**PROJECT**: RUZIZI III HYDROPOWER PLANT (147 MW)

**COUNTRY**: MULTINATIONAL (BURUNDI – DEMOCRATIC REPUBLIC OF CONGO - RWANDA)

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**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) SUMMARY**

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1. INTRODUCTION

This document is the summary of the Environmental and Social Impact Assessment (ESIA) on the Ruzizi Project. The Great Lakes Energy Organization (EGL) (the organization set up by the Economic Community of the Great Lakes Countries to plan and supervise community energy projects in said countries) commissioned the ESIA of the Ruzizi Hydropower Project. This summary was prepared in compliance with the environmental requirements of the 3 countries concerned by the project, namely Burundi, the Democratic Republic of Congo (DRC) and Rwanda, as well as with the African Development Bank's Integrated Safeguards System (ISS) for Category 1 projects.

2. POLICY, LEGAL, ADMINISTRATIVE OR INSTITUTIONAL FRAMEWORK

2.1 Policy and Legal Framework

The main texts relating to ESIA in the three countries and applicable to the project are:

- **Burundi**: (i) Decree No. 100/22/ of 7 October 2010 on the implementation of measures of the Environmental Code in relation to the Environmental Impact Assessment Procedure; (ii) Law No. 1/01 establishing the Environmental Code in Burundi, which lays down basic rules for environmental management and protection against all forms of degradation so as to safeguard and promote the rational use of natural resources, combat various forms of pollution and nuisances and thereby improve the population’s living conditions while respecting the balance of ecosystems;


- **Rwanda**: (i) Organic Law No. 04/2005 of 8 April 2005 determining the modalities of protection, conservation and promotion of the environment in Rwanda is the reference text for all forms of environmental protection; (ii) Ministerial Decree 003/2008 of 15/08/2008 on the requirements and procedures for environmental impact assessments; (iii) Ministerial Decree 004/2008 of 15/08/2008 establishing the list of works, activities and projects subject to environmental impact assessment.


2.2 Institutional Framework

Several actors in the three countries are involved in environmental and social management. These are:

- **For Burundi**: The Ministry of Water, Environment, Land and Urban Planning. This Ministry’s prerogatives include the design and implementation of national regional development and environmental policy, especially through the definition and implementation of appropriate policies for land planning, natural resources protection and conservation: water, air, forests, wildlife and plant species. The Ministry has a Directorate-General of Land Management and Environment, which is subdivided into four Departments including the Tourism and Environment Department. The latter is responsible for monitoring and reviewing environmental impact assessments. Other ministries concerned by the ESIsAs are the Ministry of Agriculture and Livestock, Ministry of Communal Development, Ministry of Mines and Energy, Ministry of Trade and Industry and Ministry of Interior and Public Security;

- **For DRC**: The Ministry of Environment, Nature Conservation and Tourism (MECNT, successor to MECNEF) is charged with environmental management. Its responsibility are to: (i) prepare environmental hygiene standards; (ii) monitor implementation of environmental impact assessments; (iii) control industrial pollution and environmental sanitation. In the particular case of the ESIA, the Ministry of Environment is responsible for granting the project a Certificate of Environmental Acceptability without which no project can begin. Pursuant to Ministerial Decree No 044/CAB/MIN/ECN-EF/2006 of 8 December 2006, the Congo Environmental Study Group assists the Ministry in the review of ESIsAs. Other ministries involved in the ESIsAs are the Ministry of Energy, Ministry of Labour and Social Welfare, Ministry of Planning and Ministry of Land Affairs;

- **For Rwanda**: the main responsibility of the Ministry of Natural Resources (MINIRENA) is to: (i) prepare and carry out the monitoring and evaluation of policies and strategies as well as environmental protection; (ii) prepare draft laws and establish standards and practices to ensure rational and effective management of land, the environment, water, forests and mines, and evaluate their implementation. The Rwanda Environment Management Authority (REMA) has a legal mandate to organize and carry out the environmental monitoring recommended by the ESIA. The Rwanda Development Board (RDB) is responsible for approving ESIA reports. Other ministries also concerned are the Ministry of Agriculture and Animal Resources (MINAGRI), the Ministry of Trade and Industry (MINICOM), the Ministry of Infrastructure (MININFRA) as well as public establishments such as the Rwanda Standards Board (RSB).

- **Key Monitoring Actors**: see the Chapter on the Monitoring Programme.

2.3 International Framework

2.3.1 For AfDB

The Integrated Safeguards System (ISS) through the following five operational safeguards:

- Operational Safeguard 1: Environmental and Social Assessment;
- Operational Safeguard 3: Biodiversity, Renewable Resources and Ecosystem Services;
- Operational Safeguard 4: Pollution Prevention and Control, Green House Gases, Hazardous Materials and Resource Efficiency; and

The other relevant policies and guidelines that remain applicable as soon as they are triggered under the ISS are:

- The Bank's Gender Policy (2001);
- Framework for Enhanced Engagement with Civil Society Organizations (2012);
- Disclosure and Access to Information Policy (2012);
- The Bank's Policy on Poverty Reduction (2001);
- The Bank's Policy on Population and Strategies for Implementation (2002);
- Environmental and Social Assessment Procedures for the Bank's Public Sector Operations (2014).

2.3.2 Policies and Requirements of Other Project Donors

Different international donors intend to finance the Ruzizi III Project, in particular the World Bank (WB), the European Investment Bank (EIB), KfW, the European Union (EU) and the French Development Agency (AFD). The project is classified as a large dam in Category A with significant impacts, and must comply with the following World Bank (WB) guidelines: (i) OP 4.01, Environmental Assessment; (ii) OP 4.04, Natural Habitats; (iii) OP 4.09, Pest Management; (iv) OP 4.10, Indigenous Peoples; (v) OP 4.11, Physical Cultural Resources; (vii) OP 4.12, Involuntary Resettlement; (viii) OP 4.36, Forests; and (ix) OP 4.37, Safety of Dams.

2.3.3 International Conventions

The main applicable conventions are: (i) the RAMSAR Convention on the Conservation of Wetlands; (ii) the Convention on Biological Diversity; (iii) the United Nations Framework Convention on Climate Change; (iv) the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); and (v) the World Commission on Dams good practice recommendations.

3 PROJECT DESCRIPTION AND RATIONALE

The Ruzizi Hydropower Project III is in keeping with the Bank's long-term objectives. It is consistent with the need to increase the production of green energy to ensure sustainable development. It is in line with the operational priorities of the Bank's long-term strategy in terms of infrastructure, regional integration and private sector development. It is also focused on one of the strategy's main areas of interest by building the capacity of two States in transition. With an estimated annual capacity of 710 GWh, while preventing the emission of 120,000 tons of carbon dioxide, Ruzizi III will significantly transform the electricity sector in Burundi, DRC and Rwanda. Furthermore, this a flagship project of the ECGLC is ranked among the PIDA priorities of the Eastern Africa Power Pool and the East African Community.

The project comprises the following three components: (A) Support for Ruzizi III Implementation; (B) Support for Regional Cooperation and Integration; and (C) Project Management.

The Bank's 'public' contribution is UA 98.5 million, representing about 28.08% of the overall project cost which is co-financed with EIB (23.40%), the World Bank (18.72%), KfW (2.65%), EU (2.34%) and AFD (2.34%). The remainder, about 22.46%, is financed by the Project Company (PC). The Bank's 'private sector' contribution is UA 35 million. The Bank's public sector window contribution will enable the three countries to contribute to the equity capital of the PC or to on-lend resources to the PC in the form of loans, subject to conditions to be determined at appraisal.
The Bank's 'public' contribution comprises the following 3 components: (A) **Support for Ruzizi III Implementation** (financial support) – cost: UA 125.5 million; (B) **Support for Regional Cooperation and Integration in the area of energy** (technical aspects, regional market development, gender aspects defined at appraisal, capacity building) - cost: UA 5 million; and (C) **Project Management** - cost: UA 3 million; i.e. a total cost of UA 133.5 million.

The project area lies in South-West Rwanda and East DRC, between Lake Kivu and Lake Tanganyika. The Ruzizi III hydropower facility is located on the River Ruzizi, which marks the border between DRC and Rwanda in the Great Lakes region.

The project will generate a maximum of 147 MW to meet peak consumption periods. The project's main characteristics are:

- A 120 m long and 30 m high embankment dam with a waterproof asphalt concrete core;
- A reservoir with a storage capacity of 1.9 million cubic metres (m$^3$) covering an area of 27 hectares.
- A headrace tunnel from the dam to the power plant. It will be 2.7 km long with a diameter of 6.7 metres, a capacity of 150 m$^3$/s and a head height of 110 m;
- A hydropower plant with installed capacity of 147 MW, located 4 km downstream from the dam, with a fire protection water storage reservoir nearby;
- The hydropower plant will have three units, each comprising a Francis-type turbine and an alternator;
- A spillway channel allowing a permanent ecological flow of 6.5 m$^3$/s;
- A 1.3 MW mini-turbine at the dam site to produce energy from the ecological flow;
- A spillway mechanism at dam level which discharges high flows into a stilling basin and energy dissipater;
- A switchyard for 220 kV power transmission lines to the Kamanyola sub-station;
• Two temporary workers' camps for the site and permanent accommodation for the operation of the hydropower plant;
• Two permanent access roads on both sides of the river with a bridge over the river and several temporary access roads to the sites; and
• Quarries as well as storage areas for equipment and materials.

4 PROJECT ENVIRONMENT DESCRIPTION

4.1 PHYSICAL ENVIRONMENT

The Climate: The Ruzizi III site and its immediate environment have a mountain and plateau climate tempered by rainfall of up to 2,000 mm per year. However, the Ruzizi Plain (Bugarama-Kamanyola) downstream from the project has a tropical climate, with much drier conditions, influenced by a much lower altitude of about 500 m and the hot, dry Foehn wind phenomenon with annual rainfall below 1,000 mm. This situation occurs, to some extent, at the bottom of the Ruzizi gorges where temperature differs by several degrees from that of the subjacent plateaux. The average annual temperature is 21°C, but the maximum daily temperature may climb to 30°C during the main dry season.

Topography: the sites are characterized by steep slopes of 30° to 60° on both banks - an area which cannot be used for agricultural purposes. The topography is marked by erosion and landslides, and by its rugged gorges between: (i) a high plateau in the North (Rwanda), farmed and populated, which slopes down towards the East carved out into valleys as far as Bugarama; (ii) a high rocky ridge fanning out towards the South in an NW-SR to South direction (DRC) deeply incised by erosion, uncultivated and uninhabited. Despite serious inconveniences due to erosion and its inaccessibility, the site's topography is suitable for the construction of a dam.

Geology: This is confined to three main parts: (i) in the North of Rwanda a plateau of basaltic lava on less abundant volcanic turf and trachyte rock from the Miocene Epoch, over an ancient metamorphosed granitic shale substratum of the pre-Cambrian era; (ii) in the South (DRC), the plateau basalts disappear at the level of Nyangezi, exposing ancient metamorphosed granitic shale quartzite units, often without soil, of uncultivated and eroded slopes - which explains why the amount of agricultural activity is so low in this area; and (iii) a covering of red soils bevelled rapidly on the right bank and which disappears completely before the site of the dam almost 5 km below Mugera Falls.

Tectonics and Seismicity: The Ruzizi River is not of tectonic origin. It simply created its outlet cutting into the basaltic plateau. The Fichtner feasibility study confirms that about fifty earthquakes between magnitude 4 and 5 have occurred within a radius of 100 km of the project dam. A magnitude of 5.9 with a maximum of 7.6 for the entire rift valley was measured. The structure must be calibrated in line with this more recent data.

Erosion Phenomena along the RUZIZI: These phenomena are particularly significant on the slopes bordering the river. The Ruzizi District region which contains the Ruzizi escarpments has the highest rates in the country with 15.7 t/ha/year. On the Ruzizi I dam site (commissioned in 1958) at only 3 km from the Lake Kivu outfall, the area exposed to erosion is confined to the very limited portion in the immediate vicinity of the water course. However, on the Ruzizi II dam site, sedimentation from plants is also highly significant upstream and downstream from the structure. Around the Ruzizi III sites, erosion is particularly severe on both the DRC and Rwanda sides.

Hydrology: Covering an area of 2,416 km² and with waters at an elevation of 1,460 metres, Lake Kivu is replenished by a catchment area of about 7,500 km². Ruzizi River provides an outlet for Lake Kivu and empties into Lake Tanganyika. The hydrological regime of Ruzizi River has not been natural since 1959 since its flow is controlled by two hydropower schemes: (i) the Ruzizi I dam 3 km from the Lake Kivu outlet, built in 1959, with a normal turbine flow rate of between 80 and 90 m³/s; and (ii) the Ruzizi II dam about 18 km downstream from Ruzizi I built in 1989. The Ruzizi River flow rate is mainly determined by the
level of Lake Kivu, which has been falling for several years due to a downward trend in rainfall, the lack of expansion of its catchment area and increasingly high withdrawals for anthropic reasons.

**Water Quality**: Water quality analyses show that, despite the urban waste discharged into the water course on the Congolese side at Bukavu, the levels of concentration of toxic substances do not exceed WHO threshold limit values at the Ruzizi III level. A series of samplings were carried out on the Ruzizi I, Ruzizi II and Kamanyola sites. It was noted that the physical and chemical parameters of the Ruzizi waters vary little from site to site despite the presence of the two plants: the values for temperature, oxygen dissolved, turbidity and conductivity are virtually identical for all the sample sites.

### 4.2 BIOLOGICAL ENVIRONMENT

Ten landscape/habitat units representing as many fairly different plant ecosystems and specific habitats for wildlife have been described in the ESIA report. This summary will focus on three of them which concern the direct impact area.

#### 4.2.1 Minor Bed

- **Plant life on the banks and islets**: some are semi-aquatic: *Phragmites mauritianus, Cyperus articularis, Phoenix reclinata, Typha domingensis and Cyperus sp.* In many sections of the minor bed, semi-aquatic species are poorly represented. Other non-aquatic species grow directly on the water's edge: *Hyparrhenia diplandra, Imperata cylindrica, Ficus vallis-choudae, Ficus capensi* and, *Musa paradisiaca*.

- **Wildlife on the banks and islets**: The minor bed in the direct impact area constitutes the habitat for land wildlife represented by insects of the *Anax imperator* type (dragonflies), avian fauna and fish species represented in particular by *Bubulcus ibis, Phalacrocorax carbo* and *Scopus umbretta*. There are also tropical-waders: crowned cranes, many herons, many egrets (ox-peaters) and many cormorants.

- **Aquatic fauna**: The *Cichlidae* family is the most represented with 8 species, including the *Oreochromis niloticus*, the second most frequently bred fish in the world after the Asian carp. It is followed by the *Cyprinidae* family (5 species) to which the barbell (*Barbus allitianalis*) belongs and which is the only known fish to migrate between Lake Kivu and Lake Tanganyika. Despite discontinuities in the water courses caused by the Ruzizi I and II dams whose fish ladders have not been operational for many years, barbells are to be found all along the water course. The *Clariidae* family is a minority (3 species), as well as the *Clupeidae* family, which only has one species in that part of the Ruzizi basin.

#### 4.2.2 Major Bed

- **Riparian vegetation on the Ruzizi banks**: Over the direct impact area, in particular the section between the dam and the plant, there is an almost continuous presence of riparian vegetation in the form of woods, shrubs and grasses on the banks of a water course. The main major bed plant species are: *Combretum collinum, Albizia zygia, Sterculia tragacantha, Cyperus articularis, Pennisetum purpureum* and *Vernonia amygdalina*. This vegetation has been degraded by the planting of crops, exploitation of fire wood, and trampling. Some cultivated species that prefer high humidity and characteristic of human activity now form part of the Ruzizi riparian landscape, e.g. banana plants comprising the following species: *Musa sapientium, M. nana* and *M. paradisiaca*.

- **Wildlife**: Riparian vegetation serves as a biological corridor well known for its important functions of bank soil protection, shelter and source of food for many animals (insects, reptiles, birds, mammals, fish, etc.). The major bed contains terrestrial wildlife comprising: (i) arthropods such as: *Narceus sp.*, *Anax imperator, Apis melifica* and *Papilio bromius*; (ii) reptiles such as: *Mabuya striata*; and (iii) avian fauna with a strong presence of *Lagonostica*.
senegal. This wildlife is experiencing both quantitative and qualitative negative variations due to the degradation of the ecosystem.

4.2.3 Escarpments

- **Natural vegetation and crops**: The steep slopes of the Ruzizi gorges are heavily used for agricultural purposes, resulting in the almost complete disappearance of natural vegetation. They are home to relatively common species such as Hyparrhenia diplandra, Combretum collinum, Bridelia micrantha, Cussonia arborea, Ficus vallis-choudae and Steganotaenia araliacea;

- **Escarpton fauna**: francolins, eagles, owls and African darters nest in the escarpments. Terrestrial wildlife are also to be found, including arthropods such as Orthoctha dasycnemis, Formica sp., Narceus sp. and reptiles such as the Mabuya striata and Mabuya maculilabris.

Despite the disappearance of natural habitats, some species are particularly adaptable to the presence of humans and to habitats that are entirely or partly cultivated, especially when they are dotted with many small reforested areas as is in the case of the grey duiker (Sylvicapra grimmia) or the baboon (Papio anubis). Smallholders have confirmed the presence of the otter and caracal.

4.2.4 Protected Areas

There are no protected areas in the direct/indirect impact areas. The following lie in the immediate vicinity of the project area: (i) in DRC: Kahuzi-Biega National Park (600,000 ha, classified in 1980) located 20 km to the West; (ii) in Rwanda: the Nyungwe Forest (102,000 ha, classified in 1933) located 20 km to the East and Cyamudongo Forest (300 ha) which still has chimpanzees or golden cats (F. aurata); (iii) in Burundi: the Ruzizi estuary 100 km downstream, is partly protected by the Ruzizi Reserve in Burundi (9,000 ha, classified in 1980). This park adjoins the cumulative impact area.

4.3 SOCIO-ECONOMIC ENVIRONMENT

4.3.1 Demography

**Burundi**: The area covered by the Ruzizi III Project forms part of Cibitoke Province located in the North-West. Cibitoke Province is sub-divided into 6 municipalities: Buganda, Bukinanyana (Mugamba), Mabayi (Mugamba), Mucina (Mumirwa), Murwi (Imbo) and Rugombo (Imbo). Rugombo is the municipality concerned by the Ruzizi III Project. According to 2008 census data, the total population of the Rugombo municipality is 78,587. The population density of Rugombo municipality is estimated at over 350 inhabitants per km².

**DRC**: South Kivu Province is one of the Democratic Republic of Congo's (DRC) ten provinces. The project area covers the Walungu Territory, Kamanyola Groupement (headquarters in Kamanyola) and the Karhongo Groupement¹ (headquarters in Nyangezi). The estimated population of Walungu Territory was about 460,000. Administrative organization is based on dual supervision: that of the State and that of the customary authorities. In Walungu Territory, population density is estimated at 300 to 400 inhabitants per km².

**Rwanda**: Ruzizi District, West Province, Rwanda: the area concerned by the Ruzizi III Project forms part of Ruzizi District, which is one of the 7 Districts of the West Province. This District contains the largest part of Rwanda's largest natural forest, now classified (the Nyungwe National Park). Kamembe town (formerly Cyangugu) is the District headquarters. The town is located on the edges of the outlet of Lake Kivu and has a population of about 45,000. Ruzizi District has a population density of between 400 and 600 inhabitants per km².

¹ Administrative sub-division
4.3.2 Health, Education and Gender

In the three countries, education is affected at all levels by a shortage of qualified teachers, appropriate teaching aids and facilities. Fairly wide disparities exist between Rwanda and Burundi on the one hand, and South Kivu, on the other, where schooling conditions are precarious for many children.

The epidemiological profile of Rwanda, Burundi and South Kivu remains dominated by communicable diseases that account for an average of 90% of the reasons for medical consultations in health facilities. The most common diseases are malaria, acute respiratory infections, diarrhoeal diseases, HIV/AIDS and tuberculosis.

Major national HIV/AIDS and STD control programmes were rolled out very early in DRC and also exist in the neighbouring countries of Rwanda and Burundi.

The gender issue is reflected in deep inequalities in terms of access to health, education, employment, land and other factors relating to capital (during succession or concerning inheritance).

4.3.3 Case of Water-Borne Diseases

**Schistosomiasis:** The *Bulinus truncatus* and *Biomphalaria pfeifferi* are well known as intermediate hosts for bilharzia parasites in the region. Two types of ecosystems are favourable for the reproduction of these two species of molluscs: the irrigated areas of the Ruzizi Plain (Kiliba) about 50 km south of the Ruzizi II site and the Lake Kivu Region in slow flowing rivers. On the health front, cases of intestinal schistosomiasis caused by *Schistosoma mansoni* have been reported in the Ruzizi Plain.

**Onchocerciasis:** Concerning black flies, surveys on the different sites explored along the Ruzizi River have not revealed the presence of these insects and their larvae. Some mesoendemic pockets are to be found along the intermediate water courses of the Ruhwa, Muhira and Kaburantwa rivers. However, there does not appear to be any transmission in the immediate vicinity of the Ruzizi River, the highly alkaline waters of which prevent the black fly larvae from developing.

4.3.4 Basic Infrastructure

Basic health infrastructure in South Kivu Province is dilapidated and access to drinking water extremely limited. Despite a fairly large water supply network in Rwanda, Ruzizi District is experiencing water supply problems.

Access to electricity is a rare phenomenon in South Kivu Province since only 2.5% of households are connected to the grid (10.3% for DRC). In rural areas in Rwanda, electricity is confined to health centres, schools, state-owned establishments and religious establishments; 86% of energy used in rural areas comes from wood and charcoal (90% in 2001).

A very good asphalt road on the Rwanda side links Kamembe to Bugarama over a distance of about thirty kilometres. This road, still paved, then continues on the Burundi side to Bujumbura. On the Congolese side, the situation in Bukavu has, in recent years, been one of great isolation. The access road to Bukavu via the Ngomo escarpments to Nyangezi in the Ruzizi III Project areas is made of earth and very slippery in the rainy season.

There is a significant industrial base in the project area. CIMERWA, which is the only cement production factory in all Rwanda, is installed in Mashyuza on the Ruzizi Plain about 7 km from the centre of Bugarama. In South Kivu in the study area, there is no longer any operational industrial unit. They existed before, but have all been destroyed or their production suspended from the 1990s. There is also a cement production unit in Rugombo in Cibitoke Province in Burundi close to the project area.
4.3.5 Architectural Heritage

The literature mentions the Ruzizi 'iron age civilization', traces of which have been found to the South-West of Kamanyola and to the South of Bugarama, and may exist in neighbouring countries. According to information provided by the Congo Institute of National Museums (Kinshasa) and the Rwanda Institute of National Museums (Butare), there are no clearly identified cultural or archaeological sites in the area directly concerned by the project. In the Ruzizi District, archaeological sites have been reported in other sectors: in Kinanira (Nyakabuye Sector), in Ruhamandyarya (Nyakabuye Sector), in Kabosa (Gitambi Sector) and in Mibirizi (Gashonga Sector). However, the importance of the Iron Age civilization throughout the region requires that the opportunity provided by the Ruzizi works be taken to carry out, prior to their start-up, a reconnaissance of the archaeological sites in the Ruzizi River area.

5 PROJECT ALTERNATIVES

The Do Nothing Option: This option was rejected because it implies a high cost of access to electricity, an increase in poverty, diseases, deforestation and pollution.

“Diesel” Thermal Option: Easy to implement from a technical standpoint, geographic flexibility and rapid establishment; however, high cost of fuels considered as non-sustainable and contributing greatly to CO₂ production and generating air and noise pollution.

“Methane” Thermal Option: Natural resource in Lake Kivu represents well-established potential. The cost price per kWh would, according to investors, be comparable to that of Ruzizi III. However, there is little consensus on the issue of impacts and environmental doubts and risks prevent this option from being considered as a substitute for Ruzizi III.

The “Photovoltaic” (PV) Option: Because of its high costs, it is only economically viable on a remote site, for low wattage. In this densely populated project area where grid extensions would ensure the connection of most localities at a low cost, the domestic solar panel is not a valid option on a large scale.

The "Wind" Option: The wind systems in the region are not suitable for large-scale wind energy development. Only small-scale projects are being studied in West Rwanda. As in the case of PV, wind energy requires large surface areas with environmental impacts not easily mitigated if the full life cycle of the equipment and road infrastructure required to access them are taken into account.

The “Geothermal” Option: For its part, Rwanda is highly interested in this renewable energy, which has the following advantages: (i) none or few polluting emissions, if the water withdrawn from the depths is re-injected into the ground; (ii) small footprint due to vertical boreholes; (iii) attractive operating costs. Quite recently, surface investigation studies were conducted in the Ruzizi III Project area (Bugarama, Ruhwa and Kavimvira) and deep borehole trials in the regions of North-West Rwanda. However, an exact assessment of resources as well as the establishment of adequate technical and institutional frameworks and the development of local skills, etc. remain prerequisites to any consideration of such energy as a medium-term solution for the three countries.

The “Small-scale Hydropower” Option: Although the average cost price per kWh is higher than those of large structures, the development of small sites with generating capacity of a few MW represents a useable option for rural electrification prioritizing villages or localities of grouped houses and rural centres, to reduce the cost and transportation. However, development of small-scale electric power would be insufficient to meet the demand of cities like Bukavu, Kigali, Bujumbura, Goma, etc. Yet, because of the indirect socio-economic impacts it generates in rural areas, this option constitutes an essential complement to the extension of the national grid.
6 SELECTED OPTION

The Ruzizi III Project was selected taking into account the technical, economic and environmental problems facing the three countries concerned. Of all the alternatives, Ruzizi III appears to be the most effective to address the situation of crisis facing the power sector in the region and the most satisfactory from an environmental and social standpoint.

However, the development of significant hydropower capacity in the Ruzizi Valley will not suffice to resolve all the problems. It will also be necessary to maintain and renovate the existing plants to ensure that they once again operate at full capacity. In addition, an energy savings programme will be beneficial to all as it will reduce electricity bills. Lastly, the exploration of other sources (methane gas, geothermal energy, etc.) will help to diversify, safeguard and increase electricity generation.

Selection of Project Site: The RUZIZI III site was selected after reviewing the economic benefit of various sites, their environmental and social impacts and their risks. A comparison was made over a wide region encompassing Burundi, Kenya, Uganda, DRC, Rwanda and Tanzania based on several criteria, including: (i) data availability; (ii) major negative impacts; (iii) affordable cost; and (iv) capacity above 30 MW. A comparison was then made between the pre-selected sites on the basis of three composite indicators: (a) socio-economic impact (population displacement, rural electrification opportunities, impact downstream from the plant, land tenure problems); (b) environmental impact (resource conservation, GHG emissions, local pollution, land use, waste and downstream impacts); (c) electricity generation costs; and (d) Project-related risk. Ruzizi III is one of the sites retained as the “best development options” following the multi-criteria analysis. Other sites are Kabu (Burundi) and Rusumo Falls (Tanzania-Rwanda).

Selection of dam type: Two alternatives were prepared for the construction of the retaining structure: (i) a concrete retention structure; and (ii) an embankment dam with a waterproof core. The choice will, in particular, influence the design of the type of flood spillway. In the case of the option selected, the flood spillway is not directly incorporated in the structure, but is on the right bank where a tulip intake (circular crested or Morning Glory spillway) will capture water and channel it to an evacuation tunnel where a 2 MW turbine will also be installed.

Selection of related structures and infrastructure: Environmental and social criteria were taken into account in the selection of related structures. The selection of sites for the installation of site facilities will also take environmental and social criteria into account.

7 POTENTIAL PROJECT IMPACTS

7.1 Definition of Areas

Following a review of the different types of impact generated (fully or partly) by the dam, (direct, indirect or cumulative impacts), three geographic areas may be identified based on the environmental and social challenges taken into consideration (see Figure below):

- The area of direct impacts generated by the structure: (i) areas linked to the rights-of-way on the dam ground and various support structures; and (ii) the section of the water course valley subjected to environmental flow between the dam and the tailrace of the hydropower plant.

- The area of indirect impacts generated by the structure: (i) the catchment area upstream from the structure, which replenishes the reservoir in the section between the Ruzizi II and Ruzizi III dams; and (ii) the human settlement area on the periphery of the dam facilities.

- The area of cumulative impacts to which the dam contributes: (the zone covered by the project's cumulative impacts consists of an area centred around the Ruzizi's major bed, extending from the Lake Kivu outlet to Bukavu in the DRC to the North up to the Ruzizi Delta in Lake Tanganyika and to Bujumbura in Burundi to the South.
7.2 Negative Impacts on the Physical Environment during the Construction Phase

**Water and Soils:** The exposure of a fairly large area in the immediate vicinity of the river will, in the short term, intensify erosion (compared to the no project situation) especially during periods of heavy rainfall, and result in the discharge of sediments into the river downstream. The most steeply sloping areas (intake, reservoir edges, surge chamber) and especially the access roads will be the most sensitive. There is a risk of accidental spillage of hydrocarbons, toxic liquids (solvents, paint and varnish) and various products that could cause water and soil pollution. Then, around the workers' camp sites, human occupancy could cause different types of soil pollution: waste, wastewater and excrement.

**Air Pollution:** The largest dust particles (100 μm in diameter) will probably settle within a radius of 6 to 10 metres from their source (blown by winds of 4 m/s); 30 to 100 μm diameter particles (the majority of site particles), more easily inhaled, will settle within a radius of about 100 m from their sources. Fine, light particles, which remain longer in suspension (like diesel soot), settle further away than the previous types. However, in the virtually uninhabited valley bottom, their impact on the neighbouring communities should be limited. Air quality will also be degraded locally by gaseous pollutants emitted by construction machinery and dump trucks (NOX, SO₂ and CO).

Figure 1: Definition of Impact Areas

![Diagram of Impact Areas](image)

Source: ESIA report (2012)

**Noise and Vibrations:** Construction site noise of over 90 decibels at source is expected. The closest dwellings are located several hundred metres from the construction sites and the nuisance should be limited for any residence over 100 metres from the site. This fairly continuous construction site noise will be compounded by the noise of explosions from rock blasting. These noises could echo in the gorges but are known to be muffled, on low frequencies, generating rumbles whose impact on people and animals will depend on the distance they are from the site of the explosion. Vibrations from blasting operations are likely to stress livestock, causing them to flee and even make them aggressive. The project activities could temporarily keep animals away from the works area.
7.3 Negative Impacts on the Biological Environment during the Construction Phase

Wild Life and Plant Species: During the construction phase, the impact on vegetation, habitats and wildlife will result from the pre-emption of 115 ha for the rights-of-way of the reservoir, related structures and transport links. In the case of aquatic wildlife, fish density in the immediate vicinity of the construction sites is expected to drop sharply during the works phase due to the disturbances but also to an increase in fishing due to the influx of workers. In the case of terrestrial wildlife, the construction phase is expected to be a period of severe disturbance in the project's immediate vicinity. Even though baboons and otters are not endangered species, in view of their small numbers, there is a real risk of causing the extinction of the last remaining representatives of these species in the project direct/indirect impact area.

7.4 Negative Impacts on the Socio-economic Environment during the Construction Phase

The main impacts are:

Expropriations: In the two countries, the total number of households affected by the loss of land is 636 i.e. a population of slightly over 4,300 people, 64% of whom live in DRC and 36% in Rwanda. This mainly concerns land which is not developed, cultivated (food and market garden crops) or planted with banana and fruit trees. However, the project will also impact several houses, 7 or 8 depending on the final route retained for the access roads, i.e. between 55 and 60 people. During the census, a vulnerable group was identified consisting solely of single or widowed women (10% of PAPs). Details are presented in the resettlement plan in annex to this summary.

Health and Security: The construction phase may impact the health of people living in the vicinity, especially with regard to: (i) gastro-intestinal problems linked to the quality of water and its use; (ii) changes in disease vectors due to habitat modification (malaria, typhoid fever, etc.); and (iii) incidence of sexually transmitted diseases. The movement of vehicles and construction machinery on the site roads could expose the inhabitants of Bugarama and Kamanyola, particularly children, to accidents. The risk of insecurity in the region could rise due to: (i) the influx of people from outside the region; (ii) an increase in the amount of money in circulation linked to the wages of site workers and dependent trades; and (iii) compensation paid to smallholders (circulation of significant amounts).

Cultural and Archaeological Heritage: According to officials responsible for cultural and heritage affairs in Rwanda (Institute of National Museums of Rwanda), and in DRC (Institute of National Museums of Congo), there are not reported to be any archaeological sites or assets identified in the project's direct impact area, historical or religious sites, or outstanding buildings. There is, however, a possibility that such sites unidentified to-date may exist in the project impact area.

7.5 Positive Impacts during the Construction Phase

The project will create direct and indirect jobs, mostly during the construction phase. These will be jobs for labourers, workers, electricians, technicians, engineers and project administrative personnel. The local recruitment of labourers will have a positive impact on the social and economic situation of the households concerned. Economic activities are expected to develop with positive spin-off for: (i) small service trades, agricultural processing and transport activities; (ii) petty traders, local entrepreneurs and other suppliers of goods and services; (iii) catering and accommodation-related services, particularly with women engaged in catering-related activities. On the Rwanda side, it should be noted that the inn is being expanded and that an individual in Bukavu has bought land in Kamanyola to build a hotel; and (iv) while the project may not directly benefit local entrepreneurs (difficulties in finding qualified firms for this type of work), it may provide subcontracting opportunities for the most common construction, maintenance and plantation-related trades, etc.
7.6 Negative Impacts on the Biophysical Environment during the Operating Phase

**Water and Soils:** Destabilized as a result of water saturation, the banks and slopes around the reservoir are highly exposed to the risk of landslides. This risk will rise as a result of: (i) the area's topography and steep slopes; (ii) widespread farming activities; and (iii) daily variations in the water level. There is also a risk of increased erosion as a result of water run-off on slopes since the access roads will interrupt the laminar flow and re-channel it towards forced drainage structures. Regarding the restoration of the river bed flow, and despite the precautions taken in this regard in the design of the tailrace (at the exit of the turbine) and energy dissipating structures (at the exit of the flood spillway), erosion and filling phenomena could also affect the banks until a balanced profile is achieved in relation to the new river dynamics over a few hundred metres.

**Air Quality, Noise and Vibrations:** In the operational phase, noise from the hydropower plants will be limited to the movement of vehicles and trucks transporting various materials, and to possible mechanized maintenance works. No vibrations are anticipated during the operational phase. Regarding air quality, operation of the plant will not have any negative impacts apart from those linked to the habits of workers at the living quarters.

**Impacts on Wildlife and Plant Species:** On the approximately 4.3 km long section of the river between the dam and plant, the flow will be severely restricted (Environmental Instream Flow - EIF), since most of the water course will pass through the penstock. The average flow rate will fall from 85 m³/s to 6.5 m³/s, representing a drop of over 90%. This significant change is likely to affect wildlife and plant species. Riparian vegetation will recede giving way to less specific shrubby vegetation. The minor bed will be considerably narrowed, with serious consequences for aquatic wildlife. The dam construction could affect the barbell's migratory cycle (see the section on cumulative impacts/hydro-ecological discontinuity).

7.7 Impacts on the Socioeconomic Environment during the Operational Phase

**Health and Security:** The presence of the reservoir and its use for drinking water could slightly increase waterborne diseases (which already exist in the area) and their frequency. With regard to bilharzia, it is worth recalling that the Ruzizi River and its main direct tributaries are the only biotopes with no malacological wildlife, which prefer slow currents and the absence of gallery forest. However, the presence of the dam and of the EIF in the downstream reaches from the dam are likely to create a favourable biotope for the reproduction of bulin snails. The reservoir could increase the frequency of drowning accidents, especially concerning children. If people are not informed of the reservoir’s depth, they could venture in without taking any precautions. Moreover, the area downstream from the dam could become dangerous due to water released by the dam.

7.8 Positive Impacts during the Operational Phase

The project will generate positive impacts at the international, national and local level. Significant benefits will be obtained as a result of the project for the macroeconomic development of the three countries, Burundi, Rwanda and DRC (South Kivu Province), and for the living conditions of their populations. The initial benefits will consist in meeting rising demand for electric power.

The reservoir will become a new breeding ground for certain aquatic species and for avian wildlife. Statistical analyses based on a comparison of fish populations in the different environments have shown that habitats associated with submerged hydraulic structures are 4 times more populated. This information was also confirmed during the fishing campaigns carried out as part of this assessment at the level of the Ruzizi I and II reservoirs. If the EIFs are maintained, and if the channels are improved and rehabilitated at the level of the structures in compliance with the Consultant's recommendations (especially fish ladders, see 8.5.2), aquatic wildlife should benefit from the restoration of hydro-ecological continuity of the water course, with an increase in populations and in exchanges between Lakes Tanganyika and Kivu.
7.9 Cumulative Impacts

The ESIA report analysed the cumulative impacts of the existing dams (Ruzizi I and II), future dams (Ruzizi III and IV) and the presence of villages and towns along the river (use and pollution). The impacts that appear most important are: (i) those relating to the consequences of a dam failure; (ii) those relating to erosion phenomena; and (iii) those relating to the hydro-ecological continuity of the water course.

**Dam Failure:** Table I below indicates the time for flood waters from one plant to reach the other plants in the cascade. This will help to measure the response times in the event of the failure of one of the dams following, for example a strong earthquake. Therefore, it will take 4 hours 30 minutes to 5 hours for Ruzizi I water to reach Ruzizi III, which allows sufficient time to release the Ruzizi III flows when the alarm is given, and to absorb and release the flows from Ruzizi I. Notwithstanding, it is recommended to present the phenomenon and the wave propagation on a physical or digital model to facilitate the updating of the alert and release plan. This complementary study will form part of the environmental and social action plan.

<table>
<thead>
<tr>
<th>River Section under consideration</th>
<th>Flow Time in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Ruzizi I to Ruzizi II</td>
<td>150 to 180 (2h30)</td>
</tr>
<tr>
<td>From Ruzizi II to Ruzizi IV</td>
<td>2</td>
</tr>
<tr>
<td>From Ruzizi II to Ruzizi III</td>
<td>120</td>
</tr>
<tr>
<td>From Ruzizi IV to Ruzizi III</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: ESIA (2012)

**Erosion and Sedimentation**\(^2\): Erosion of the Ruzizi I to III catchment areas, due to cropping and the expansion of built up land as a result of urban development. The Ruzizi I reservoir is now largely invaded by sediment. The phenomenon is reported to have begun about 20 years ago and was caused by the cultivation of the slopes by refugees displaced as a result of the conflicts in the 1990s. According to information gathered from officials on the Ruzizi II site, this is expected to reduce average generating capacity by at least 10%. Around the Ruzizi III site, erosion phenomena are particularly pronounced. The cultivation of steep gradients and slopes in an area regularly destabilized by a series of earthquakes of all magnitudes and subjected to very heavy rainfall causes landslides or even the detachment of entire rock layers (see figure below).

\(^2\) A study was commissioned for the rehabilitation of Ruzizi I and II and will be available in December 2015
**Hydro-Ecological Discontinuity**: The barbell of the *Barbus altianalis* species is to date the only known fish to migrate between Lakes Kivu and Tanganyika. Despite the discontinuities induced by the Ruzizi I and II dams, this barbell is observed on the entire water course. Therefore, it is likely that the barbell will reproduce in the small water courses adjacent to the main water course. The ESIA report notes the presence of barbell fry in the Muzinzi, a tributary of the Ruzizi perched several hundred metres up on the plateau above the gorges, which shows that the adults can climb very steep slopes. The two existing dams which cannot be crossed upstream do not irreversibly impede the maintenance of the species since it is able to reproduce in the more or less permanent lateral tributaries (Muzinzi, Mugera, Ngomo, etc.). However, most of these tributaries flow into the river between Ruzizi II and Ruzizi III. One of the largest – the Ngomo - flows into the Ruzizi a few hundred metres upstream from the plant. Assuming that these are the water courses that enable the species to survive, the adding of the Ruzizi 111, then Ruzizi IV dams will further reduce and fragment the area currently available for the *Barbus altianalis* and could even further disrupt its reproductive cycle.

8 MITIGATION, OPTIMIZATION AND COMPLEMENTARY INITIATIVES

8.1 Mitigation Measures on the Physical and Biological Environment during the Works Phase

**Soils, erosion and sedimentation and water pollution**: To manage all the erosion problems, an erosion control programme was prepared. It concerns the control of erosion on exposed or excavated land, embankments and deposits of temporary or permanent materials, which will be carried out to minimize and control the resulting sediment loads. This protection will be achieved using slope stabilization methods and also by harvesting run-off water. Erosion control will include methods integrated into construction practices, including the installation of temporary mechanical-type protection devices (geotextile covers, sediment barriers) or the temporary replanting of the areas concerned. More specifically, the contractor will take into consideration the erosion aspects of the sites concerned in order to adapt its intervention plan. Based on the...
ESIA recommendations, the contractor will prepare plans and measures for: (i) the management of accidental soil pollution: prevention, identification, information for exposed people, mitigation and decontamination (Accidental Pollution Prevention Plan); (ii) waste and wastewater management to minimize environmental damage from construction activities, including the training of workers involved in construction, storage, handling, utilization, cleaning and removal of oils, fuel and other chemical products and the establishment of a comprehensive intervention plan including equipment and training (Waste and Wastewater Management Plan and Hazardous Waste Management Plan). A Water Quality Monitoring Plan for the Ruzizi River, and possibly its tributaries, will also be implemented by the contractor. This plan will include regular water quality monitoring: daily visual inspection, sampling at regular intervals and immediate measures if pollution is detected.

**Air Quality, Noise and Vibration:** An Atmospheric Emission Prevention and Reduction Plan will be implemented by the contractor during the works and will include measures for the storage of materials, periodic sensitization of machine operators, and stabilization of excavation and backfill sites, etc. A Sound Level and Vibration Prevention and Reduction Plan will guide the contractors’ control and monitoring activities entailing: (i) measures concerning the site environmental and health standards; (ii) intervention periods in line with working hours; (iii) technical options concerning silencing equipment for construction machines; and (iv) measures imposing speed limits on machines and trucks.

**Wildlife and Plant Species:** In addition to the emission, waste and soil pollution measures, the Project Company will implement the following measures: (i) rapid start-up of erosion control and catchment area protection measures; (ii) decorative planting within the workers' accommodation area; (iii) measures to protect plant species and habitats, with a ban on the exploitation or destruction of riparian vegetation outside the direct rights-of-way of the structures; (iv) combating poaching and prohibition of fishing in the immediate environs of the site; and (v) supply of food to the sites, thus reducing additional wildlife harvesting for workers' food. In accordance with the ESAP in annex, a site replanting and rehabilitation plan must be implemented. An initial target of 15 ha of trees at a rate of 3000 seedlings per hectare is planned. In the case of the barbell, see the section below on the ecological discontinuity measures.

### 8.2 Mitigation Measures on the Human Environment during the Pre-Works and Works Phases

**Health and Safety:** Extremely strict measures will be taken during the works regarding workers' health and safety. The measures will also extend to site discipline in terms of waste collection. These different topics are the subject of specific plans, details of which will be specified by the contractor in a Hygiene, Health, Safety and Environment Plan (HHSEP) and in the Waste and Wastewater Management and Hazardous Waste Management Plans. The list of plans in the context of the HHSEP is provided below.

**Management of Fortuitous Discoveries:** No historical and religious sites have as yet been identified, but it is possible that sites which have not yet been identified do exist in the project impact area. Such sites, if discovered, must be protected in compliance with the related national legislation and international requirements. A Fortuitous Discoveries Plan will, therefore, be finalized by the Project Company under the control of the national and provincial cultural and heritage authorities of the countries concerned.

**Full Resettlement Plan:** Physical and economic displacements must be carried out in compliance with the already prepared FRP. For further details, refer to the FRP summary attached in annex to this summary.

### 8.3 Main Specific Management Plans to be Prepared and/or Implemented by the Contractor

On a practical level, the successful contractors will be required to prepare, based on the project ESMP and within a specific timeframe following notification, specific environmental and social plans setting out in detail how these contractors (and their sub-contractors) will be organized, and endeavour to meet their environmental and social obligations. At this stage, the list should include:

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3 The list of complementary plans and studies to be implemented is indicated in the Environmental and Social Action Plan (ESAP) attached in annex. Implementation of the ESAP will be a condition for granting the ADB loan.
• **An Environmental and Social Management System (ESMS)** for the construction phase, which should be prepared. This document will have a contractual nature and for all parties will constitute the reference framework for environmental and social management. This document will be prepared by the project manager and the main contractors as soon as they have been contracted, and will fully meet the requirements stipulated in the (Contractors’) Bidding Documents (BD);

• **The Hygiene, Health, Safety and Environment Plan (HHSEP)** will have the following specific components:
  
  o Camp/Encampment/Living Quarters Management Plan;
  o Atmospheric Emissions Prevention and Reduction Plans;
  o Sound Level and Vibration Prevention and Reduction Plan;
  o Road Traffic, Access Management and Road Safety Plan;
  o Waste and Wastewater Management Plan;
  o Hazardous Waste Management Plan;
  o Accidental Pollution Prevention Plan;
  o Riparian Communities Information and Security Plan; and
  o Workers’ Health Plan.

• **Erosion and Sedimentation Control Plan**: It provides guidance on the necessary actions to minimize erosion and sedimentation: (i) ensure the maximum reduction of disturbed or exposed areas; (ii) stabilize and rapidly protect disturbed areas, and anticipate all work interruptions; and (iii) divert run-off water upstream from the site; spread out the groundwater run-off on the site to prevent it concentrating.

• **Site Replanting and Rehabilitation Plan**: see above.

• **Quarry and Borrow Area Management Plan**: Quarries and borrow areas should be the subject of a study and particular attention. Once the location is known and the quantity of materials to be extracted determined, a set of operating rules and specific mitigation measures for these sites should be prepared. This will be done, either as part of the specific plans already prepared by the contractor or in the form of a separate plan specifically dealing with this issue.

• **Initial Reservoir Filling Plan**: This Plan will set out the procedure listing the activities to be carried out and their implementation schedule prior to any site activities that could lead to a temporary or permanent rise in water level. This procedure will cover critical aspects such as the information communication chain, assessment of the rise in water level after the closing of the cofferdam, intermediate aspects likely to cause a rise in the water level before the final filling, the removal of waste and contaminated soil, etc.

• **Fortuitous Discoveries Management Plan**: see above.

• **Water Quality Monitoring Plan**: It should highlight the quality of the environmental management carried out on the sites. This monitoring concerns compliance monitoring, i.e. it will be mandatory at all points where liquid effluents (wastewater, drainage) leave the limits of the project site concerned into a natural environment. Regular samples will be taken of the camp distribution water at the drinking water abstraction points.

• **Workers’ Environmental and Social Training Plan**: It will ensure the smooth implementation of the measures proposed in the ESMP on the construction sites. This Plan will define the general training programmes (sensitization) for all workers and specialized
training programmes for those involved in particularly sensitive environmental activities (hydrocarbon management and distribution, hazardous waste management, landfill site management, etc.).

- **Site Dismantling Plan**: This Plan will list all the measures taken for removing material and equipment, etc. and the measures that will be taken to restore the sites.

### 8.4 Mitigation Measures during the Operational Phase

The action plans listed below will be carried out under the responsibility of the Project Company. Not yet formulated in detail at this stage, they will form part of the ESMP. They are: (i) the Regulatory and Management Framework; (ii) the Public Consultation and Information Plan; (iii) the Community Development Action Plan; (iv) the Emergency Alert Plan; (v) the Hygiene, Health, Security and Environment Plan; and (vi) the Project Impact Mitigation and Monitoring Plan. All the plans will also help to meet the dam safety requirements of the World Bank, in particular:

- **Operation and Maintenance Plan** covering the organizational structure, personnel, technical expertise and training requirements; necessary equipment and installations to operate and maintain the dam; and the procedures including long-term maintenance and safety inspections. The final plan must be submitted at least six months prior to the initial reservoir filling.

- **Emergency Preparedness Plan**, which specifies the role of the different responsible parties in the event of an imminent malfunction of the dam or when the planned flow released represents a threat. The Plan is prepared during the project's implementation and is submitted at least one year prior to the reservoir filling (see Section 9 for details of the Plan).

**Water and Soils**: The development of 7 to 8 reaches in cascades up to the Ngomo River, with 3 to 4 basins limited by reinforced natural sills downstream and 4 to 5 basins limited by artificial sills with rock or concrete spillways maintaining a depth of 0.50 m to 1.00 m, protecting the banks and safeguarding the biotope. The installation of spillways will create a flushing effect and small oxygenating waterfalls. The retention of water on this reach will also help to prevent black flies (vectors of onchocerciasis) from settling. It will also be necessary to prepare and implement an Erosion Control Programme with a triple objective: (i) minimize the project's environmental impact; (ii) protect the structure against the risk of sedimentation and silting; and (iii) improve agricultural practices in the project area.

**Wildlife and Plant Species**: It is necessary to: (i) prohibit the exploitation or destruction of riparian vegetation outside the direct rights-of-way of the structures; (ii) combat poaching; (iii) rehabilitate the Ruzizi I and II fish ladders and install a similar system at Ruzizi III; (iv) ensure that the instream flow is well maintained throughout the structure's life; and (v) stock the dam with fish.

### 8.5 Hydro-Ecological Discontinuity and Cumulative Impact Management

Scientific knowledge on this subject along the river is extremely limited. In keeping with the precautionary principle, and as a compensatory measure, a mechanism is necessary at the level of the Ruzizi III dam to maintain a river continuum acting as a biological corridor to ensure that fish make their seasonal upstream migration then their downstream run as part of their development cycle. This mechanism will be designed and implemented in a way that will limit maintenance requirements. The selection among the different types of fish ladders or elevators will be done on the basis of feedback on experience in other hydropower facilities with appropriate steps, taking into account the height of the dam (30 m), avoiding night-time light pollution and, if possible, equipped with an observation system to allow counting. It is also proposed to develop reaches of the river and basins in a cascade system maintaining an average depth of 0.50 m to 1.00 m. The rehabilitation and durability of the fishways at Ruzizi I and II is also recommended. An ecological flow is also recommended between the dam and the future Ruzizi IV plant. Lastly, complementary studies should
also be conducted on hydro-ecological discontinuity not only concerning the barbell but also for other species.

8.6 Complementary Studies Recommended by the ESIA

It was agreed with EGL that the existing studies should be updated and completed in accordance with ESAP recommendations. More specifically, a number of additional studies will be conducted. The following points provide, by type of study: (i) the Objectives; (ii) Scope of the Results; (iii) Influence on the Extent of Impacts; and (iv) Influence on the Project Design and Costs

8.6.1 Hydrological Study

A study on the hydrology of the Ruzizi valley, starting from the Lake Kivu system and finishing downstream of the steep Ruzizi valley in Kamanyola, was conducted under the Ruzizi III project. This study was used to size Ruzizi III. However, the ESIA recommends a more comprehensive analysis of the submersion levels in order to more accurately define the Emergency Preparedness Plan (EPP) to be used in the project's operational phase (Table 2).

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Scope of Results</th>
<th>Influence on the Extent of Impacts</th>
<th>Influence on Project Design and Costs</th>
</tr>
</thead>
</table>
| Complementary hydrological study | • Accurately determine the submersion levels of the minor and major beds based on flow rate fluctuations  
• Map out the areas to be protected, install on the ground the necessary signage, and sensitize the communities concerned. | This study will contribute to the finalization of the Emergency Preparedness Plan (EPP). | This study has no influence on the extent of project impacts. It will, however, contribute to the establishment of the emergency preparedness mechanisms, including in the event of failure (see point below) | This study will not affect the project's original design or its costs for the following reasons: (i) the EPP is finalized once the DDs have been validated; and (ii) an appropriation has already been made for the conduct of this study in the project budget. |

8.6.2 Study on Erosion and Sedimentation in the Catchment Area

The erosion and sedimentation phenomena were analysed in the ESIA for Ruzizi I, II and III. Their origin was determined and a specific management plan with an adequate budget has been proposed for Ruzizi III. To strengthen these measures in the long-term, an analysis of the entire catchment area was recommended by the ESIA (Table 3 below). This study is currently being conducted by EGL and the initial results are expected in December 2015.

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4 The updating of studies would help to finalize the required list of complementary studies. The ESSAP will be updated, if required.
Table 3
Update on the Study on Erosion and Sedimentation in the Catchment Area

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Scope of Results</th>
<th>Influence on the Extent of Impacts</th>
<th>Influence on Project Design and Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study on erosion and sedimentation in the catchment area</td>
<td>Deepen knowledge of sedimentary inflows across the catchment area.</td>
<td>It will help to more accurately specify technical solutions for erosion control and define the Water Development and Management Master Plan.</td>
<td>The future structure has no direct impact on this phenomenon the origin of which is rooted in upstream agricultural practices without erosion control mechanism.</td>
<td>This study will not affect the original project design or the costs. It will confirm the findings of the preliminary study and propose solutions for the catchment area as a whole.</td>
</tr>
</tbody>
</table>

8.6.3 Simulation of a Dam Failure

The ESIA report analyses the possible chain effect of the failure of one dam leading to the failure of other dams. The impacts of the worst-case scenario were analysed. Exceeding the scope of the Ruzizi III plant alone, this study should not be the responsibility of the Project Company alone but could be conducted under the oversight of ABAKIR (Table 4 below).

Table 4
Summary of the Dam Failure Simulation

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Scope of Results</th>
<th>Influence on the Extent of Impacts</th>
<th>Influence on Project Design and Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation of a dam failure</td>
<td>More accurately define emergency measures.</td>
<td>It will help to more accurately define the EPP as well as the Alert and Evacuation Plan in the operational phase</td>
<td>This study will have no influence on the extent of the impact already analysed, considering the worst-case scenario.</td>
<td>This study will have no impact on the project design but will contribute to the preparation of the necessary plans for the operational phase.</td>
</tr>
</tbody>
</table>

8.6.4 Study on Hydro-Ecological Discontinuity

An analysis has been carried out on the impacts of Ruzizi III and IV on the reproductive cycle of the barbell (which is to-date the only migratory fish species in the river). In the absence of recent scientific data on the evolution of aquatic wildlife, particularly fish, the precautionary principle was adopted: “...the Ruzizi River is a space for natural biotic exchanges between Lakes Kivu and Tanganyika and should be preserved in accordance with the relevant international standards.” ABAKIR will have the responsibility of deepening existing knowledge (Table 5 below).
Table 5

<table>
<thead>
<tr>
<th>Study on Hydro-Ecological Discontinuity</th>
<th>Objective</th>
<th>Scope of Results</th>
<th>Influence on the Extent of Impacts</th>
<th>Influence on Project Design and Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study on Hydro-Ecological Discontinuity</td>
<td>Deepen knowledge on the evolution of aquatic wildlife, in general, and migratory species, in particular.</td>
<td>Contribute to the integration of mitigation measures in the development of the Ruwizi catchment area.</td>
<td>This study will have no influence on the extent of the impact since, in the absence of scientific data, the precautionary principle was adopted.</td>
<td>A precautionary approach was adopted and the necessary measures incorporated into the project design.</td>
</tr>
</tbody>
</table>

It should be noted that the findings of these studies will contribute to the finalization of specific management plans in the operational phase. In general, these plans are required at least one year prior to commissioning (see ESAP). However, AfDB has recommended that preliminary details of the EPP be available before works start-up.

9 RESIDUAL IMPACTS AND ENVIRONMENTAL RISK MANAGEMENT

9.1 Residual Impacts

During the construction phase, the main residual impact concerns the negative effects on vegetation and habitats. Although they can be mitigated following works completion (re-planting when the site is closed), a lasting residual impact is envisaged. There is also the possibility of the resumption of erosion if the protection or planting of the site or operating rights-of-way is not kept in good repair and maintained. Even when the mitigation measures aimed at providing maximum protection to the area are subjected to the EIF, the ecosystem will suffer considerable damage, particularly to wildlife and plant species.

9.2 Risk Management and Emergency Situations

An Emergency Preparedness Plan will be prepared and implemented during the dam's operational phase. This Plan will specify the role of the different responsible parties in the event of imminent malfunction of the dam or when the planned flow released represents a threat. The plan is prepared during the project's implementation and is submitted at least one year prior to the scheduled reservoir filling. This Plan should contain the following elements: (i) the dam's classification based on its vulnerability; (ii) the level of consequences in the event of failure (study on dam breaches, flood hazard mapping, etc.); (iii) safety standards relating to floodwaters and earthquakes (flood typology, seismicity map, etc.); (iv) an impoundment management plan, especially in the case of situations likely to jeopardize the safety of people and property (maximum level of operation, evacuation curves and communication strategy, etc.); (v) a prevention plan including signage, information and sensitization measures for workers and riparian communities to prevent risks of accidents or drowning, especially when water is released; (vi) an emergency measures plan (inventory of situations, risk classification, alert procedures, information for authorities and the population, etc.); (vi) a dam surveillance plan (reconnaissance visits, regular inspection, specific inspections, etc.); (vii) a dam register recording all interventions concerning the structure; (viii) periodic independent security assessments (verifying that all the above-mentioned elements are taken into account and updated); and (ix) a security programme accompanied by the necessary authorizations and rights.

A fire-prevention mechanism is planned with the establishment of two reservoirs each with a capacity of about 500 m³ at an elevation of 1155 m.
MONITORING PROGRAMME

Works Supervision: This will be carried out through the Works Control and/or Supervision Mission established by the Project Company to ensure the Project's smooth implementation. It will include a specific position for environmental and social control (see Figure below). The objective will be to control on a daily basis the smooth implementation of activities and works throughout the project in compliance with the environmental commitments made by the Project Company and, more generally, with respect for the environment and its protection.

Environmental Monitoring: The objective is to ensure compliance of the results achieved with the environmental and social requirements of the countries concerned as well as of civil society in the three countries. Its frequency will vary according to the themes. A Multipartite Monitoring Committee is recommended by the Consultant. This Committee will commission an Environmental Monitoring Mission to conduct field studies.

EGL: Mandated by the three countries since this project's owner is the key actor. EGL is the guarantor of compliance with the ESMP and requires the Project Company (PC) then, through it, the contractors in charge of construction and their possible subcontractors, to comply with the ESMP requirements. More specifically, EGL will take action concerning: (i) the establishment of the committees proposed below; (ii) release of information to stakeholders; (iii) ESMP restitution and validation seminars; (iii) consultation of civil society during ESMP implementation; (iv) monitoring of ESMP implementation; and (v) implementation of complementary measures to resolve unexpected problems.

The Multipartite Monitoring Committee (MPMC): The MPMC will comprise about forty members from entities participating in the project, representatives of the local authorities, representatives of the ministries concerned, representatives of the population, NGOs and civil society organizations. The Multipartite Monitoring Committee will meet twice a year to carry out the monitoring of the ESMP and RAP.

Source: ESIA (2012)
**Project Company (PC):** The PC undertakes to comply with all the ESMP measures during the construction and operational phases. It passes on the obligations stemming from the ESMP to all contractors operating on the site, either to a single contractor (EPC or turnkey contract) or to several specialized sub-contractors responsible for the different project components (contracts in lots). The contractors as a whole are called “the Contractor”. Following the construction, the Project Company will either operate the plant itself or sub-contract its operation. The term used is “the Operator”.

**Environmental and Social Project Management (ESPM):** ESMP’s duties will be to steer the process, to carry out itself a number of specific activities including regular on-site environmental monitoring and mobilize the necessary skills to implement the activities planned under the ESMP and RAP.

**The Panel of Experts:** The panel of independent experts will represent the international actors (donors). Its role will be to periodically verify that the implementation of the works and subsequently the operation of the plant are carried out in compliance with donors' requirements.

The current ESMP proposes monitoring indicators. Its updating will help to fine-tune these indicators both in the construction and operational phases.

11 **PUBLIC CONSULTATION AND INFORMATION DISCLOSURE**

The public consultations had 4 objectives: (i) inform the communities concerned about the project in compliance with the legislation on disclosure of information procedures in the countries concerned as well as with the relevant international requirements; (ii) gather information from the population, authorities and civil society (points of view, opinions, local and specific knowledge, constraints, fears, comments on the findings of the study and solutions, etc.); (iii) seek the agreement of interested groups and the approval of the population; (iv) convey the preliminary conclusions and compensatory measures to the inhabitants, civil society and the local and national authorities, and incorporate their comments in the final version of the study report.

The following stages have been completed:

- Initial meetings in July and early August 2010 in Burundi, Rwanda and DRC (South Kivu Province);
- Cyangugu Scoping Workshop on 16-17 August 2010, with EGL and stakeholder representatives from each of the three States (see Annex 9);
- Information and Consultation Sessions on the content of the Ruzizi III Project in the project localities (18 August - 7 September 2010), accompanied by the establishment of Committees of Project Affected Smallholders (CPAS) in South Kivu and in Rwanda, and discussions with the customary authorities;
- Disclosure of information to inhabitants and local authorities during the conduct of the census in the project areas from 25 August 2010 to 21 October 2010 in South Kivu Province and in Rwanda;
- Discussion workshops at village level concerning individual and collective compensation measures, noting concerns and wishes, discussions with the CSAP and inhabitants;
- Discussion workshops with women;
- Seminar to present the preliminary results of the specific ESIA/RAP studies on Ruzizi III in Bukavu (South Kivu Province, DRC) on 1/11/2010.
Final institutional workshop to validate the Ruzizi III ESIA/RAP with the participation of the local and national authorities, civil society and all the stakeholders in the three countries: held in Cyangugu (Rusizi District, Rwanda) from 28 to 30 March 2012

The exchanges with the inhabitants of the villages of Ruduha, Ibambiro, Ishamba, Bujenjere, Kafnda, and Bugano in South Kivu and of Nzahaha in Rwanda clarified their concerns and wishes on the following subjects: (i) electrification of villages; (ii) drinking water supply; (iii) assistance for the rehabilitation of primary schools; (iv) prioritizing of jobs for village inhabitants and especially for those who will lose land; (v) contribution to the development and diversification of economic activities in the area; (vi) management of indemnification and compensation for losses and damages, guarantees on indemnification; (vii) need for regular and comprehensive information on work progress so that the inhabitants are not presented with a fait accompli. Women's requests quite logically concern all the items of equipment that could facilitate their work: mills, drinking water supply, electrification to lower the cost of milling and, especially the road which is a priority factor.

All these concerns will be analysed and prioritized in light of available resources under the Community Development Action Plan. To inform the consultations and guide the participation of the main stakeholders during the remaining phases of the project, a Public Consultation and Information Disclosure Plan will be established.

12 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN SUMMARY

An Environmental and Social Management Plan (ESMP) was prepared as part of the ESIA and takes into account the main environmental and social impacts identified and the related mitigation measures. This ESMP will be updated in accordance with AfDB requirements. The total cost of the measures contained in the Plan at this stage (2012) is USD 17.14 million, including USD 4.19 million for the Full Resettlement Plan (Table 6).

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social and Environmental Management (SEM)</td>
<td>1,700,000</td>
</tr>
<tr>
<td>Full Resettlement Plan (FRP)</td>
<td>4,190,000</td>
</tr>
<tr>
<td>Local Community Development Plan</td>
<td>5,500,000</td>
</tr>
<tr>
<td>Other ESMP measures</td>
<td>3,860,000</td>
</tr>
<tr>
<td>NGO contracting</td>
<td>500,000</td>
</tr>
<tr>
<td>Capacity building for environmental and agricultural services</td>
<td>500,000</td>
</tr>
<tr>
<td>Various training sessions for APO</td>
<td>500,000</td>
</tr>
<tr>
<td>Capacity building for key climate change actors</td>
<td>200,000</td>
</tr>
<tr>
<td>Watershed Management Programme (planting and management of 4500 ha)</td>
<td>1,735,000</td>
</tr>
<tr>
<td>Construction of 8 gabion sills in the reach downstream from the dam</td>
<td>200,000</td>
</tr>
<tr>
<td>Stocking the reservoir with fish</td>
<td>3,000</td>
</tr>
<tr>
<td>Specific Studies: Catchment Area Programme, Hydrological Study, Erosion and Sedimentation Study, Dam Failure Simulation Study, Hydrological Discontinuity Study</td>
<td>350,000</td>
</tr>
<tr>
<td>Water quality analyses</td>
<td>62,000</td>
</tr>
<tr>
<td>Monitoring</td>
<td>850,000</td>
</tr>
<tr>
<td>Contingencies (5%)</td>
<td>800,000</td>
</tr>
<tr>
<td><strong>Total ESMP and RAP</strong></td>
<td><strong>17,14,000</strong></td>
</tr>
</tbody>
</table>

Source: ESIA Report, 2012
Main Challenges: Volume III of the technical study notes that there is no correlation between national meteorological data on rainfall and preferred to rely on external radar data. The Ruzizi flow, which is no longer natural since the construction of Ruzizi I and Ruzizi II, is mainly dependent on the level of Lake Kivu which has been falling for several years due to a downward trend in rainfall, the lack of expansion of its catchment area and increasingly high withdrawals for anthropic reasons. The analyses carried out by the Climate Service Centre (Fichtner Report, 2010) report an average increase in temperature of 1.9°C and 2.5°C and a projected increase in rainfall of 2.5% and 4% by 2050 and 2060. Variations in level will also depend on the plant operating modalities to be defined by the Operator in coordination with the Ruzizi I and II plants (and subsequently Ruzizi IV) upstream. Lastly, seismic activity in the project area combined with exceptional high water conditions may affect the project. Based on the challenges identified, the project was classified in Category I from a climate change standpoint.

Adaptation Measures: The main function of the Panel of Experts is to review the safety measures taken as well as any other critical aspects of the dam and its adjoining structures, the retention basin, the area surrounding the reservoir and the downstream reaches, and to advise the Borrower on these issues. Pending confirmation by this panel, adaptation measures have been incorporated in the project design. The sizing criteria for the dam provide for, under normal operating conditions, variations between 1107 m (maximum operating level under flood conditions of 450 m³/s) and 1101 m (minimum level). The normal operating level is 1104 m, corresponding to a daily rise and fall of 3 m. Also the main flood spillway sized accordingly is contained in a concrete structure on the right on the Congolese bank. The flood discharge system comprises two spillways: (i) a regulating spillway with a control flap valve, and (ii) a main spillway equipped with two radial gates. According to the FICHTNER studies, the structure is calibrated to withstand an earthquake of magnitude 6, while the estimated return period for the occurrence of an earthquake of magnitude 5.6 is 10,000 years.

Notwithstanding these measures, it is recommended to update the hydrological study to more accurately determine the minor and major bed submersion levels on the basis of variations in amounts of water released by the dam. This will help to map out the areas to be protected, to install the necessary signage, and to sensitize the population concerned.

Mitigation Measures: The amount of GHG produced during the works is estimated at about 39,000 tonnes of CO₂ equivalent for the dam construction (excluding GHG emissions due to plant fermentation and decomposition in the reservoir). These emissions will be mitigated by tree planting over 15 ha at a rate of 3000 per hectare. Also, according to AFD simulations, implementation of the Ruzizi III project would avoid over 50 years the emission of 7.5 million tonnes of CO₂ equivalent compared to the energy production of the three States concerned, i.e. a typical year avoidance of about 151,000 tonnes of CO₂.

Monitoring: One of the keys will be the anticipation and reduction of withdrawals before reaching the critical level. These projections could be made based on regular analysis of the Lake's hydrological parameters and levels. Monitoring will also be carried out to detect extreme changes (changes in hydrology, increased erosion) to ensure the smooth operation of the plant. Particular attention will be paid to exceptional climatic events such as flood waters and their possible interaction with the plant. The monitoring indicators should be reported in the quarterly report on the implementation of the Project's ESMP.

14 INSTITUTIONAL CAPACITY AND BUILDING PLAN

In addition to the establishment of the entities to ensure the smooth implementation of the project (see monitoring programme), it is planned to build the capacity of the environmental and agricultural services:

- Capacity Building Programme for the Environmental and Agricultural Services: The environmental services in the project area in South Kivu and in Ruzizi District will carry out environmental monitoring and, in particular, will be closely involved in the work of the
External Monitoring Mission. The agricultural services of South Kivu and those of Rusizi District will play key roles in support to and supervision of smallholder organizations in the agro-forestry programme in particular. It is important to allow them to provide this support. In both cases, targeted training will be provided in accordance with the needs established by the services themselves.

- **Various Training Sessions in Support of Agricultural Professional Organizations (APO):** Training will be given to APOs in project-affected villages. It will ensure that they take environmental considerations into account in their trade and will familiarize them with erosion control practices and techniques as well as agro-forestry practices.

- **Capacity Building for Climate Change:** This will involve capacity building for the main structures responsible for implementing and monitoring of adaptation and mitigation measures. Capacity building will focus, in particular, on the monitoring indicators. Pending the Bank's appraisal of the project which will clearly define the activities concerned, an appropriation has been made in the cost of the ESMP.

### 15 CONCLUSION

This ESIA identifies the main project's key environmental and social challenges (physical and economic displacements, sharp drop in the rivers' flow rate over a 4.3 km section with severe impacts on wildlife and plant species, risk of disrupting the hydro-ecological continuity of the water course, significant erosion problems that could persist throughout the reservoir's life span). These are compounded by the usual consequences of a site on this scale in terms of emissions, noise pollution, accidental pollution, etc. However, all these impacts can be mitigated by implementing the appropriate measures contained in the ESMP.

### 16 REFERENCES AND CONTACTS

#### 16.1 References (main references)


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