12 Cumulative Impact Assessment

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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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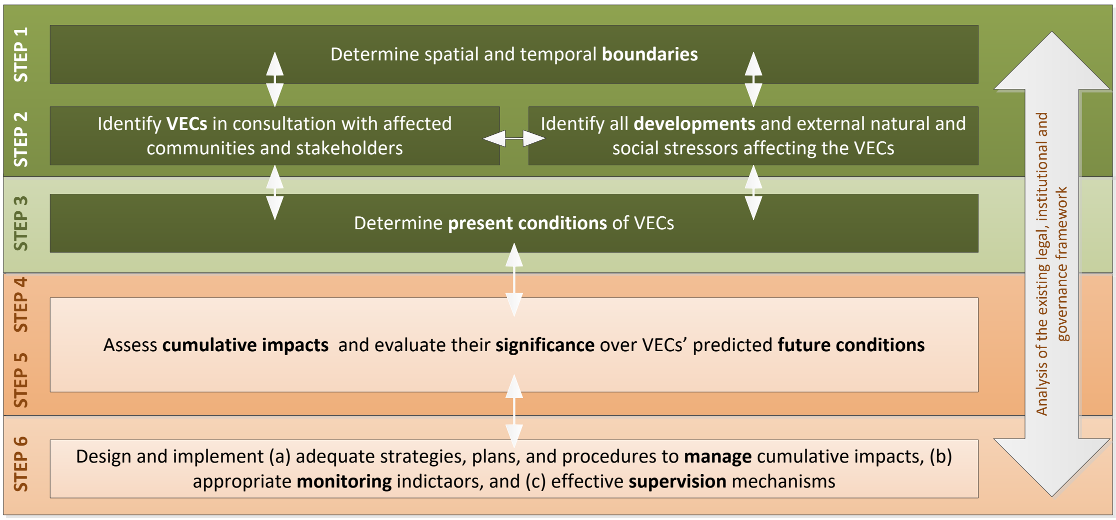

Source: (IFC, 2013)

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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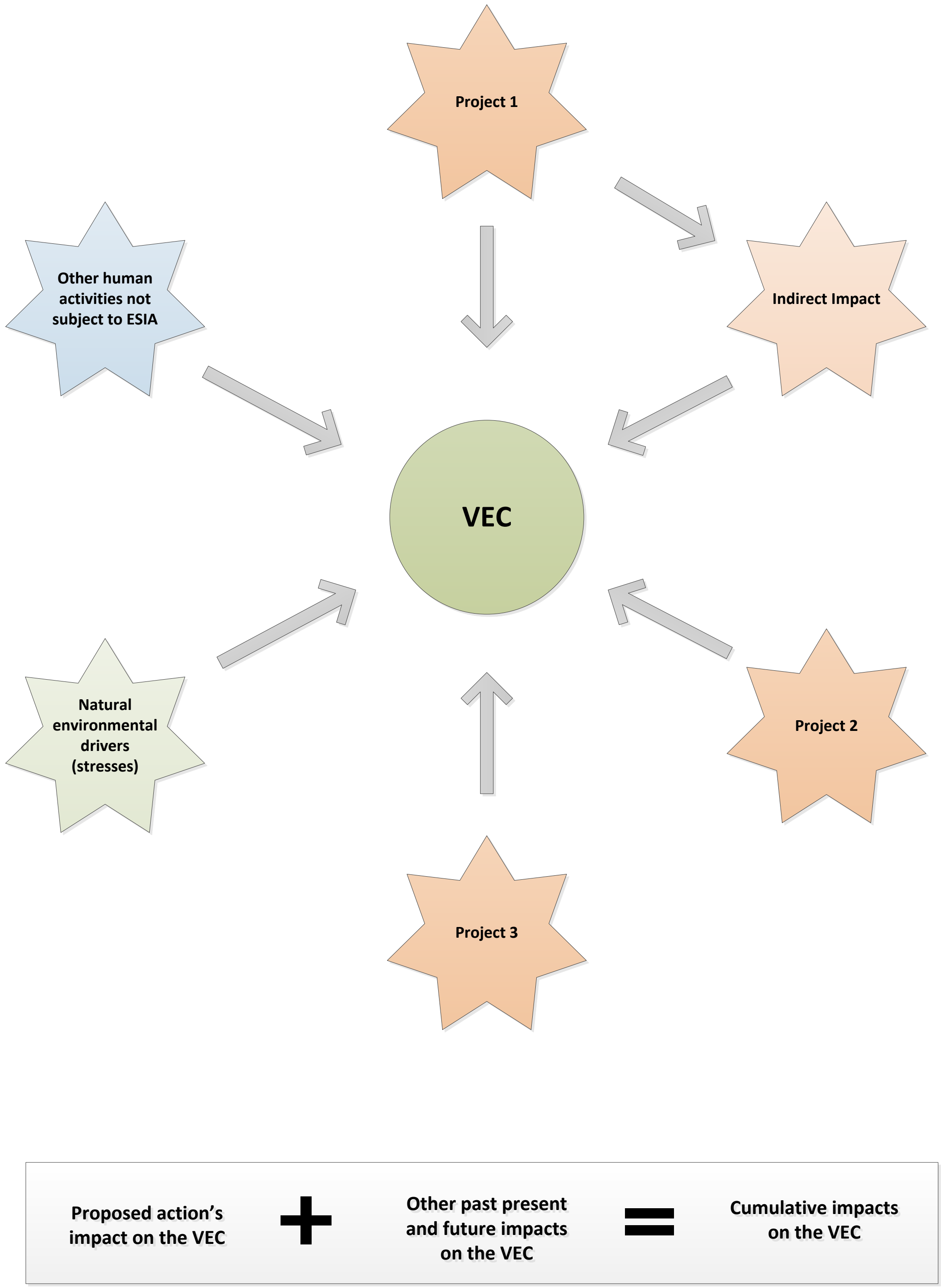

Source: (IFC, 2013)

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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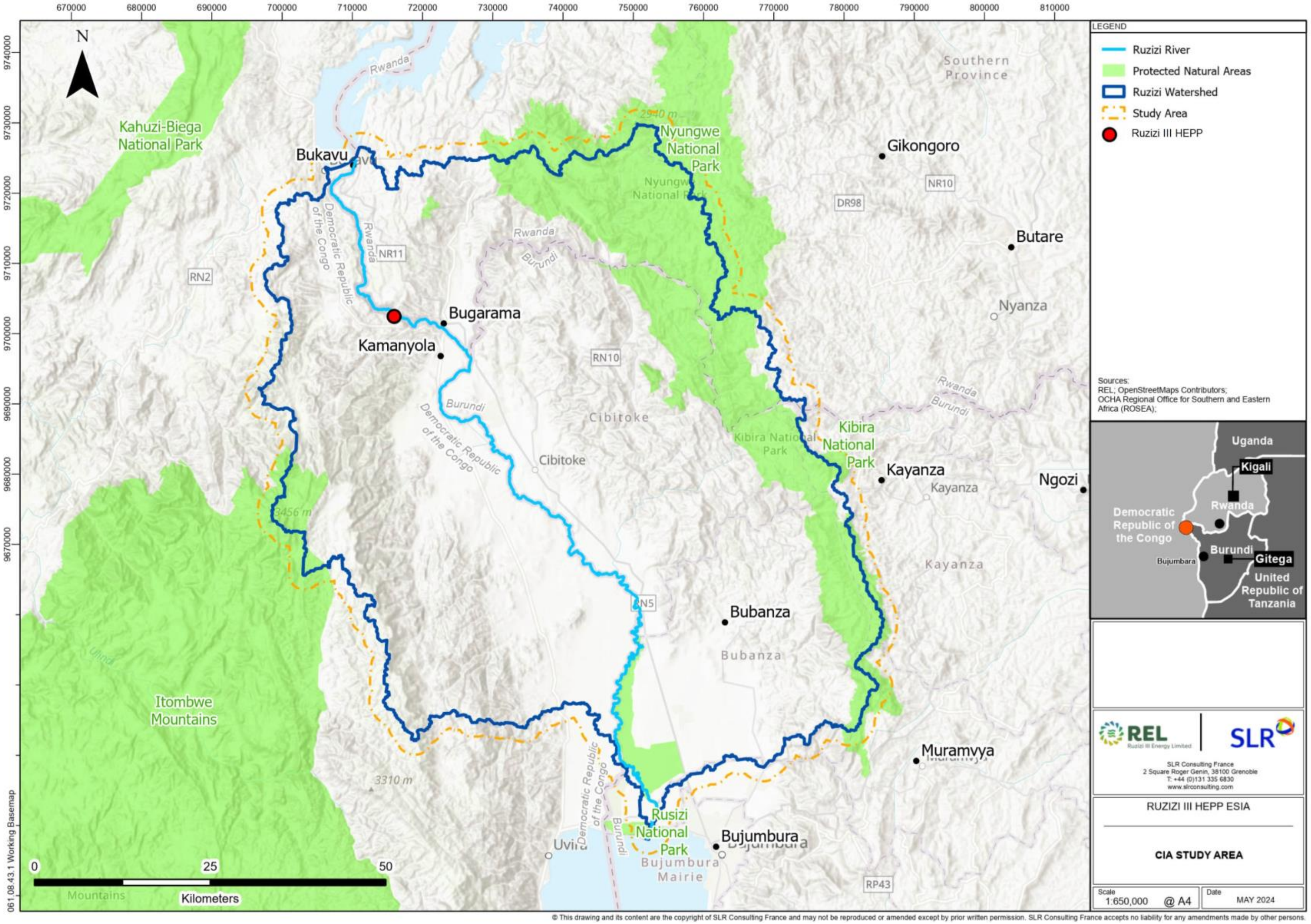

Figure 12-3 CIA Study Area Map

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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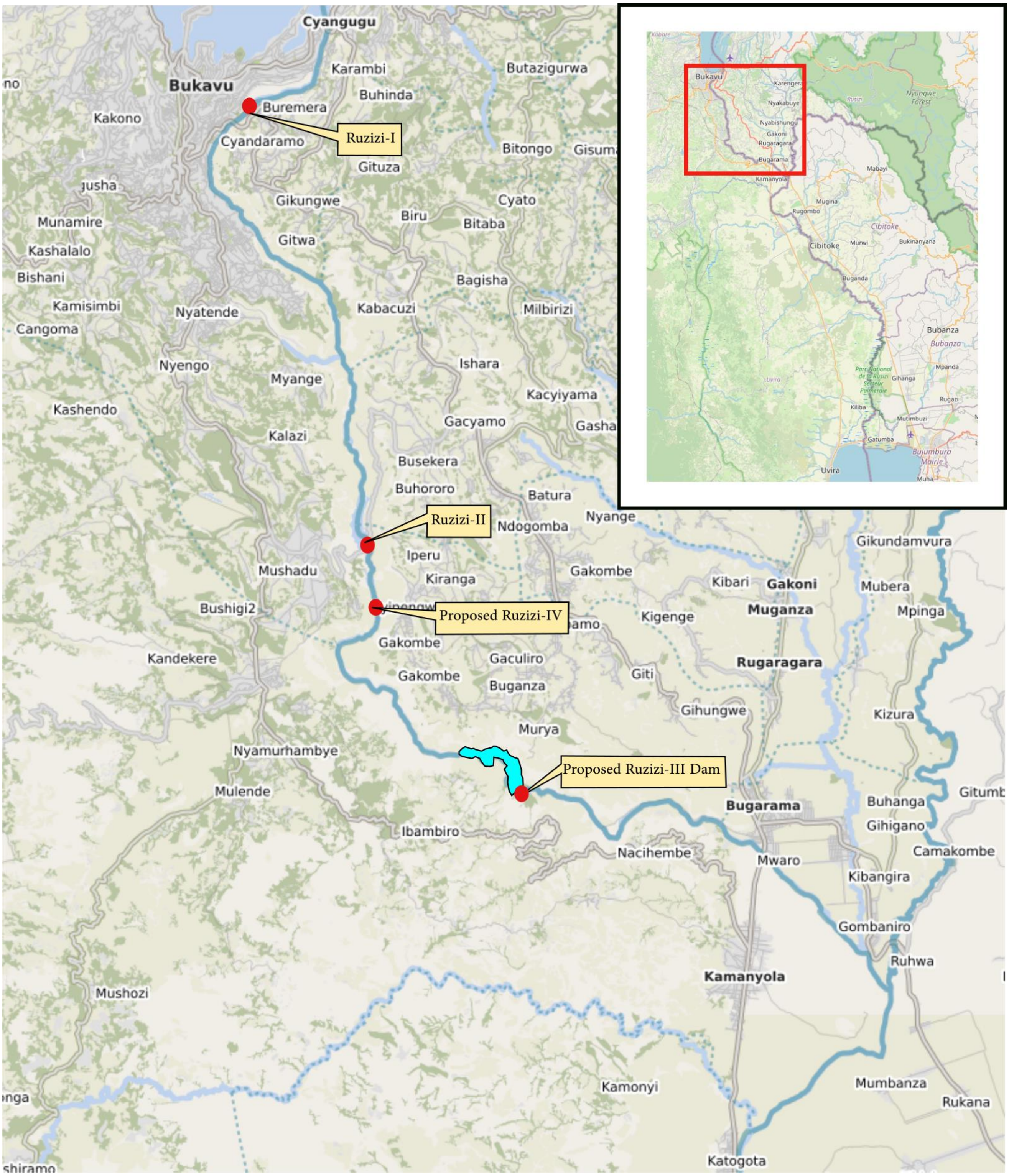

Figure 12-4 Map Showing Locations of Ruzizi-I, -II, -III and -IV HEPPs

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

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.			

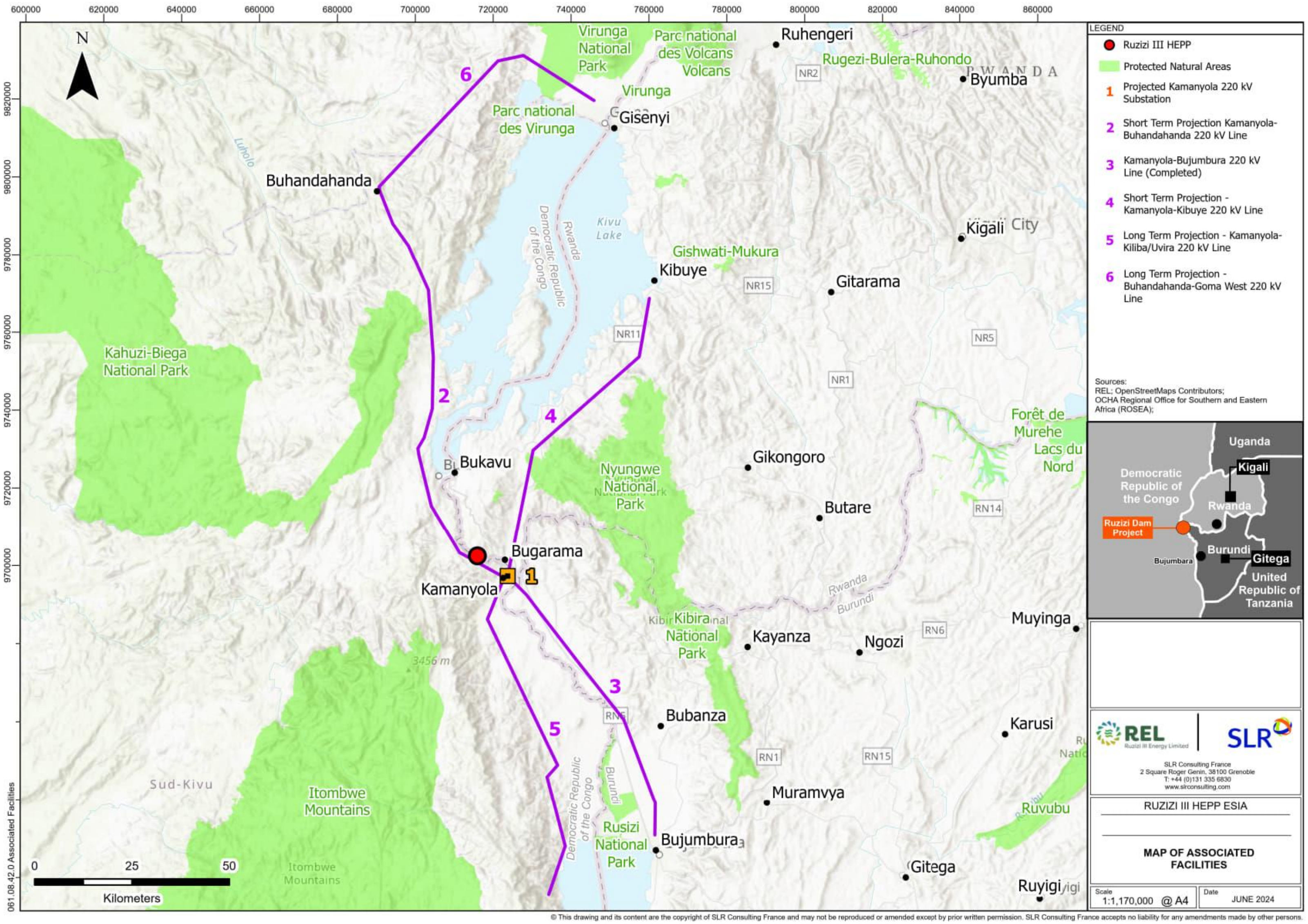

Figure 12-5 Regional Transmission Line Network (Associated Facilities)

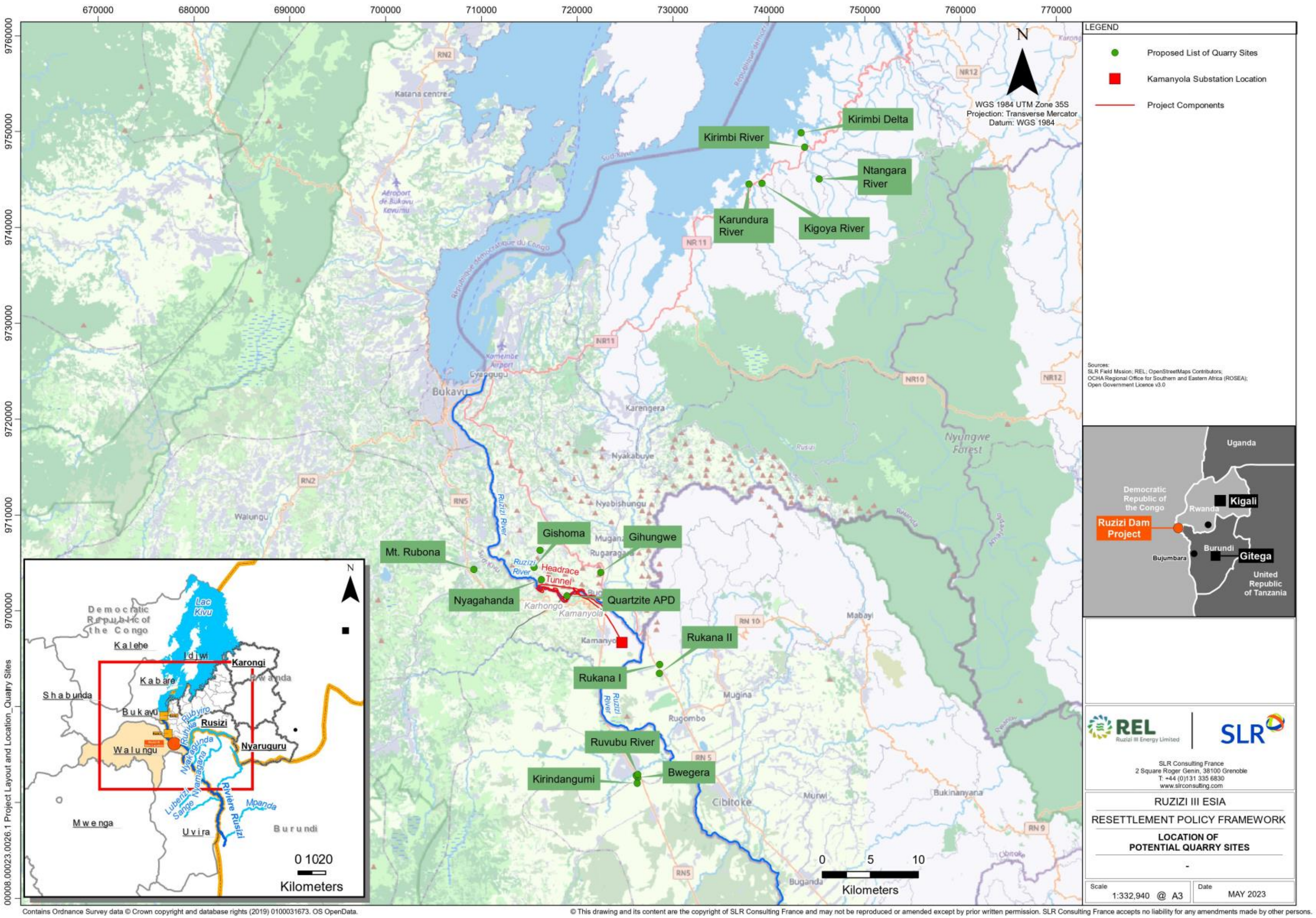

Figure 12-6 Locations of Potential Quarry Sites

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)

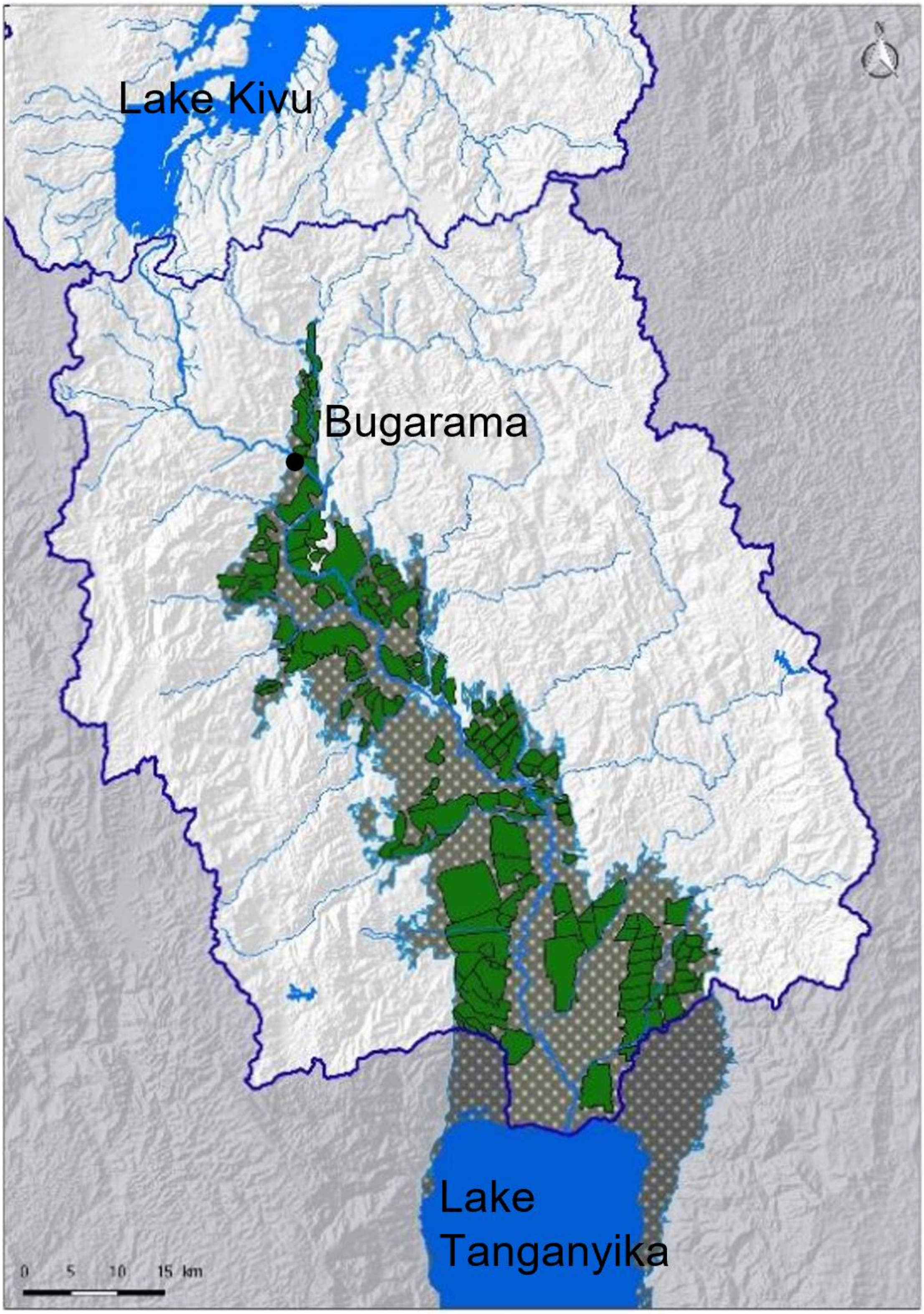

Figure 12-7 Irrigated Perimeters in the Ruzizi Plain

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/

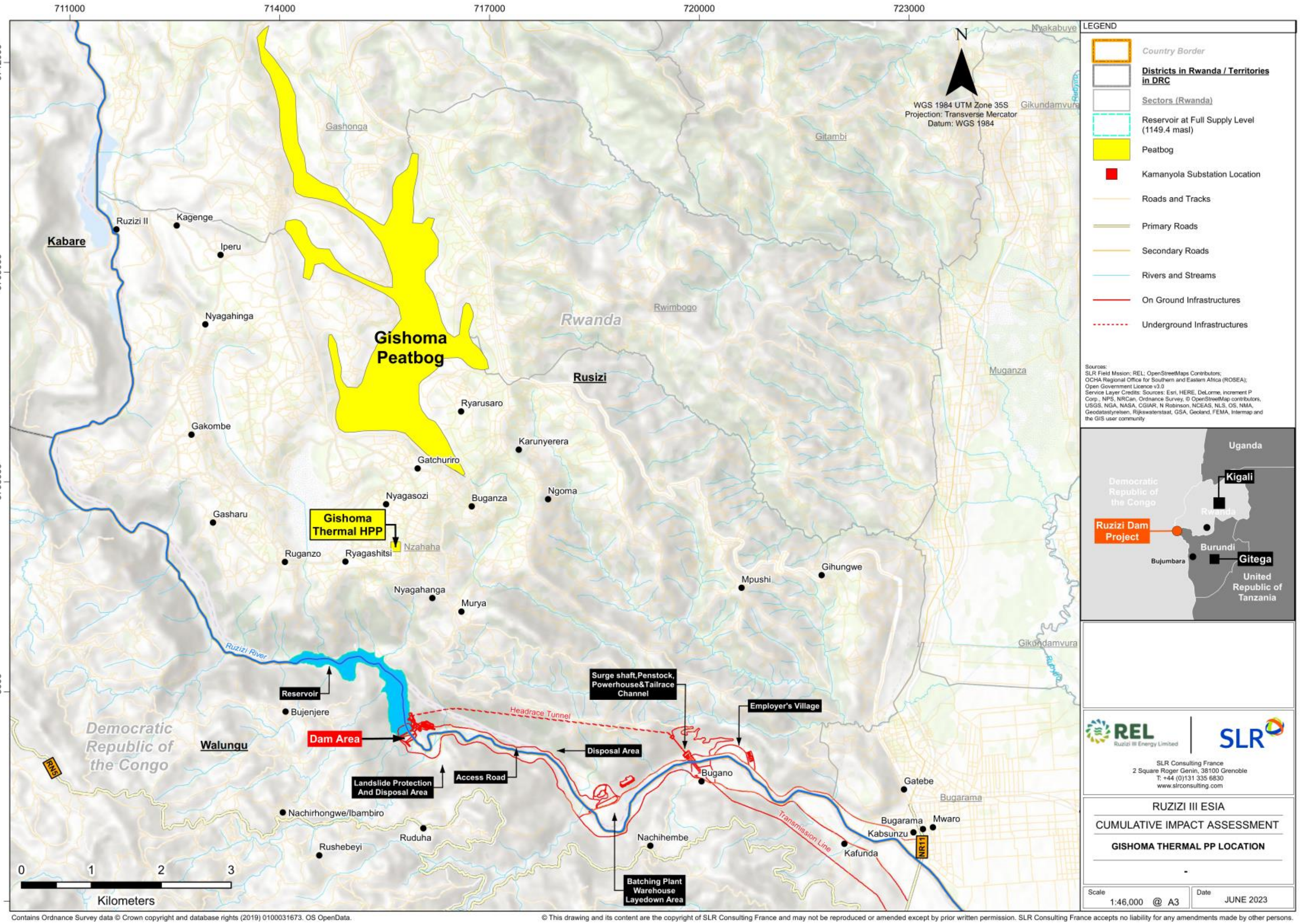

Figure 12-8 Location of Gishoma thermal PP and peatland

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.

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[4] https://rdb.rw/export/export/products-directory/tea-sector/

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.

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.

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

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

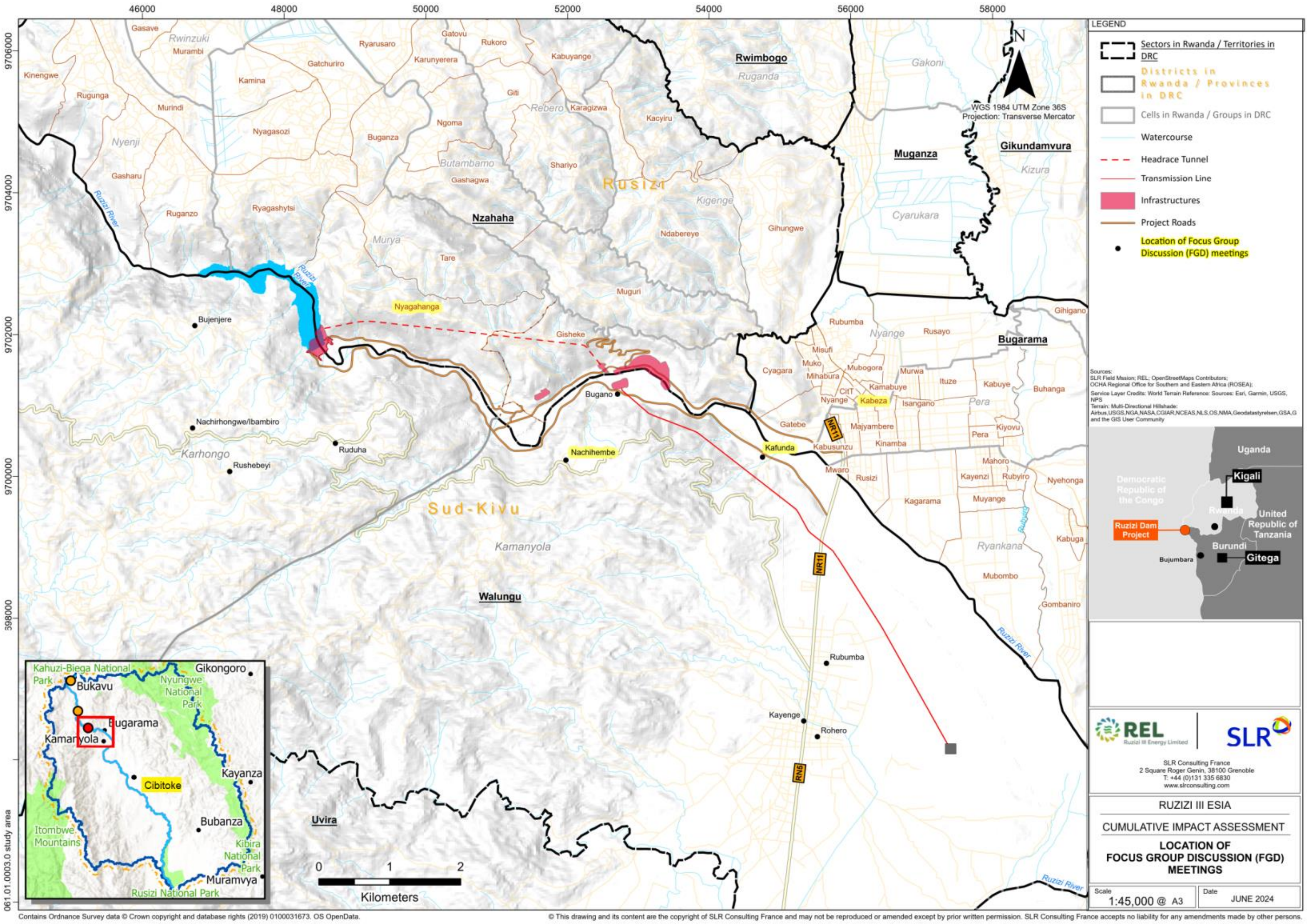


Figure 12-9 Map Showing Location of Focus Groups Discussion (FGD) Meetings with Communities

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.

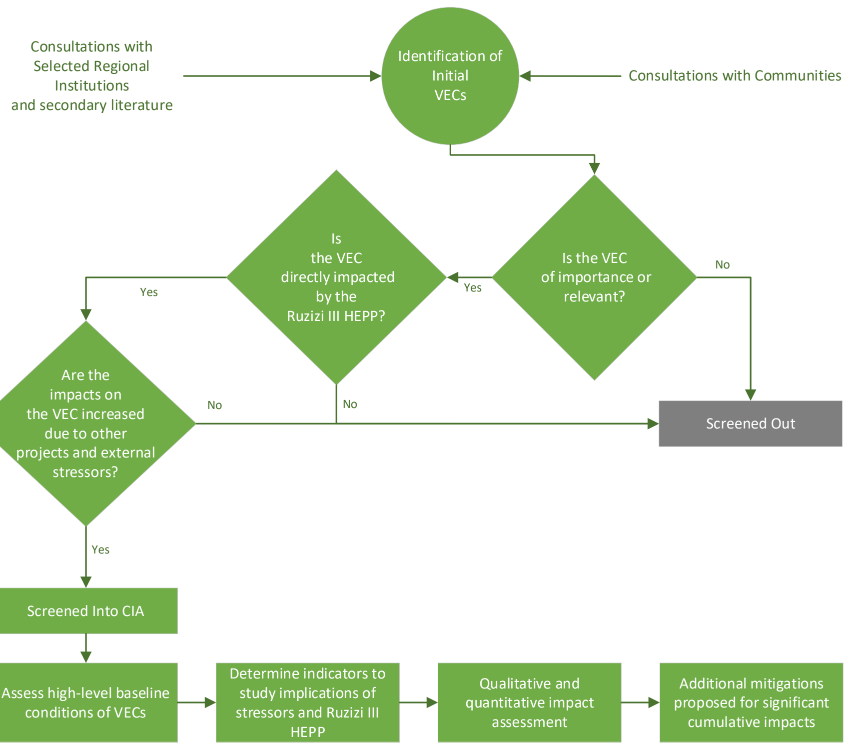


Figure 12-10 VEC Screening Process

The initial VECs and outcomes of the screening process are provided in Table 12-7.

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	

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	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**
	Increased damage to forest/woodland caused by illegal collection of firewood			
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**

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	

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

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

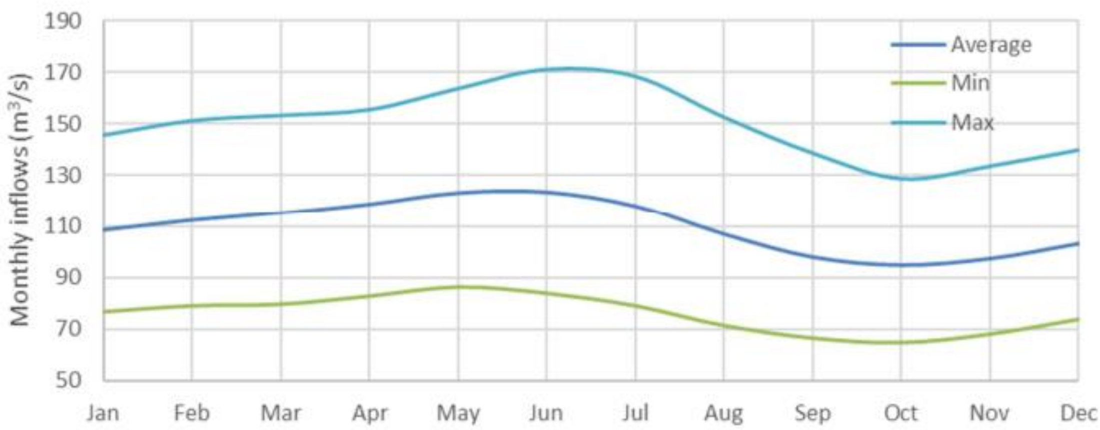
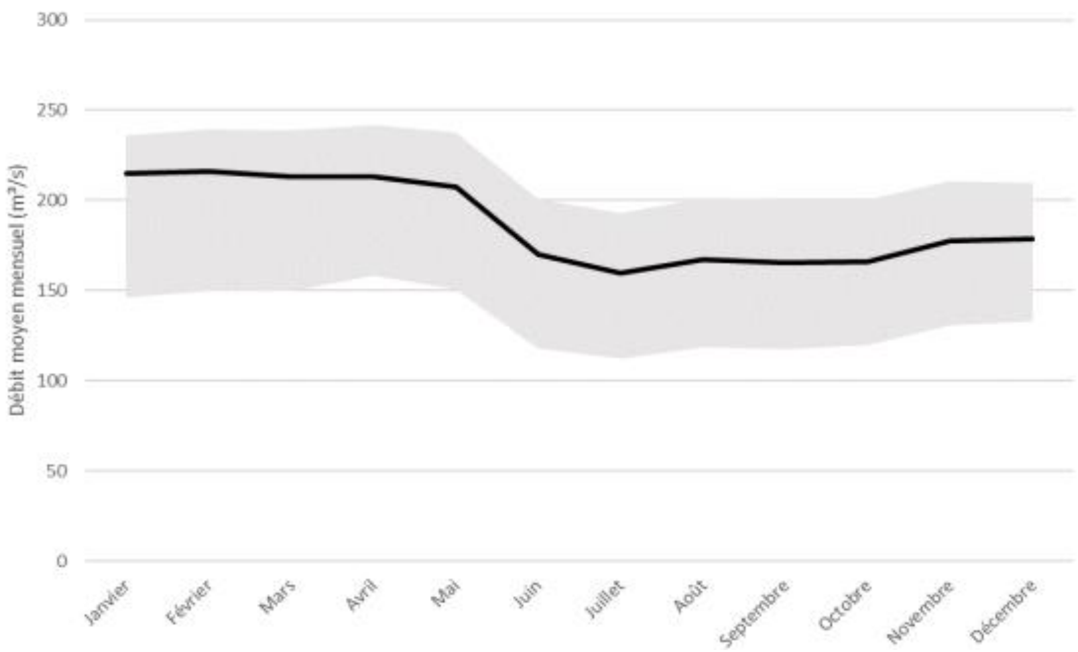


Figure 12-11 Monthly Distribution of Ruzizi River Flows at the Lake Kivu Outlet



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.

- 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.

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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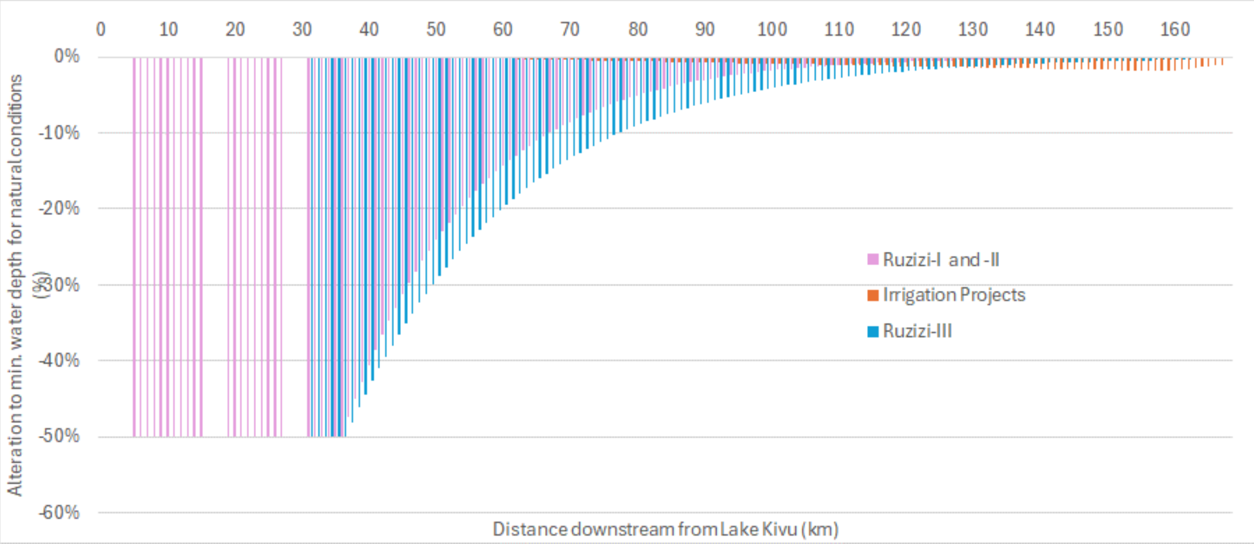
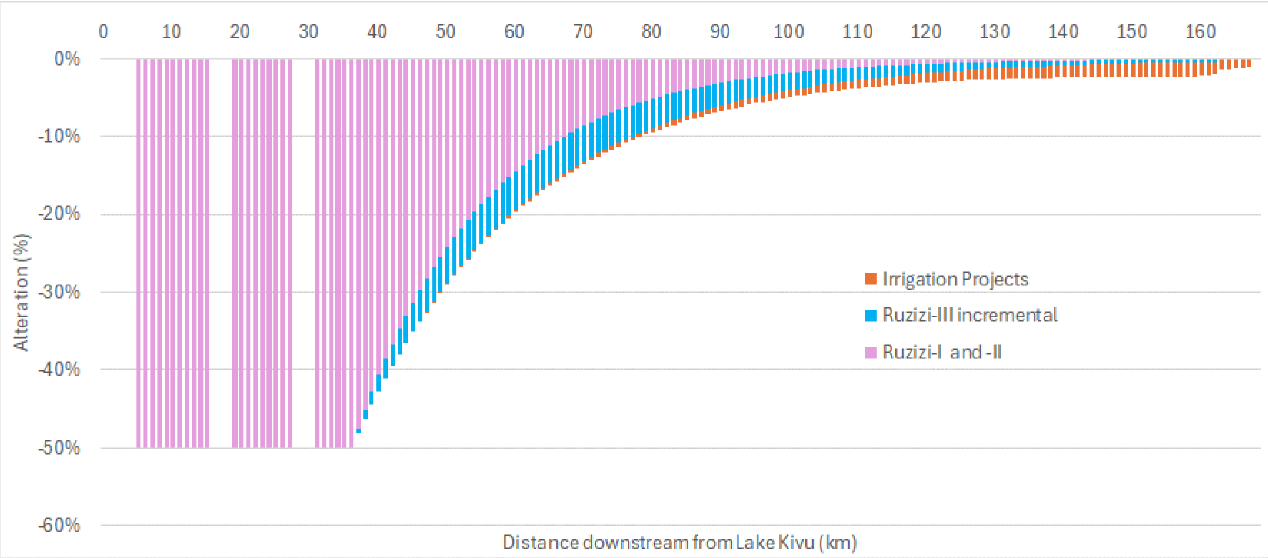


Percentage alteration to natural conditions minimum water level for individual contributors



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 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.

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.

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).

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%

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

flow of 10 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 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 10 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

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.

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

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

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.

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	