibility studies and

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ESIAs in alignment with international standards have been undertake, and construction will be completed before the start of the opertation of the Project:

- The Project's 220 kV line (7 km) from the Project's 220 kV switchard adjacent to the Ruzizi-III powerhouse.
- Kamanyla – Bujumbura (Burundi) 220 kV line (77 km).
- Kamanyola – Kiliba and Uvira (DRC) 220 kV line (~80 km)
- Kamanyola – Buhandahanda (DRC) 220 kV line (68.5).
- Kamanyola – Kibuye (Rwanda) 220 kV line (82 km).

In addition, a 220 KV transmission line from Ruziz-IV will also need to be constructed to transport the electrcity to the Kamanyola substation. The routing of the Ruzizi-IV transmission line is not currently available.

The layout of the above lines and other lines that make up the inter-regional network are illustrated in the Figure 12-5.

12.3.3 Ruzizi-III Quarries and Borrow Areas

Quarries and borrow areas will be required during the Ruzizi III HEPP construction. Potential quarry and borrow areas have been identified by REL (see Table 12-2). However, the EPC contractor will select the sites to be exploited, and these may include some or all of the potential sites identified by REL or alternative sites. The locations of the potential quarries and borrow areas identified by REL for the Ruzizi III HEPP are illustrated in Figure 12-6 .

Table 12-2 Potential Quarries and Borrow Areas for the Ruzizi III HEPP

Country	Site	Type of material	Area (ha)
DRC	Bwegera	River Sand	8*
	Kirindangumi	River Sand	8*
	Ruvubu River	River Sand, coarse grained gravelly sand	25
	Lower Nyarubare	Basalt Aggregates	1.3
	Upper Nyarubare	Basalt Aggregates	2.5
	Mt. Rubona	Sandstone Aggregates	8*
	Total DRC		52.8
Rwanda	Ntangara River	River Sand, Medium to coarse grained Sand with mica flakes	8*
	Kirimbi River	River Sand, Fine to medium with visible organic matter / mica	8*
	Kirimbi Delta	River Sand, Fine to medium grained with micas	8*
	Kigoya River	River Sand, Dark Brown Silty Sand	8*
	Karundura River	Whitish Grey, medium to coarse grained sand	8*
	Gihungwe	Mafic, fine grained columnal basalt	8*
	Quartzite APD	Light grey, slightly foliated, Quartzite Schist	8*
	Gishoma Power Plant	Lateritic Clayey Soil for Dam Core	8*
	Coline Butambamo	Type of Material: Lateritic Clayey Soil	8*
	Nyagahand	Lateritic Clayey Soil	8*
	Total Rwanda		80
Burundi	Rukana II	Lateritic Clayey Soil	3
	Rukana I	Basalt rock	11
	Binyange	Lateritic Clayey Soil	6
	Total Burundi		20
Grand Total (DRC, Rwanda and Burundi)			152.8
* To be defined by the EPC Contractor, for the purpose of this CIA assumed to occupy an area of 8 ha.			

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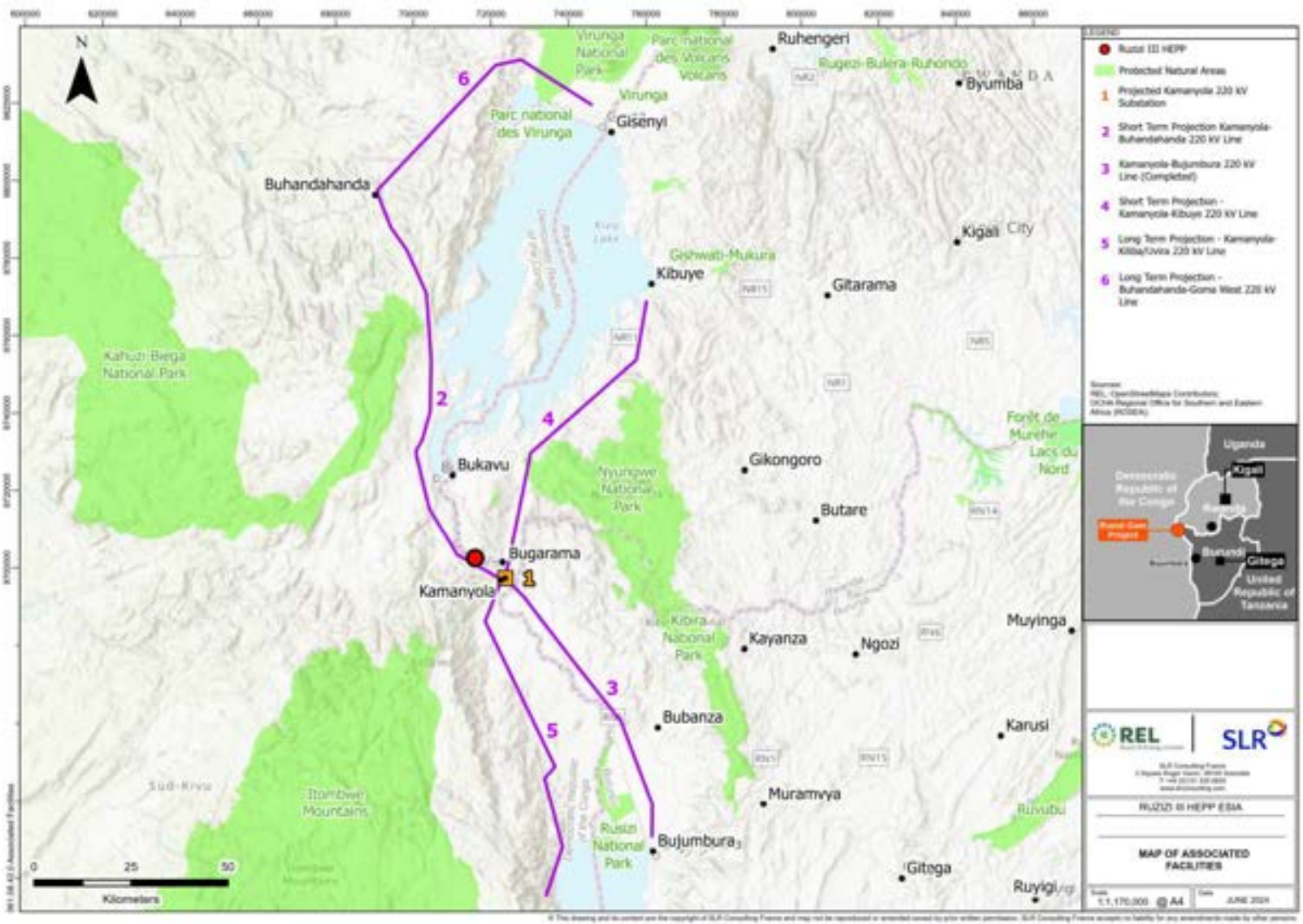


Figure 12-5 Regional Transmission Line Network (Associated Facilities)

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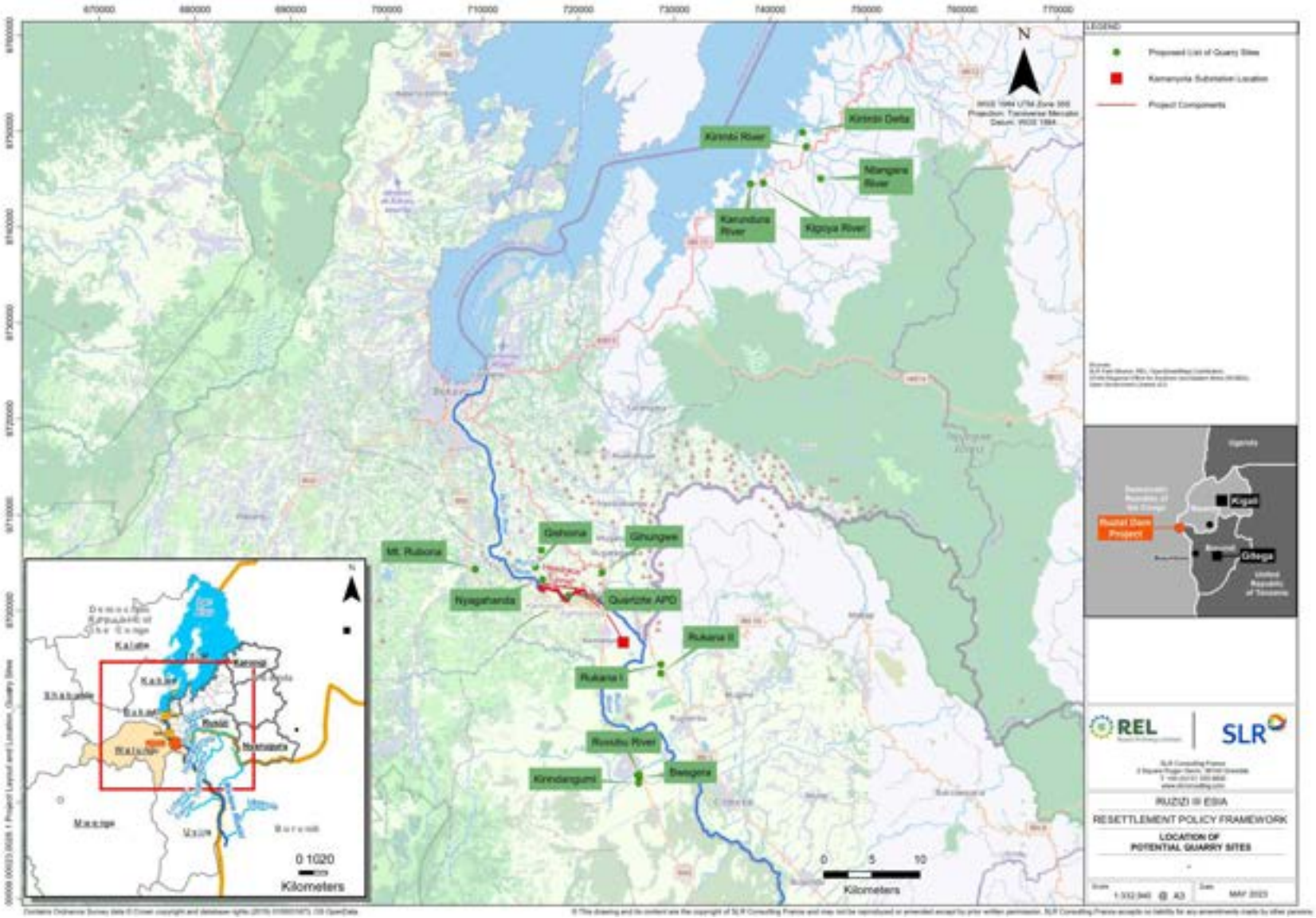


Figure 12-6 Locations of Potential Quarry Sites

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12.3.4 Master Plan for the Development of the Ruzizi Plain

In the frame of CEPGL's Integrated Regional Programme[1], a master plan for the development of the Ruzizi plain[2] was prepared in 2019.

The total area of the Ruzizi plain is 177,905 ha, with an agricultural potential of 125,713 ha. Within the boundaries of the plain there are a large number of developed irrigated areas with a total surface area of 59,287 ha, mostly shared between Burundi and DRC, but of which only a fifth (12,500 ha) was functional in 2019. The irrigation areas suffer from technical and social problems that hinder the development and exploitation of their potential.

The Master Plan comprises development of six categories of projects: (i) Sugar Plant Irrigated Areas, (ii) Functional Irrigated Areas, (iii) Priority 1 Planned Irrigated Areas, (iv) Priority 2 Planned irrigated Areas, (v) Projected Irrigated Areas, and (vi) Annual Investment Plan zones (AIP). The summary is presented in Table 12-3 and locations are shown in Figure 12-7.

Table 12-3 Summary of Irrigation Area Categories

Irrigation area category (IA)	Area per Country (ha)			Total area (ha)	Percentage (%)
	Burundi	DRC	Rwanda		
Sugar Plant IA	2,331	4,371	-	6,702	11.3%
Functional IAs	5,726	-	-	5,726	9.7%
Priority 1 Planned IA	6,022	8,642	2,270	16,934	28.6%
Priority 2 Planned IA	2,493	12,631	-	15,124	25.5%
Projected IA	9,378	2,383	-	11,761	19.8%
AIP Zone	-	3,040	-	3,040	5.1%
Total	29,950	31,067	2,270	59,287	100%

The sub-catchment areas with the greatest irrigation potential are:

- Kiliba in DRC (13,973 ha)
- Mpanda in Burundi (9,299 ha)
- Luvubu in DRC (8,513 ha).

The only catchment located in Rwanda which has an irrigation potential is the Rubyiro catchment (2,270 ha).

The main crops cultivated in the irrigated areas comprise rice, maize, market gardening, beans, sweet potato, and tomato.

In total, the estimated annual water needs for all the areas amounts to 486 million m^3/year. The current annual water needs corresponding to the functional areas amount to 102 million m^3/year. However, the water for the irrigation is not abstracted from the Ruzizi River but is diverted from the various tributaries.

The average annual flow rate of the Ruzizi River at the inflow to Lake Tanganyika is 206 m^3/s, which corresponds to an annual volume of 6,500 million m^3. The reduction in flow from the diversion of tributary water (486 million m^3) to the irrigated areas represents 7.5% of the annual flow.

[1] *Programme Régionale de Développement intégré de la plaine de la Ruzizi* (PREDIR)
[2] *Schéma Directeur d'Aménagement de la plaine de la Ruzizi* (SDAR)

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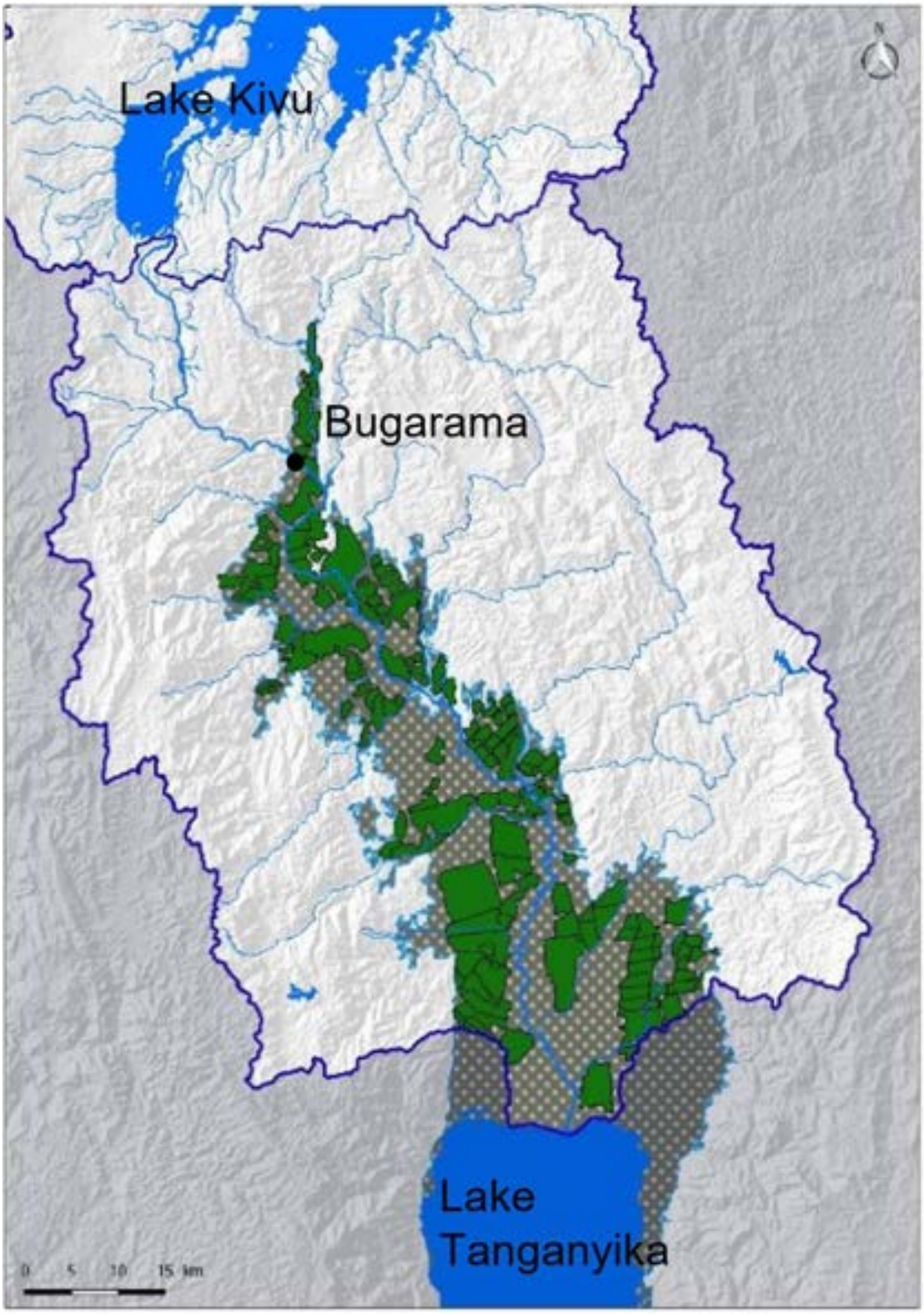


Figure 12-7 Irrigated Perimeters in the Ruzizi Plain

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12.3.5 Water Abstraction for Use as Potable Water

The Republic of Rwanda (MINIRENA-RNRA) published in 2015 the Rwanda National Resources Master Plan with the objective to ensure a sustainable water resources development, utilisation and management in the country. The plan includes an estimate of the quantity of water abstracted from the Ruzizi for use as potable water. The volume estimated was 0.9 million m^3 per year, which is negligible compared to annual flow of the Ruzizi, which is 6,500 million m^3 per year. This low volume of abstraction can probably be explained by the unsuitability of the Ruzizi River water for potable water use as it is degraded from receiving untreated sewage from the city of Bukavu (DRC), which has a population of over 2 million and is without municipal sewage collection and treatment infrastructure.

12.3.6 Gishoma Peat-Fuelled Power Plant

Since 2010, the Government of Rwanda started development of the 15 MW peat fired thermal power plant in Gishoma, Ruzizi District, to reduce electricity deficit which the country was facing and to coincide with a significant growth of electricity demand observed in the region as a result of the expansion of the local cement factory and country development. The project was completed in 2017. The peat fired in the power plant is extracted from Gishoma peat bog that covers a surface of 420 ha. The peat is extracted seasonally, during the dry season, while crops are cultivated during the wet season. Figure 12-8 shows the location of Gishoma thermal PP and peatland.

12.3.7 Other Anthropogenic Activities

12.3.7.1 Mining

Mining activities in the Ruzizi plain watershed are dominated by artisanal mining, with very little investment in improving working conditions or environmental protection. Existing legislation is not really binding on these small-scale mines, which are a potential source of contamination of surface water through, for example, the release of mercury into water bodies. Artisanal gold mining has developed significantly in the region, particularly in South Kivu province and in the rivers of Burundi (ABAKIR, 2021).

The exploitation of minerals takes place mainly in the riverbeds of the Ruzizi tributaries. This activity, mostly developed in an artisanal way (but on a large scale in places, particularly in the Muhira River), causes severe degradation of the riverbeds and conflict over the use of water.

According to the online mining cadastre[3], the closest mining licences (research or production) from the Project that have been awarded are the following:

- Research licence for gold, diamond, and tin in DRC, 25 km South of Kamanyola.
- Research authorizations for calcium carbonate in DRC, 5 km and 10 km South of Kamanyola.
- Research authorization for limestone, sandstone and silica in DRC, 15 km South of Bukavu.

A gold, copper and silver mine project is operated by Tanganyka Mining Burundi in Mabayi, located in the Cibitoke province. Mabayi is located is the Northeast part of Burundi, approximately 30 km East of Bugarama. In July 2021, operations were stopped by the government. The Minister of Hydraulics, Energy and Mines reported that the company had not complied with the terms of the contract.

[3] http://drclicences.cami.cd/EN/

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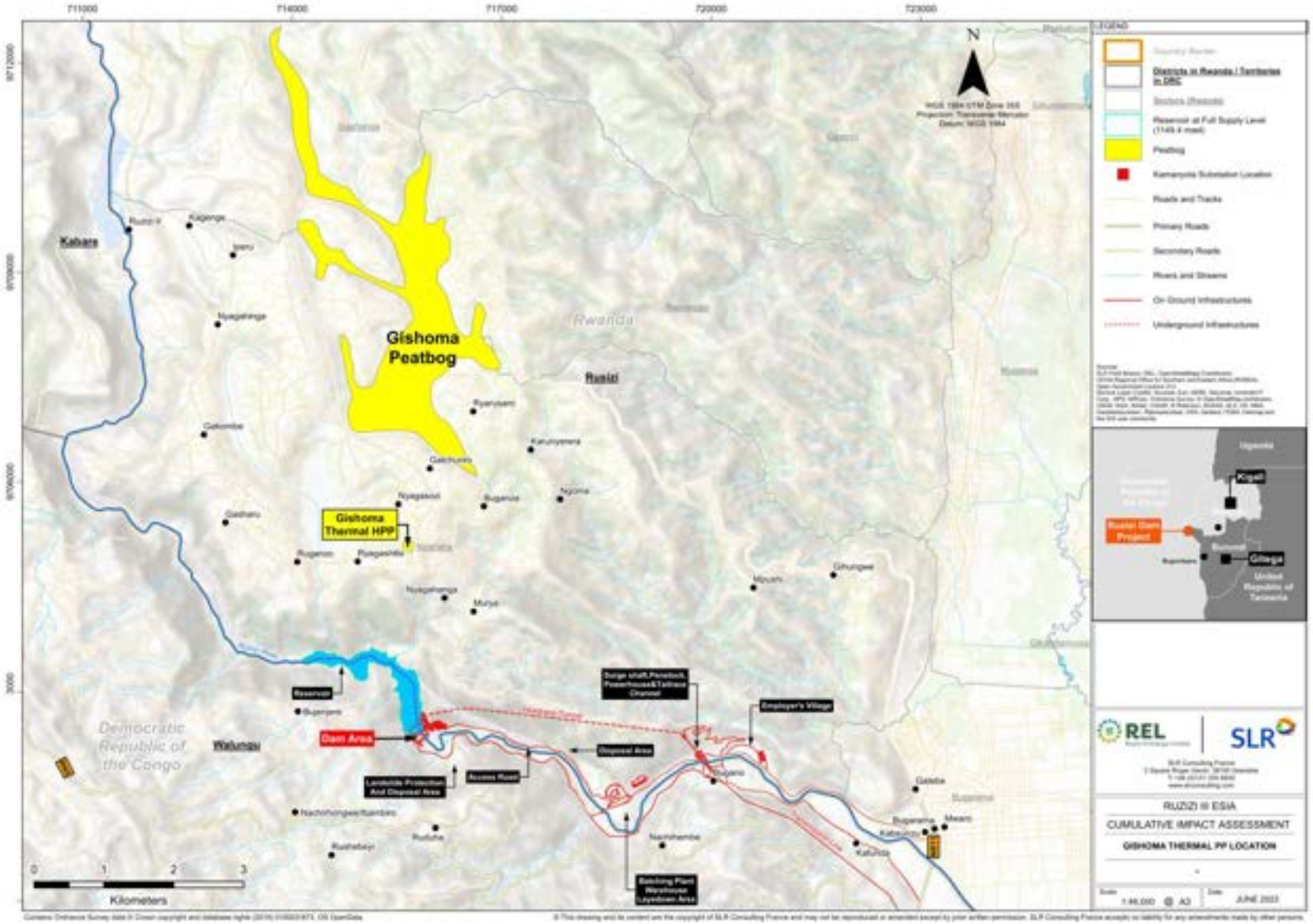


Figure 12-8 Location of Gishoma thermal PP and peatland

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12.3.7.2 Cement Factories

Limestone rock is present in the south of the Kivu Basin and in the Ruzizi River basin. There are two cement factories in the Ruzizi plain:

- CIMERWA factory was established in 1982 and is located in Muganza sector (Rwanda), in the town of Bugarama. The installed factory capacity is 600,000 metric tonnes annually.
- BUCECO cement factory was established in 2011 and is located in Cibitoke city in Burundi (25 km South of Bugarama). The installed factory capacity is 300,000 metric tonnes annually.

12.3.7.3 Aquaculture

The FAO is sponsoring fish farming programmes in the Ruzizi plain. Fish fry are developed at a pilot project managed by the Bukavu's ISP consisting of several fish ponds adjacent to the Ruzizi River near Kamanyola, DRC. The fish fry are then transported to artisanal fish farms in the Ruzizi plain. In the Imbo plain in Burundi, there are a total of 2,091 fishponds producing nearly 68 tons of fish annually. The fishponds are supplied with river water occasionally to top them up. However, they do not require a continuous supply of water. Most fishponds are supplied with water from the Ruzizi's tributaries rather than the Ruzizi River. The pilot project near Kamonyala, where the fish fry develop is however supplied by diverting water from the Ruzizi River.

12.3.7.4 Tea Plantations

Rwanda produces approximately 30,000 tonnes of tea annually[4], cultivated over an area of 26,000 ha. Among the fifteen tea factories established in Rwanda, eight are present in the Western Province of Rwanda east of Cyangugu. However, there are no tea plantations in the Ruzizi plain or on areas that overlap with Ruzizi-III Project facilities.

[4] https://rdb.rw/export/export/products-directory/tea-sector/

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12.4 Environmental Stressors and External Factors

12.4.1 Demographic Changes

The population of the lake Kivu and Ruzizi River basin in 2020 was estimated at 11 million inhabitants, with 6.8 million inhabitants in DRC (62%), 2.5 million in Rwanda (23%) and 1.7 million in Burundi (15%). Given the current annual population growth rate in the three countries, the population of the basin is predicted to reach 27.5 million inhabitants in 2050, an increase of almost 150% over 30 years (ABAKIR, 2021). The population of the Ruzizi plain has an annual population growth rate of 3.03% and will increase from 3.4 million inhabitants in 2016 to around 5.9 million in 2040 (9 million when considering nearby cities). The population is predominantly rural (85.3%) and with extensive poverty with 33-60% of people living below national poverty lines (SDAR, 2019).

12.4.2 Land Cover / Land Use Changes

In 2016, the catchment area of the Lake Kivu and Ruzizi River Basin comprised 45% agricultural land, 30% forest, 20% grassland, 3% shrubland and 1% urban area. The agricultural areas around Lake Kivu and the Ruzizi River are mainly located on steep slopes, with smaller irrigated areas in the Ruzizi plain. Over the past 25 years, the land area dedicated to agriculture has increased by 29%, with more than 3,200 km^2 now used for agricultural purposes. Conversely, the area covered by forest has decreased to 530 km^2 and grassland areas have declined to 2,500 km^2. Although urban land use represented only 1% of the study area in 2016, the size of the urban area increased by 43%, from 164 km^2 to 290 km^2, between 2011 and 2020, with an average annual growth rate of around 3%. This shows that cities are expanding rapidly.

12.4.3 Climate Change

Climate change studies undertaken by ABAKIR (2021), predict that annual rainfall in the Lake Kivu and Ruzizi River Basin area will tend to increase slightly for all the climate change scenarios studied. However, most scenarios show a significant increase in rainfall in November, December and January in the range of 11-19% by 2050. A decrease in precipitation of around 2% is expected for the month of July. The models predict a significant average temperature increase by 2050, in the range of 0.6-2.3°C for the most favourable scenario and from 1.1-3.2°C for the most unfavourable. However, the study concludes it is unlikely that predicted changes in rainfall will lead to widespread water scarcity in the region, but the increased temperatures and a changed monthly rainfall distribution, the occurrence of prolonged and more frequent droughts is more likely. The current variations induced by climate change combined with the effects of increased erosion in the sub-watersheds of Lake Kivu and the Ruzizi River are already leading to significant soil degradation (see below).

The Project has undertaken a climate vulnerability assessment during the feasibility study through the application of the Hydropower Sector Climate Resilience Guide (Tractebel, 2020c) and this is described in section 11.2. The findings are consistent with the trends reported by ABAKIR.

The climate change vulnerability assessment informed the design of the Ruzizi-III spillway. The spillway is designed with a capacity to allow the safe discharge of a 10,000-year return period flood (986 m^3/s) and has been checked for the Probable Maximum Flood (PMF) (1,420 m^3/s). This means that when flash flood occur, the flood waters can be safety routed downstream and the flow rate will be no higher than the situation without the dam. The presence of the dam will have an attenuation effect and reduce the flow rate of the flood peak flow.

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12.4.4 Anthropogenic Pollution

Diverse potential sources of river water pollution are present in the Ruzizi catchment. Throughout the catchment area there is no collective sanitation infrastructure, nor solid waste collection. Bacteriological and chemical contamination from inadequately treated, poorly treated or untreated domestic and industrial wastewater from rapidly growing urban agglomerations adds chemicals, biochemical oxygen demand and effluent to surface waters cause degradation of the quality of the. The intensification of agriculture leads to contamination of surface and groundwater.

12.4.5 Soil Degradation

Rapid population growth In the Ruzizi River basin, has resulted in small-scale agriculture to be increasingly characterised by overexploitation of the natural resources on which it is based. In the short and medium term, this overexploitation leads to soil degradation phenomena that in turn lead to declining soil productivity, mud- or landslides and decreased quality and production of drinking water. In addition, canopy reduction, removal or alteration of understorey vegetation, mining, forest destruction, human-induced fires and soil compaction through grazing by domestic animals greatly increase the risk of soil erosion. Annual soil losses in different parts of the basin are estimated to range from 91-290 t/ha/year. The highest erosion rate is found in the Chabiringa sub-catchment and is due to its young, poorly structured and friable volcanic soil type and limited vegetation cover. Conversely, the rate of erosion on undisturbed forest land is generally very low. The sediments carried by the Ruzizi are mainly brought in by direct tributaries. (ABAKIR, 2021).

Slope stability and landslide risks in the Ruzizi gorge are described in Chapter 7 baseline situation. There has been a major landslide on the right bank in the vicinity of the proposed Ruzizi-III dam site and there are 22 areas on both sides of the Ruzizi River where slopes are subject to landslides which contribute to sediment load in the river.

12.4.6 Natural Hazards

The Ruzizi River is located in the Albertine Rift, the western branch of the East African Rift, which is composed of divergent tectonic plates moving apart at a rate of 6-7 mm per year. Numerous earthquakes occur every year and in the past 15 years more than 28 earthquakes of a magnitude greater than 4 on the Richter scale have occurred. Large dam-reservoirs can under certain conditions can induce seismic activity, a phenomenon known as Reservoir Induced Seismicity (RTS).

The International Commission On Large Dams (ICOLD) has defined thresholds for potential RTS for dam-reservoirs. For there to be a risk of RTS the dam hight needs to be over 100 m and the reservoir capacity greater than 500 million cubic metres. The Ruzizi-III has a dam height of 51 m, and a total storage volume at full supply level of 7.7 million cubic metres.

Floods are directly linked to a high rainfall event but also depend on the characteristics of the catchment (size, form, land use, topography). Floods are expected to be more frequent in the future due to climate change, increasing urbanisation and greater soil degradation linked to land pressure in particular. In April 2020, high rainfall in the catchment caused the area of the Ruzizi delta adjacent to Bujumbura, Burundi to be subject to flooding, affecting some 6,000 households and in DRC, nearly 20,000 farming households were affected, and 10,000 ha of food and market gardening crops were destroyed (ABAKIR, 2021).

Lake Tanganyika water levels reached a record high of 777.2 m in April 2024, Bujumbura, and other coastal towns and cities, were badly affected, hundreds of buildings, including hospitals and schools, were abandoned, and roads and bridges destroyed. Burundian government and the UN reported that over 200,000 people in Burundi had been affected by torrential rains, with nearly 100,000 people displaced.

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12.5 CIA Temporal & Spatial Boundaries

12.5.1 Spatial Boundaries

12.5.1.1 Ruzizi III Project Area of Influence

The areas included in the CIA with regard to the Ruzizi III Project area of influence are defined as follows:

- Footprint occupied by temporary and permanent Project facilities.
- Temporary and permanent roads and access tracks constructed for the Project.
- Zones surrounding the above areas potentially affected by noise, dust, changes in air quality and runoff.
- Villages and lands owned or utilised by people affected by economic or physical displacement caused by Project.
- Reaches of the Ruzizi River directly affected by the Project, and which extend from the reach impounded by the Project reservoir to Lake Tanganyika (but excluding the lake).

The following are excluded from this CIA:

- Areas occupied by Associated Facilities (see section 12.3.2). This is because they are not located within the boundaries of Project's area of influence, and ESIAs for the Associated Facilities will include a CIA.
- Areas occupied by quarries and borrow areas used by the Project. This is because site selection will made at a later stage by the EPC contractor, and ESIAs for the quarries and borrow areas will include a CIA.

12.5.1.2 Regional Development, Environmental Stressors and External Factors

The areas included in the CIA with regard to regional development, environmental stressors and external factors encompasses the Lake Kivu and Ruzizi River Basin.

12.5.2 Temporal Boundaries

The Ruzizi River has been modified by the operation of the Ruzizi-I and -II hydropower schemes which were commissioned in 1959 and 1989 respectively. The Ruzizi-III Project is expected to start power production in 2029 and the power production agreement has a duration of 25 years.

Consequently, the temporal boundaries for the CIA are 1959 – 2054.

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12.6 Identification of VECs

12.6.1 Initial VEC Identification

Valued environmental components (VECs) are defined as fundamental elements of the physical, biological, or socioeconomic environment, (including the air, water, soil, terrain, vegetation, wildlife, fish, birds, and land use) that are likely to be the most sensitive receptors to the impacts of a proposed project or the cumulative impacts of several projects.

A set of initial VECs was developed based on the experience of the CIA team and with input from institutional stakeholders and communities.

The initial VECs are listed in Table 12-7 and are grouped under the following main types of VEC:

- River hydrology
- River geomorphology
- Fish and aquatic habitat
- Designated conservation areas
- Socioeconomics
- Community health and safety

The initial VECs have been screened and final VECs selected for further assessments using the process described in 12.6.3.

12.6.2 Stakeholder Participation

12.6.2.1 Engagement with Institutional Stakeholders

Several institutional stakeholders were met in 2022 during the preparation of the draft CIA. The purpose of the meetings was to inform the stakeholders of the ongoing ESIA process and interim findings of the assessment, and to collect secondary data and give stakeholders the opportunity to inform the ESIA team of their expectations and concerns. Institutional stakeholders encountered, topics discussed, and feedback are summarised in Table 12-4.

Table 12-4 Engagement with Institutional Stakeholders

Stakeholder	Date	Country	Topics Discussed	Key Feedback
Regidesco	22 Feb. 2022	Burundi	Status of 220 KV Kamanyola-Bujumbura transmission line project	Project construction due to start in Q2 2022, with funding from AfDB.
Office Burundais pour la Protection de l'Environnement (OBPE)	22 Feb. 2022	Burundi	Environmental and social situation at the Rusizi Delta Park (RAMSAR site) Alteration to hydrology and sediment transport from current operation of Ruzizi-I and -II	The biggest challenge facing the park is poaching and encroachment from adjacent informal development. There are currently no noticeable effects of the hydropeaking mode of operation of Ruzizi-I and -II Recent flooding in May 2021 is a major concern.
Lake Kivu and Ruzizi River Basin Authority (ABAKIR)	25 Feb. 2022	Rwanda	Alteration to hydrology and sediment transport in the Ruzizi River downstream from Ruzizi-I and -II, Master Plan for the Development of the Ruzizi Plain	There are no particular concerns regarding the hydropeaking mode of operation of Ruzizi-I and -II. Flooding at Bujumbura in April 2020 and May 2021 was raised as a major concern.

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Stakeholder	Date	Country	Topics Discussed	Key Feedback
Société Nationale d'Electricité (SNEL)	28 Feb. 2022	DRC	Operation of Ruzizi-I HEPP and current environmental and social issues	Accumulation of domestic waste in the reservoir is a major problem. Reservoir capacity significantly reduced by the accumulation of sediment.
Société Internationale d'Electricité des pays des Grands Lacs (SINELAC)	28 Feb. 2022	DRC	Operation of Ruzizi-II HEPP and current environmental and social issues	Accumulation of domestic waste in the reservoir is a major problem. Reservoir capacity significantly reduced by the accumulation of sediment. Only 2 of the 3 turbine groups currently in operation. Fish pass is not operational.
Département de Biologie ISP Bukavu	28 Feb. 2022	DRC	Fish farming in the Ruzizi Plain	Fish farming activity adjacent to Kamanyola is for development of fish fry which are then distributed to fish farms in the Ruzizi Plain -a project funded by the FAO. The Ruzizi-III Project is not expected to affect the activity as the fishponds at Kamanyola are only filled from the river periodically, and fishponds on Ruzizi Plain are supplied with water from tributaries of the Ruzizi.
Rwanda Energy Group (REG)	2 March 2022	Rwanda	Status of 220 KV Kamanyola – Kibuye transmission line	A Pre-Feasibility and ESIA for the Project were carried out in 2014, but the studies will need to be updated

12.6.2.2 Engagement with Communities during the Social Baseline Survey

Potentially affected communities in DRC and Rwanda were given the opportunity to express concerns about the Project and potential impacts and risks during the social survey conducted in January and February 2022. Communities in Burundi were not engaged because no land acquisition is planned in Burundi. In addition, the ESIA has assessed that the incremental impacts on river hydrology, sediment transport and bank erosion in Burundi from hydropeaking operation of Ruzizi III will not be significant compared to the alterations caused by ~50 years of hydropeaking mode of operation of Ruzizi-I and -II.

12.6.2.3 Meetings with Rusizi National Park Authorities

In addition to the meeting held in 2022, a second meeting was held 18 June 2024. The key findings are as follows:

- The number of visitors to the park is declining because of the recent flooding and proximity of the informal settlements living in extreme poverty. People do not want to visit the park because of the presence of dangerous animals and the parks limited resources to protect visitors.
- The park needs to be protected from neighbouring population who are entering the park to collect wood and hunt. At the moment the park is unable to patrol because of fuel shortages in Burundi.
- There is currently no environmental monitoring.
- Because of the recent flooding, animals have escaped, and the park has lost 12 antelope eaten by dogs.

The priority actions are as follows:

- Build a protection dyke to protect the park from flooding.
- Stop poaching.
- Increase the work by women who help with clearing weeds, dead wood and keep the park clean.
- Make the park functional, as currently, the park is not functional.

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12.6.2.4 Focus Group Discussions with Communities

To involve communities in the CIA process, a series of consultations were organised in May 2024. The consultations were in the form of Focus Group Discussions (FGDs). The purpose of the consultations was to inform the communities of the Project activities and to initiate discussions on themes and topics that are of concern to the people. The CIA team identified VECs that are of importance to the communities from review and interpretation of responses to the questions asked in the FGDs.

The FGDs were organised in villages near the Ruzizi River in Rwanda, DRC and Burundi. In each village a FGD with both men and women, and with women only were organised. The duration of each FGD was 60-90 minutes, and there were about 8 participants of varying ages and positions in the village participating.

The villages, country and dates of the FGDs are provided in Table 12-6. The minutes, attendance sheets and photographs are provided in Vol. III Annexes. The location of the villages where FGDs were held are shown on the map provided in Figure 12-9.

Table 12-5 List of FGDs with Communities

Country	Village	Date of FGD	N° participants	
			Male	Female
Rwanda	Kabeza / Nyange call / Bugarama sector / Rusizi District	17 May 2024	6	5
	Nyangahanga / Murya cell / Nzahaha sector / Rusizi District	17 May 2024	3	5
DRC	Kafunda village / Nyangezi / groupement Kashenyi	23 May 2024	7	8
	Nacihembe village / Kamanyola / groupement Karhongo	24 May 2024	6	5
Burundi	Cibitoke	18 June 2024	3	3

The FGDs were centred on 5 questions as shown in Table 12-6.

Table 12-6 Questions, Responses and VECs Identified during FGDs with Communities

Question	Summary of responses	Specific concerns expressed by women	Corresponding VECs determined from interpretation of FGD outcomes
#1 What economic changes do you think might happen in the village because of the Project and why - and how important is that to you?	• Job opportunities • Higher salaries • Increase in small businesses opportunities • Inflation • Higher house rental prices • Increased demand and price of commodities • Improved access to banks • Infrastructure improvement • Improved public services • Access to electricity • Development of local economy	• Increased demands for food and non-food items • Men/husbands may leave the village because they have become richer • Job opportunities for women	Quality of life Infrastructure
#2 What changes to the cultural life and social fabric of the village might happen because of the Project, how important is that to you?	• Introduction of new cultural practices – causing family conflicts • Social changes causing family conflicts • Lifestyle changes could shift social norms • Social conflict with newcomers • Reduction of youth migration to urban areas	• Increased presence of illegitimate children • Men/husbands may leave the village because they have become richer • Increased prevalence of STD and other diseases • Negative influence of culture – bad behaviour by young girls and married women, divorce • Increase in GBVH	Traditional way of life

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Question	Summary of responses	Specific concerns expressed by women	Corresponding VECs determined from interpretation of FGD outcomes
	• Increased cohesion between Burundi, DRC and Rwanda	• Increased drunkenness among men • Increased polygamy	
#3 What are your concerns regarding the employment of workers from outside the region at the Project worksites? How might the presence of the workers affect the life in the village? How important is that for you?	• Competition with incoming workers for jobs • Social conflicts with incoming workers • Increase renting of properties • Increased pressure on health education services • Inflation	Risk of GBVH Foreign workers and opportunity seekers could include thieves, swindlers, prostitutes Village girls and women become prostitution	Traditional way of life Family cohesion Public services
#4 What changes to the natural environment caused by the Project are you concerned about and why?	• Pollution of water • Reduced water availability • Habitat destruction and disturbance of wildlife • Noise pollution - disturbance of animals and people • Overfishing in the Ruzizi River • Loss of access to river for fishing • Loss of medicinal plants • Inappropriate disposal of waste	No specific comments	Water Natural habitat Wildlife
#5 Please list the 6 most important aspects of your community and way of life we discussed, by order of priority. For each one, explain why it is important.	<u>Rwanda</u> 1. Employment 2. Local business opportunities 3. Access to public services, and improving quality of life 4. Community engagement participation 5. Environmental protection 6. Maintaining traditions & strong community ties <u>DRC</u> 1. Access to drinking water 2. Building schools 3. Environmental protection of the Ruzizi River watershed 4. Rehabilitation of health centres 5. Building of access roads to access agricultural land 6. Access to electricity 7. Income-generating activities for women, young people and people with disabilities 8. Rehabilitation of markets to people sellers of necessities. 9. Socio-professional training centre to strengthen our children's vocational training. <u>Burundi</u> 1. Modernisation of agricultural practices 2. Improved housing 3. Improved health services 4. Improved quality of life 5. Improved education 6. Improved transborder relations	<u>Rwanda</u> No specific comments <u>DRC</u> No specific comments <u>Burundi</u> 1. Business opportunities for women 2. Trans-border relations 3. Job opportunities for women 4. Womens' support groups 5. Quality of life 6. Personal development	Quality of life Public services Natural environment Traditions and community cohesion

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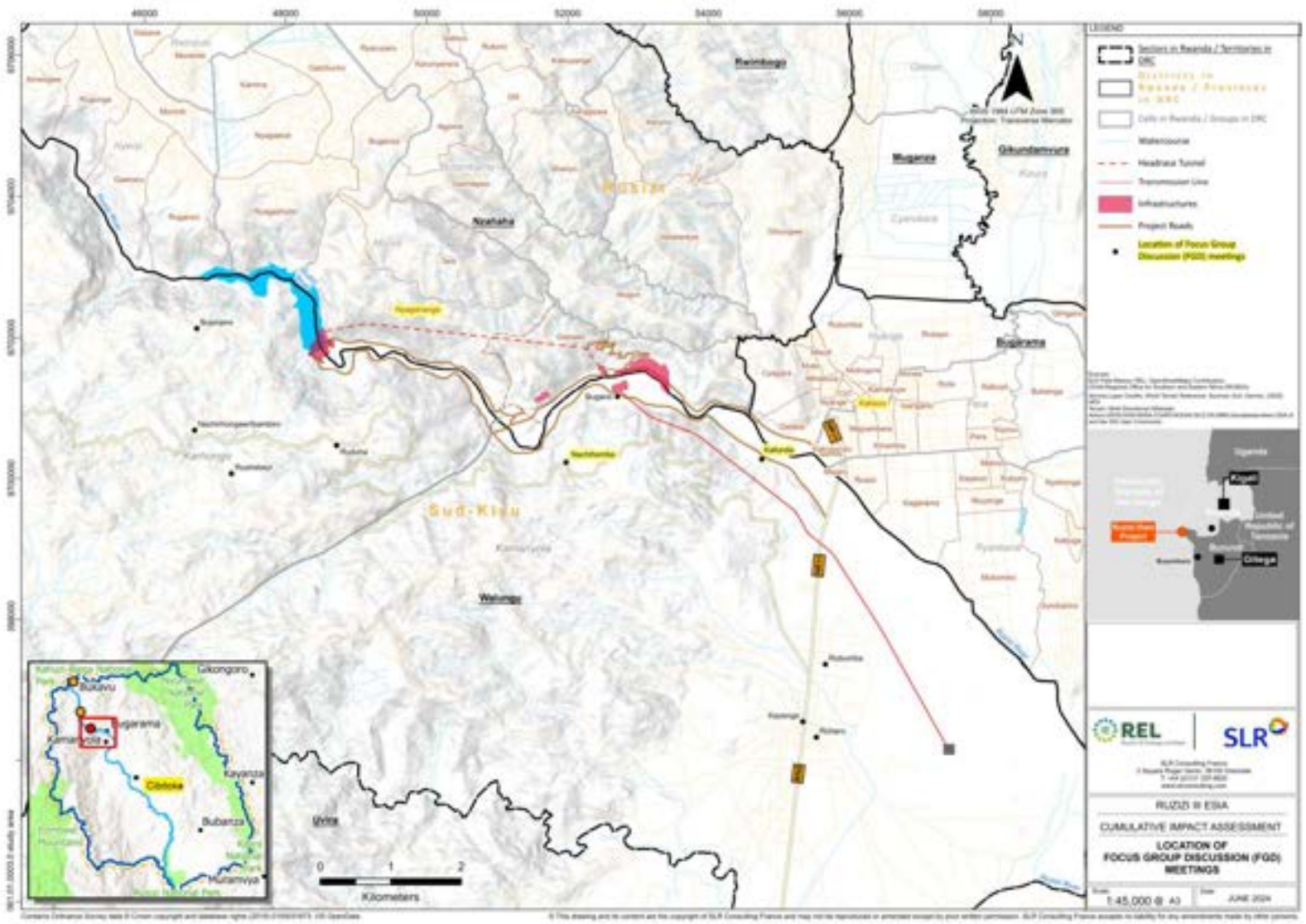


Figure 12-9 Map Showing Location of Focus Groups Discussion (FGD) Meetings with Communities

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The CIA study has selected the following VECs from review of the responses to questions discussed in the FGD:

- Household incomes / Quality of life of the family.
- Public services available to communities.
- Public infrastructure.
- Traditional way of life of the family and community.
- Natural environment.

A VEC is defined as the ultimate component of the natural and social environment that can be impacted. Keeping this definition in mind, the communities' responses with regard to salaries, business opportunities and jobs have been assessed to correspond to the quality of life VEC.

It is noteworthy that the communities did not refer to river flow characteristics, sediment and river channel morphology in the FGDs, but this does not mean that these are not important for them. It may reflect limited understanding of the interplay or linkages between these factors and tangible ecosystem services derived by communities. In terms of importance, it would appear that the income/quality of life, access to health and education services and public infrastructure have the highest priority for communities. The natural environment while seemingly assigned less importance may be under-played especially given the huge reliance of communities on soil and water for farming that is sustained by the natural environment, and some fishing.

12.6.3 Screening of Initial VECs

The initial VECs identified by the ESIA team with input from institutional stakeholders and communities (see Sections 12.5.1 and 12.6.2) underwent a screening process as shown in Figure 12-10. The process consists of scoping out initial VECs that are (i) not important or relevant for stakeholders, (ii) not directly impacted by the Ruzizi III HEPP, and (iii) are not augmented by impacts from other projects and external stressors.

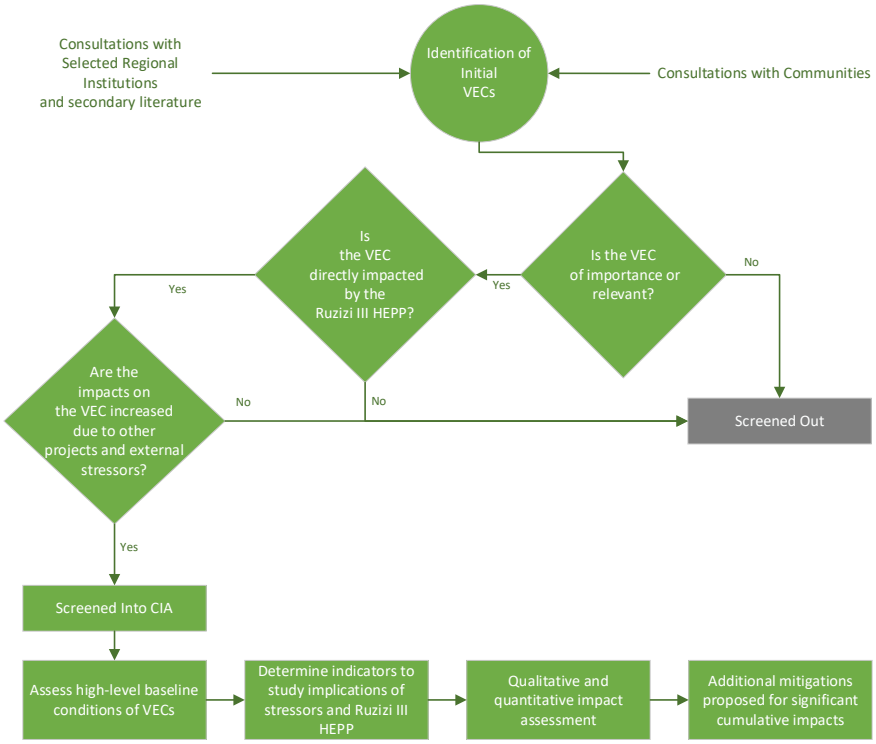


Figure 12-10 VEC Screening Process

The initial VECs and outcomes of the screening process are provided in Table 12-7.

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Table 12-7 Initial VECs and Outcomes of the VEC Screening Process

VEC	Pressure / Risk Indicator	Direct Impacts from Ruzizi III HEPP	Initial VEC identified by	Cumulative Implications and Outcome of Screening
River hydrology	River flow alteration exceeds natural inter-annual variations	• Alteration to levels and rates in dewatered reach. • Alteration to levels and rates downstream from powerhouse – magnitude decreasing with distance.	ESIA team	VEC affected by the Ruzizi III Project: • Have been altered by the past operation of Ruzizi-I and -II hydropower schemes. • May be impacted by climate change. • Expected to be influenced by future Ruzizi-IV HEPP. **Screened into the CIA as river hydrology**
River geomorphology	Alteration to river sediment loads causing riverbank / riverbed erosion and/ or deposition of sediment	Trapping of sediment in the Project reservoir causing an alteration to downstream sediment loads	ESIA team	VEC affected by the Ruzizi III Project: • Have been altered by the past operation of Ruzizi-I and -II hydropower schemes. • May be influenced by ongoing/future sediment dredging of Ruzizi-I and II reservoirs. • Will be impacted by climate change. • Expected to be impacted by future land use/cover changes and increased soil erosion. • Expected to be influenced by future Ruzizi-IV HEPP. **Screened into the CIA as river geomorphology**
Fish and aquatic habitat	River under modified flow conditions	• Inundation of 3 km flowing river habitat • Reduced flows and loss of connectivity in 5.5 km dewatered reach • Altered flow below powerhouse	ESIA team Communities	VEC affected by the Ruzizi III Project: • Have been altered by the past operation of Ruzizi-I and -II hydropower schemes. • Expected to be influenced by future rehabilitation of Ruzizi-I and II fish ladders. • May be impacted by climate change. • Expected to be impacted by future land use/cover changes, demographic changes and increased soil erosion. • Expected to be influenced by future Ruzizi-IV HEPP. **Screened into the CIA as fish and aquatic habitat**
	Dams as barriers for fish migration	Prevents migration to/from the upper reach of the Ruzizi (31 km length)	ESIA team Communities	

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VEC	Pressure / Risk Indicator	Direct Impacts from Ruzizi III HEPP	Initial VEC identified by	Cumulative Implications and Outcome of Screening
Natural Habitats	Pressure on areas of natural habitat	Alteration to natural habitat caused by land use changes for Project components	ESIA team Communities	No temporal and spatial overlap of Project impacts and impacts from other projects, including project's quarries and borrow area, and Associated Facilities (Transmission Lines) have been identified. **Not screened into the CIA** *Measures to ensure that ESIAs for Associated Facilities and ESIAs for quarries and borrow areas include CIA are included in Section 12.10*
	Increased frequency and magnitude of flooding in the Rusizi National Park (Burundi)	No influence expected	OBPE and ABAKIR	VEC not expected to be influenced by the Ruzizi III Project as hydrological changes caused by the Project at the Rusizi delta are negligeable. • Recent flooding has been reported but it is understood to have been caused by exception rainfall and not influenced by operation of Ruzizi-I/II. • Risk may be influenced in the future by climate change, Ruzizi Plain irrigation projects, land use/cover changes, demographic changes and increased soil erosion. **Not screened into the CIA**
	Risk of increased poaching in National Parks and Nature Reserves Increased damage to forest/woodland caused by illegal collection of firewood	No influence expected	OBPE	• The closest National Parks and Nature Reserves to the Project are the Nyungwe National Park (Rwanda/Burundi), Rusizi National Park (Burundi) and the Itombe Nature Reserve (DRC). • These protected areas are not expected to be influenced by the Ruzizi III Project because they are too far away. The distance by road from the Project construction camp are 73 km to Nyungwe National Park, 94 km to the Rusizi Delta reserve and 159 km to the Itombe Nature Reserve. **Not screened into the CIA**
Livelihoods	Physical and economic displacement	Land acquisition for Project components Job opportunities	ESIA team Communities	No temporal and spatial overlap of Project impacts and impacts from other projects (including Associated Facilities Transmission Lines) have been identified. There is a risk of temporal and spatial overlap of impacts of physical and economic displacement required for Project quarry areas and the past physical and economic displacement required for the Gishoma peat power plant project. **Not screened into the CIA** *Measures to ensure that ESIAs for quarries and borrow areas and ESIA for Associated Facilities include CIA are included in Section 12.10*
	Adverse impacts on aquaculture	Negligible alteration to aquaculture	Département de Biologie, ISP, Bukavu	• VEC not influenced by the operation of Ruzizi-I/II hydropower schemes as aquaculture developed after the river became modified by these schemes. • VEC not influenced by the operation of Ruzizi-II Project (see Chapter 11 – Assessment of Impacts and Mitigation Measures) **Not screened into the CIA**
	Adverse impacts on fishing in the Ruzizi River	Alteration to fish population caused by changes to river flow conditions and barriers for fish migration	ESIA team	Fishing in the Ruzizi River is marginal subsistence activity and not a source of revenue for households (see Chapter 8 – Social Baseline) **Not screened into the CIA**

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VEC	Pressure / Risk Indicator	Direct Impacts from Ruzizi III HEPP	Initial VEC identified by	Cumulative Implications and Outcome of Screening
Cultural heritage and traditions	Adverse impacts on cultural and religious sites	Impacts on cultural and religious sites (see Chapter 11 – Assessment of Impacts and Mitigation Measures)	ESIA team Communities	No temporal and spatial overlap of Project impacts and impacts from other projects, including associated facilities and Project quarries and borrow areas have been identified. **Not screened into the CIA** *Measures to ensure that ESIAs for Associated Facilities and ESIAs for quarries and borrow areas include CIA are included in Section 12.10*
Community health and safety	Risk of alteration to surface water quality (other than Ruzizi River), degraded by industrial effluents	Negligible alteration to water quality	Communities	No temporal and spatial overlap of Project impacts and impacts from other projects, including associated facilities have been identified. There is a possible overlap of impacts from a quarry that may be established near the Gishoma peat power plant. **Not screened into the CIA** *Measures to ensure that ESIAs for Associated Facilities and ESIAs for quarries and borrow areas include CIA are included in Section 12.10*
	Risk of increased incidence of STDs	Presence of construction workforce and any influx of opportunity seekers is expected to increase the risk	ESIA team	
	Accumulation of domestic waste	Support from Project to manage the waste	SNEL SINELAC Local communities	Quantities of domestic waste originating from Bukavu will not be altered by the Project. However, the Project will support regional initiatives to manage the issue (See Vol. IV ESMP) **Not screened into the CIA**
Quality of life	Household income	Job opportunities	ESIA team Communities	No temporal and spatial overlap of Project impacts and impacts from other projects, including associated facilities have been identified. **Not screened into the CIA**
Public services	Quality of services available	Support provided by the LADP	ESIA team Communities	
Public infrastructure (roads)	Quality of infrastructure available	Improvement to existing roads used by the Project and new roads required by the Project constructed	ESIA team Communities	

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12.6.4 VECs Selected for Assessment

Table 12-8 VECs Selected for Assessment

VEC	Pressure / Risk Indicator	Metric for Pressure/Risk Indicator	Projects, Stressors and External Factors Contributing to the Cumulative Impact
River hydrology	River flow alteration exceeds natural inter-annual variations	% river water level alteration	• Existing Ruzizi-I and -II hydropower schemes • Proposed Ruzizi-III HEPP • Future Ruzizi-IV HEPP • Future irrigation projects on the Ruzizi Plain • Climate Change • Demographic changes • Land use / land cover changes
River geo-morphology	Alteration to river sediment loads causing riverbank / riverbed erosion and/ or deposition of sediment	% alteration to sediment transported by the river	• Existing Ruzizi-I and -II hydropower schemes • Proposed Ruzizi-III HEPP • Future Ruzizi-IV HEPP • Future irrigation projects on the Ruzizi Plain • Climate Change • Natural hazards • Land use / land cover changes
Fish and fish habitat	River under modified flow conditions	% of total river length affected by alteration to minimum water level	As for river hydrology above
	Barriers for fish migration	Number of kilometres of river that migrating fish are prevented from reaching	• Existing Ruzizi-I and -II hydropower schemes • Proposed Ruzizi-III HEPP • Future Ruzizi-IV HEPP

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12.7 Assessment of Cumulative Impacts on Ruzizi River Hydrology VEC

12.7.1 Metric for Assessment of VEC

The metric for assessment of cumulative impacts on river hydrology is:

- % alteration to minimum water depth for natural conditions.

12.7.2 Spatial and Temporal Boundaries

The spatial and temporal boundaries are:

- The length of the Ruzizi River from the outflow from Lake Kivu to the inflow to Lake Tanganyika (168 km) – excluding the lakes.
- The period between 1959, when the first hydropower scheme started operation on the river until 2054 when the Ruzizi-III HEPP PPA is expected to expire.

12.7.3 Baseline Conditions

Prior to the construction of the first hydropower scheme on the river (Ruzizi-I HEPP, 1959) the flow in the Ruzizi River was regulated by the water level in the Lake Kivu. The flow conditions are summarised in Table 12-9 and graphs provided in Figure 12-12 and Figure 12-12.

Table 12-9 Summary of Ruzizi River Flow Conditions Prior to Start of Ruzizi-I Hydropower Scheme

Flow condition	Units	Lake Kivu outlet	Lake Tanganyika inlet
Average annual flow	m^3/s	95-125	~ 150-220
Seasonal high flow	m^3/s	170	~ 240
Seasonal low flow	m^3/s	65	~ 110

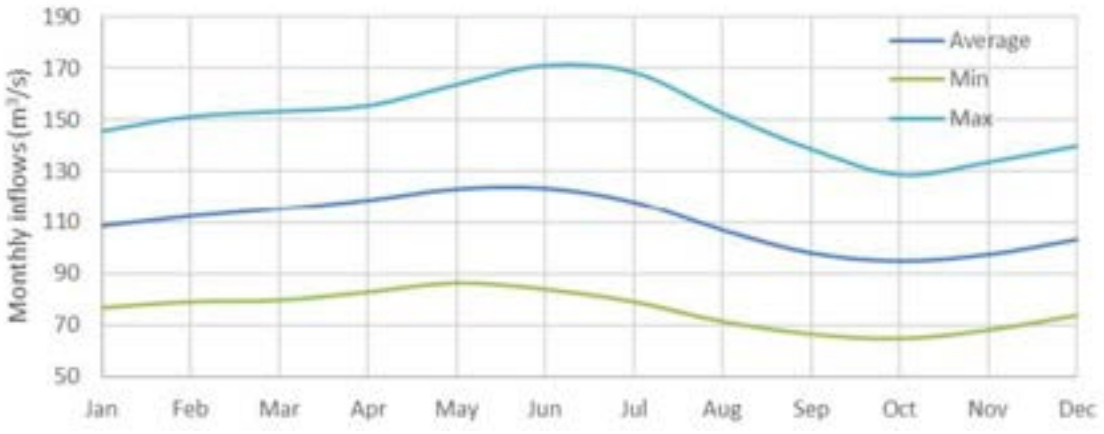
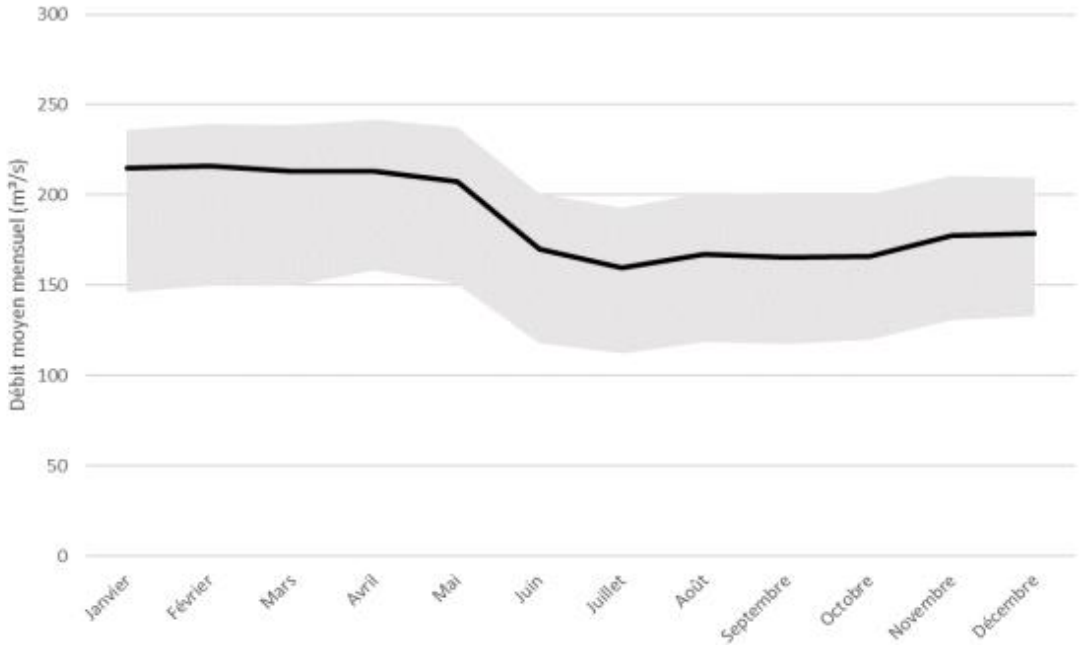


Figure 12-11 Monthly Distribution of Ruzizi River Flows at the Lake Kivu Outlet

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Average Monthly Flows of the Ruzizi at the Inflow into Lake Tanganyika

Figure 12-12 Ruzizi River Hydrographs for Natural Conditions (Prior to Start of Ruzizi I HPP)

12.7.4 Projects, Stressors & External Factors Contributing to the Cumulative Impact

12.7.4.1 Ruzizi-I and -II Hydropower Schemes

The Ruzizi-I and -II hydropower schemes started operation in 1959 and 1989 respectively. The schemes operate with periods of peak and off peak flows. The key characteristics are provided in Table 12-10.

Table 12-10 Ruzizi-I and -II HEPP Peak and Off Peak Flow Characteristics

Parameters	Ruzizi-I	Ruzizi-II
Peak flow rate (m^3/s)	150	150
Peak flow duration (hours)	3	2
Travel time for peak flow to reach next reservoir (hours)	3	2 (to reach Ruzizi III)
Off peak flow rate (m^3/s)	≥10.7	≥10.8
Source: Tractebel (2022a)		

The alteration to the Ruzizi River hydrology caused by the operation of Ruzizi-I and -II schemes are summarised as follows:

- Flow conditions are altered over the total distance between Ruzizi-I and the outflow into Lake Tanganyika (165 km). However, the magnitude of the alteration decreases with distance downstream. There are intermittent high and low flows, high flows do not exceed upper limits of inter-annual variations, but low flows are lower than the lower limits of inter-annual variations.
- In the reach between Ruzizi-I and Ruzizi-II reservoir, variations in flow rate of 10 to 150 m^3/s occur on a sub-daily basis. The peak flows do not exceed the upper limit of inter-annual variations. However, the off peak flows create water depths that are ~50% lower than under natural conditions.
- Downstream from Ruzizi-II, the lowering of minimum water depth decreases with distance. In the reach immediately downstream, the off peak water depth is ~50% lower than natural conditions, and at the outflow into Lake Tanganyika the depth is <1% lower.

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- The magnitude of lowering of minimum water depth decreases with distance because of flow attenuation effects and the inflow of tributaries.

12.7.4.2 Ruzizi-III HEPP

The proposed Ruzizi-III Project will alter flow conditions of the Ruzizi River and overlap the alterations caused by Ruzizi-I and -II. The peak and off peak flow rates discharged from Ruzizi-III are the same as for Ruzizi-I and -II.

The Ruzizi-III Project is located 12 km downstream from Ruzizi-II and consequently the alterations to the Ruzizi River extend slightly further downstream than the alterations caused by Ruzizi-II (for more details see section 12.7.5).

12.7.4.3 Ruzizi-IV HEPP

The Ruzizi-IV is currently at the planning stage. It will be located between Ruzizi-II and -III. The Ruzizi-IV HEPP will operate as a run-of-river scheme. Consequently, alteration to minimum water depths is not expected.

12.7.4.4 Irrigation Projects on the Ruzizi Plain

The irrigation projects plan to divert water from the Ruzizi's tributaries as it crosses the Ruzizi Plain, reducing inflows into the river. Water requirements estimated by ABAKIR (2021) represent 7.5% of the Ruzizi's annual flow. Some lowering of water depth is expected. The degree of water depth alteration will increase with distance downstream from Bugarama (Rwanda) - northern extremity of the Ruzizi plain.

12.7.4.5 Climate Change

The most plausible scenario predicts a small increase in annual rainfall, but with wider ranges of intra-annual and inter-annual rainfall variability. Which will result in dry seasons and dry years getting dryer, and wet seasons and wet years getting wetter. However, the Lake Kivu acts as a buffer attenuating to a certain extent the variations. The Project's climate resilience study (Tractebel, 2020c) predicts that for the most plausible future scenario the average annual flow of the river will be <+1% that of the current situation, but that it is plausible that it may be altered by -7% to +6% in the near term and -10% to +13% in the long term (2050-2079).

12.7.4.6 Demographic Changes and Land Use / Land Cover Changes

With an increase in population resulting in increased deforestation in the Lake Kivu and Ruzizi River basin, alteration to runoff characteristics in the Lake Kivu basin are expected with seasonal increase in runoff flowing into the Lake and increasing the flow in the Ruzizi River.

12.7.5 Assessment of Significance of Cumulative Impact on Hydrology

12.7.5.1 Degree of Alterations to Minimum Water Depth

The % alterations to minimum water level under natural conditions for each of the hydropower schemes and irrigation are presented in Table 12-11 and Figure 12-13.

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Table 12-11 Alteration to Natural Conditions Minimum Water Level vs River Length

Reach (km)	Alteration to natural conditions minimum water level (%)				Comments
	Ruzizi-I	Ruzizi-II	Ruzizi-III	Irrigation	
0-3	-	-	-	-	No alteration
3-4	-	-	-	-	No alteration - Ruzizi-I reservoir
4-16	-50%	-	-	-	Ruzizi-I off peak flows
16-19	-	-	-	-	No alteration - Ruzizi-II reservoir
19-28	-50%		-	-	Ruzizi-II off peak flows
28-31	-		-	-	No alteration - Ruzizi-III reservoir
31-37	-50%		-50%	-	Ruzizi-III dewatered reach, also altered by Ruzizi-I/II, Alterations overlap, but do not cumulate
31- 41	-50% to -38%		-50% to -41%	<-1%	Ruzizi-III dewatered reach Altered by Ruzizi-I/II Alterations from Ruzizi-I, -II and -III overlap, but do not cumulate. Alteration from Ruzizi-III and irrigation cumulate.
41-61	-38% to -14%		-41% to -19%	<-1%	
61-81	-14% to -5%		-19% to -9%	<-1%	
81-101	-5% to -1.5%		-9% to -3.7%	<-1%	
101-121	-1.5% to <-1%		-3.7% to -1.5%	-0.9% to -1.23%	
121-141	<-1%		-1.5% to <-1%	-1.23% to -1.5%	
141-168	<-1%		<-1%	-1.5% to -2%	

12.7.5.2 Incremental Changes Caused by Ruzizi III Project

It is concluded that the operation of Ruzizi-I and II has caused a significant impact on river hydrology, ~60 km of river (36%) of the Ruzizi River length has been affected by a significant (>10%) lowering of minimum water level. The operation of the proposed Ruzizi-III Project is expected, to cause minor (<10%) lowering of water levels along an additional 40 km (24%) of the river. The degree of alteration decreases with distance downstream from the Project due to flow from inflowing tributaries. The incremental impact caused by Ruzizi-III on river flow is therefore assessed as minor (non-significant).

12.7.5.3 Incremental Changes Caused by Irrigation and Ruzizi III Project

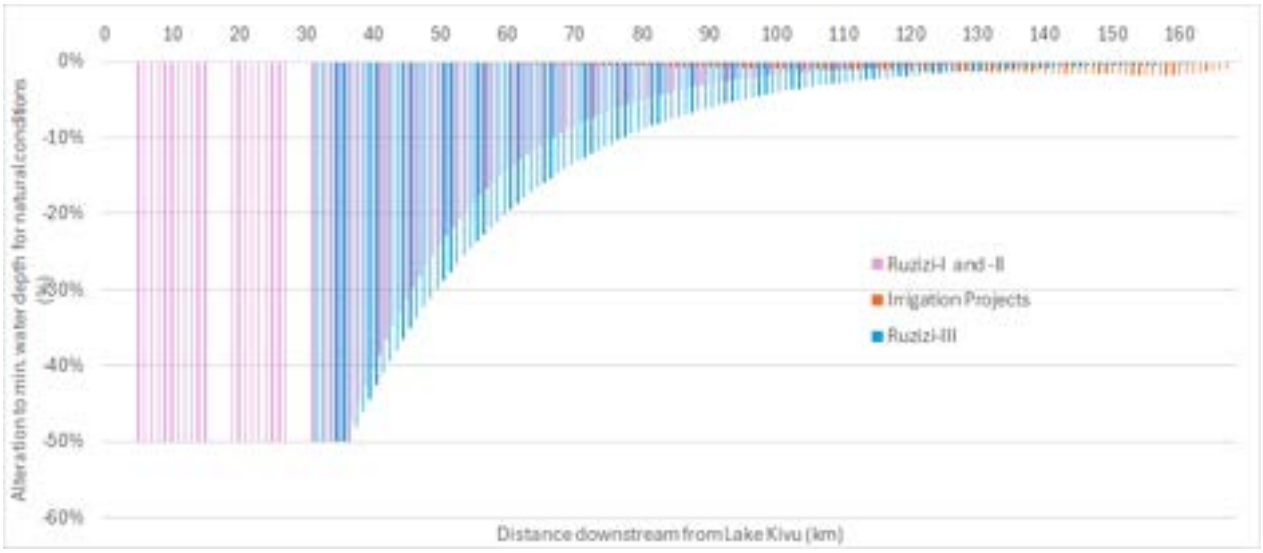
Water abstraction for planned irrigation is expected to cause minor lowering of minimum water level in the Ruzizi River, and which increases with distance downstream (except the final few kilometres before discharge into Lake Tanganyika, because of the backwater effect caused by the Lake). The degree of alteration caused by Ruzizi III decreases with distance. Therefore, the combined effect of Ruzizi III and irrigation is assessed as non-significant.

12.7.5.4 Incremental Changes Caused by Irrigation, Ruzizi III and Climate Change

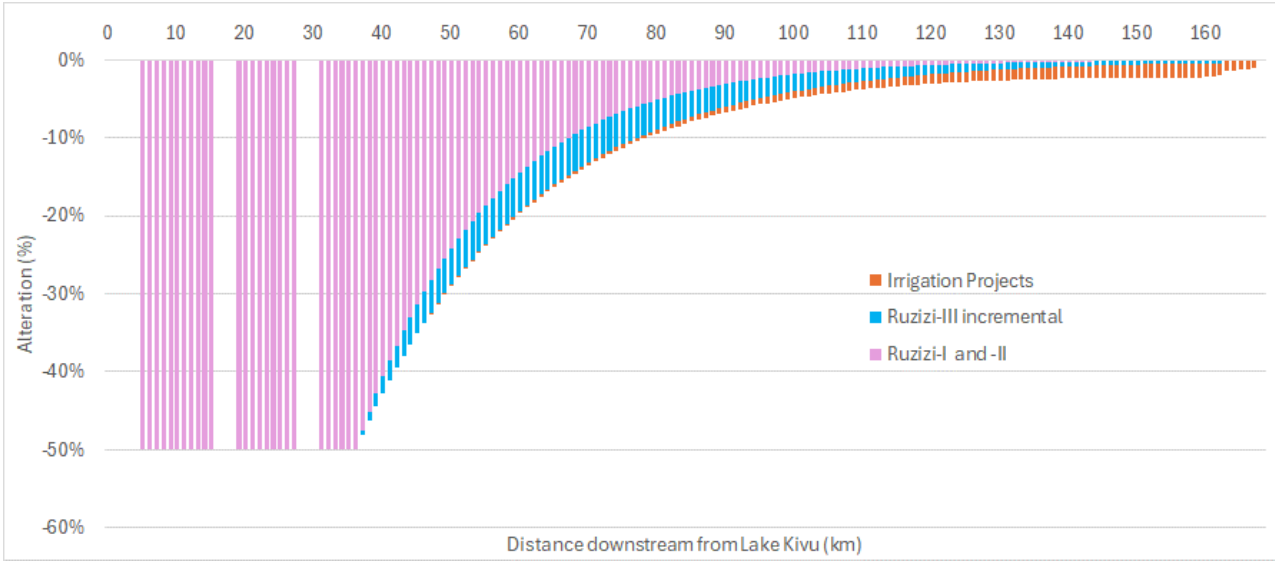
Because of uncertainties with regard to changes in temperature and precipitation in the watershed due to climate change, it is not possible to make detailed predictions of overall changes in minimum water level during the life of the Project caused by the combined effects of hydropower schemes, irrigation and climate change. If the most plausible climate change predictions materialise, the average lowering of minimum water level in the river would probably be minor. However, the dry seasons and dry years being dryer could periodically reduce the water levels in the Ruzizi River. This alteration, when combined with the changes caused by Ruzizi III and irrigation could result in incremental changes (compared to current conditions) that are significant.

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Percentage alteration to natural conditions minimum water level for individual contributors



Cumulative percent alteration to natural conditions minimum water level

Note: Alteration due to climate change are not shown. The Project's climate resilience study concludes that for the most plausible % future scenario average annual river flow will be changed by <+1%, but could be altered by -7% to +6% in the near term (2024-2049) and -10% to +13% in the long term (2050-2079)

Figure 12-13 Percentage Alteration to Natural Conditions Minimum Water Level vs River Length (Illustrative)

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12.8 Assessment of Cumulative Impacts on Ruzizi River Geomorphology VEC

12.8.1 Metric for Assessment of VEC

The metric for assessment of cumulative impacts on river geomorphology is:

- % alteration to sediment transported by the river under natural conditions.

12.8.2 Spatial and Temporal Boundaries

The spatial and temporal boundaries are:

- The length of the Ruzizi River from the outflow from Lake Kivu to the inflow to Lake Tanganyika (168 km) – excluding the lakes.
- The period between 1959, when the first hydropower scheme was constructed on the river until 2054 when the Ruzizi-III HEPP PPA is expected to expire.

12.8.3 Projects, Stressors & External Factors Contributing to the Cumulative Impact

12.8.3.1 Ruzizi-I and -II Hydropower Schemes

The Ruzizi-I and -II hydropower schemes started operation in 1959 and 1989 respectively. Since the start of operation, the reservoirs have trapped sediment carried into the reservoirs by the river and the storage capacity of the reservoirs has progressively diminished. The trapped sediment originates from soil erosion in the catchment basin and from landslides on the steep slopes on the left and right banks of the Ruzizi River upstream from the Ruzizi-I and -II reservoirs. The reservoirs' storage capacities and volume of trapped sediment are provided in Table 12-12. The trapping of the sediment causes reduced sediment load in the waters discharged from the reservoirs and the significance of this alteration is discussed in Section 12.8.4.

Table 12-12 Sediment Accumulation in Ruzizi-I and -II Hydropower Scheme Reservoirs

Parameter	Units	Ruzizi-I	Ruzizi-II
Year of start of operations	Year	1959	1989
Years in operation	Year	65	35
Initial reservoir live volume	Mm^3	1.59 (1)	2.6 (1)
Reservoir live volume 2013	Mm^3	No data	1.6 (1)
Reservoir live volume 2021		No data	0.75 (2)
Rate of sediment trapping	Mm^3/year	0.042 – 0.057 (4)	0.042 – 0.057 (3)
Rate of sediment trapping	t/y	63,000-85,500 (4)	63,000-85,500 (3)

Notes:
(1) Source: Tractebel, 2022b
(2) Source: Studio Pietrangeli 2013a/2103b
(3) Computed by SLR as part of this study
(4) By analogy with Ruzizi-II

The operators of Ruzizi-I and -II are dredging the reservoirs in an attempt to increase the live storage capacity of the reservoirs. For the purpose of this study, it is assumed that the dredged sediment will be returned to the Ruzizi River downstream from Ruzizi-II.

If the dredging is successful, it can be expected that additional sediment management measures such as sluicing and flushing may be possible in the future. This would result in enabling the passage downstream of inflowing sediment in the future. However, if the sediment

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management measures are not successful, the quantities of sediment trapped will continuously increase until the reservoirs are completely filled with sediment. If this were to happen, the schemes would not be able to operate with hydropeaking but should be able to continue to operate as run-of-river schemes if the turbines can be protected. In this case the inflowing sediment would overflow downstream.

12.8.3.2 Ruzizi-III HEPP

The Ruzizi-III project will trap sediment in the same way as the upstream Ruzizi-I and -II reservoirs. The Project's Feasibility Study (Tractebel, 2022a) includes sediment studies to evaluate the quantities of sediment that will enter the reservoir, quantities that will be trapped and assess sediment management measures. This is discussed in Chapter 7 – Environmental Baseline Situation, and Chapter 11 – Assessment of Impacts and Mitigation Measures. The quantity of sediment that is expected to be trapped annually is 78,100 m^3 (117,150 tonnes). The trapping of the sediment in the Ruzizi-III reservoir is expected to cause reduced sediment load in the waters discharged. The significance of this alteration is discussed in Section 12.8.4.

12.8.3.3 Future Ruzizi-IV HEPP

The Ruzizi-IV HEPP is currently at the planning stage and feasibility studies are not yet completed. The Project will be located downstream from Ruzizi-II and upstream from Ruzizi-III. However, it will operate as a run-of-river scheme and no water storage reservoir is planned. Consequently, no significant trapping of sediment by the Ruzizi-IV HEPP is expected.

12.8.3.4 Soil Erosion in the Ruzizi River Basin Catchment and Future Changes in Land Use

Soil erosion in the Ruzizi River Basin is the source of sediment that is input into the Ruzizi River downstream from the Ruzizi III Project. The Baseline Study for the Basin of Lake Kivu and Ruzizi River (SHER, 2020) modelled sediment yield in the basin using the Revised Universal Soil Loss Equation (RUSLE). The modelling computed sediment yield in the lower Ruzizi Basin to be in the range of 91-290 t/km^2/year. The Ruzizi River Basin occupies an area of 5,800 km^2. Using an average sediment yield of 190 t/km^2/year and considering the size of the catchment (excluding the 346 km^2 catchment for Ruzizi-I, -II and III HEPPs), there is an estimated annual input of 1.04 million tonnes of sediment into the Ruzizi River downstream from the Ruzizi III HEPP.

Land use has changed over the last 25 years, with forest land decreasing from approximately 1,740 km^2 to 530 km^2 (30% reduction) because of the increase in agricultural land. With the current rate of population growth, it can be expected that the current trend in land use will continue. Consequently, average sediment yield in the catchment is expected to increase. Assuming that the future sediment yield is 247 t/km^2/year (30% increase in current average), the future annual input of sediment into the Ruzizi River downstream from the Ruzizi III HEPP would be 1.34 million tonnes. The significance of this alteration is discussed in Section 12.8.4.

12.8.3.5 Future Irrigation Projects on the Ruzizi Plain

The future irrigation projects plan to divert water from tributaries of the Ruzizi thus reducing inflows into the Ruzizi River and altering the overall flow of the Ruzizi River. The water requirements for irrigation estimated by ABAKIR (2021) represent 7.5% of the Ruzizi's annual flow.

The reduced flow from tributaries into the Ruzizi River is expected to reduce the sediment input into the river. The reach of the river affected is the reach downstream from the Ruzizi-III Project and extending to the river's inflow into Lake Tanganyika. If the flow from tributaries is reduced by 7.5% it can be estimated that the inflow of sediment will also be reduced by 7.5%. The significance of this alteration is discussed in Section 12.8.4.

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12.8.3.6 Climate Change

The most plausible scenario predicts a small increase in annual rainfall, but with wider ranges of intra-annual and inter-annual rainfall variability. Which will result in dry seasons and dry years getting drier, and wet seasons and wet years getting wetter. However, the Lake Kivu acts as a buffer attenuating to a certain extent the variations. The Project's climate resilience study (Tractebel, 2020c) predicts that for the most plausible future scenario the average annual flow of the river will be <+1% that of the current situation, but that it is plausible that it may be altered by -7% to +6% in the near term and -10% to +13% in the long term (2050-2079). The significance of this alteration is discussed in Section 12.8.4.

12.8.4 Assessment of Significance of Cumulative Impacts on Geomorphology

The assessment of significance is undertaken by estimating the degree of alteration to sediment load at the Ruzizi River's inflow into Lake Tanganyika caused by individual projects and stressors.

The Ruzizi River sediment budget is provided in Table 12-13 and considers the following situations:

- Natural conditions, prior to the start of operation of the first hydropower scheme on the Ruzizi River in 1959.
- Conditions in 2024, with Ruzizi-I and -II in operation, but without the operation of Ruzizi-III and implementation of the irrigation projects on the Ruzizi plain.
- Conditions in 2059 with operation of Ruzizi-I, -II and -III, implementation of the Ruzizi plain irrigation projects - with, and without, an increase in soil erosion caused by climate change and change in land use.

Key interpretations are as follows:

- Prior to 1959, when the first hydropower scheme started operation, the sediment load of the Ruzizi River at the inflow to Lake Tanganyika was in the order of 1 million tonnes per year. Most of the sediment (70%) originated from soil erosion in the Ruzizi catchment downstream from the proposed Ruzizi-III HEPP, and 20% originated from soil erosion and landslides in the catchment area of the still to be developed Ruzizi-I and -II HEPPs, and 10% from the proposed catchment for the proposed Ruzizi-III HEPP.
- In 2024, after a 65- and 35-year period of operation of Ruzizi-I and -II, respectively, and prior to the start of Ruzizi-III operation, the sediment load in the Ruzizi is assessed to have increased compared to the natural conditions. The trapping of sediment in Ruzizi-I and -II reservoirs has reduced the sediment load under natural conditions by 14%, but increased soil erosion has increased the sediment load by 30%, resulting in a net increase of 16%.
- In 2059, which is at the end of a period of 25 years of operation of the Ruzizi-III Project, it is assessed that the sediment load of the Ruzizi River will have been altered. It is assumed that sediment is no longer trapped in Ruzizi-I and -II, but is trapped in Ruzizi-III, and this reduces the sediment load under natural conditions by 26%. However, soil erosion will increase sediment load by between 23% and 50%. The net alteration is therefore between -3% and +25%.
- In the absence of Ruzizi-III Project the sediment input into Lake Tanganyika would increase by 21% to 50%. The Ruzizi-III Project therefore attenuates the negative effects of increased soil erosion in the catchment caused by land use changes and climate change.
- The most plausible climate change predictions are that average annual flow of the river increase by <1%. However, wet seasons will be wetter, dry seasons dryer and this is expected to cause an increase in soil erosion. This is factored into the assessment by considering cases with and without an increase in soil erosion.

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In terms of significance of the cumulative impact on sediment load. The impact of hydropower projects and external stressors is considered significant, with an alteration of between 25% and 50% is expected. The Ruzizi-III HEPP has a significant attenuating effect (i.e. positive effect).

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Table 12-13 Ruzizi River Sediment Budget for Natural, Current and Future Conditions

Source of sediment	Natural conditions [1]		2024 situation [2]			2059 situation (scenario 1 – continued increase in soil erosion in the catchment) [3]			2059 situation (scenario 2 – no further increase in soil erosion in the catchment) [4]		
	Sediment input (t/y)	%	Sediment input (t/y)	Alteration cf. natural conditions (t/y)	% alteration cf. total for natural conditions	Sediment input (t/y)	Alteration cf. natural conditions (t/y)	% alteration cf. total for natural conditions	Sediment input (t/y)	Alteration cf. natural conditions (t/y)	% alteration cf. total for natural conditions
Ruzizi-I and -II catchment	204,520	20%	56,020	-148,500	-14%	204,520	-	-	204,520	-	-
Ruzizi-III catchment	104,100	10%	104,100	-	-	-161,550	-265,650	-26%	-161,550	-265,650	-26%
Downstream catchment	725,382	70%	1,036,260	310,878	+30%	1,246,103	520,721	+50%	958,541	233,159	+23%
Ruzizi River discharge to Lake Tanganyika	1,034,002	100%	1,198,404	162,378	+16%	1,291,132	257,130	+25%	1,003,570	-30,433	-3%

Notes:

(1) Values for sediment inputs from Ruzizi-I, -II and -III catchments taken from Ruzizi-III Sediment Management Study (Tractebel, 2022b), input from landslides included.
Value for downstream catchment sediment input computed using the Ruzizi River catchment area, less the catchment area of Ruzizi-I, -II and -III (5,454 km^2) and a sediment yield of 133 t/km^2/year.
The sediment yield equals the average yield for 2020 (190 t/km^2/year)) reported in the ABAKIR Baseline Study for the Lake Kivu and Ruzizi River Basins (SHER, 2020) multiplied by 0.7, to factor in the 30% loss of forest land and increased soil erosion that has occurred in last 30 years.

(2) Values for sediment inputs from Ruzizi-I and -II have been computed by subtracting the estimated qualities of sediment trapped in Ruzizi-I and -II reservoirs. Values taken from Ruzizi-III Sediment Management Study (Tractebel, 2022b).
Value for downstream catchment sediment input computed using the Ruzizi River catchment area less the catchment area of Ruzizi-I, -II and -III (5,454 km^2) and a sediment yield of 190 t/km^2/year. The sediment yield equals the average yield for 2020 reported in the ABAKIR Baseline Study for the Lake Kivu and Ruzizi River Basins (SHER, 2020) multiplied.

(3) It is assumed that sediment inflow to Ruzizi-I and -II reservoirs is discharged downstream and trapped in the Ruzizi-III reservoir.
Ruzizi III reservoir traps 117,150 t/year. Value taken from Ruzizi-III Sediment Management Study (Tractebel, 2022b).
The sediment yield for calculating the sediment input from the downstream catchment is the average yield for 2020 reported in the ABAKIR Baseline Study for the Lake Kivu and Ruzizi River Basins (SHER, 2020) multiplied by 1.3, to factor in the continued loss of forest land and increased soil erosion that is expected to occur over the next 30 years. A factor of 0.925 is also applied to factor in the reduced flow from tributaries caused by irrigation projects on the Ruzizi Plain.

(4) It is assumed that sediment inflow to Ruzizi-I and -II reservoirs is discharged downstream and trapped in the Ruzizi-III reservoir.
Ruzizi III reservoir traps 117,150 t/year. Value taken from Ruzizi-III Sediment Management Study (Tractebel, 2022b).
Value for downstream catchment sediment input computed using the Ruzizi River catchment area, less the catchment area of Ruzizi-I, -II and -III (5,454 km^2), and a sediment yield of 190 t/km^2/year.
The sediment yield used is the average yield for 2020 reported in the ABAKIR Baseline Study for the Lake Kivu and Ruzizi River Basins (SHER, 2020). The sediment yield is multiplied by a factor of 0.925 to account for reduced flow from tributaries caused by irrigation projects on the Ruzizi Plain, which reduce inflow by 7.5%

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12.9 Assessment of Cumulative Impacts on Fish & Aquatic Habitat VEC

12.9.1 Metrics for Assessment of Impacts on VEC

The metric for assessment of cumulative impacts on fish and aquatic habitat comprise:

- % of total river length affected by alteration to minimum water level.
- % of total river length that migrating fish are prevented from reaching.

12.9.2 Spatial and Temporal Boundaries

The spatial and temporal boundaries are:

- The length of the Ruzizi River from the outflow from Lake Kivu to the inflow to Lake Tanganyika (168 km) – including tributaries but excluding the lakes.
- The period between 1959, when the first hydropower scheme was constructed on the river until 2054 when the Ruzizi-III HEPP PPA is expected to expire.

12.9.3 Projects, Stressors & External Factors Contributing to the Cumulative Impact

12.9.3.1 Ruzizi-I and -II Hydropower Schemes

Ruzizi-I and -II hydropower schemes started operation in 1959 and 1989, respectively. Both schemes operate with hydropeaking. The hydropeaking causes sub-daily variations in flow in the range of 10-150 m^3/s. The off peak flows result in river water level that are lower than inter-annual variations for natural conditions (see Section 12.7.5).

The Ruzizi-I powerhouse is located at the foot of the dam, and consequently there is no dewatered reach downstream from the dam. The Ruzizi-II powerhouse is located downstream from the dam, and there is 1.2 km-long dewatered reach.

The physical presence of the dams (23 m and 11 m) represents barriers preventing the migrating fish to access the upstream water. Both Ruzizi-I and -II dams were originally equipped with fish ladders, but these are no longer operational.

The significance of the alterations to the natural conditions is discussed in Section 12.9.4.

12.9.3.2 Ruzizi-III HEPP

The proposed Ruzizi-III HEPP is planned to start operation in 2029. The scheme will operate with hydropeaking. The Ruzizi-III powerhouse is located downstream from the dam and results in the creation of a 5.5-km-long dewatered reach.

The hydropeaking causes sub-daily variations in flow in the range of 10-150 m^3/s, which is identical to the off peak and peak flows of the upstream Ruzizi-I and -II schemes. The Ruzizi-III off peak flows result in river water level than natural conditions (see Section 12.7.5). However, the alterations overlap with the alterations caused by Ruzizi-I and -II.

The physical presence of the Ruzizi -III dam represents a 51-m-high barrier that will prevent the migrating fish from being able to access the upstream reaches of the Ruzizi River, curtailing access by an additional 12.5 km. However, access to upstream reaches and Lake Kivu have already been hindered to a certain extent by Ruzizi-I and -II dams.

The significance of the alterations to the natural conditions is discussed in Section 12.9.4.

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12.9.3.3 Ruzizi-IV HEPP

The Ruzizi-IV HEPP is planned to be situated between Ruzizi-II and Ruzizi-III. The project is currently at the planning stage, and it is expected that operation could start within the next 10 years. The project will operate as a run-of-river scheme and there is no water storage reservoir. However, a dewatered reach will be created. The sub-daily variations in flow are expected to be in the range of 10-150 m^3/s, which is identical to the off peak and peak flows of the upstream Ruzizi-I and -II schemes. However, the alterations to minimum water level overlap with the alterations caused by Ruzizi-I and -II.

12.9.3.4 Irrigation Projects on the Ruzizi Plain

The irrigation projects plan to divert water from tributaries of the Ruzizi thus reducing inflows into the Ruzizi River and altering the overall flow of the Ruzizi River. The water requirements for irrigation estimated by ABAKIR (2021) represent 7.5% of the Ruzizi's annual flow at the inflow to Lake Tanganyika.

12.9.3.5 Climate Change

The most plausible scenario predicts a small increase in annual rainfall, but with wider ranges of intra-annual and inter-annual rainfall variability. Which will result in dry seasons and dry years getting drier, wet seasons and wet years getting wetter. However, the Lake Kivu acts as a buffer attenuating to a certain extent the variations. The Project's climate resilience study (Tractebel, 2020c) predicts that for the most plausible future scenario the average annual flow of the river will be <+1% that of the current situation, but that it is plausible that it may be altered by -7% to +6% in the near term and -10% to +13% in the long term (2050-2079).

12.9.3.6 Demographic Changes & Land Use / Land Cover Changes

With an increase in population resulting in increased deforestation in the Lake Kivu and Ruzizi River basin, alteration to runoff characteristics in the Lake Kivu basin are expected with an increased runoff flowing into the Lake and increasing the flow in the Ruzizi River.

12.9.4 Assessment of Significance of Cumulative Impacts on Fish & Aquatic Habitat

12.9.4.1 Length of River Affected

Alterations to minimum water level and fish migration caused by hydropower schemes on the Ruzizi River are provided in

Table 12-14. The key points are as follows:

- Operation of Ruzizi-I and -II has caused intermittent significant lowering of minimum water levels along 61 km of the Ruzizi River, corresponding to 36% of the total length of the river.
- The proposed Ruzizi-III project will cause an additional lowering of water levels along 40 km, but the degree of alteration is minor (5-10% lower).
- The physical presence of the Ruzizi-I and -II dams has prevented migrating fish accessing the uppermost 19 km (11%) of the Ruzizi River, because fish ladders are no longer operational. Planned rehabilitation of fish ladders (with support from the KfW) if made fully functional may however facilitate some upstream fish migration.
- The proposed Ruzizi-III project will cause an additional 12 km (7%) of river to no longer be accessible for migrating fish. An additional 5.5 km dewatered reach with a minimum

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flow of 11 m^3/s may pose additional constraints on fish migration depending on the extent of connectivity.

Table 12-14 Alteration to Minimum Water Levels and Fish Migration

Projects and Stressors Contributing to Cumulative Impacts [a]	km of river affected by significant [b] alteration to minimum water level (% total river length affected)	km of river that migrating fish are prevented from reaching (% of total river length)
Ruzizi-I and -II	61 (36%)	19 (11%)
Ruzizi-III – without alteration caused by Ruzizi-I and -II	50 (30%)	31 (18%)
Ruzizi-III – incremental increase cf. Ruzizi-I and -II	- [c]	12 (7%)
Cumulative impact (Ruzizi-I, -II and -III)	61 (36%)	31 (18%)

Notes:

[a] Ruzizi-IV, Ruzizi plain irrigation projects, demographic changes & land use / land cover changes and climate change are not expected to cause significant lowering of minimum water levels (see Table 12-11) or hinder fish migration

[b] Significant is when the alteration of natural conditions water levels is >-10%

[c] Incremental changes are <-10%, i.e. non-significant.
40 km (24%) of river are affected by minor incremental alteration >-5% and <-10%

12.9.4.2 Discussion on Impact on Fish Migration

A Context

Prior to the start of hydropower development on the Ruzizi River in 1959, several species of fish migrated along the Ruzizi River between Lake Tanganyika and Lake Kivu. Strong swimming fish would be able to migrate the full 168 km upstream to Lake Kivu from what are believed to be their spawning grounds in the floodplains of the Rusizi National Park and Ramsar site at the inflow to Lake Tanganyika. However, fish migration between the two lakes was obstructed in 1959 by the construction of the Ruzizi- I dam (3 km from Lake Kivu), and then in 1989 by the construction of the Ruzizi-II dam (19 km from Lake Kivu).

Evidence for migratory behaviour was inferred in the results of the fish surveys undertaken in August and October 2021 (SOFRECO) for the first ESIA (prepared by Sofreco), the presence of larger numbers of Labeo species being distributed further upstream in October than in August. In addition, the SLR team observed seasonal aggregations of fish at the base of the spillway of Ruzizi-II in January 2022. Discussion with security guards posted at Ruzizi-II revealed that migrating fish were typically stranded by down-ramping of the hydropower facility, during which time they were easily targeted by local fishers.

The 23-m-high Ruzizi-I dam and the 11-m-high Ruzizi-II dam, were equipped with fish passes. However, the Ruzizi-II fish pass became inoperable around 1998. Therefore, fish migration along the full length of the Ruzizi River ceased approximately 25 years ago.

B Current Fish Migration in the Ruzizi River

Migratory fish in the Ruzizi River are primarily larger bodied, strong swimmers of the Labeo genus (e.g. *Labeo altianalis*, *L. cylindricus*). Although generally considered 'obligatory' migrators, other similar Labeo species have been found to be adaptable to undertake short migrations. It is therefore possible that the migratory fish of the Ruzizi can also adapt to shorter migrations, although the health and vigour of populations are likely to be impacted. Given the low abundance of macroinvertebrates recorded during SLR 2022 surveys, it is considered unlikely that Labeo species feed during their migrations and are unlikely to have sufficient food if they are trapped in the 12.5-km reach between Ruzizi III and II.

The river's flow conditions have been highly modified by the hydropeaking mode of operation of the Ruzizi-I and -II hydropower schemes. Before the construction of Ruzizi-I, the natural average annual flow of the river was ~100 m^3/s. However, the flow rate of the river downstream

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of the hydropower schemes now alternates between 10 and 150 m^3/s on a sub-daily basis. This has made fast-flowing rapid cascades in the middle reach of the river restrictive for smaller-bodied migratory fish. It is mainly the larger-bodied adult fish of Labeo species that can now access the middle-upper reach of the Ruzizi River. In addition, the hydropeaking operations causes fish stranding at the Ruzizi-II and facilitates harvesting by local fishers.

Despite the above challenges to fish migration, some fish migration from the spawning grounds to Ruzizi-II dam continue. As noted above, fish surveys undertaken for the ESIA observed migratory fish (e.g. Labeo species) at the Ruzizi-II dam site (where they were harvested by local fishers) and in the reach of the river downstream from the proposed Ruzizi-III dam site. Higher numbers of the migratory species *Labeobarbus altianalis* were observed during the wet season, which is considered the migratory period.

C Impact of Ruzizi-III HPP on Fish Migration

Fish migration will be further constrained by the construction of the proposed 51-m-high Ruzizi-III dam, which will represent a large physical obstruction that will prevent migrating fish reaching the upper reaches of the river. The reaches that migratory fish will not be able to reach comprise:

- 12 km between the Ruzizi-III and -II dams.
- 16 km between Ruzizi-II and -I dams (currently inaccessible for migratory fish, but which could become partially accessible with the implementation of the KfW funded rehabilitation of the Ruzizi-II fish pass).
- 3 km between Ruzizi-I and Lake Kivu (currently inaccessible for migratory fish, but which could become partially accessible with the implementation of the KfW funded rehabilitation of the Ruzizi-II fish pass).

In addition, the creation of the 5.5-km-long dewatered reach downstream from the proposed Ruzizi III dam will represent an additional constraint for fish migration, with reduced water flow (in the order of 11 m^3/s) in sections of steep cascades. This is expected to result in a shallower river and possible reduction in connectivity between pools which may facilitate increased fishing pressures by local residents on migratory fish that can access this reach.

D Ruzizi-III Fish Pass Viability

A fish pass for a 51-m-high dam, 5.5-km-long dewatered reach, and with hydropeaking operations in an already modified habitat is considered by the Project as not viable. There would be financial risks associated with the inclusion of a fish pass in the design, as such a structure would need to be innovative and without a proven track record in Africa. There would be many uncertainties regarding the efficiency of any fish pass on such a large dam, and the environmental gain would probably be small and cost would be significant.

Providing upstream and downstream fish passage on a 51-m-high dam with topography unsuitable for conventional pool-weir or nature-like fishways presents significant challenges. In such scenarios, alternative fish passage methods, particularly fish lifts, would need to be considered. Conventional pool-weir and nature-like fishways, commonly used for low-head obstacles, rely on gradual slopes and natural materials to facilitate fish passage. However, they are not suitable for high-head dams like the 51-m-high Project dam due to the impracticality of long nature-like channels on steep slopes. Therefore, alternative solutions such as fish lifts would need to be considered.

Fish lifts, also known as fish locks or fish elevators, are vertical transportation systems designed to assist fish in overcoming barriers such as dams. They consist of chambers that lift or lower fish between different water levels, bypassing the dam's obstruction. However, the feasibility of implementing fish lifts in a tropical river in Africa presents several challenges:

- Fish lift efficiency can be poor, with passage rates <20% for salmonids (which do not occur in the region) to <10% for non-salmonid species. This inefficiency can hinder the overall effectiveness of fish passage efforts.
- Poor attraction of fish into the lift structures is a significant issue for hydropeaking projects, necessitating auxiliary water releases to enhance attraction flows. This

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requirement adds complexity and cost to fish lift operations and will reduce power generation efficiency.

- Maintenance and operational costs associated with fish lifts can be significant, particularly in remote or challenging environments. These ongoing expenses must be carefully considered in project planning.

While fish lifts can offer benefits for fish passage, their limitations in terms of efficiency, size constraints, attraction flow challenges and operational costs should be carefully evaluated in the context of specific project requirements and environmental conditions. In summary, the numbers of fish that would likely be able to use fish ladders across three (possibly four) HPP barriers and swim through each reservoir to reach the upper Ruzizi River is likely to be very low for the high cost of installing fish ladders on a dam the size of Ruzizi-III.

E Feasibility of Truck and Haul

Catching, trucking and releasing fish is one option for aiding fish migration whereby fish can be caught below Ruzizi-III and trucked and released into a stretch of river higher up. There are 31 km of river above Ruzizi-III, with 12 km between Ruzizi-II and -III, 16 km between Ruzizi-I and -II, and only 3 km between Ruzizi-I and the outlet at Lake Kivu.

Theoretically, fish could be released into the 12 km reach of river above Ruzizi-III to make use of this reach or to try and swim up to reach the fish ladder on Ruzizi-II. There would be no point of releasing fish above Ruzizi-I given the short distance to the lake.

Truck and haul of fish is an intensive process requiring significant human and equipment resources. It is mainly done in the northern hemisphere for high value fish such as salmon where significant resources and expertise are available. Unless truck and haul can be done with good management by qualified personnel it is likely to result in significant fish mortality in transit. This is especially because of the poor road access by long and steep roads and hot and / or wet conditions. It is also likely that there would be interference by community members wanting to keep the fish that would need to be policed which is unlikely to be effectively done given the limited potential for enforcement. Also, the project's transboundary location may result in claims by residents on one side (DRC) that residents on the other side (Rwanda) are unfairly removing the fish with accusations of unequal benefits. Overall, truck and haul is considered impractical and would incur a high cost, and is unlikely to be sustainable.

12.9.4.3 Conclusion on Significance of Cumulative Impact on Fish and Fish Migration

A % of Total River Length Affected by Alteration to Minimum Water Level

The increase in length of river affected by the lowering of minimum water depth caused by off peak flows form hydropower schemes and irrigation is provided in Section 12.7.5. The summary is as follows:

- Ruzizi-I and II has caused a significant impact on river hydrology, ~60 km of river (36%) has been affected by a significant (>10%) lowering of minimum water level.
- Operation of the proposed Ruzizi-III Project is expected, to cause minor (<10%) lowering of water levels along an additional 40 km (24%) of the river.
- Water abstraction for irrigation is expected to cause minor lowering of minimum water level, increasing with distance downstream. The degree of alteration caused by Ruzizi III decreases with distance, therefore, the combined effect is assessed as non-significant.
- If the most plausible climate change predictions materialise, the average lowering of minimum water level in the river would probably be minor. However, the dry seasons and dry years being dryer could periodically reduce the water levels in the Ruzizi River. This alteration, when combined with the changes caused by Ruzizi III and irrigation could result in incremental changes in flow (compared to current conditions) that are significant. However, less likely climate change predictions would cause significant changes, that either attenuate or augment the changes caused by Ruzizi III and irrigation.

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Therefore, by analogy with alterations to minimum water level, it is assessed that in terms of impacts on fish and fish habitat, the operation of Ruzizi-I and -II has caused significant impacts on 36% of the Ruzizi River. The operation of the proposed Ruzizi-III Project is expected, to cause a minor incremental increase affecting, to a minor degree, an additional 24% of the river through reduction in minimum water level. Overall, the incremental increase in impact on fish and fish habitat caused by Ruzizi III alone, and combined with irrigation is assessed as minor.

However, when considering the combined changes caused by Ruzizi III, irrigation and climate change, significant impacts on fish and fish habitat can be expected. The magnitude of the impact will depend on the magnitude of changes caused by climate changes, and there are many uncertainties regarding this.

B Percentage of Total River Length that Migrating Fish are Prevented from Reaching

The physical presence of the Ruzizi-I and -II dams has prevented migrating fish accessing the uppermost 19 km (11%) of the Ruzizi River, because fish ladders are no longer operational. The proposed Ruzizi-III project will cause an additional 12.5 km (7%) of river to no longer be accessible for migrating fish, with possible reduced migration in the 5.5-km dewatered reach. The total length of river that cannot be reached by migrating fish once the Ruzizi III Project is implemented is 31 km (18% of total river length). There will still remain 124 km of free-flowing Ruzizi River reach between the Lake Tanganyika and the Ruzizi III power outlet for fish migration from the floodplains of the Rusizi National Park and Ramsar site. However, the upper 31 km reach with the most rapids will be effectively restricted to fish migration. This leaves approximately 4-5 km of the reach between the power outlet and Bugarama with rapids and riffles for fish to migrate but where fishing pressures may be high due to lower minimum flow.

The cumulative impact of fish migration is therefore considered as significant. However, mitigation of the impact by construction a fish pass or undertaking truck and haul are not considered feasible. Therefore, mitigation measures are planned as discussed in Section 12.10.2

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12.10 Conclusions and Mitigation & Monitoring Framework

12.10.1 Conclusions

The overarching conclusions of the CIA are as follows:

- A comprehensive list of initial VECs have been considered, including VECs identified by the ESIA team, institutional stakeholders and communities. VECs include receptors from the physical, biological and social environment.
- A VEC screening process has been undertaken and three VECs (and corresponding metrics) have been identified for detailed assessment.
- Other VECs have been screened out of the detailed assessment because there is no spatial and temporal overlap of Ruzizi-III impacts with impacts from other projects, regional development activities, environmental stressors and external factors.
- The VECs (and metrics) assessed in the detailed CIA are as follows:
  - River hydrology (% alteration to natural conditions minimum water level).
  - River geomorphology (% alteration to sediment transported by the river under natural conditions).
  - Fish and aquatic habitat (% of total river length affected by alteration to minimum water level, and % of total river length that migrating fish are prevented from reaching).
- There have been significant impacts on hydrology from the operation of Ruzizi-I and -II. However, the incremental change caused by Ruzizi-III alone is minor.
  - Operation of Ruzizi-I and -II has caused intermittent significant (>10%) lowering of minimum water levels along 61 km of the Ruzizi River, corresponding to 36% of the total length of the river.
  - The proposed Ruzizi-III project will cause an additional lowering of water levels along 40 km (24%) of the river already impacted by Ruzizi-I and -II, but the degree of alteration is minor (<10% lower).
- The incremental increase in impacts on hydrology caused by the combined effects of Ruzizi-III, irrigation and climate change is assessed as significant, because of effects of the most plausible climate change scenarios. However, there are uncertainties with regard to the magnitude of climate change, and the less likely climate change predictions would cause significant changes, that either attenuate or augment the combined changes caused by Ruzizi III and irrigation.
- The cumulative impacts on river geomorphology are assessed to be significant. Overall, there is a significant increase in sediment load in the Ruzizi downstream from the Ruzizi-III Project caused by soil erosion in the watershed. However, the alteration caused by sediment trapping in the Ruzizi-III reservoir has an attenuating effect, reducing the degree of alteration caused by soil erosion in the watershed.
- The cumulative impacts on fish and aquatic habitat are assessed to be significant. There are significant impacts from the operation of Ruzizi-I and -II. However, the incremental change caused by Ruzizi-III is minor:
  - The incremental lowering of water levels caused by Ruzizi III alone is minor (see above), and this is considered a suitable proxy for assessing impacts on fish and fish habitat. However, when considering the combined effects of Ruzizi III, irrigation and climate changes, impacts on fish are expected to be significant.
  - The physical presence of the Ruzizi-I and -II dams has prevented migrating fish reaching the uppermost 19 km (11%) of the Ruzizi River. This is partly because fish ladders are no longer operational. The Ruzizi-III project will cause a loss of access to

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an additional 12 km (7%) of river, but this loss is expected to have a minor incremental impact and some mitigation is proposed to reduce fish impacts.

- The plans to rehabilitate the Ruzizi-I and -II fish ladders would mean that the Ruzizi-III Project will prevent fish from reaching 31 km of river upstream, i.e. reducing the benefits of the fish ladder rehabilitation.

12.10.2 Mitigation and Monitoring Framework

12.10.2.1 Measures Implemented by REL to Manage Cumulative Impacts

A CIA for Ruzizi-III HEPP Quarries and Borrow Areas

An ESIA (or several ESIAs) for Ruzizi-III HEPP quarries and borrow areas will be prepared at a later stage by REL, the Project Developer. The ESIA(s) will be undertaken when the EPC Contractor has selected the locations of the quarries and borrow area. At this stage in the Project, potential sites have been identified, but it will be the EPC Contractor that make the final site selection, and sites not pre-selected by REL may be used. The ESIA(s) for quarries and borrow areas should include an assessment of cumulative impacts, which aligns with the approach and level of detail of this CIA and the IFC Good Practice Guide. The CIA will assess temporal and spatial overlaps of impacts caused by the quarries and borrow areas, Ruzizi-III components, transmission lines (including associated facilities) and other projects or anthropogenic activities. VECs will include - but are not limited to - natural habitat, livelihoods, cultural heritage, water resources and other VECs identified by communities and institutional stakeholders during a stakeholder consultation process.

B Monitoring

REL will undertake monitoring of Project impacts on hydrology, sediment transport and fish. The information will be shared with third parties such as ABAKIR, EGL and other institutional stakeholders as appropriate to assist in management of basin-wide cumulative impacts (see Section 12.10.2.4).

C Coordination with ABAKIR and Rusizi National Park Authorities

REL will coordinate with ABAKIR and the Ruzizi National Park Authorities. This will comprise the following:

- Informing on a regular basis ABAKIR and park authorities of the Project activities, hydropeaking operating regime, sediment flushing operations, anticipated impacts and monitoring programme along the Ruzizi River and at the Rusizi National Park.
- Provide ABAKIR and park authorities on a regular basis the results of monitoring of hydrology, sediment transport, and fish.
- Establish communication channels for incident reporting, so that REL can inform ABAKIR and park authorities of any incidents that have a bearing on the Ruzizi River and National Park, and vice versa.

D Coordination with Developers of Projects within the Ruzizi III Project Area of Influence

REL will identify projects and project developers in the Ruzizi III Project's area of influence. This will comprise:

- Identification of projects that have spatial and temporary overlap with the Ruzizi III Project's quarries and borrow areas (as part of the quarries and borrow area CIA), and
- Monitoring of development of any new projects not identified in this CIA, which may have cumulative impacts with the Ruzizi III Project.

REL will put in place channels of communication to coordinate with the project develops, and this will comprise the following:

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- Informing the developers on a regular basis of the Ruzizi III Project activities, anticipated impacts and monitoring programme.
- Establish communication channels for incident reporting, so that REL can inform project developers of any incidents that have a bearing on the their project's and vice versa.

12.10.2.2 Coordination with Developers of Associated Facilities

ESIAs (including CIA) for transmission line projects that are considered as Ruzizi-III HEPP Associated Facilities are currently under preparation. The transmission line projects are supported by IFIs including the EIB, KfW and AfDB and consequently are required to align with the lenders E&S policies in the same way as the Ruzizi-III Project. REL will nominate a focal point within their organisation who will coordinate as necessary with the developers of the transmission line projects and the lenders with regard to the ESIAs for the Associated Facilities. REL shall keep track of ESIA progress and as a stakeholder in the transmission line projects shall review the ESIAs (including the CIAs) as part of their risk management process.

The ESIAs for the transmission line projects should include an assessment of cumulative impacts, which aligns with IFC Good Practice handbook (IFC, 2013). The CIA will assess any temporal and spatial overlaps of impacts caused by transmission lines, Ruzizi-III quarries and borrow areas, and other projects or anthropogenic activities. VECs will include - but not limited to - natural habitat, livelihoods, cultural heritage, water resources and VECs identified by communities and institutional stakeholders during a stakeholder consultation process.

12.10.2.3 Coordination with Third Parties to Manage Cascade Impacts

A Cascade Management Plan

To ensure that the Ruzizi-I, -II, -III and -IV hydropower schemes on the Ruzizi River operate in a coordinated and optimised manner, a Cascade Management Plan is expected to be prepared by EGL.

REL will coordinate with EGL and their consultants to facilitate the exchange of information necessary to establish the Cascade Management Plan. REL will inform the Cascade Management Plan of environmental and social constraints specific to the Ruzizi-III Project that need to be taken into consideration when establishing operating schedules. REL will participate in defining a coordinated and optimised schedule of operation.

B Cascade EFlow Assessment

It is recommended that a Cascade EFlow Assessment be undertaken to assess the cascade of hydropower schemes on the Ruzizi River, including the future Ruzizi-IV HEPP. It is assumed that the Cascade EFlow Assessment will be undertaken by EGL with funding from IFIs.

REL will coordinate with EGL and their consultants to facilitate the exchanges of information necessary to undertake the EFlow Assesment. REL will provide, as necessary, the information needed by consultants engaged to undertake the study, including operational constraints that need to be taken into consideration.

12.10.2.4 Coordination with Third Parties to Manage Basin-Wide Issues

A Basin-Wide Comprehensive CIA

REL recognises the need for a basin-wide comprehensive CIA to be prepared in the future by the Contracting States with the support of IFIs. The basin-wide CIA will differ from this project-focused CIA in that it should consider temporal and spatial overlap of all projects, regional development activities, environmental stressors and external factors. Whereas this project-focused CIA considers impacts from overlap with the Ruzizi-III Project, and therefore has a more limited scope.

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REL will nominate a focal point who will coordinate with government agencies, institutional stakeholders and their consultants with regard to the preparation of the basin-wide comprehensive CIA. REL will provide, as necessary, the information needed by consultants engaged to undertake the study, including operational constraints that need to be taken into consideration.

B Integrated River Basin Management Plan

REL recognises the need for an Integrated River Basin Management Plan to be prepared in the future by ABAKIR with the support of IFIs. REL will nominate a focal point who will coordinate with ABAKIR and their consultants with regard to the preparation of the plan. REL will provide, as necessary, the information needed by consultants engaged to prepare the plan, including information on modes of operation, sharing of information on environmental and social impacts and operational constraints that need to be taken into consideration.

C Basin-Wide Waste Management Plan

REL recognises the need for an Integrated River Basin Management Plan to be prepared in the future by ABAKIR with the support of IFIs. REL will nominate a focal point who will coordinate with ABAKIR and their consultants with regard to the preparation of the plan. REL will provide, as necessary, the information needed by consultants engaged to prepare the plan, including information on modes of operation, sharing of information on environmental and social impacts and operational constraints that need to be taken into consideration.

12.10.2.5 Recap of Roles and Responsibilities

Roles and responsibilities of the Project Developer (REL) and institutional stakeholders with respect to each mitigation and monitoring measures are set out in Table 12-15.

Table 12-15 Roles and Responsibilities for Mitigation and Monitoring of Cumulative Impacts

	Mitigation and Monitoring Measures	Owner	REL's Role and Responsibility
Project level	CIA for Ruzizi-III Quarries and Borrow Areas	REL	• Undertaking of CIA and public disclosure
	CIA for Associated Facilities	Developers of Transmission Line Projects	• Stakeholder, review of CIAs as part of the Ruzizi III's risk management process
	Monitoring of hydrology, sediment loads and fish	REL	• Undertaking of the monitoring and public disclosure
	Coordination with ABAKIR and Rusizi National Park Authorities	REL	• Establishment of the channels of communication and maintaining regular exchanges
	Coordination with other project developers	REL	• Identification of the project developers • Establishment of the channels of communication • Maintaining regular exchanges
Cascade level	Cascade Management Plan	EGL	• Stakeholder • Provide information on Ruzizi III Project operations, technical constraints, impacts and monitoring results
	Cascade EFlow Assessment	EGL	
Basin level	Basin-Wide Comprehensive CIA	Contracting States	• Promote the need for the studies and plans • Provide information on Ruzizi III Project operations, impacts and monitoring results • Provide financial support
	Integrated River Basin Management Plan	Contracting States	
	Basin-Wide Waste Management Plan	Contracting States	

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