EXECUTIVE SUMMARY OF THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF THE MULEMBWÉ PROJECT

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Summary of the Environmental and Social Impact Assessment

Project Name: JIJI AND MULEMBWÉ HYDROPOWER PLANTS DEVELOPMENT PROJECT:
Country: BURUNDI
Project Number: P-BI-FAO-100

1. Introduction

This document is a summary report of the Environmental and Social Impact Assessment (ESIA) for the JIJI development, conducted as part of the Jiji and Mulewbwé hydropower plants development project.

The Mulembwé project is part of a larger project called the "Jiji and Mulembwé Hydropower Complex" which includes the following components:

- The Mulembwé Hydropower Project on the Mulembwé River, which has been the subject of an Environmental and Social Impact Assessment (ESIA) and a Resettlement Action Plan (RAP);

- The Mulembwé Hydropower Project on the Mulembwé River, which has been the subject of an Environmental and Social Impact Assessment (ESIA) and a Resettlement Action Plan (RAP);

- The power transmission lines network to transport energy to consumption centres, which has been the subject of an Environmental and Social Impact Assessment (ESIA) and a Resettlement Action Plan (RAP);

- And a fourth component on secondary energy distribution (rural electrification). This component which has not been technically studied in detail to date, has been the subject of an Environmental and Social Management Framework (ESMF) and a Resettlement Policy Framework (RPF).

The Environmental and Social Impact Assessment (ESIA) of the Jiji hydropower plant construction and operation project follows upon feasibility studies on the development of Small Hydropower Plants in Burundi conducted by Fichtner under the Multisector Water and Electricity Infrastructure Project (PMIEE).

2. Project Description and Rationale

Project Objectives: The project aims to boost Burundi’s energy production and to harness the country’s (so far largely untapped) green energy potential, especially as concerns hydropower. The project's specific objectives are to:

(i) Increase Burundi's renewable energy supply;
(ii) Step up energy security by developing the hydroelectric potential of the South region in particular;

(iii) Improve the sector's sustainability by producing low-cost renewable energy; and

(iv) Improve the living conditions of people in the project area (PA), by facilitating access to basic socio-economic services and infrastructure such as electrification services (rural electrification).

**Overall Project Description:**

The overall project consists of two main aspects, namely energy production and integration of such energy into the national grid. The project includes the following components:

**Component I: Hydropower Generation**

Component I involves financing the construction of the Jiji hydropower plant of 31.5 MW and (ii) the 16.5 MW Mulembwé plant; the two hydropower projects are located a few kilometres away from each other in Bururi Province, on the Mulembwé River and its tributary, the Jiji River.

**Component II: Strengthening Power Evacuation**

Component II will be devoted to establishing the necessary infrastructure to transport energy to energy consumption centres, particularly in Bujumbura. Component II will comprise two sub-components:

- Sub-component II. A will finance a total of 132.6 km of transmission lines of 220kV, 110 kV and 30 kV as follows:
  - L1: 220 kV line (110 kV) connecting the switchyard to the Kabezi sub-station (73 km)
  - L2: 30 kV line connecting the switchyard to the Itaba sub-station (17.3 km)
  - L3 110 kV line linking the Jiji plant to the Mulembwé plant (5.5 km)
  - L4 110 kV line linking the JIJI plant to the HOREZO switchyard (5.1 km)
  - L5 110 kV line linking the Mulembwé plant to the HOREZO sub-station (2.3 km)
  - L6 220 kV line (110 kV) connecting the Kabezi station to the RN 1 sub-station (21.3 km)
  - L7 30-kV line connecting the Kabezi sub-station to the existing 30 kV South Bujumbura (8.1 km)
Sub-component II.B construction and/or extension of seven sub-stations:

- Bururi switchyard 110/30 kV to Horezo
- Sub-station 10/30/10 kV to Kabezi south of Bujumbura
- The switchyards of the Jiji and Mulembwé plants (110 kV)
- Extension of the RN1 (110/30 kV), South Bujumbura (30 kV line) and Itaba (30 kV line) sub-stations.

**Component III: Rural Electrification**

In the context of establishing a new production centre south-west of the country, the plan is to provide power to the rural population directly affected by the electrification project (PA). The component will include the connection of homes, businesses and social facilities in the area. This component has not been technically defined to date.

**Component IV: Capacity Building, Works Supervision and Environmental and Social Mitigation Measures**

The component will entail capacity building activities for Burundi's power company and the financing of feasibility studies and costs related to works monitoring and supervision as well as environmental and social mitigation measures.

The project will be jointly financed by the Bank, the EIB, the World Bank and the European Union. Government's counterpart, contribution estimated at 5% of the total project costs, will in particular cover compensation and resettlement.

**Description of the Jiji Hydropower Plant Project and Related Works:**

The Mulembwé project is small-sized, with a less than 15-m high and run-of-river dam (therefore not classified as a large dam), i.e. without a significant reservoir (limited to 50,000 m³ only). All the water flows into the dam up to 8 m³/s are diverted to the water intake to be pumped through the turbines. In addition, all flow rates above 8 m³/s are pumped back into the river.

The production plant is located on the same river, about 1.5 km downstream of the dam. Water flows in through a 1.13 km-long underground intake tunnel (2.8m diameter) followed by a 600m-long surface penstock (diameter, 1.6 m).

In order that the stretch of river between the dam and the plant (1,500 m) does not dry up, there are plans for pumping equipment at the dam to ensure a minimum firm yield of 0.424 m³/s at any time in this section.
Other components of the project include the establishment of a base camp to accommodate operating personnel after construction and various access roads, including the rehabilitation of 2 km of existing track roads (for access to the dam site) and the construction of 10.75 km of new roads.

The project characteristics are:

- Design flow: 8 m3/s
- Length of intake channel: 600 m of buried pipe
- Length of gallery: 1130 m with surge chamber
- Turbine height: 258 m (free fall)
- Installed capacity 16.5 MW
- Estimated production: 90.5 GWh/year

The total project cost is estimated at USD 52.3 million, of which USD 31.6 million devoted to civil engineering works.

Figure 1: DEVELOPMENT OF THE JIJI AND MULEMBWÉ HYDROPOWER COMPLEX
**Impoundments:** The impoundment will be in concrete measuring 14 x 47 x 11.5m (height of the structure relative to the riverbed x width x length). The coping wall on the 1423 m elevation with a width of 5 m, allows crossing by vehicles.

The impoundment will include:

- **A spillway** divided into 3 passes with a width of 6 m separated by a pillar. The spillway is sized for a flood return period of 10,000 years, corresponding to a flow rate of 66.1 m³/s.

- **A tank venting system** consisting of two 2 x 2 m sluices in reinforced concrete set on the right bank at the bottom of the tank. This system will be equipped with roller gates and an upstream cofferdam. It will allow for: (i) diversion of the river during construction, (ii) cleaning of the tank and removal of sediment deposits during operation, (iii) lowering of the tailbay in case of an anomaly with the structure, and (iv) ensuring environmental flow during the filling of the impoundment.

- **Feedwater flow system.** In compliance with environmental requirements and the findings of hydrological studies, a feedwater flow of 424 l/s will be guaranteed by a coated pipe in the concrete structure of the impoundment. Given the findings of the fishery studies, there is no provision for a fish migration structure.

**SUPPLY WORKS (WATER INTAKE, TUNNEL, PIPING)**

The supply system is located on the right bank and includes:

- **A front intake** with 2 openings. It is found directly in the impoundment. The intake will be equipped with a floating debris retention grid, a valve system and cofferdams necessary for maintenance operations.

- A two-basin **sand trap** located upstream of the impoundment. Sized to eliminate grains of more than 0.2 mm, it will effectively be 55 m long. The discharge valve will be in a dedicated concrete structure located downstream of the energy dissipation basin, making it possible to transport the sand on the river bed directly downstream of the structure.

- **A 1130 m-long power tunnel.;** a valve chamber will be installed at the gate downstream of the tunnel for maintenance and inspection of the penstock.

- A 1.6-m diameter and 600 m-long steel **penstock:** the penstock will be laid more or less along the line of maximum gradient. It will be placed on the surface of the anchor brackets and intermediate support posts in concrete.
**Plant**

The plant will be located on a flat terrace, 5 m above the river bed and will include a machine room, office and other necessary amenities. The plant will be equipped with 3 Pelton generators that will churn a total flow rate of 8 m$^3$/s. Once through the turbines, the flow will be returned to the river.

**BASE CAMP**

The base camp will be located on the left bank of the Mulembwé River a few hundred metres upstream from its confluence with the River Jiji, along the road section connecting the two hydropower plants. The advantage of this site is that its topographic conditions are less rugged. The camp will also serve for both the Jiji and Mulembwé projects.

**ROAD INFRASTRUCTURE:**

Existing tracks will be improved over about 2 km.

Construction of 10.75 km of new roads/tracks:

- Access road to the impoundment: 2 km
- Access road to the valve chamber upstream of the penstock: 3.3 km
- Access road to the Mulembwé plant from the Jiji plant: 4.2 km
- Access road to the base camp from the Jiji plant: 1.75 km
- The new link between the Jiji base camp and the Mulembwé plant: 4.2 km
- Existing dam-camp-road link: 1.25 km

**CONSTRUCTION METHODS AND TEMPORARY WORKS:**

**River Diversion:**

No bypass channel will be created for the river. Dam construction on the river will be in two stages. The sluice structures, water intake and sand trap on the right bank will first be constructed, given that water will be diverted to the left of the stream using cofferdams. The concrete spillway situated on the left part of the dam will be built afterwards. The river flow will be diverted through the sluice drain on the right bank, allowing for construction of the remaining portion of the impoundment on the left bank.

**Transport of Equipment and Materials to Sites**

Most of the building equipment and materials cannot be supplied by Burundi and must be imported from abroad by sea. Maritime transport is usually done via Dar-es-Salaam in Tanzania or Mombasa in Kenya, where equipment will eventually be loaded by truck and conveyed to the project site.
Works Schedule

Overall implementation of the project will be carried out in three main stages expected to cover a total of 42 months, or 3.5 years, including 36 months of construction:

- Stage I: Bidding procedure and contract award (6 months)
- Stage II: Construction, production and installation of equipment (30 months)
- Stage III Commissioning, testing and training (6 months)

The implementation schedule was drawn up with the understanding that the contractor would prepare own final implementation draft. The study and development of implementation plans should be drawn up under the contractor’s responsibility. It is also considered that the contractor is experienced and has all the necessary equipment to carry out the work.

The labour force is estimated at 500-700 persons, given that most of the works would be developed simultaneously. This figure may vary depending on the degree of mechanization used for earthworks, especially for the roads.

WORKS OPERATION PRINCIPLES AND PRODUCTION

The Jiji hydropower development will be a run-of-the-river development, namely that the flows into the impoundment will be pumped directly to the supply system for energy production. However, it was decided that the structure will allow for a slight production regulation of about 3 hours. Flow rates exceeding the design flow will be discharged through the spillway.

For the Mulembwé Hydropower Project, the flow rate is 2.29 m3/s, after reduction of the ecological flow of 424 l/s, which should at all times be a guaranteed minimum on the riverbed downstream of the impoundment, a guaranteed energy production of 34.17 GWh/year.

3. Political, Legal and Administrative Framework

Issues related to natural resources, with the exception of mines and quarries, are handled by MEEATU (Ministry of Water, Environment, Land and Urban Planning). The Directorates-General attached to the Office of the Minister are: (i) the DG for Water Resources and Sanitation, (ii) the DG for the Environment and Forestry (iii) the DG for Regional Development and Land Tenure, (iv) the DG for Urban Planning and Housing, and (v) the DG for National Surveys. Environmental impact assessments are managed by the Directorate General of the Environment and Forestry, specifically within its Department of the Environment.

Land management, including expropriation for public interest, falls under the remit of the DG for Regional Development and Land Tenure. There is a National Land Commission, governed by the Land Code, and which issues opinions prior to decisions relating to expropriation for public interest. Since 30 June 2000, the Republic of Burundi has enacted Law No. 1/010 on the Environmental Code which makes it an obligation, in some cases, to prepare environmental impact assessments. Chapter 3 ("Administrative Organization of the Environment") under Part II of the Code sets out guidelines for preparation of environmental impact assessments (the most
important are Articles 21 to 24). Article 45 in turn provides for the protection of water against pollution. Specifically, it prohibits any spills, discharges, residue, direct or indirect deposits, and generally all acts or events that may cause or increase the pollution of surface or ground water, whatever the origin.

Article 53 stipulates that the works, structures and facilities to be developed on river beds will be designed and executed in such a manner as to maintain a minimum water flow or volume that can guarantee life, movement and reproduction of the species that inhabit the waters at the time of development of these works, structures and facilities.

Decree No. 100/22 of 7 October 2010 subsequently determined the implementation conditions and arrangements of the environmental impact assessment procedure. According to Article 2 paragraph 1 of the Decree, environmental impact assessments, when prescribed, are subject to prior administrative authorization by the Ministry of the Environment for planned works. Failure to conduct the impact assessment, to ensure its validation in compliance with the Environmental Code as well as any related authorization by the Ministry of the Environment are substantive procedural flaws vitiating the authorization process.

The decree also states in Article 15 that the petitioner or contracting authority must consult the public and take into consideration the comments and the recommendations of the communities that may be adversely affected by the project.

Article 21 stipulates that projects subject to impact assessment give rise to a public survey the conduct of which is the remit of the Ministry of the Environment.

For want of regulatory instruments on the taxation of services of the Ministry of the Environment, this public survey is not practised in Burundi. However, the Directorate General of the Environment requires public consultation of communities affected by the project and publishes the environmental certificate once it is issued.

The policies and procedures of the African Development Bank trigged by this project are the Environmental Policy of the African Development Bank Group, 2004, the involuntary displacement Policy, 2003, the Gender Policy, 2001, the policy and guidelines of the Cooperation with civil society, 2001 and the Environmental and Social Assessment Procedures (ESAP) for operations related to Public Sector, 2001.

Policies and guidelines of the World Bank: Environmental Assessment (OP / BP / GP 4.01) and Involuntary Resettlement (OP / BP 4.12) have been applied in the context of environmental and social assessment, as well as the Guidelines on Dams and Development: a new framework for decision-making, November 2000.
4. Description of the Project Environment

Geological Setting

According to Burundi’s geological map at the scale of 1:100,000 (Bururi map), the project is sited on the Rumeza granite, namely in the foliated granite and gneissic granites.

At the impoundment site, the ground is completely covered with colluvial materials, i.e. scree and talus deposits. Soils at the site are predominantly made up of laterite. The feasibility study considered that there was limited risk of landslide after the embankment at the impoundment.

The Mulembwé site seems geologically well suited for a hydropower project. The site chosen is suitable for the establishment of a concrete dam. The expected excavation volumes are not very significant, and after clearing the site of unconsolidated materials as well as the surface of weathered rock, the conditions in place will allow for easy construction of a concrete impoundment.

Similarly, the construction conditions of the power tunnel seem very favourable. The layout of the tunnel should cross, along its entire length of approximately 950 metres, granitic gneisses favourable for traditional excavation by drilling and blasting.

No soil instability was found along the layout of the penstock and the bedrock should be a few metres deep.

The hydropower plant will be set up on the terrace composed of alluvium and colluvium. Although it requires some excavation depth, it should be relatively limited, since there are some rocky outcrops already on the riverbed. Thus, there is no particular foreseeable problem for the foundations of the plant.

Climate Change

94% of the active population are involved in rain-fed agriculture mainly, which accounts for over 50% of GDP, provides 95% of the population's food and over 80% of foreign exchange earnings. Climate change could affect agriculture which plays a key role in Burundi's economy. During the last century, Burundi experienced various periods of weather events: droughts to the North-East of the country bringing about a fall in the level of some northern lakes, and torrential rain causing a 4-m rise in the level of Lake Tanganyika between 1961 and 1964.

A temporal rainfall trend analysis for Burundi over a longer period reveals its cyclical nature, with a periodicity of roughly 10 years, periods of surplus rainfall alternating with those of rainfall deficiency compared to normal (see figure below). Conversely, average temperature trend analysis shows a persistent temperature increase compared to normal. The average temperature in the region has risen from 0.7 to 0.9°C since the 1930s.

The results of climate change simulation for 2050 according to the MAGIC SCENGEN model (First National Communication, 2001), in a high GHG-emissions scenario, show the following projections:
An overall 3-10% increase in rainfall with, however, a 4-15% decrease for the month of May (end of rainy season) and October (beginning of rainy season). The cyclical nature of rainfall, with alternating periods of normal rainfall and droughts, is expected to continue.

Average temperatures are expected to increase by 0.4°C every 10 years, representing an increase of 1.9 °C by 2050.

As concerns agriculture, these changes will impact water needs (higher evapo-transpiration due to increased temperature) and the agricultural calendar (lengthening of the dry season and shortening of the rainy season, with probable disappearance of the short dry season in February).

**Water Resources:**

The mean annual flow rate at the Mulembwé site is 5.9 m³/s. Monthly variations in rates show that the period from December to May is relatively wet while that from August to September is the driest. The feasibility study also highlighted a slight reduction in annual feeds over the duration of the 1981-2009 series. It is not possible to state with certainty whether this observation is the result of climate change or alterations in the basin over this long period.

Upper Mulembwé crosses many areas of papyrus swamps, which are seasonal flood-prone areas and subject to the development of recession agriculture during the dry season. These wetland areas play an important role in water storage during the flood period; the stored volumes are then gradually released during the dry season. Therefore, these marshes have a regulatory role that helps to sustain low flows in the downstream part of the river where the project is located. Their long-term preservation is important.

The average minimum flow observed during the hydrological observation period is 2.12 m³/s, varying between 0.89 m³/s (1993) and 2.97 m³/s (1983).

Solid transport, as well as feeds from the thrust will be controlled by the presence of grit chambers located upstream of the dam and thus limit the amount of materials carried into the inlet system and which degrade the components of the turbines. These grit chambers are regularly flushed out.

**Erosion**

The Jiji and Mulembwé development sites leave an impression of limited erosive activity. Very few signs of erosion such as gullies and landslides are observable. Landslides observed are mainly small-scale (a few metres to some dozen of metres) and are usually associated with the destabilisation of slopes caused by the creation of roads or tracks.

The dominant erosion is therefore probably sheet erosion, widely spread over landscape where more than 90% of the space, consisting of steep to very steep slopes, is farmed.

**Biodiversity**

Plant biodiversity is very poor in the project area, given that almost all of the space is being farmed or temporarily fallowing. Woody flora made up of bushes and shrubs is most prevalent.
along natural streams. There is no longer any forest formation; trees are often isolated and consist mainly of oil palm and eucalyptus planted for firewood production.

Terrestrial animal biodiversity is extremely poor due to strong human pressure and the cultivation of almost all rural lands involving especially the seasonal burning of dried crop residue, a major constraint to the development of diverse terrestrial wildlife.

The river aquatic fauna at the project sites is also poor, limited to a few species of small fish, common to other rivers in the country and the lake and without any commercial interest. No migratory species were observed during scientific fishing or reported by residents. The villagers do not fish in the river. All the fish consumed in the project area comes from Lake Tanganyika.

**Socio-economic Framework**

The hydropower complex is developed in the Bururi Province, the largest of Burundi's 17 provinces, especially in two of its nine municipalities: Buyengero and Songa. Burundi is one of the countries with the highest poverty rates in the world. It is estimated that 67% of the national population live with an income less than or equal to the poverty line, with this figure rising to 69% for the rural population and 34% for the urban population. Bururi Province where the project is situated fits into this average value with 72% of the population rated as poor.

Agriculture occupies over 90% of the population in the two municipalities engaged primarily in the production of food crops (cassava, maize, sweet potato, beans, potato) and cash crops (dominated by coffee especially in Buyengero) and to a lesser extent, fruit and vegetable crops. Cassava production in Buyengero, in terms of weight, accounts for more than 65% of the total food production in this municipality. In comparison, production from the Songa municipality is much more balanced, dominated by banana which represents about a quarter of total food production. Livestock is mainly extensive, dominated by cattle in Songa, and sheep and goats in Buyengero.

The villagers do not practise fishing. Fishing is ignored completely. Currently, the population of the municipality consumes fish (Ndagala and Mukeke), which is sold by traders from Rumonge. This fish is caught in Lake Tanganyika.

There are no industrial facilities in the Buyengero and Songa municipalities, with the exception of three small coffee pulping and washing units. Craft is underdeveloped in the area.

No sites of cultural value (historical, archaeological or religious) were spotted within or near the project sites.

In Burundi, the health situation remains disturbing and marked by the predominance of numerous communicable and non-communicable diseases. According to the 2009 Statistical Yearbook, the major causes of morbidity and mortality are malaria, acute respiratory infections, diarrhoeal diseases, malnutrition, AIDS and tuberculosis. According to the Demographic and Health Survey conducted in 2010, the overall HIV prevalence among the population aged 15-49 years stands at 1.4%: 1% for men and 1.7% among women.

The Buyengero municipality has 2 health centres located in the Muyama and Muzenga areas. The Songa municipality has 4 health centres located in the Muheka, Kiryama, Ndago and Songa
areas. The Province boasts of 4 hospitals, 1 private clinic, 48 Public Health Centres (PHC). From the epidemiological point of view, malaria is the most common disease followed by acute respiratory infections and diarrhoeal diseases.

The Buyengero municipality has 44 primary schools and six secondary schools including one with a full cycle. The Songa municipality has 27 primary schools and six secondary schools, including one with a full cycle, as well as a vocational technical school with over 800 students.

5. Project Alternatives Considered

The identification of strategic alternatives to the Mulembwé hydropower project was carried out in 1983 during the Study on the Development of Burundi's Hydropower Resources conducted by Lahmayer. On this basis, REGIDESO selected 10 small hydropower projects that were compared during the first phase of the pre-feasibility and feasibility studies conducted by Fichtner. Four projects from this analysis (Jiji, Mulembwé, Ruzibazi and Masango) were selected for more detailed assessment during the pre-feasibility stage. The latter study concludes that the Mulembwé and Jiji projects should be given priority over other options considered based on technical, economic and environmental criteria.

“No Project” Option:

Implementation of the Mulembwé Hydropower Project will provide an additional source of electricity that will partially offset the country's significant electricity deficit.

Only 10% of Burundi's population has access to electricity. Electrical energy supplied by no means meets demand, causing very significant outages especially in Bujumbura. It is estimated that potential demand is now four to five times the energy supply capacity. Most industrial and hotel establishments as well as several private residents meet their own electricity needs by means of thermal generators. Daily power cuts have adverse effects on the economy, owing to temporary stoppages of electrical equipment, and on public health.

Without the Mulembwé project, 16.5 MW, i.e. almost equivalent to half the country's current hydropower electricity capacity, will not be made available for 2017, and if this project is linked to that of Jiji, nearly 50 MW, i.e. more than double the current production capacity, will not be mobilized for the country's economic development. If these projects are not implemented, annual electrical power needs for nearly 500,000 people will not be met.

Project Configuration Alternatives

The choice of the dam site is motivated by geological considerations. No other potentially interesting sites were identified on the Mulembwé that would help to maximize the significant gradient and the distance between the water intake structure and discharge as would the chosen site. However, the feasibility study considered the possibility of establishing the structure 150 m upstream of the current site. This alternative was abandoned for less favourable geological reasons. The thermal alternative is not to be considered owing to the need for Burundi to import gas or hydrocarbons at rates that would render electricity production uneconomical.
6. Potential Impacts and Mitigation/Enhancement Measures

Significant Positive Impacts:

Several beneficial impacts are expected from the Jiji electricity production project including:

- Reducing Burundi's significant electricity deficit: with a demand estimated at 70 MW, the country currently produces only 35 MW. The 16.5 MW from Mulembwé represents almost 50% of the country's current capacity;
- Reducing deforestation in the country by substituting biomass electricity in urban areas;
- Improving economic and, especially, industrial and handicraft production, now severely constrained by the lack of electric power;
- Reducing rural poverty considering that the poorest populations currently pay more for their lighting (kerosene, candles) than if they had electricity;
- Improving hygiene conditions through access to cold storage;
- Promoting development of the project area through improved access resulting from the construction or rehabilitation of new roads, which will enhance trade and the marketing of local agricultural produce;
- Producing an immediate economic impact on the project area through the recruitment of labour and the provision of regular income for the households concerned, improving the overall purchasing power in the area; 500-700 jobs will be created for the project duration (3 years);
- Producing an economic impact on the area by promoting the creation of indirect jobs through subcontracting arrangements between the main contractors and small local businesses;
- Producing a long-term economic impact by enabling locally recruited labour to be trained during the construction period in various techniques and, at the end of the project, extending their professional capacity to fields other than agriculture;
- Sensitizing local labour on aspects of hygiene and good environmental practices (protection against pollution, personal sanitation, waste management etc.), so that these principles can be passed on to their communities to improve behaviour in the long run;
- Maintaining in the long term a community of engineers and technicians responsible for operating the facilities, thereby helping to keep up a certain purchasing power locally (fresh produce, various services);
- Significantly reducing the production of greenhouse gas (GHG) emissions compared to alternative thermal electricity generation: according to the alternative considered (gas, coal or heavy fuel) Mulembwé will help to prevent the emission of about 45,000 to 100,000 tonnes of CO2 per year.
Negative Impacts:

Project impacts on the environment are generally modest, the most significant being aspects related to land occupation and work site operations. Because of the high population density in the project area, any need for land has to entail private land acquisition or involuntary population displacement.

The needs initially identified for the project relate to 10.6 ha for linear facilities (access roads and penstock) and 6.16 ha for ad hoc installations (dam and impoundment, plant and base camp), totalling 16.8 ha. A number of facilities undefined to date are excluded from these figures: workers' camps, excavation products residue drop zones, equipment storage areas, landfill site for waste etc. A surface area of 24 ha (0.24 km²) has been earmarked for preparation of the RAP. Almost all land is used for farming and will be compensated as such. Land acquisition will involve around 380 homesteads, of which 4 homes will be lost.

The project will not have any significant impact on forest resources, owing to their absence from the project area. Only isolated trees or shrubs and bushes will be affected. Owners of bigger trees or fruit trees will be compensated according to established and accepted criteria. Most other negative impacts relate to construction activities, which, if poorly supervised, could cause a host of problems for the population. However, strict control of contractors and the obligation for them to apply good environmental practices in their construction activities can reduce these risks to quite acceptable levels.

Efforts should focus on the following risks most frequently observed in poorly controlled sites:

- **Air pollution from exhaust fumes and smoke**: Strict control of equipment and maintenance; waste burning prohibited;
- **Dust generation**, observed on site and along unpaved roads: covering of trucks during the transportation of fine material, humidification of material depots, regular watering of unpaved roads in residential areas, speed control for trucks in sensitive areas;
- **Water pollution** by wastewater discharges, domestic waste, hazardous material (diesel, engine or hydraulic oils, paints and solvents, water from the washing of concrete production and transportation equipment). All these risks can be controlled through appropriate management;
- **Erosion** and sediment transportation to surface waters pose a significant risk considering the steep slopes characterizing the local terrain, especially in connection with road construction; appropriate measures during excavation, establishment of an efficient drainage system along the roads, protection of sensitive-sized fronts pending their re-vegetation, establishment of anti-sediment mechanisms (sedimentation basin, silt fences etc..) will significantly reduce the impacts;
Much waste will be produced on-site including: (i) domestic waste, (ii) inert construction waste and (iii) hazardous waste. Daily domestic waste production is estimated at about 1 m$^3$. The ESMP requires the Contractor, at the beginning of the assignment, to present a detailed waste management plan. Inert waste may be buried during embankment construction or with unused excavation products. Hazardous products (mainly motor and hydraulic oils used) will be stored and be subject to special treatment. This will reduce the risk of soil and water pollution through accidental spillage.

The relocation of recruitment offices, recruitment through community leaders (chefs des collines) and coordination with police authorities, as from the beginning of the worksite, will allow for effective control of this phenomenon.

No sites of cultural value were identified in the project area during field visits or reported by residents. Therefore, the impact is highly unlikely. However, in case of accidental discovery during excavation, a procedure for immediate cessation of work will be implemented to secure and preserve any physical cultural resource discovered.

No significant impact is expected on animal and plant biodiversity because of its scarcity. However, measures will be introduced: ban on traps or hunting weapons in the camps, ban on eating game (bush meat) in camps, sensitization of workers on the protection of biodiversity.

During the operational phase, impacts will be very limited:

- There will be no impact on the river hydrology downstream of the plant. Only the river stretch (1,500 m) between the dam and power plant could possibly dry up during the drier periods of the year. The establishment of an ecological flow of 0.4 m$^3$/s complete with permanent flows from streams along the watercourse (estimated at about 0.5 m$^3$/s) will help prevent such dry-up.

- The expected impact on the fish population is also limited due to the very low biodiversity observed and the absence of migratory species. There will be no impact on fishing, since none is practised. However, the presence of the small impoundment could favour the development of a more abundant fish fauna than that currently observed.

- No impact is expected on the erosion of the riverbed downstream of the dam for several reasons: the bed is mainly rocky, sediment collected in the sand trap will be regularly released into the river during the rainy season (when the water sediment load is highest), the bulk of the flow will remain in the river without going through the turbines (design flow of 8 m$^3$/s maximum).

- Without creating areas of stagnant water, the project will not in any way change the current situation of water-borne diseases.
Cumulative Impacts

Considering that the Jiji project will be developed on a tributary of the Mulembwé downstream of the Mulembwé project, an analysis of the cumulative effects of the two projects was conducted with the following conclusions:

- The two being run-of-river projects, located on different branches of the river (not cascading) and with very limited storage (50,000 m³ for Mulembwé and 80,000 m³ for Jiji) they will have no impact on the hydrology of the Mulembwé downstream of the confluence with the Jiji.

- None of the information collected (current lack of a diversified fish fauna and migratory species) suggests that these two projects could have an impact on fishery resources downstream of the Jiji and Mulembwé whose stretch along the plain is directly influenced by Lake Tanganyika.

- During construction, the simultaneous implementation of the two projects could negatively impact the agricultural activity of the area owing to the recruitment of too many villagers, thereby reducing farmlands developed during the project period. Preventive measures related to recruitment rules will be necessary. Local recruitment services will be involved in the recruitment process.

- In the long term, both projects will increase the number of families in the two base camps and, accordingly, the number of potential customers for fresh produce (garden produce, fruits, small stock) with a positive impact on the villagers settled in the area.

MITIGATION MEASURES RELATED TO THE LOCATION OF THE PROJECT

- Specific compensation measures will be implemented
- Establishment of a guaranteed downstream of the dam to preserve aquatic life flow

MITIGATION MEASURES RELATED TO CONSTRUCTION WORKS

- Strict technical requirements that will be imposed on the company, particularly with regard to product cuttings management
- Detailed Technical Review for roads ‘technical design and proposed construction methods’. Technical monitoring of road construction. Revegetation by erosion control species (Vetiver), revegetation walls, timber plantations
- Drainage workshops & garages equipped with oil separator
- Master the storage of hazardous materials including hydrocarbons
- Control of waste oils: Monitoring records and dedicated storage areas
- Treatment of wastewater before discharge (lagoon, septic tanks) on black water (toilets) and gray water (showers, canteens)
- Monitoring the quality of effluent discharged outside the area of influence of the camps
- Creation and maintenance of ditches to ensure efficient drainage and removal of standing water area
- Systematic awareness of any newcomer to camp meetings, posters in the crossings, checks the camp leader
- Prevention through systematic medical examination hiring
- Monitoring of hygiene conditions through medical camps on-site service
- Anti-malaria prophylaxis for camp residents
- Regular awareness campaigns in the camps and at the nearest inhabited areas by specialized and independent NGOs
- Provision of protection (condoms)
- Strict access control in construction areas and camps, limited to staff
- Communication with communities and local authorities around
- Formal prohibition for residents to own guns and traps inside the camp. Consumption of bush meat will be prohibited in the camps.
- Establish systematic dry latrines and disinfection with quicklime during the demobilization of facilities (U.S. EPA procedure according WQ424, pH > 12 for 30 minutes)
- Location of site materials crushing remote areas of residence and adapting activity schedules if necessary
- Provision of personal protective equipment to workers and monitor the implementation of their use
- Equipment dust reduction (sprinklers) and good operational practice
- Prior markdowns limits clearing in areas of the dam and the powerhouse and monitoring during operations
- Procedure warning shot
- How strict storage and handling of explosives
- Access control on construction sites
- Requirement of a Management Plan Hazardous waste produced by the company
- Implementation of storage areas that meet safety standards
- Identification of existing centers of waste oil recycling in Burundi
- Registry monitoring production / waste oil recycling
- Communication on the event of impoundment dam to the people of the area and workers, and implementation of staff around the site to prevent accidents. The preparation of a Safety Plan on filling of the reservoir will be required
- Monitoring the quality of effluent discharged
- Provision of bins in the camps and regular collection
- Establishment of a separate collection for recycling
- Choice of the storage site of materials away from sensitive structures
- Choice of drop zones. Plan Management Areas deposit will be required of the company
- Respect the natural drainage or drainage plan appropriate late filing
- Erosion control Preventive measures: erosion control barriers, revegetation of slopes and berms flow across the slope, etc.
- Drainage and sedimentation basins if necessary
- Monitoring of runoff from areas of deposition and concentrations in sediment
- Stand deposit at least 25 m of a river bank with preservation of vegetation between deposit and river
- Upon discovery of cultural heritage, development of a procedure to stop work and to prevent hierarchy and national authorities to make the preservation of discovery and recovery work. Staff awareness of the procedure
- Establishment of a strict control of speed in populated areas (police and retarders control) and signals the danger points; Awareness populations in Burundi crossings and drivers
- Regular watering of unpaved runways in populated areas at the expense of the company
- Promoting whenever possible new dressed access roads.
- Fire equipment at each storage site (fire extinguishers, sand) and safety posters
- Training of staff with personal protective equipment and on-site presence safety data sheets; Emergency First Aid Kits at sites
- Procedure for emergency response in the event of accidental spillage

**MITIGATION MEASURES RELATED TO THE OPERATION**

- Implementation of economic and social development plans in support of electrification in order to improve the beneficial impacts of the electricity access
- Enhanced Signaling humps to sensitive sites, awareness of local populations including women and children, strengthening of police
- Establishment of a sanitation process for camp wastewater compatible with the long-term workers system.
- Use of the landfill implemented during construction works
- Establishment of an ecological guaranteed flow of approximately 0.33 m³/s to maintain aquatic life downstream of the dam. This flow is slightly increased by the flows of intermediate basin.
- Establishment of a water quality monitoring in the reservoir
- Sedimentary monitoring by the project technical unit
- Ecological monitoring for 3 years after the operation.

The proposed Environmental and Social Management Plan (ESMP) includes three Supplementary Action Programmes adapted to the pre-construction, construction and operation stages of the works:

- **Construction Preparatory Action Plan (PAP)**, which incorporates all recommended measures prior to initiating construction. These measures essentially concern the organization and training of teams that will be responsible for environmental and social management during construction and operation of the project, as well as all the studies and additional surveys identified during ESIA preparation and deemed necessary prior to undertaking the works.

- **Construction Action Plan (CAP)**, which defines the principles of organization and procedures for the environmental inspections of construction sites. The CAP also defines Contractors' obligations regarding the environmental and social management of project sites and camps.

- **Operations Phase Action Plan (OAP)**, which defines environmental quality controls (water, air and noise) applicable during operation of the structures and necessary to assess the efficiency and environmental performance of corrective measures implemented.
The ESMP describes the framework in which all proposed corrective measures should be implemented in terms of:

- The arrangements to be made to ensure the effective implementation of corrective measures and environmental monitoring;
- The role and responsibilities of the various parties involved in the Project;
- The key tasks to be undertaken during the of project's preparation, construction and operation phases;
- The additional studies deemed necessary;
- Financial resources to be mobilized and their source.

The following table sets out the estimated budget required for ESMP implementation during the three stages of the Jiji Project, corrective and monitoring actions identified in the ESIA. This budget is prepared on the basis of an overall period of 5 years including one year of preparation prior to construction, 3 years of construction and the first year of operation.

<table>
<thead>
<tr>
<th>No.</th>
<th>CORRECTIVE MEASURE/ACTION</th>
<th>RESPONSIBLE PARTY</th>
<th>DURATION OF IMPLEMENTATION (YEARS)</th>
<th>BUDGET (USD103)</th>
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<tr>
<td></td>
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<td>IMPLEMENTATION</td>
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<td>Water Quality Study</td>
<td>REGIDESO</td>
<td>REGIDESO (Lab)</td>
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<td>PAP 02</td>
<td>Meteorology</td>
<td>REGIDESO</td>
<td>Consultant</td>
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<tr>
<td>PAP 03</td>
<td>Aquatic Biodiversity Study</td>
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<td>Consultant</td>
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<td>Mapping of Agricultural Areas Affected</td>
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<td>Consultant</td>
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<td>Preparation of Communication Equipment/Material</td>
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<td>Consultant</td>
<td>1</td>
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<td>PAP 06</td>
<td>Preparation of E&amp;S Specifications for Contractors</td>
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<td>Consultant</td>
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<td>PAP 07</td>
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<td>PAP 08</td>
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<td>PAP 09</td>
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<td>Consultant</td>
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<td>ESIA Quarries and Earthworks Dumping Site</td>
<td>Constr. PCS</td>
<td>Constr. PCS</td>
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<td>CONSTRUCTION ACTION PLAN (CAP)</td>
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<td>CAP-01</td>
<td>Waste Management</td>
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<td>Management of Earthmoving Surpluses</td>
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<td>Erosion and Sedimentation Management</td>
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<td>Management of Camps</td>
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<td>Public Health Management</td>
<td>Constr. PCS</td>
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<td>Air Pollution Management</td>
<td>Constr. PCS</td>
<td>Contractor</td>
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<td>Traffic and Road Access Management</td>
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<td>Water Quality Monitoring (Contractor)</td>
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<td>E&amp;S Monitoring during Construction</td>
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<td>CAP-16</td>
<td>Water Quality Monitoring (Engineer)</td>
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<td>Engineer</td>
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<tr>
<td>CAP-17</td>
<td>Air Quality &amp; Noise Monitoring</td>
<td>REGIDESO</td>
<td>Engineer</td>
<td>3</td>
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</table>

| OAP-01 | Public Safety Measures | REGIDESO | REGIDESO | 1 | 10 |
| OAP-02 | Firm Yield Control | REGIDESO | REGIDESO | 1 | 5 |
| OAP-03 | Monitoring of Fish Species | REGIDESO | Consultant | 2 | 40 |
| OAP-04 | Monitoring of Water-borne Disease Vectors | REGIDESO | Consultant | 3 | 45 |

| TOTAL | 2,180 | 518 | 3,108 |

Note: (1) The cost of these activities is included in the contractor’s budget
This budget represents 5% of the total project (USD 52.2 million). The budget presented does not include costs related to the Resettlement Action Plan presented separately in this document.

REGIDESO currently has an Environmental and Social Manager (ESM) to monitor the environmental and social aspects of various studies and projects. This role will need to be strengthened by focusing it exclusively as ESM on the monitoring of Jiji and possibly Mulembwé if the latter project is implemented alongside the Jiji project. The ESM will be assisted by a team including at least (i) a social specialist to monitor all activities related to land acquisition, (ii) a technician to regularly monitor Environment, Health and Safety aspects at construction sites, and (iii) an assistant.

The awardees of works contracts shall put in place Environment Coordinators (ECs), responsible for effective implementation of the recommended measures and compliance with all environmental specifications established by the Contracting Authority and forming part of the Contract Agreement.

7. Environmental Risk Management

Public Safety Risks

The main public safety risks associated with the project are related to the following activities:

- Handling of explosives,
- Storage and handling of inflammable hydrocarbons,
- Transportation of equipment and materials increasing truck traffic, and
- Risks of accidents.

Although the impact related to blasting is considered insignificant due to the remoteness of the residential areas and the absence of specific wildlife in the area of the dam and the power plant and the removal of early career sites, security measures are proposed (Respect of a time range blasting between 6h and 20h, providing personal hearing protection equipment for workers and implementation of their use, warning shot Procedure, access control on construction sites and strict procedure for storage and handling of explosives).

Specific management plans for all these aspects will be required of the Contractor at initiation of its contract.

Risks to Human Health

Potential impacts on public health have several causes. Population concentration in isolated camps increases the risk of transmission of infectious or epidemic diseases in case of inadequate hygiene or integration of already infected and undetected individuals. The risk of accidents (burns by hazardous products, trauma by road or on-site accidents) is higher. Contractors will be required to put in place various measures to control these risks: implementation of STI and HIV/AIDS fight program, recruitment medical assessments for all employees, mosquito nets and
prophylaxis against malaria, supply of drinking water, rain and waste water drainage in camps, waste management, training in basic hygiene practices. In addition, a health center will be set up at the camp to provide routine medical services required by employees and other eligible and emergency response in case of accidents.

Seismic Risk

According to feasibility studies, there is a significant seismic risk that was considered for the sake of prudence as equivalent to an MCE (Maximum Credible Earthquake) of 7 and integrated into the structure design criteria.

Risk of Dam Failure

Despite the small size of the impoundment concerned, the Consultant was requested to analyse the risk of dam failure. The mathematical modelling conducted shows that water layer damping is relatively fast, from a thickness of more than 10 m at the level of the dam to less than 2 m at the confluence with the Jiji or 6 km further downstream. The water layer thickness then gradually reduces to less than 1 m at the river mouth in Lake Tanganyika. After dam failure, it will take the wave less than 12 minutes to reach the confluence with the Jiji and about 2 hours to reach the lake. The wave will only take one minute to reach the plant and could at this point reach 3m. It is however not anticipated significant damage to the plant, the latter being located 5.3 m above the raft return channel, itself located about 50 cm above the riverbed. Between the dam and the confluence with the Jiji, there are no public or private buildings located deep in the valley that could be affected by the wave. Further downstream, the river bed is sufficiently steep-sided for the wave, of low amplitude, not to flow out. No significant flooding of downstream areas is to be anticipated.

8. Inspection and Monitoring Programme

The Ministry of the Environment will be responsible for conducting inspection and monitoring of construction sites as needed during the construction period and during the first years of operation in order to assess the efforts made to protect the environment and social welfare of the affected population. Travel costs will be borne by the Contracting Authority (REGIDESO). The Contracting Authority remains the Ministry's interlocutor of choice for any matter relating to the Project.

Project monitoring by the Environment Ministry will include the following tasks:

- Evaluating additional ESIAs, which will be conducted in order to issue the relevant Certificate of Compliance;
- Ensuring scheduled or impromptu visits to activity sites, construction sites, workers' camps, quarries, resettlement sites for displaced persons, etc.;
- During these visits, discussing as appropriate with representatives of the parties involved in the project: EPC constructor, supervising engineer, REGIDESO, PAPs and their representatives, State personnel in charge of compensation and relocation of people, etc.;
Receiving from REGIDESO the quarterly environmental and social monitoring report, and assessing the results of mitigation measures implemented and compliance with national standards;

Receiving from REGIDESO for information the ESMP prepared by the EPC constructor and other project documents, such as quarterly reports from the Independent Auditor in charge of environmental and social aspects;

Organizing ad hoc meetings with REGIDESO to clarify the development of specific situations (conflictual or critical).

**During the construction phase,** the Project Manager (Engineer), through the Environmental and Social Director (ESD) and his/her team, is the entity that will ensure environmental supervision.

- Contractors' compliance with their environmental and social obligations will be specifically monitored and coordinated by the ESD.

- To ensure the effectiveness of proposed mitigation measures, including compliance with recommendations during construction phases, the environmental monitoring programme will include:
  - Environmental supervision of contractors and sub-contractors: the objective is to ascertain the proper application of social and environmental measures developed under the Project Service Providers' Obligations and Action Plans submitted by these providers;
  - Environmental quality monitoring: the objective is to monitor the quality of the environment to assess the effectiveness of mitigation measures implemented and amend, if necessary, acceptability thresholds or methods; this primarily concerns the water quality of the river downstream of the activity sites;
  - Monitoring the compliance of discharges: the objective is to verify that discharges from the project sites comply with environmental legislation or specifications of the DCEs;
  - A weekly inspection of the various work sites will be organized by the ESD and will be the subject a report using an inspection template.
  - Each environmental event (EE) will be the subject of a template to be filled out by the observer (Inspector) and submitted to the ESD for action.
  - Regular coordination meetings between ESC and ESD teams will be organized. During these meetings, on-going EE, resolution measures and any other topic such as Action Plans submitted by the EC will be discussed.
  - Water quality monitoring: sampling will be carried out in the Jiji river upstream and downstream of the main construction areas in particular, to monitor turbidity and some pollutants such as hydrocarbons and faecal coliform, which are
indicators of the significance of the impact and effectiveness of mitigation measures implemented.

➢ Monitoring the implementation of specific health and safety plans.

**During the operating phase,** the monitoring programme will include at least the following activities:

➢ Impromptu checks will be conducted by REGIDESO during dry seasons to ensure that the firm yield downstream of the dam is actually released in accordance with the Operator's specifications.

➢ Monitoring of fish species in the impoundment and downstream of the Jiji dam

➢ Monitoring of water-borne disease vectors This activity will focus particularly on the annual inventory of aquatic vegetation that grows around the impoundment and the presence in the vegetation of certain species of snail that could be the intermediate hosts of bilharzia vectors.

9. **Public Consultations and Information Dissemination**

Several public consultations have been conducted since 2010 as part of this project:

➢ The Consultant, Fichtner, organized several meetings at the level of the Municipalities and Hills concerned by the project in 2010-2011;

➢ In July-August 2013, ARTELIA-SHER conducted further consultations at the Buyengero and Songa municipalities;

➢ A start-up workshop was organized on 23 August 2013 in Bujumbura;

➢ A dissemination workshop for the presentation of the preliminary ESIA and RAP was held in Bujumbura on 18 October 2013.

During these consultations, all participants as well as the local population confirmed their interest and support for the project.

REGIDESO also made provision for a plan for consultation and communication with the communities. External communication will remain REGIDESO’s prerogative through the Environmental and Social Officer assisted by a Communication Officer. This will concern mainly information exchange with the media, NGOs and State representatives at Central and Prefectural levels.

It was recommended that during the construction phase, decentralized recruitment centres be opened at the Headquarters of the Municipalities concerned and in the nearest major towns.

Besides a specific disputes resolution procedure implemented within the framework of the Resettlement Action Plan (RAP), provision is made for a grievance resolution process that will
enable the entire population affected by possible nuisance resulting from construction activities to channel to project management the problems routinely encountered.

Furthermore, this summary will be published on the website of the African Development Bank 120 days before presentation of the project to the Board of Directors.

10. **Complementary Initiatives**

383 households totalling 2,237 people will be affected by the Mulembwé project. The same household may have one or more assets affected by the project (loss of land, losses of farm produce for both annual crops (cassava, beans, maize, potato, onion, etc.) and perennial crops (citrus, banana, mango, avocado trees etc.), loss of constructions.

The losses are as follows:

- 97 households affected by non-linear components will lose annual crops (cassava, beans, combination of crops and other perennial or non-farm crops)
- 55 households affected by linear components will lose perennial crops (banana, coffee, palm, avocado, mango trees)
- 454 trees used for timber and firewood
- 4 buildings to be compensated
- 286 people affected by linear components (pipes and roads)

Implementation of the Resettlement Action Plan includes a number of measures in addition to compensation and assistance in view of the premise that the project ought to improve the general living conditions of persons affected:

- **Livelihoods restoration measures (M1)**
- **NGO support during the resettlement process (M2)**
- **Food aid for the transition period (M3)**
- **General assistance to resettlement and all PAP arrangements (M4)**
- **Training in financial management (M5)**
- **Additional measures: Rural electrification** is a major factor for social acceptability of the project.

Furthermore, and apart from job creation for the local population during the various phases of the project, REGIDESO will encourage its contractors to source local produce (foodstuff, provisions, livestock products, etc.) with the aim of stimulating local production and creating permanent income sources primarily during the operational phase.
11. Conclusion

The Mulembwé Hydropower Project is one of national importance. It will enhance access to electricity and socio-economic development.

Given that it may produce negative environmental and social impacts, integration of the environmental dimension in the project's planning, design and implementation is necessary to maximize its benefits for the population and reduce the negative impacts. Project evaluation will be facilitated by environmental and social inspection and monitoring of the actual short- and medium-term impacts of project operations.

An Environmental and Social Management Plan and a Resettlement Action Plan have been prepared as part of this project. The RAP summary is published on the Bank's website separately from this summary.

12. References and Contacts

In drafting this summary, the following documents were consulted:

- ESIA of the Jiji Development (Artelia November 2013)
- ESIA of the Mulembwé Development (Artelia November 2013)
- ESIA of the power lines and sub-stations associated with the Jiji and Mulembwé hydropower developments (Artelia November 2013)
- RAP of the Jiji Development (Artelia November 2013)
- RAP of the Mulembwé Development (Artelia November 2013)
- RAP of the power lines and sub-stations associated with the Jiji and Mulembwé hydropower developments (Artelia November 2013)
- The Environmental and Social Management Framework of the grid associated with the Jiji and Mulembwé projects (ARTELIA November 2013)
- Resettlement Policy Framework (ARTELIA, November 2013)

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