3 ESIA Process & Methodology

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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Baseline environmental and social survey data collected by SOFRECO in 2012 is considered outdated and is not presented in this report.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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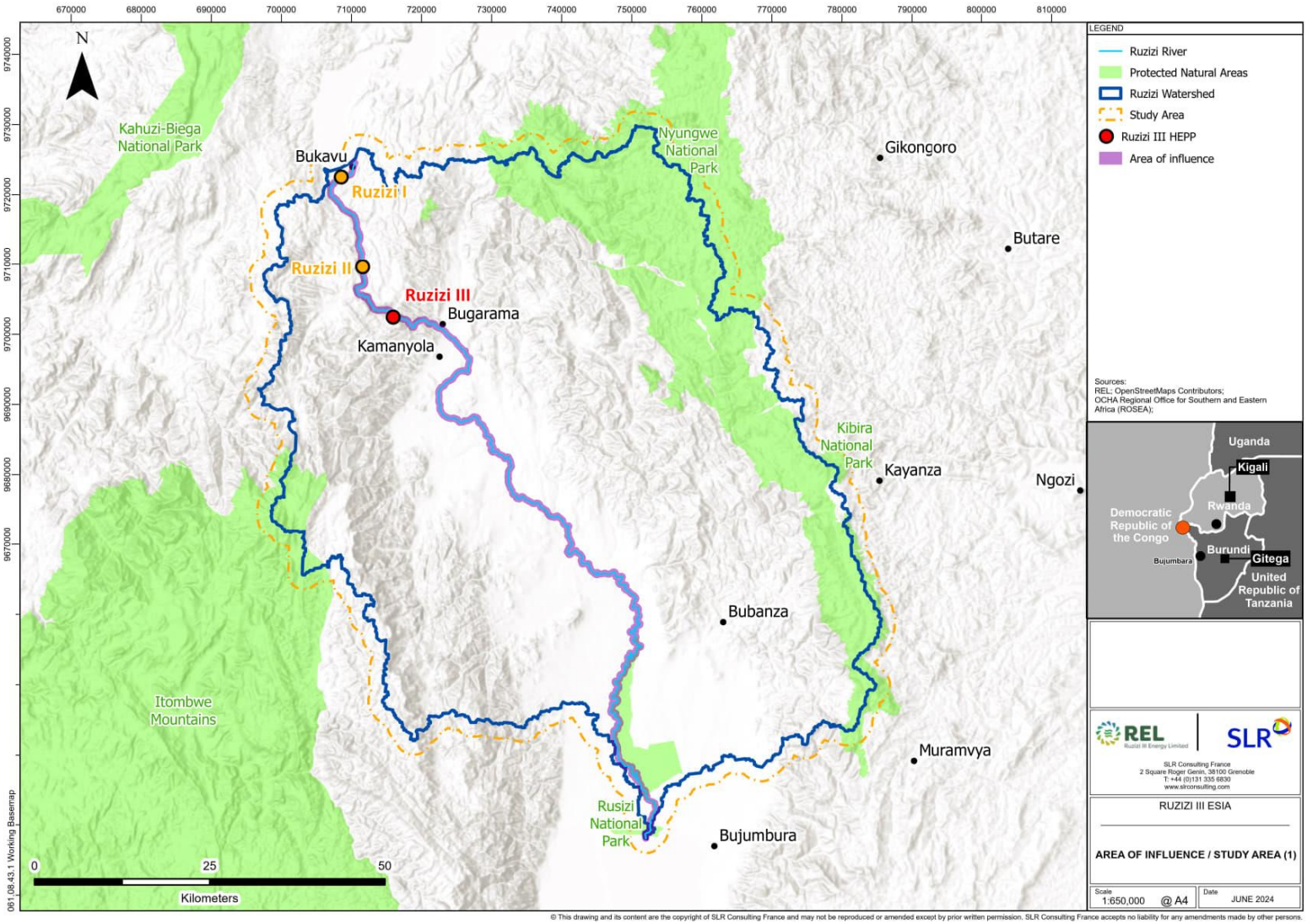

Figure 3-1 Area of Influence / Study Area Map (1/2)

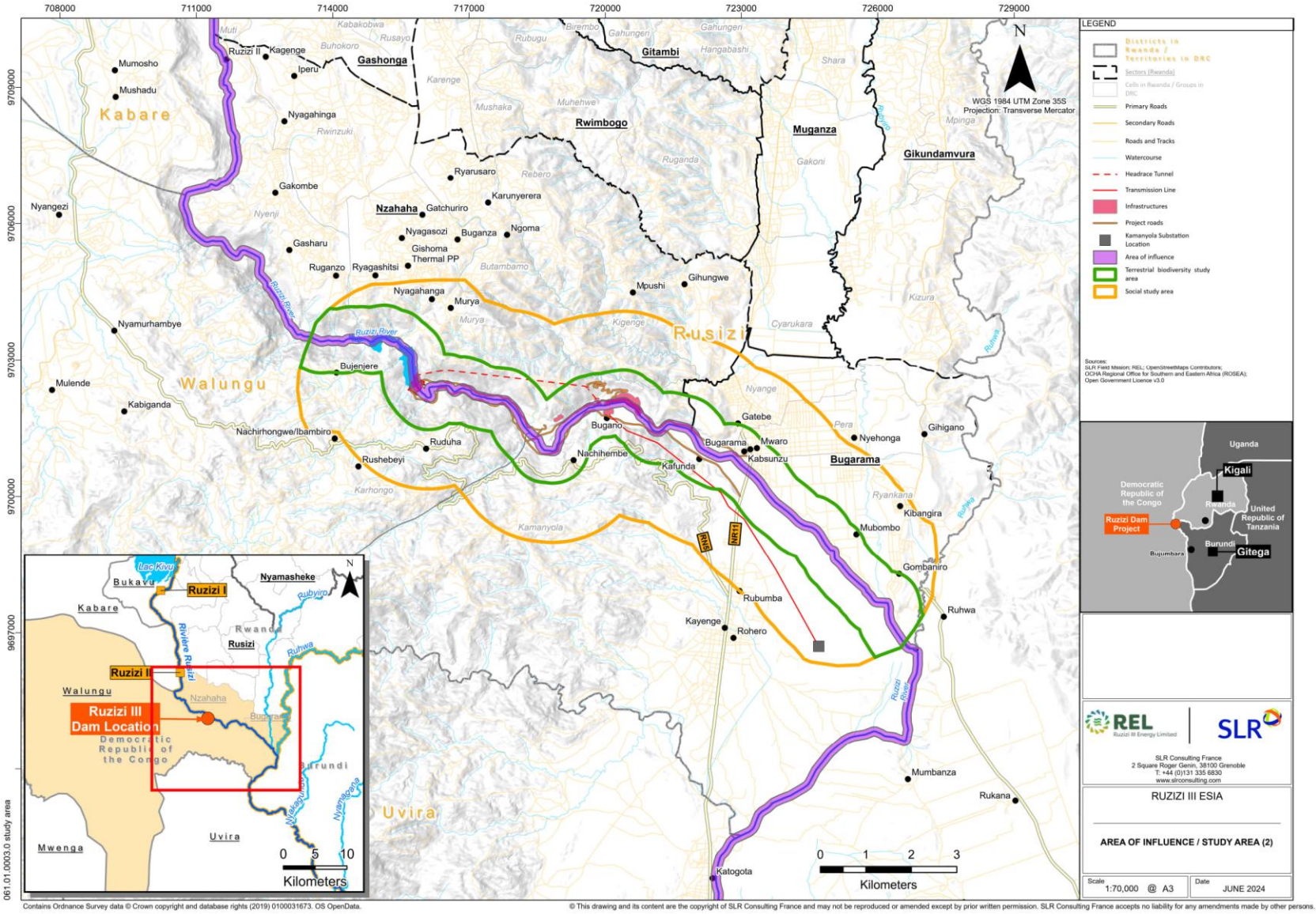

Figure 3-2 Area of Influence / Study Area Map (2/2)

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.

- 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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