Summary Environmental and Social Management Plan

Project Name: Empress Eugenie Falls Hydropower Plant (CDI), Fougamou, Ngounié Province and FE2 Falls Hydropower Plant, River Okano, Woleu-Ntem Province.

CASE STUDY OF FE2 FALLS, RIVER OKANO, WOLEU-NTEM PROVINCE

Project Number : P-SC-GB0-002

Country : Gabon

Department : OPSM Division : OPSM.3

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1. Brief Project Description and Main Environmental and Social Components

The Gabonese Government has defined a hydropower sector development plan to meet the country's electricity needs. The Renewable Energy Development Company (CODER) has signed an agreement with the Government for the construction of two hydropower plants - one at the Empress Eugenie Falls on River Ngounié and the other at the FE2 Falls on River Okano.

SEDEP Company has signed a concession contract with CODER to design and construct the hydropower plants, as well as provide assistance during their operation. The design and installation of high voltage transmission lines from the two hydropower plants to create a national network is a separate contract with the Government. The power transmission lines are considered in another environmental and social impact assessment.

The FE2 falls on River Okano are located in South-East Mitzic, Woleu-Ntem region, North-East Gabon. The project consists in building a 36 MW run-of-water hydropower plant. The design and installation of high voltage transmission lines from the two hydro-power plants (FE2 and CDI) to create a national network is a separate contract with the Government. The power transmission lines are considered in another environmental and social impact assessment.

The location is accessible by the Mitzic-NDjolé road over a 12-km distance and by a 27 km good laterite forest track which ends adjacent to the site of the future hydropower plant. A logging camp, a saw mill and an aerodrome are located about 12 km upstream at Saint-Germain.

To the north-east of the study area, the relief is a southern extension of the erosion surface of North Gabon. On the rest of the area, the relief is young, designed by the erosion of the downstream river course of River Ogooué and its tributaries. The average altitude gradually decreases from 500 to 300 m from the north to Ogooué valley. Steep slope rivers flow through often very encased valleys, such as that of River Lalara, followed by Mitzic road.

In the project area, the west side of the falls has relief made up of hills (500 to 1,000 m high on average), while the east side is relatively lower (0 to 300 m high). The site is located on land of the Late Precambrian era consisting of granites and migmatites.

In the works area, the Archean basement is granite-gneiss, comprising old undifferentiated gneisses. The yellow tropical soils of the site are typically lateritic and very thick. The soils are of low fertility. The "slope" is a handicap for local peasant agriculture, and especially for modern agriculture as it reduces and disperses the percentage of arable land areas. Subsistence farming and logging (FOREEX) are the main activities in all the villages of the study area.The project area is located in Dja-Odzala-

Minkébé (Tridom) ecological landscape, identified by the Congo Basin Forest Partnership (PFBC), under the aegis of the Central African Forests Commission (COMIFAC) and subject to the COMIFAC Tridom intergovernmental cooperation agreement signed in 2005. The landscape mainly consists of forest concessions near the protected areas. Most of the landscape already has a status associated with the primary land assignment (logging concession, protected areas and community-managed areas). Almost 70% of the Tridom will be used for the production of timber, and most of the area will be located in forest concessions. Tridom's ecological health depends mainly on these forest concessions, and logging has an important socio-economic role to play in remote and often impoverished rural areas. The area has a wet equatorial climate, with average monthly temperatures of 23-28°C. Relative humidity is generally above 80%, and annual rainfall varies between 1,680 mm in Mitzic and 1,770 mm in Bitam, with two wet seasons between September and December and between March and May.

The project involves the construction of a 36 MW hydropower power plant at FE2 Falls; all facilities are located on the right bank of River Okano. Since the hydropower plant is with the water current, there is no need for any artificial water catchment or basin formed by a dam. However, a sill will be built on the river with a spillway to control the level of water sent to the facility. The retained water level will be within the river's maximum flood limits.

The FE2 Falls site is particularly suitable for a facility with the water current because of the reliability of the water system throughout the year, the 90 meters differential spread over two sets of waterfalls/ rapids, and a topography which will facilitate the construction of the water supply canal, the spillway and the power plant. As a result of its remote location and lack of any human occupancy of the land, people will not be displaced at the site or in the nearest cities (such as the FOREEX logging camp in Saint-Germain).

The FE2 Hydropower Project also has the following:

- A catchment area with an open Creager sill, an outlet valve operated by a hydraulic jack (located on the right bank), and a lateral water intake for a 54 m³/s bypass under a 3 m load of. This jack is equipped with a grid and a hydraulic screen rake.

- A two-compartment scouring channel and a loading chamber. The channel is equipped with two sluice outlets for hydraulic flushing of sedimented material in each compartment. The loading chamber helps to maintain water on the cask of the water intake pipe at a level sufficient to prevent entry of air into the pipe that can cause draw resonance.

- A 20 mm thick and 2,000 m long welded steel **supply pipe** through which water flows at 54 m³/s on full load under 5 bar pressure. It is installed on a straight line between the loading chamber and the control basin.

- A reinforced concrete **control basin** to control turbine flow at the hydropower plant, and a basin to absorb any water-hammer due to abrupt shutdown of hydropower generators.

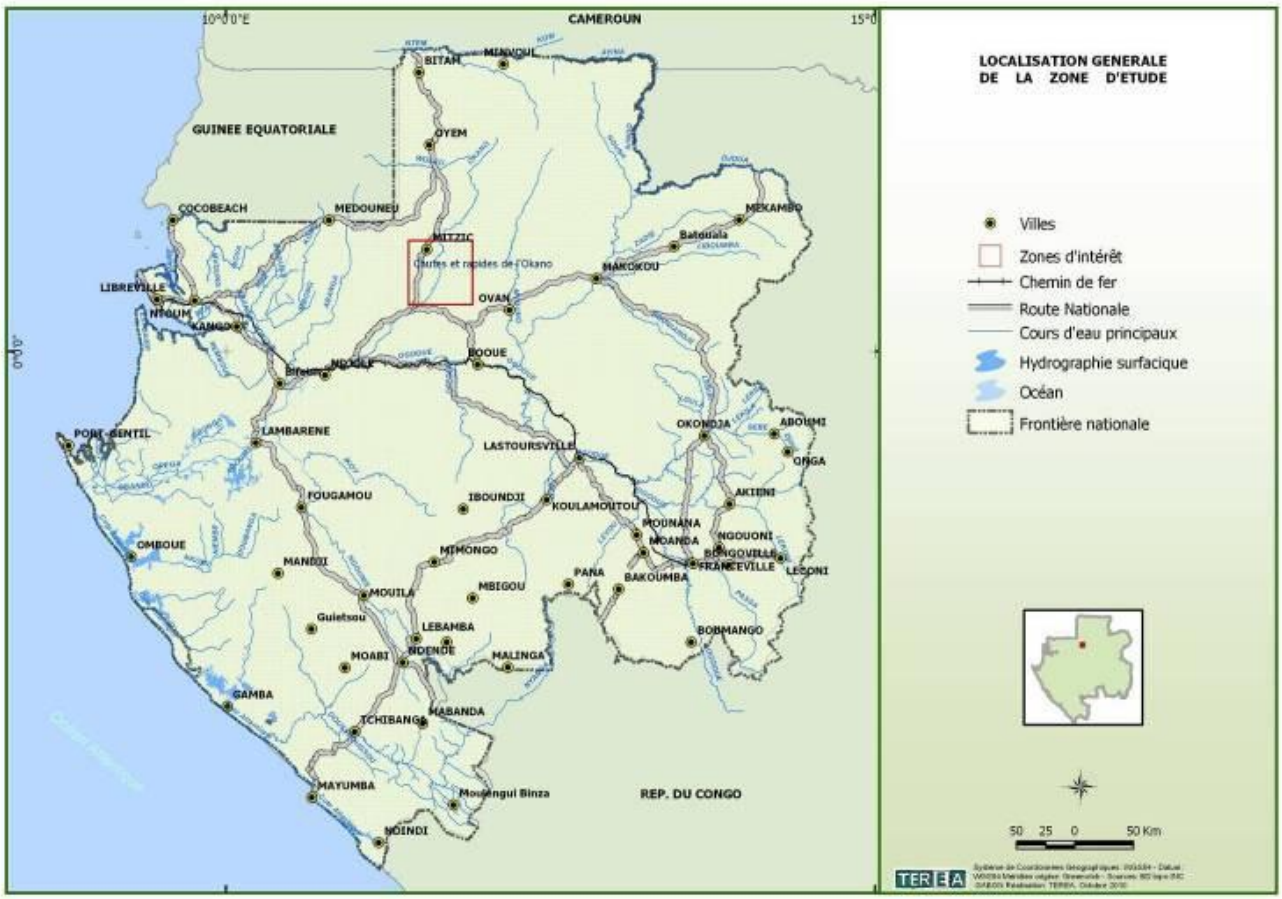
- **Three penstocks** connecting the control basin to each hydropower generator in a straight line. They are half-buried upstream and on blocks of concrete in the steepest part of the route downstream. The flow is 18 m³/s per pipe under 10 bar pressure.

- The building of a **hydropower plant**, with three 12 MW vertical Francis hydropower generators, and all the necessary equipment (turbines, alternators, cells, control systems, transformers, handling equipment, auxiliary equipment). The plant site will also have

ancillary facilities (temporary construction camp, accommodation units, kitchen, canteen, stores, play grounds, etc.).

- **Access Roads:** The site is located about 27 km from the entrance to the main access road to the FOREEX forest concession just south of Mitzic. CODER wants to use the existing access roads to the forest concession from the Mitzic-Lalara road as much as possible, and then to finalize access to the site by constructing roads similar to those used in the forest concession areas (that is 5m wide compacted untarred roads).

Figure 1
Site Location of the Proposed Hydropower Plant at FE2 Falls on the River Okano



All the land required by the project for access roads, as well as the construction and the operation of the facilities belong to the Government, and is made available to CODER under a concession contract. The Gabonese Government has granted CODER temporary authorization to use the site. A document declaring the two sites of public utility was given to CODER in December 2011.

The Government's contract with CODER provides for a 30-month period for completion of the works. The works will end in December 2012 (site clearing, geotechnical testing, earthworks, building of turbines, civil engineering, manufacturing of pipes, and installation of equipment). Operators will be trained in September 2012 and March 2013, and preliminary tests will be conducted between December 2012 and March 2013. The plant will be commissioned in March-April 2013.

Once in service, the FE2 facilities will work 24 hours a day, 7 days a week, 52 weeks a year, subject to temporary closures for essential maintenance works.

During the operation of the power plant, about four skilled workers, mainly engineers and technicians, will be employed to ensure that the hydropower plant runs 24 hours/day. The unskilled workers will include security guards and cleaners, and they will be recruited locally.

The project study area is located in Okano Division, Woleu Ntem Province, a province with a relatively low population density. The Lalara rural district has 2,118 inhabitants, and the study area has 600 villagers (2003). The Fang ethnic group makes up the majority of the provincial population. Lalara2 village, created recently, is multi-ethnic, comprising the Fangs, the Kotas and the Sakes. The FOREEX base camp in St. Germain has not only the ethnic groups mentioned above, but also people from other provinces of Gabon and immigrants from various African countries and other continents.

In the project area, like the rural areas, the people are often poor, and live on subsistence farming. The farms identified in Okano Division include well-kept new plantations which provide the bulk of the production, and the old plantations (fallow) for other products for home consumption. Hunting is carried out on a small scale in the study area. This is certainly due to the policy of banning FOREEX hunting.

Fishing in the study area is on the main rivers (Lalara, Okano), but it is not major activity of the population. Fishing products are sold in the village in case of surplus. Fishing in the area is mainly for home consumption.

Harvesting areas are mainly located around the plantations and in the surrounding forest. The harvests are mainly for home consumption. There is virtually no production of handicraft, with the exception of baskets that are made by the villagers.

The secondary sector is represented here by the FOREEX company activities, and there is no tertiary sector activity in the study area - it is concentrated in Mitzic municipality. The most recurrent diseases are malaria, febrile gastroenteritis, lung infections, bacteria, viruses, mycoplasma, opportunistic organisms, and various traumas.

2. Major Environmental and Social Impacts

2.1 Positive Impacts

The construction of the hydropower plant will, upon start-up of the works, very quickly lead to an influx of people seeking employment or business opportunities. The construction works will have a strong impact on the region's economic dynamism through the creation of jobs for the local people. Some 200 direct jobs and 100 indirect jobs will be created for skilled and unskilled workers and labourers. Although the activity is temporary, it will cause significant financial flows to the surrounding villages through recruitment of people in the villages and the purchase of local foodstuffs.

The impact is strongly positive, and will last throughout the construction period and cover the entire area beyond Mitzic and Lalara. Reversibility will depend on the number of persons whose jobs are maintained during the operating phase which will, in large part, require skilled labour. Employment opportunities will decrease accordingly at the end of construction works on the structure and related infrastructure.

The adoption of a policy to employ local people and the utmost sustainability of these jobs would contribute significantly to the region's dynamism and the poverty reduction policy.

Generally, the construction sites do not bring equal benefits to men and women. The recruitment of local workers must be identical for men and women. It will be necessary to ensure compliance with

the provisions of the Gabonese Labour Code and labour requirements and working conditions are respected. Special assistance could be considered in terms of creating positions and/or opportunities for women and other vulnerable people so as to enhance the potential benefits of the project; for example, by providing additional targeted assistance as well as opportunities for improving or, at least, restoring the ability to earn an income.

Access to Resources: The construction of small roads for the works and the operation of the plant will further facilitate the movement of the local population, and thereby provide greater access to natural resources. Since agriculture is the main activity of the population, the construction of small roads is likely to lead to occupancy of new arable land by the villagers.

Access to Energy: The project aims at providing electricity to Woleu Ntem region, with an interconnection to the power grid in Libreville. This will have a very positive impact on the people's quality of life.

2.2 Negative Impacts

Air quality and Climate Change

The main sources of air quality deterioration (exhaust gas, dust, noise generation and vibration) will be the presence of machines, vehicle traffic and equipment operation at the temporary base camp. The other sources are tree degradation and other unpicked plant debris, and the presence of some equipment at the temporary base camp. The impact will be temporary and extended beyond the project area.

The plant will emit negligible levels of greenhouse gases during operation. The air pollution directly attributable to the plant during the operational phase will be negligible compared to thermal methods of power production. During routine activities and on-site maintenance operations, internal combustion engines and vehicles will emit exhaust gas and dust into the air, but in an insignificant quantity.

Dust Emissions

Dust will be generated mainly from works on the opening of an access road to the project site from the existing forest road and internal circulation tracks, earthworks, and mobilization of excavated soil.
Traffic on the roads will be negligible during the operational period, it will be occasional during maintenance or repairs.

Noise and vibration

Noise and vibrations will come from the engines of equipment and vehicles, detonations when using explosives during construction (excavations), earthworks and loading/unloading of excavated material. This noise will affect mainly workers on the site and wildlife around the site. The explosions will generate vibrations that may affect a wide area, occasionally and over a short period. Residential areas are far from the site. Since the site is located in a natural untouched environment, sensitivity to noise will be extremely high. Noise and vibration levels, as well as the waterfall noise, will likely not exceed threshold values during the operational phase, in compliance with the levels defined in the technical specifications.

Storage of Hydrocarbons on Base Camp Platform

Hydrocarbon vapor emissions will be captured in diesel and gasoline tanks during the supply, storage and distribution of fuel. Emissions from petroleum products consist mainly of volatile organic

compounds (VOCs). These gases include CH4, which is a powerful greenhouse gas. However, given its low proportion and the total quantities emitted in comparison to national levels, the emissions could be considered as negligible. The emissions will occur throughout the project.

Water Resources

Surface Water

Located on its right bank, the Okano is a tributary of the River Ogooué and takes its rise in the North-East of the country, some 50 km east of Oyem, and drains into a watershed covering area of 10,900 km² before flowing into the Ogooué, equidistant from Lambaréné and Booué. The Okano watershed at the site covers an area of 3,480 km².

The FE2 site has two sets of waterfalls with vertical drop 88 metres over a distance of 2,150 metres. Upstream waterfalls have a vertical drop of about 50 metres over a distance of 250 metres, and the downstream waterfalls have a vertical drop of about 20 metres over a distance of 300 metres.

Between these two sets of waterfalls that flow in channels separated by islets, the Okano flows quietly on a gentle slope. The right bank channel handles most of the flow. On the right bank, three talwegs flow perpendicularly to the Okano bed. One of them, with a perennial flow and a platform at its outlet, will harbour the hydropower plant.

Monthly average flows of the Okano at FE2 vary between 38.9 and 132.0 m³/s. During low-water periods in July, August and September, the flows are always less than 50 m³/s, but rarely go below 20 m³/s. Minimum flows are observed in August and September at the end of the dry season.

Surface water samples were used to assess its physical and chemical quality, appropriateness for use and biology. All the water collected from the FE2 site has an overall good to very good quality in terms of biology and drinking water production.

The main sources of impact on the area's hydrography and surface water quality are removal of the plant cover and earthworks, building of the hydropower plant facilities, excavations or backfilling, and the construction of service roads. The waste material from these activities, including the dismantling of the plant and facilities, are likely to pollute the water (surface water or the Okano) either directly or indirectly through leaching and runoff water. The impacts could be physical (flow disruptions and increased suspended solids during deforestation and earthworks) or chemical (spilling of chemicals, waste, etc.).

Flow Disruptions

During the construction and rehabilitation works phase, flow could be disrupted by abandonment or accidental spillage, storage of plant debris and/or excavation or backfilling materials in inappropriate conditions, or poor design and maintenance of bridges over the rivers. These permanent impacts could be moderate on the Okano, but significant on the tributaries crossed by the projected roads.

Increased Turbidity

Natural erosion caused by runoff of storm water on soils, will be worsened by the operations that destabilize soil, remove the plant cover, mobilize land, thereby destructuring the soil. The areas covered by these works will be subject to increased erosion, leading to increased water turbidity downstream through the transfer of soil particles by runoff water.

Increased turbidity of surface water is an impact that will last throughout the project. The quantity of suspended solids (TSS) is deemed significant, even though the Okano mixes quickly with the Lalara before flowing into the Ogooué. The scope of the impact is considered significant.

Surface Water Pollution

Pollution could be caused by direct or indirect discharges into the rivers (runoff, sanitary wastewater, effluent discharges, etc.). Potential sources of pollution include hydrocarbons and other chemicals, used oil and polluted waste, accidental spill from trucks carrying construction materials, leaching of contaminated soils and runoff to rivers, spill of concrete and related products during the cleaning of production equipment and the transportation of concrete, etc., especially during the construction of infrastructure in direct interaction with the river bed, and the discharge of organic waste and wastewater into the tributaries or the Okano.

This pollution could alter the physical, chemical or biological quality, thereby affecting aquatic life and users of the river in the event of consumption of water from the river or contaminated fish. The risk of polluting surface water is present throughout the project. The impact will be moderate to significant, with high intensity and requiring action. During the operational phase, surface water pollution can be caused by truck accidents or in the storage/distribution of hydrocarbons, dysfunction of drainage ditches/retention basin, etc. as a result of poor waste management and unsuitable wastewater management.

Hydrography

During the construction phase, a temporary cofferdam will be built on the Okano where the river splits into two. The aim is to divert water on the left bank to allow for dry foundation works. The diversion will temporarily change water flow change with the risk of flood/dewatering and disruption of the aquatic ecosystem. It is likely that some fine particles will be carried into the river, thereby degrading water quality (including increase in SS).

Risk of eutrophication and heavy metal solubilization

The risk of eutrophication would due to dysfunction of weirs or the channel of approach, leading to the release of mineral matter from the decomposition of vegetation and soil leaching. This risk is considered negligible due to the absence of a reservoir. Indeed, the plant is with the water current; in times of high water, the floodable areas will be equivalent to those observed before construction of the hydropower structure. Water retention is very limited, its level is regulated by a weir, and therefore the risk of nutrient pollution remains negligible. Similarly, the risk of solubilization of heavy metals resulting from potentially flooded and degraded vegetation is low.

Underground water

Underground water Pollution

Construction works due to a change in the watershed drainage are likely to affect the level of water. The impact during drilling will be significant depending on the working method. Given the link between the water table and surface water, as well as the proximity of the Okano to the drilling location, the scope of the impact will be greater. During the construction and rehabilitation phase, the main sources of impact on underground water quality are pollution generated by accidents, indirectly through contaminated surface water or seepage of contaminants. During the operational phase, the water table will be affected by the amount of water drawn at the base camp. 500 m3 of water will be drawn to meet water needs on the site.

Aquatic wildlife and flora

Aquatic wildlife in the project area comprises mainly fish. The study area has 38 fish species belonging to 14 families and 26 genera, which are exclusively continental. Downstream FE2 Falls is relatively richer and more diverse than upstream, particularly as regards species. Since samples have not been collected from the entire watershed, the available information is fragmented and inadequate for assessing the quality of wildlife in this area in terms of scarcity, protected status, and other uses. Fishermen have reported the presence of many reptiles (crocodiles, monitor lizards, aquatic cobras, smooth snakes, and pythons) and otters. The otter is a protected species and it is not marketed. In fact, there are no statistics on it.

currently, there is not much fishing activity in the Okano near the project area; only a few FOREEX workers are engaged in fishing there. The main sources of impact on aquatic wildlife and flora are flow disruption, increased water turbidity, deterioration of physical, chemical or biological water quality caused by accidental pollution, and unsuitable solid waste and effluent management.

Disruption of aquatic ecosystems

The impacts of the construction phase include obstruction of waterways by service roads, increased suspended solids (SS) which can alter aquatic habitats, and a decrease in biodiversity, change in water quality, and the disruption of lateral migration of fish. The waterfalls are a natural barrier to longitudinal migration. Despite the Okano's high dilution capacity in the event of an accidental spill or the sweeping away of sediments, especially in times of rain, the intensity of the impact remains significant.

Fishing activities

The absence of villages in the project area implies low pressure on fishing activities. The settlement of workers throughout project implementation is likely to increase demand for fish, and therefore intensify fishing activities by or for employees. On-site workers and their families will be sensitized on the preservation and protection of aquatic resources.

Soils

The soils in the study area are very thick lateritic soils on granite-gneiss. Samples were taken from 5 stations. Analyses show that the soil in the study area is mainly composed of silica, alumina and iron, which are mainly rich in calcium. The slopes around the falls facilitate soil leaching. Hydrocarbons, although lower than the recommended levels, were identified in samples collected near Saint Germain, an area that is relatively anthropized. During the works and rehabilitation phase, the potential impacts concern soil erosion and stability, and modification of soil quality in the event of accidental spill.

Soil erosion and stability

Clearing removes protection against soil erosion and reduces its stability. Access roads will be affected by storm and runoff water carrying sediments to waterways and increasing water turbidity. The most sensitive points are the roads. Erosion will heavily depend on the relief and slopes on the roads, especially the slope parallel to the supply channel along the river. Excavation works along the buried supply pipe (1,900 m) and the clearing of the road linking the base camp to the plant can lead to local landslides and land subsidence. There is also a risk of destabilization of the banks during some foundation works on the river.

Erosion downstream the Okano

The construction of the hydroelectric project is likely to decrease the amount of sediment downstream the Okano, and thereby increase the risk of erosion. The installation of standardized valves will allow for removal of sediments and floating objects, thus maintaining the river's sedimentological balance.

Soil pollution

During the construction phase, the impacts may be caused by direct discharges to the ground or after storm water or wastewater runoff. The pollutants include hydrocarbons and other chemicals, used oils and polluted waste, construction equipment, concrete and related products, and random dumping of waste. The pollution can carry contaminants through runoff water into waterways, or leach contaminants into the ground, with the risk of polluting the water table.

Fauna and flora

Terrestrial fauna

The most common mammalian species are the elephant, bush pig and duiker. The other species are the giant pangolin, the sitatunga, and water chevrotain. This area seems fairly rich in mammalian wildlife. However, proximity to roads leading to Cameroon, to which many poaching products are taken, may be considered a threat to wildlife, particularly the elephants. The impacts of deforestation/earthworks, the construction and operation of the plant and related infrastructure can disrupt animal lifestyle and leading to the emigration of local wildlife. This disruption is mainly due to noise and the project which will encroach on the temporary or permanent land use. These changes will affect terrestrial wildlife which populate or occasionally come to these areas.

Indeed, the area available for wildlife relocation is largely adequate near the project area. The animals will migrate and modify their territory to compensate for losses caused by the site development. The absence of villages in the area and the long distance from major highways, as well as proximity to the FOREEX forest concession which is engaged in the fight against poaching, will allow for negligible pressure on wildlife. On-site workers and their families will be sensitized on the preservation and protection of terrestrial wildlife.

Flora

The major vegetation types on the site include the banks of the Okano and flooded forests (varzea type, characterized by the Uapaca), swamp forests (located in the Okano tributaries; 2.7% of the plots identified), marantaceae forests (25%), and open forests on the mainland (66.7%), present on most of the surveyed area. It is unlikely that the area has a particularly remarkable vegetation type.

Cultural heritage

The survey did not identify any archaeological remains in the area. There are no areas or buildings of legally protected cultural heritage on the site and the surrounding area. The history of the FE2 Falls area seems little known to people in the study area. However, at public meetings in villages during the socio-economic survey, the local people underscored the need to carry out rituals before the start of construction on the site.

After consulting with religious and community leaders, the rituals will be carried out before the start of construction. Throughout the project, consultations will be undertaken to hear views and maintain contact with people living around the falls, and the community will be contacted for the access road management.

Public health

The most recurrent diseases in the project area are malaria, febrile gastroenteritis, lung infections, bacteria, viruses, mycoplasma, opportunistic organisms, and various traumas.

The main sources of impacts associated with the FE2 Falls development likely to affect human health are the influx of people to the site (HIV, other sexually transmitted infections, waterborne and parasitic diseases, new diseases), the presence of standing water (malaria and filariasis), dust or gas emissions, increased turbidity, pollution of surface and underground water, and vehicle-related noise.

Pollution of soil, surface water and the water table by chemical contaminants can have direct effects on health in the event of ingestion, contact or consumption of contaminated products. Flying dust as motorized vehicles circulate is likely to be inhaled and could cause respiratory problems.

Security

The main effects are accident-related:

Road Accidents: The entrance to the site is about 25 km south-east of Mitzic, a relatively big town. The site receives supplies from Libreville mainly by road. The forest road to the FE2 Falls site from the main road is also plied by vehicles belonging to FOREEX which is the owner. Increased traffic will increase the risk of road accidents. During the construction phase, there will be an increase in traffic, especially supply trucks and movement of machines during excavation. This increased traffic will also increase the risk of collision between vehicles and accidents involving pedestrians (workers, villagers) and FOREEX staff. The risk is very high with serious consequences; the impact is permanent and it will be there throughout the construction phase.

During the operational phase, the structure will bring more people to the project area, and thereby increase the local traffic. However, the risk of road accidents will be considered negligible during periods of routine operations and/or maintenance of the structure.

Drowning-related accidents: The absence of large volume of water reduces the risk of drowning often due to sudden rise in water levels during reservoir discharge operations. However, it will be necessary to create a security area to limit access to the site to authorized staff. The staff and population will be sensitized on the risks of abrupt rise in water levels. Officials of the plant will ensure that the facilities are in good working order.

Electrocution-related accidents: The risk of electrocution is considered negligible, and access to power control and maintenance activities is reserved for qualified, licensed and trained staff.

Risk of fire/explosion: The risk of explosion /fire is related to the presence of electrical equipment. Lightning or any electrical problem can cause a fire. The impact is considered moderate, as there are appropriate preventive and corrective measures.

Use of explosives: The risk of accidents associated with the use of explosive devices should be noted, although such use will be occasional.

3. Improvement and mitigation programme

An Environmental and Social Management Plan (ESMP) has been prepared in accordance with Gabonese law and African Development Bank requirements.

The objective of the ESMP is to:

- underscore mitigation measures;
- define the necessary specific actions and implementation schedules;
- identify roles and responsibilities in implementation; and
- estimate the cost of additional measures not included in the existing budgets.

The following is a summary of proposed measures to mitigate the project's negative impacts:

Air quality and climate change

The mitigation measures include regular maintenance of machines and vehicles, route optimization, watering of roads, speed limits, conservation of a wooded strip around the roads and the recycling of materials. The impact after implementation of the mitigation measures will remain moderate during the construction phase.

Dust emissions

The measures to minimize dust emissions are the implementation and enforcement of speed limits, reducing the number of roads to a minimum, the watering of roads, and route optimization to reduce traveling. These measures will help reduce the intensity, scope and frequency of the impact of dust, especially during the dry season. The residual impact will be negligible to moderate.

Noise and vibrations

The mitigation measures include the use of hearing protectors, and limitation of the use of motorized vehicles and explosives to working hours and at a prescribed distance from residential areas. The potential use of explosives would be limited to the excavation of channels. The residual impact will be negligible to moderate during the construction phase. Maintaining a wooded strip around the plant will mitigate nuisances and serve as a screen to the propagation of sound waves. Regular maintenance of equipment will reduce noise emissions at the site. During normal operation, except for maintenance work and in view of the long distance from settlements (12 km from FOREEX camp), the residual impact will be negligible to moderate.

Storage of hydrocarbons on the base camp platform

To minimize emissions and the effects of hydrocarbon vapours, mitigation measures will be taken at various levels: storage of fuel in standardized tanks, promoting the use of anti-overflow systems, regular elimination of fuel effusions, and cleaning up of accidental spills. The impact will be reduced as regards its intensity, reversibility and frequency.

Surface water

Flow disruptions

To maintain long-term natural hydrological regime, utmost efforts will be made not to allow routes go across waterways. Other mitigation measures to minimize flow disruptions include the development of nozzles to ensure free flow of water downstream, ensuring proper management of construction waste, and the design of rubble storage plans. Hydrological modeling will be undertaken during the pre-construction phase, and water quality will be monitored during the operational phase. These measures will help to maintain the project area's long-term natural hydrological regime and replenishment of waterways downstream; the residual impact will be negligible to moderate.

Increased turbidity

The mitigation measures include development and maintenance of drainage ditches and water retention basins during the construction phase so as to prevent any dysfunction, reducing slopes and embankments, and their re-vegetation; removal of accidentally spilled material within the shortest possible time, and developing embankments in successive layers to minimize soil erosion during rainfall. These mitigation measures will reduce its intensity, duration and frequency, and thereby limiting this impact to potential accidents or dysfunctions; the residual impact will be negligible to moderate.

Pollution of surface water

The mitigation measures to consider include avoiding, as much as possible, to cross permanent waterways with machines and trucks and to cross at the narrowest and stable locations if necessary; maintaining vehicles, machinery and equipment in good condition, prohibiting refueling close to the river and tributary, preserving a strip of vegetation in the areas to be developed (factory, channels etc.), maintenance of drainage ditches and the retention basin, establishing machine washing stations, designing a plan for safe management of hydrocarbons/chemicals, providing enough toilets/ hygiene facilities, and collecting and treating wastewater on the worksites. These measures will help to reduce the intensity of the impact and facilitate its reversibility. The residual impact will be negligible to moderate.

During the operational phase

The measures to be considered include the regular maintenance of drainage ditches, retention basins and facilities, the design of a chemicals and waste management plan, planning of emergency measures in the event of accidental spills, the collection and treatment of wastewater, and ensuring quality water control prior to discharging into the river, especially at the plant. The residual impact will be negligible to moderate.

Hydrography

The mitigation measures include carrying out the works in the dry season, promoting work techniques that reduce the dumping of sediments (e.g. cofferdam, construction of the sill), and putting in place methods to restore drainage of waterways after construction. This impact should be closely monitored; the mitigation measures will help to reduce its intensity and reversibility. The residual impact will be negligible to moderate.

Risk of eutrophication and solubilization of heavy metals

The mitigation measures include preparing a programme to monitor water quality, maintaining sufficient water flow to avoid a rise in water level upstream the threshold, preparing a plan to monitor water levels on the Okano, and maintaining the screen rake in good working and cleaning conditions. Residual impacts will be negligible to moderate.

Underground water pollution

The mitigation measures to maintain the quality of underground water include adopting drilling methods that will minimize impacts on underground water, making the appropriate choice of the site for the water point to minimize risks of water pollution, and ensuring quality control of the borehole. These measures will reduce the intensity and frequency of the residual impact (negligible to moderate).

Disruption of aquatic ecosystems

The mitigation measures include constructing nozzles to ensure free flow of water downstream, creating a protection area around sensitive ecosystems, avoiding the introduction of foreign or exotic flora, preparing storage plans for debris, building and maintaining drainage systems and water settling ponds during the construction phase, prohibiting the fuelling of machinery and vehicles within the vicinity of near, and putting in place a chemical products and waste management plan. Hydrological modeling will be undertaken during the pre-construction phase, and water quality will be monitored during the operational phase.

It will also be necessary to develop a programme for monitoring aquatic wildlife populations considered to be sensitive, given that they have developed unique capabilities to adapt to these environments (species restricted to waterfalls), so as to assess the impact in the absence of a fish ladder. It could be necessary to conduct further research on the technical alternatives for the fish ladder and monitor fish populations to determine the impact. The impact may be observed only after several years.

These measures will limit the suspension of solid particles and minimize the increase in water turbidity. Furthermore, the measures will help reduce the risk of incidents leading to the dispersal of pollutants in the environment. The residual impact will be moderate to significant.

Erosion and soil stability

The mitigation measures include developing and maintaining drainage ditches and water settling ponds along the roads and structures, building embankments in successive layers, working preferably in the dry season, installing nozzles on the waterways so as not to disrupt their natural flow, and soil remediation at the end of construction works using revegetation techniques.

These measures will ensure soil stability and minimize the risk of erosion by waterways and storm water; the residual impact will be negligible to moderate.

Soil pollution

The mitigation measures include regular maintenance of machines and vehicles, maintenance areas and washing stations for machines, and preparation of a chemicals and waste management plan. The residual impact would be negligible to moderate.
During the operational phase, the plant activities will generate a risk of accidental soil pollution. Measures will be taken to act on the intensity, frequency and reversibility of the impact: maintenance of the facilities, drainage ditch equipment and retention basins to prevent any dysfunction likely to pollute the soil, preparation of a chemicals and waste management plan, storage of fuel in standardized tanks, use of anti-overflow systems, fuel retention tanks, and the preparation of an emergency plan in case of soil pollution.

Terrestrial wildlife

This impact does not require any specific mitigation measure - except the following: if necessary, the formation of a temporary team to rescue animals in distress, especially during clearing and construction activities, prohibition of hunting by workers, and regulation of access to the site (access roads closed, guarded day and night, access for company vehicles only, etc.). The access roads for equipment must avoid crossing local trails or terrestrial wildlife routes.

Health: The mitigation measures will act on the intensity, duration and frequency of the impacts on health, and will include a health problems management plan, effective presence of health care services

and first aid, a sensitization and information campaign for staff and the public on sexually transmitted infections (especially HIV/AIDS), a sensitization campaign on water-borne diseases (filiariasis and malaria), distribution and installation of mosquito nets, and rational use of chemicals in the fight against water-borne diseases (especially malaria). Enough good quality toilets will also be provided in accordance with the regulations, and all sewage and industrial waste will be collected and treated.

Security: Mitigation measures to reduce the frequency of the impact include improving road conditions, preparing a road rehabilitation and maintenance plan, speed limitation, adequate road signs, establishing an emergency plan in the event of accident with measures for stabilizing and evacuating victims, and defining traffic rules, particularly with FOREEX company which also uses some sections of the road. The residual impact after implementation of mitigation measures will be negligible to moderate.

Drowning-related accidents: However, it will be necessary to create a security area so as to limit access to the site to authorized staff. The staff and population will be sensitized on potential risks of an abrupt rise in water levels. Officials of the plant will maintain the facilities are in good working order.

Risk of fire/explosion: The mitigation measures include the installation of lightning conductors, preparation of an emergency plan in the vent of accident and providing first aid facilities, as well as establishment of a network of hose systems to fight fire.

Use of explosives: The employment of skilled staff and the firing methods used will help to reduce this risk.

4. Monitoring programme and complementary initiatives

Monitoring programme

A monitoring programme has been prepared for the construction and operational phases of the project:
Monitoring in the construction phase:

- monitoring of health and safety in the workplace;
- establishment of a procedure for chance discovery of cultural and archaeological heritage;
- monitoring compliance of tree felling and clearing on deforested areas of the site with good forest conservation practices; compliance with forest fire prohibition, etc.
- regular monitoring of wildlife in the project area and up-to-date keeping of a register for incidents;
- onduct of specific aquatic studies to determine the project's impact on fish and other aquatic species during construction and throughout project operation;
- monitoring of air quality
- monitoring of water quality:
    - Monitoring the quality of surface water (pH, dissolved O2, temperature, conductivity (EC), TSS (TSS), turbidity, mineralization (TDS), Ca, Mg, Na, K, Cl, ammonia, sulfates, phosphates, heavy metals and hydrocarbons);

- monitoring the quality of treated wastewater: pH, BOD, COD, nitrogen, phosphorus, hydrocarbons, grease and coliforms;

- monitoring the quality of drinking water: pH, turbidity, Mineralization, TSS, EC, Ca, Mg, Na, K, Cl, sulfate, and bicarbonate; and

- Monitoring sensitization activities and programmes for workers on water safety measures to reduce water-borne diseases;

- Verification of rules and procedures for the use of sub-contractors: No child labour/forced labour, discrimination, freedom of association, right to collective bargaining, hours of work, minimum wage, staff discipline and claims management, percentage of local employees, percentage of women employees, discriminatory behavior/complaints; etc.

- Liaison with the community and complaints handling mechanism

Additional measures in the operational phase:

- Monitoring of hydrological parameters: As part of the monitoring process, hydrological parameters monitoring stations will be established on the River Okano to measure the volume of water intake upstream and water outlet downstream, etc., together with information on water quality. Appropriate equipment, such as a graduated ruler, etc., will be installed to continuously record water level at the weirs/water entry point, if necessary, to regulate the project's water intake. The monitoring parameters include: temperature (°C), dissolved oxygen (mg/l), pH, conductivity (S/cm), turbidity (NTU (Nephelometric Turbidity Unit)); stratification and flow (m/s).

- Monitoring of water quality: temperature, dissolved oxygen, BOD, pH, conductivity and suspended solids;

- Monitoring of aquatic and river ecology: This programme aims at documenting how the aquatic community reacts to the operation of the CDI project. A periodic inspection of water quality and river habitats will take place, and will be accompanied by an annual sampling of micro-flora/fauna, aquatic plants (including the case of invasive alien species accumulation) and benthic organisms upstream and downstream the project.

Furthermore, a specific aquatic ecosystems monitoring study will be conducted during the construction and operational phases to quantify the impacts on the fish population and crustacean (including shrimps). The monitoring campaign will commence with the construction, and will propose any appropriate corrective measure.

CODER will put in place a system of sanctions for the violation of the good environmental and social performance rules outlined in the ESMP. This system will have three levels of sanctions: warning, penalty and dismissal of the person or company, and will provide for several levels of sanctions for repeat offenses. The fines will be deducted directly from payments for the works.

Complementary initiatives

1% of the construction budget is allocated for measures consistent with CODER sustainable development vision; its main objective is to provide assistance to the local populations in education, health, and economic development:

- CODER intends to better respond, within the limits of its financial, operational, technological and human resources, to the grievances of the local population and balance its initiatives across all villages and districts near the site;

- The health programme aims at facilitating access to medical information and care for all, especially for women and children; and

- An education programme which aims at sensitizing young people on the potential dangers of misusing electricity and on environmental issues related to energy consumption.

To achieve these complementary objectives, CODER will promote collaboration and solicit the support of local, national and international NGOs and other external resources to support it in its development projects and activities for local communities. 1% of the construction budget is allocated for measures consistent with CODER sustainable development vision, its main objective is to provide assistance to the local population in education, health, and economic development:

- CODER intends to better respond, within the limits of its financial, operational, technological and human resources, to the grievances of the local population, and balance its initiatives across all villages and districts near the site;

- The health programme aims at facilitating access to medical information and care for all, especially for women and children;

- An education programme which aims at sensitizing young people on the potential dangers of misusing electricity and on environmental issues related to energy consumption;

- Sensitization and prevention campaigns against STDs, malaria and other water-borne diseases;

- Digital knowledge dissemination in rural areas;

- Distribution of school supplies; and

- Construction of sports and cultural centres.

5. Institutional measures and capacity building needs

During the planning /pre-construction phase, the inclusion of HQSE specifications in the Bidding Documents for sub-contractors will help to ensure implementation of the measures identified in the ESMP.

The CODER HQSE official will be responsible for the following tasks:

- Design CODER Environmental Policy and Objectives;

- Design CODER Health, Safety and Environment Plan (HSEP);

- Design CDI base camp internal regulations (Operating regulations and Code of Conduct) ;

- Design health emergency and evacuation plans (EVASAN);

- Design procedures for control of non-compliance and correction tools;

- Design a mechanism for handling the complaints of workers and local communities, etc.

- Ensure that contract documents are adopted appropriately;

- Plan health, education and liaison programmes with local communities, prevention and sensitization campaigns on health, safety and environment and other socio-economic initiatives in collaboration with local authorities and stakeholders (municipality, Social Affairs Official, schools, local and international NGOs, etc.);

- Manage the mechanism for handling the complaints of local communities in collaboration with the Municipality in order to manage complaints, mailbox and facilitate communication between the local communities and CODER; and

- Take preparatory measures for ISO 14001 certification (2004).

At the construction phase, all sub-contracting and CODER staff will be responsible for implementing the measures identified in this ESMP. The on-site enforcement and compliance with HSE measures by sub-contracting and CODER employees will be the responsibility of:

- Site managers and HSE sub-contracting officials;
- The Operations Manager (monitoring);
- Technical team comprising 8-10 works engineers (monitoring);
- HQSE official (monitoring) ;
- Local authorities and investors (monitoring).

The enforcement and compliance with HSE measures by sub-contracting and CODER staff in the base camp will be the responsibility of:

- Site managers and HSE sub-contracting officials;
- Base camp management official;
- HQSE official (monitoring).

Implementation of the Complaints Handling Mechanism (local communities and workers) shall be the responsibility of:

- HQSE official ;
- Local council (complaints from local communities);
- Operations manager and technical team (complaints from on-site workers) ;
- Base camp management official(complaints from on-site workers) ;
- Project director and BET director (monitoring) ;
- Three representatives of the plaintiffs (local population or workers as the case may be);
- A neutral representative, such as a member of a local NGO.

The Environmental and Social Management Plan will be implemented by the HQSE Manager, under the supervision of the Project Director and in collaboration with the local authorities and stakeholders (Municipality, Social Affairs Official, schools, local and international NGOs, etc.).

In the operational phase, the staff numbers will be significantly reduced on the site, and the ESMP measures to be implemented will mainly consist in monitoring and surveillance. The implementation and compliance with HQSE measures by on-site sub-contracting and CODER employees will be the responsibility of:

- The operations manager (monitoring) ;
- Technical team;
- HQSE official (monitoring) ;
- Local authorities and investors (monitoring).

The technical team, operations manager and HQSE official will be responsible for monitoring and tracking. In addition, CODER will appoint specialized sub-contractors for activities related to water sampling and analysis, as well as for the programme to monitor aquatic life, the mammalian fauna, etc.

In addition, CODER employees will receive training in Health, Safety, Quality and Environmental aspects, and grievance handling procedures. The members of the technical team will also be trained in giving first aid.

The Operations Manager and on-site technical team will each week receive an HSE theme from the HQSE Official which they will communicate to the sub-contracting HSE officials during HSE Committees. HSE bulletins will be sent to all CODER staff and displayed in places where they will be likely seen by all.

The HQSE Official will coordinate training and sensitization /prevention campaigns on the site and in local communities, in collaboration with the HSE sub-contracting officials, local authorities and stakeholders (Municipality, Social Affairs Official, schools, local and international NGOs, consultants, etc.).

In addition, CODER employees will receive training in Health, Safety, Quality and Environmental aspects and grievance handling procedures. The members of the technical team will also be trained in giving first aid.

The Operations Manager and on-site technical team will each week receive an HSE theme from the HQSE Official which they will communicate to the sub-contracting HSE officials during HSE Committees. HSE bulletins will be sent to all CODER staff and displayed in places where they will be likely seen by all.

The HQSE Official will coordinate training and sensitization /prevention campaigns on the site and in local communities, in collaboration with the HSE sub-contracting officials, local authorities and stakeholders (Municipality, Social Affairs Official, schools, local and international NGOs, consultants, etc.).

6. Public consultations and information disclosure requirements

The project team sought the opinions of local and national authorities during the supervision phase. The first launching meeting was held on 7 June 2010 to discuss the project, source available information and obtain advice on the best approach to consult with people affected by the project.

Meetings were also held in October 2010 between TEREA and the Central Mayor of Mitzic, the Vice President of the Okano Divisional Assembly, the outgoing Secretary-General of Okano Prefecture and the Mitzic brigade commander and the prefecture's department heads, the Mitzic medical centre, the St Germain dispensary and the divisional assembly.

TEREA also consulted with the following NGOs: Brainforest, Wildlife Conservation Society and World Wildlife Fund in January 2011. To date, they have not shared their observations.

After presentation of the survey project to the local authorities during the ESIA process, discussions with village chiefs and villagers were scheduled. The discussions were aimed at collecting information in order to identify areas used for village activities on the project site, traditional and cultural activities, and conflict management.

The field survey (the socio-economic phase) was conducted by TEREA in six villages in Lalara district: Mindzi, Zomoko, St Germain, Elarmilot, and Larara1 Lalara2. Under the field survey, public meetings were held in affected villages from 23 September to 1 October 2010. Information on the meetings was displayed locally and invitations were sent to participants in advance. Each village was represented by a sample of at least 20 people.

The environmental and social studies, which were the subject of a formal communication on 26 January 2011, were approved by the General Directorate of the Environment and Nature Protection on 25 February 2011.
The summary of the project's Environmental and Social Management Plan is posted on the African Development Bank's website at least 30 days prior to approval by the ADB Board of Directors.

7. Cost Estimates

In the overall CDI project amount (about CFAF 80,000 million or €122 million for the first tranche), CODER allocates 1% of the construction budget for the environmental and social measures identified in the ESMP, including complementary initiatives. This cost will be fine-tuned when finalizing contracts to sub-contractors (mitigation and monitoring measures). Further studies on aquatic wildlife and surveillance activities and monitoring will be partly financed by CODER's own funds.

In the overall FE2 project amount (about CFAF 51,000 million, or €78 million), CODER allocates 1% of the construction budget for the environmental and social measures identified in the ESMP, including complementary initiatives. This cost will be fine-tuned when finalizing contracts to sub-contractors (mitigation and monitoring measures). Further studies on aquatic wildlife and surveillance activities and monitoring will be partly financed by CODER's own funds.

8. Implementation schedule and reporting

The project will report on the status of the environmental and social component of the project through an environmental and social monitoring report which will be submitted twice a year to the Bank.