NEHO
Nouvelle Energie Hydroélectrique de l'Onive

# Madagascar
# Sahofika Hydropower Project

## ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

# Summary

Date: August 2019

ESIA summarised version: D

# 1 Introduction

On 17 June 2016, the Ministry for Water, Energy and Hydrocarbons declared the consortium consisting of Eiffage, Eranove, Themis and HIER to be the awardees to develop the Sahofika Hydropower Development Project (the "Project"). This consortium will be responsible for designing, financing, constructing, operating and maintaining the Project under a concession agreement, by means of a Madagascar company named Nouvelle Energie Hydroélectrique de l'Onive (Onive New Hydropower Energy) ("NEHO").

This document is a summary of the Environmental and Social Impact Assessment (ESIA) prepared in order to ensure the project's compliance with national legislation and the environmental and social policies of the International Finance Corporation and the African Development Bank. A Resettlement Action Plan (RAP) has also been developed and is subject to a separate summary.

The ESIA and the RAP were disclosed and subject to public consultations on June 1st - 18th 2019, both in the impacted communities and in administrative centres. The project affected population, the civil society organizations and the administrations were consulted. Based on the outcomes of these public consultations, the ESIA and the RAP were finalized and were officially submitted on July 22nd, 2019 for review to the ONE (Office National de l'Environnement), the competent permitting authority in the Republic of Madagascar. As of August 2019, the review by ONE is ongoing.

The ESIA and the RAP will also be subject to disclosure according to the requirements of the International Financing Institutions involved in the project financing.

# 2 Description of the Project

## 2.1 Location and access


The Project is located 100 km South-South-East of Antananarivo, as the bird flies.

Access to the Project zone from the capital, Antananarivo, is by the tarred road RN7 until Antanifotsy. It is then necessary to continue East-South-East for 60 km (as the bird flies) on a series of tracks that are initially drivable and then navigable by foot in order to reach the Project site.

The electric transmission line will connect the Project to Antananarivo by passing through Antanifotsy.

## 2.2 Objective of the Project

The Project is located on the Onive River and will have an installed capacity of 192 MW, of which 130 MW will be 99% guaranteed. The objective of the Project is to provide energy

from an inexpensive and renewable source for the Antsirabé-Antananarivo grid. The annual average production will be 1570 GWh.

## 2.3 Organisation of the Project

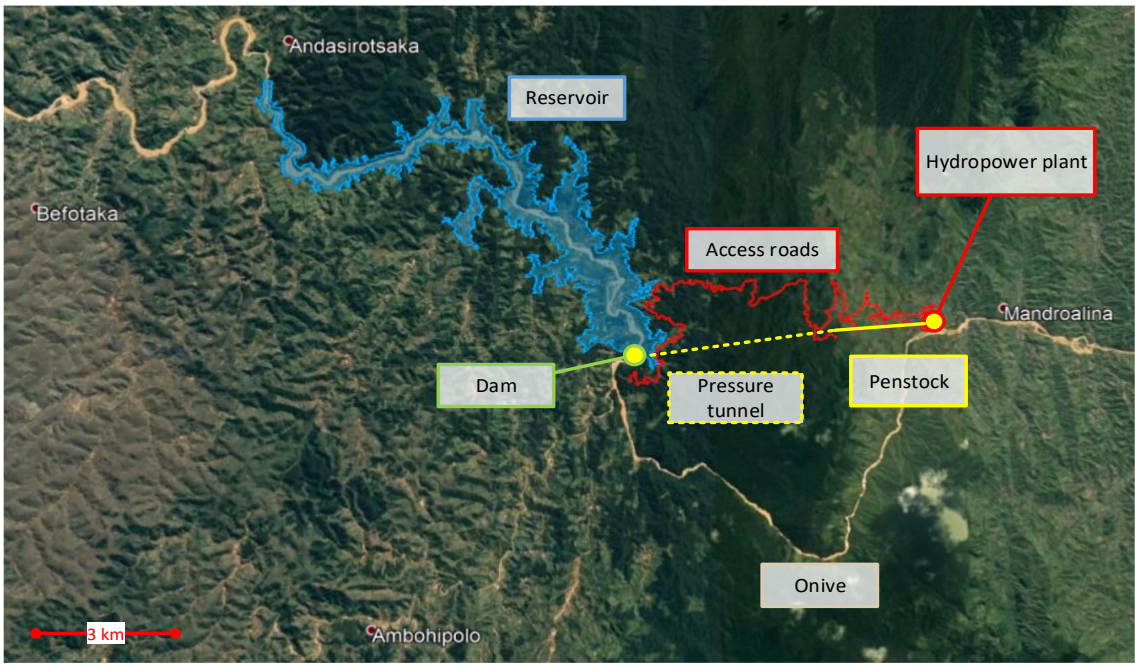
NEHO is the developer and the concessionaire for the Project.

For the detailed and construction studies for the Project, NEHO will rely on a construction company supported by an engineering consulting firm, in the form of a standard EPC (Engineering + Procurement + Construction) agreement.

The operation of the project will be carried out directly by NEHO. The electrical energy produced by the plant will be transmitted to the network managed by the JIRAMA, which will ensure the distribution of the electricity.

## 2.4 Components of the Project

The Project comprises a principal dam on the Onive that is 60 m high and forming a reservoir of 140 $hm_3$ (8.9$km^2$), an underground gallery (headrace tunnel – with a length of 4.2 km) followed by a penstock (with a length of 2 km) down to the hydropower plant located 6.5 km downstream (13 km following the bed of the Onive). The dam foundation level will be at the altitude of 1328 m, whereas the hydropower plant will be at the altitude of 610 m: thus the total height of the fall will be approximately 700 m.




The Project also includes lines for the transmission of energy and all of the infrastructure necessary for its construction or its operation: access roads, service lines, temporary camps and definitive buildings, borrow areas and dredging removal areas, etc.

The energy transmission line will be a double circuit 225 kV type. It will follow as much as possible the access roads for the Project, while avoiding as much as possible the sensitive zones (inhabited zones, biodiversity interest zones, etc.). From the plant to the dam, the line will follow the access route as much as possible. From the dam to Antananarivo, the exact position of the line has not yet been defined and a corridor of 2km wide in which the transmission line will be constructed has been defined and studied for this purpose.

## 2.5 Method of construction of the Project

The Project consists in general of carrying out earthworks or excavation and then installing structures made essentially of concrete (the dam, plant and gallery) or of metal (the penstock, the pylons for the line).

In the construction phase up to 1,200 persons will be employed. The personnel working to perform the Project will use the facilities provided to them nearby for each work site. Shuttles will be put in place to ensure the transportation of the personnel from the base camp to the work site. The sites will be closed and prohibited to the public. They will have a principal gate for access by heavy and light vehicles and an entryway for people on foot.

In order to construct the dam without water and protect it from floods, it is necessary to locally divert the course of the Onive by having it follow its left bank (for the construction of the right half of the dam) and then its right bank (for the construction of the left half of the dam). This will be carried out without entirely deviating the riverbed.

## 2.6 Schedule for performance

The schedule for performance of the Project is based on the following assumptions:

- A construction period spread over 5 years, starting in 2020 and terminating upon the industrial commissioning of the structure.
- An operating period of 35 years (the duration of the concession).

## 2.7 Commissioning and operation

The filling of the water reservoir will take place at the end of the construction period and will allow the correct operation of the development to be tested and verified. The Project will then be placed in production and will thus enter the operating phase.

During the operating phase, the Project will employ 25 persons.

The nominal flow of the hydropower power plant is 35 $m^3/s$ and the operating mode of the development is intended to produce the maximum energy (thus, to process 35 $m^3/s$ as often as possible) by using the water reserve of the reservoir during the dry season when the natural flow of the Onive is insufficient.

In the operating phase, the hydraulic regime of the Onive will thus be modified as follows, depending on the use of the turbines and the reservoir:

- In flooding season, once the reservoir is full: the plant will operate at its nominal capacity, and thus 35 $m^3/s$ will be diverted at all times from the reservoir to the plant.
- In the dry season, the level of the reservoir, which is full at the beginning of the season, will progressively lower in order to complement the natural flows and allow 35 $m^3/s$ to be processed.
- At the end of the dry season, with the resumption of the floods, the level of the reservoir will rise progressively until it attains the level for the normal reservoir level. Complete filling is certain for each year.

Between the dam and the plant, the flow of the Onive River will never be less than the flow planned for the development, equal to 5.7 $m^3/s$.

The tidal range of the reservoir over the course of the year will be determined by the passage of flooding during the rainy season and the use of the water in the reservoir in

order to ensure the flow during the dry season. This will be variable from one year to the next.

During a very dry year, the minimum operating level may be attained if the scheme is exploited at full capacity. For example, at the time of a ten-year dry period, the minimum operating level, located at 33 m below the normal operating level, may be attained for a period of two consecutive months.

## 2.8 Management of sediment

The largest sediment will be stopped at the upstream end of the reservoir, but the seasonal drawdown of the reservoir will allow a portion of this sediment to migrate towards the dam. Bottom valves are planned for the dam and near its water intakes in order to evacuate the sediment that may be deposited near the dam over time.

## 2.9 Zone of Influence of the Project

The Zone of Influence of the Project includes:

- The footprint and the surroundings of the infrastructures that will be constructed or rehabilitated.
- The zone that will be flooded by the reservoir.
- The zones that will be affected by disturbances (noise, dust, smoke) from the Project:
  - The construction sites and their immediate surroundings.
  - Access roads to the dam from Antanifotsy, whether they exist (and are thus subject to rehabilitation) or are to be created.
  - Access routes for constructing the line.
- The natural and social environments neighbouring the Project zone and which may be influenced by it.
- The zones with a particular status (for example protected areas) which are near the Project and for which the management may be impacted by the Project.
- The zone where the hydrological regime will be influenced by the operation of the project, namely the headway from the dam to the confluence with the Mangoro.
- The zone affected in the case of a dam break, namely the entire Onive and the Mangoro to the Indian Ocean.
- The sites for resettlement of displaced persons.

The urban centres that will benefit, thanks to the Project, from an improvement in the electricity supply are not considered to be within the influence zone of the Project, on the one hand because the impact on these populations will be essentially positive and on the other hand because the distribution of the additional electricity produced by the Project will be provided by a third party company, the JIRAMA.

# 3 Analysis of alternatives

## 3.1 Justification of the Project

In 2015, the government of Madagascar adopted a 2015-2030 New Energy Policy, as well as a 2015-2019 National Development Plan. By 2030, the objective is to attain a 70% level

of access to electricity or another modern source of lighting, as well as an 85% mix of renewable electricity, based on 75% hydropower.

The Project is fully consistent with the objectives of the New Energy Policy. It is justified, on the one hand, by the need to improve access to electricity in order to meet the unsatisfied demand for electricity in Madagascar and, on the other hand, by the national strategy to replace electricity production capacity based on fossil fuels with a production capacity based on renewable energy.

## 3.2 The alternative: "No Project"

The solution "No Project" would avoid the expected environmental or social negative impacts described in this study. But this would also exclude the positive impacts expected at the national level and which justify the Project. These are the reduction of dependence on the import of the fossil fuels necessary to operate the combustion plants and the reduction of the greenhouse emissions of the country. For all of the reasons set out above, the "No Project" alternative is not considered to be an acceptable and sustainable option in the context of Madagascar.

## 3.3 Alternatives to the Sahofika hydropower development

The analysis of alternatives considered all of the technically possible solutions to provide the same service as the Sahofika Project, namely guaranteed renewable energy of 130 MW supplying the Antananarivo-Antsirabe grid.

The thermal fossil fuel-based alternatives, which are not compatible with the national energy strategy, which produce large amounts of greenhouse gases and which require Madagascar to undertake costly imports, do not constitute acceptable alternatives.

The non-hydropower renewable alternatives (solar and wind turbines) are penalised by their intermittent nature and their incapacity to deliver guaranteed energy. They do not represent a possible alternative to the Sahofika Project.

Small-scale hydroelectricity would require the construction of a multitude of projects with an installed capacity much greater than that of the Project, simply in order to attain the objectives of the Sahofika Project. This would be a particularly inefficient alternative from the economic point of view and its feasibility is not guaranteed (in terms of availability of a sufficient number of sites that can be equipped).

Large-scale hydroelectricity proposes alternatives to the Sahofika Project which are technically viable and which are consistent with the national energy strategy. However, only one project (Mahavola) has the capacity to deliver an annual energy output and a level of guaranteed energy at least equal to the Sahofika Project - all other hydropower alternatives require the combination of several schemes.

The comparison with these other hydropower alternatives was based on the information available in two key planning documents: (i) the Least Cost Electricity Sector Development Plan, finalized in 2018 as part of the PAGOSE Project for an improved governance and operations in the electricity sector and (ii) the "hydropower schemes comparison" done in December 2009 in the frame of the pre-feasibility study of a large hydropower development, as part of the Plan of Restructuring and Renovation of the Energy and Electricity Sector (P2RS2E).

The possible alternatives were compared to the Project: none of them is without environmental or social impacts and none of them appears to be significantly better than

the others: some alternatives have less impact on biodiversity, but would result in much higher physical resettlement (up to ten times in the case of Mahovala), while other alternatives have less social impacts, but would result in much more significant impacts on biodiversity and protected areas. The multi-criteria environmental and social analysis conducted to compare the relevant alternatives showed that the Sahofika Project is one of the best alternatives, in the sense that there is no equivalent project with significantly less E&S impacts, and thus is entirely justified.

## 3.4 Optimisation of the development and avoiding/ minimising the impacts

The location and the choice of technical solutions for the dam, the water ways and the hydropower plant were subject to technical studies where the essential objectives, as with any hydropower development, was to control the costs and the risks of the Project. In the context of the Sahofika Project, this approach allowed the environmental risks or impacts to be minimised while making the best possible use of the space and the resources available.

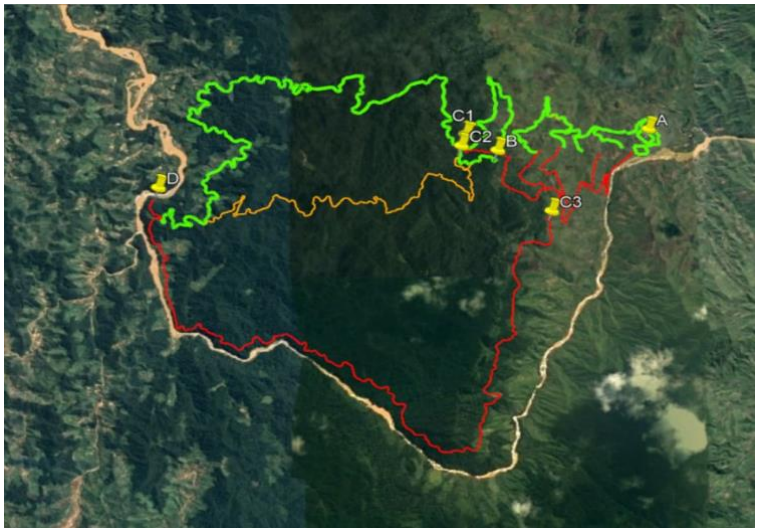
## 3.5 Rehabilitation or creation of access roads

**Between Antananarivo and Belanitra**, in order to avoid the creation of new access roads, it was decided to use the existing earth roads and to rehabilitate them for most of their path between Antanifotsy and Belanitra. As these roads are public, the Project will generate a positive social impact, while avoiding a negative environmental impact.

**Between Belanitra and the dam**, the Project crosses the protection zone (the buffer zone) of the Marolambo Park. An access road to the dam will have to be created. The principle that was retained for this zone is to design the line and the road so that they avoid as much as technically possible the wooded zones.

**Between the dam and the hydropower plant**, the Project crosses the Madagascar Forest Corridor which is very rich in terms of biodiversity. The zone is nearly uninhabited and is covered for the most part by forests that are home to species of flora and fauna of great interest. In this zone, the Project will construct the transmission line and an access road connecting the hydropower plant to the dam, as for the moment there is only access by foot.

***Options for the routes considered between the hydropower plant and the dam***




Several options to minimise the impact of the road and the transmission line on the natural environment have been envisioned: (i) the shortest possible route (in yellow), (ii) a route following as closely as possible the Onive (in red) and (iii) a route using already deforested zones as much as possible (in green).

A multi-criteria analysis of these three options was carried out in order to choose the solution with the least impact from an environmental and social point of view. The NGO, Sadabe, which sponsors the project for a protected area in this part of the Forest Corridor, as well as the general and regional directorates for water and forests were consulted while preparing this analysis and concerning the choice of the preferred alternative. The route that uses the already deforested areas as much as possible (in green on the above figure) was retained, essentially because it will minimise the environmental impacts which are the principal risks in this zone, by using zones that have already been impacted and by thus avoiding the creation of a new corridor in addition to the existing pedestrian corridor. The precise installation of the structures according to the selected routes remains to be decided in the context of detailed studies, on the basis of field surveys which will bring together technical and environmental teams in order to effectively ensure that the impacts are also minimised at this stage.

# 4 Regulatory and legislative framework

The regulatory and legislative framework with which the Project must comply includes:

- Madagascar legislation (especially the "MECIE" decree n°2004-167, dated February 3rd, 2004 that sets the requirements for the compliance of greenfield investments with the national legislation, through the preparation of an environmental impact assessment subject to formal approval), including international treaties and conventions ratified by the Republic of Madagascar.
- The Integrated Safeguard System Policy and Operational Safeguards (2013) of the African Development Bank.
- The 2012 Performance Standards of the International Finance Corporation.

The E&S institutional framework for the Project and ESMP implementation involves essentially the ONE (Office National de l'Environnement), who is the autonomous and competent authority in charge of the review and approval of the project environmental impact assessment. ONE forms for this review and approval work an ad-hoc committee involving all the technical services and administrations that are relevant to the Project. One will then be in charge of the monitoring of the project, including regular visits to verify the effective implementation of the ESMP.

# 5 Description of Project Environment: Physical Environment

## 5.1 Geography

The Onive basin, measuring 4,565 km² at the site of the dam is located on the high plateaux of Madagascar, to the South of Tananarive. With a rather compact form, it has a rugged terrain particularly in the Western region where one notes altitudes of up to 2,643 m in the Ankaratra range. The site of the planned dam is at an altitude of 1,300 m.

Because of steep slopes and the inter-annual rainfall on the order of 1,400 mm, the Onive is subject to significant flood events. The basin is covered for the most part by the prairie of the High Plateaux with islands of forest and shreds of primary forest on the Eastern slope. In the irrigated alluvial zones rice growing has developed.

East of the dam site is located a small range of wooded mountains on the North-South axis, forming part of the Madagascar Forest Corridor and where the altitude in the Project zone is on the order of 1,500 to 1,600 m. Continuing to the East, the range drops suddenly and loses nearly one thousand metres of altitude over approximately two kilometres: it is in this zone that the hydropower plant will be located to take advantage of this natural difference of altitude. The altitude at the powerplant site is 600 m: it reduces gradually as one approaches the Ocean, located 95 km away as the crow flies.

## 5.2 Geology and soils

There are three main geological formations in the Onive basin: the crystalline basement, volcanic rocks and sedimentary terrain in the bottom of the valleys. Iron-bearing soil forms the most represented soil conditions in the basin, either on acid rocks (migmatite) or basic rock (basalt).

## 5.3 Climate

Madagascar has a rainy season from November to March and a dry season from April to October. The cool period, from the middle of May to September, coincides with the dry season. In this period, on the East coast, the South-East trade winds dominate, which are cool and dry everywhere except along the coast, where they release the humidity accumulated above the ocean. Consequently, rain is possible all year on the East coast and the Eastern slopes of the mountains, which favours the development of the tropical forest.

In the interior zones the altitude softens the climate, at least in the intermediate altitudes. In the Project zone there are two types of climate depending on the altitude. The climate in the lowest zone is hotter and more humid (average temperature of 23°C and annual precipitation greater than 2,000 mm). The climate in the highest zone is dryer and cooler (average temperature of 10 to 15°C and annual precipitation between 1,500 and 2,000 mm).

The wind pattern is dominated by the trade winds which circulate from East to West. The most violent winds are observed during the passage of cyclones (250 km/hr or more).

## 5.4 Waterway and hydrology

The course of the Onive upstream of the Project site drains a vast basin (4,565 km²) where it collects numerous tributaries. The upstream course of the Onive is generally calm, with the exception of the rapids zones and several waterfalls, the most important of which are those at Tsinjoarivo (50 m high). The average flow of the Onive at the dam site is 110 $m_3$/s. The driest and wettest months over the period 1963-2008 had average flows estimates respectively at 9 and 485 $m_3$/s.

Starting from the site of the dam (1,300 m in altitude), the Onive enters a steep and narrow valley interrupted by numerous waterfalls: over a distance of 13 km, the altitude of the riverbed reduces from 1,300 to 600 m in altitude, which creates the height of the waterfall used by the Project.

The Mangoro receives water from the Onive at 200 km from its source and 110 km from the Indian Ocean. It drains a catchment area of 17,175 km² (including the 4,860 km² of the Onive).

## 5.5 Quality of the water and the sediment

Water and sediment quality analyses have been carried out in the dry season. The biochemical quality of the water of the upstream and downstream zones is comparable, with the downstream being slightly colder.

The water of the Onive contains sufficient nutrients to feed eutrophication phenomena at least in the stagnant zones. Measurements carried out on salmonella, coliform bacteria, heavy metals and pesticides indicate an absence of pollution. The Onive is not a river with chronic pollution.

## 5.6 Transport of solids

The water of the Onive is very loaded with suspended matter in all seasons. The measurements of suspended matter that have been carried out to date indicate values on the order of 100 g/$m_3$ in the rainy season. By extrapolating these values for the six months of the dry season and the six months of the rainy season, and assuming an additional contribution of 30% corresponding to the transport of solids from the riverbed, the annual collection at the dam site is estimated on the order of 1.5 to 2 million tons per year (or at least one million $m_3$).

## 5.7 Air quality

The hydropower development zone is distant from any industrial pollution or pollution connected with automobile traffic. The burning of vegetation is the principal source of air pollution in the Project zone.

## 5.8 Noise

A noise measurement campaign was carried out: the principal sources of noise are generally due to vehicle traffic. The sound intensity found is relatively low in the hydropower development zone because of the absence of traffic or combustion engines. The sound intensity in the city of Antanifotsy is much higher, considering that it is the principal town in the district where there is much more traffic than in the rural area.

# 6 Description of Project Environment: Social Environment

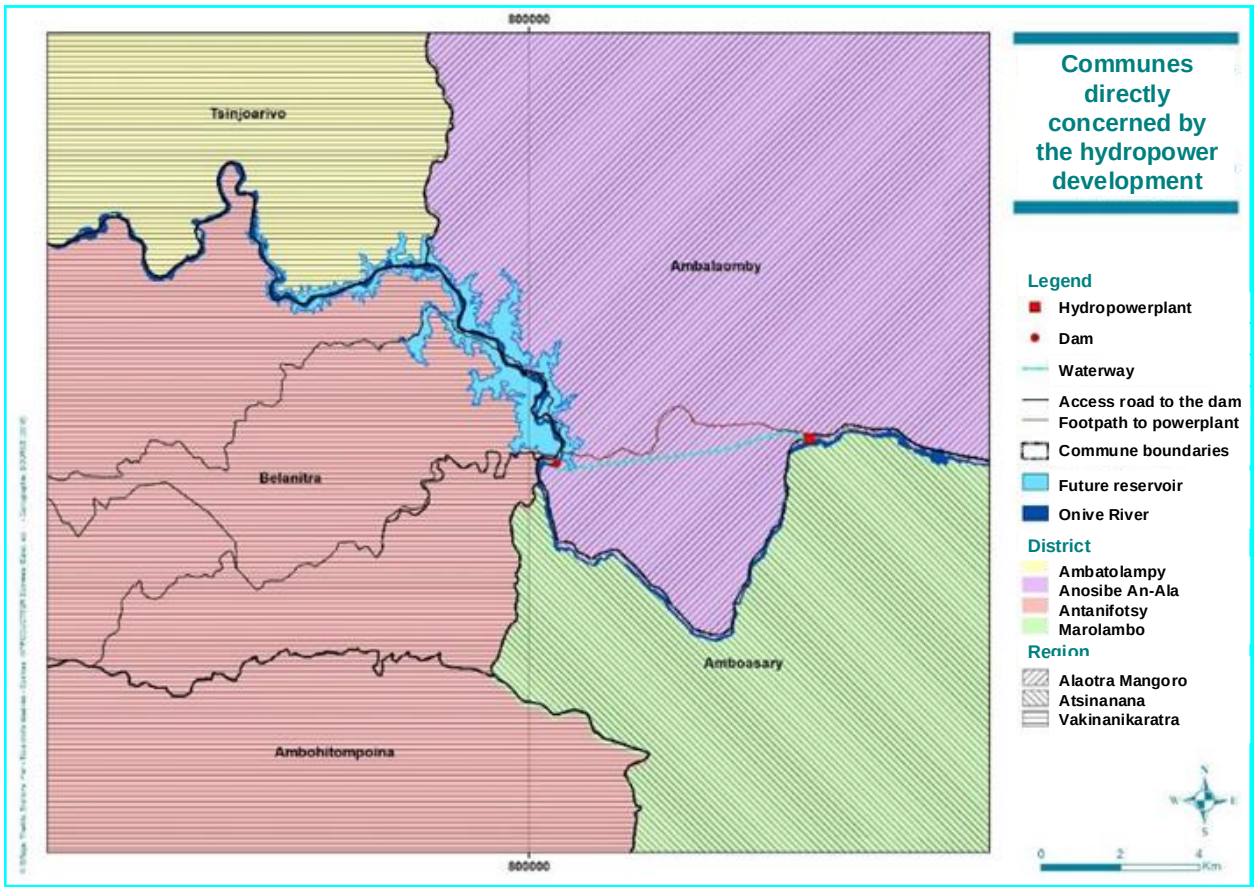
## 6.1 Administrative framework

The communes (standard Madagascar administrative divisions) located in the project influence zone are presented in the table and the figure below (the list of communes impacted by the transmission line between Antanifotsy and Antananarivo is not indicated because this will depend on the exact position of the line).

| Component of the Project | Commune | District | Region |
|---|---|---|---|
| Dam and its related constructions, the reservoir zone | Belanitra | Antanifotsy | Vakinankaratra |
| | Tsinjoarivo | Ambatolampy | |
| Hydropower plant | Ambalaomby | Anosibe An'Ala | Alaotra Mangoro |
| Access Road | Antanifotsy | Antanifotsy | Vakinankaratra |
| | Ambatomiady | | |
| | Ambohitompoina | | |

| | | | |
|---|---|---|---|
| | Belanitra | | |
| | Ambalaomby | Anosibe An'Ala | Alaotra Mangoro |
| Potential re-installation sites | Belanitra | Antanifotsy | Vakinankaratra |
| | Tsinjoarivo | Ambatolampy | |

***Figure 1 - Communes concerned directly by the hydropower development***




## 6.2 The reservoir and dam zone

The reservoir and dam zone is composed of four fokontany (villages/quarters, a traditional Madagascar administrative unit) including Antenina, Befotaka, Antandrokomby and Ankazomena, overlapping between the communes of Belanitra and Tsinjoarivo. This zone is where the site of the Project will be most significant. It is currently home to approximately 5,760 persons for all four of the fokontany.

## 6.3 Zone of the hydropower plant

Two main villages are located in this zone: Faravohitra and Sahofika. Located in the commune of Ambalaomby, the village of Faravohitra is located in the fokontany of Sahofika, approximately 7km East of the dam, and several hundred metres from the place where the hydropower plant of the Sahofika Project will be installed. The village of Sahofika (which is the principal town of the fokontany) is connected with Faravohitra by a footpath of approximately 2 km, or some thirty minutes' walk.

## 6.4 The "Merina" and "Betsimisaraka" ethnic groups

The zone is principally inhabited by two ethnic groups: the "Merina" who are located particularly on the left bank of the Onive on the side of the Vakinankaratra region, and the "Betsimisaraka" who are located on the right bank of the Onive on the side of the Alaotra Mangoro region (Nosibe An'Ala District).

The Merina ethnic group occupies the high region of Madagascar, particularly located in the region of Analamanga, Vakinankaratra and Itasy. The language used is the official dialect that the entire country can use and understand. However, the Merina cannot always understand the dialects of other ethnic groups.

The Betsimisaraka principally occupy the East coast of Madagascar, from Mananjary to Antalaha. These are peoples with their own languages and cultures and which today form the richness of Betsimisaraka.

## 6.5 Population and demographic dynamics

The overall population is relatively young. The development of the population shows a growth rate of the population over 10 years of between 23 and 64% for an average of 31% in the overall zone of influence of the Project. The birth rate in the Project zone is on the order of 40 births per 1,000 inhabitants.

The population density in the zone is relatively low, with the exception of Antanifotsy. The average density of the Project zone is 97 inhabitants/ km². The commune of Ambalaomby which covers the site of the hydropower plant and includes the villages of Faravohitra and Sahofika, possesses a very low population density which is explained particularly by the isolation and the dominance of zones with steep slopes.

In the Project zone, the city of Antsirabe has become since the 1980s a centre of attraction: the presence of industries has attracted peasants who have become temporary workers. The temporary migration of rural people principally concerns men seeking employment; definitive migrations concerning entire families are rare. More than 40% of the population questioned in the study zone have lived there more than 15 years. 17% of the resident population has inhabited the region for less than 5 years. These new arrivals are for the most part immigrants (essentially young people between 20 and 40 years of age) or natives of the region coming from the exterior.

## 6.6 Households and families

In the process of preparing this ESIA, a sample of 150 households was surveyed.

The number of heads of household who are men is clearly greater than the number of women who are heads of households, with 89.3% for men compared to 10.7% for women. The figures do not differ from the national tendency. The women who occupy the role of head of household are generally widows, divorced women or single mothers and sometimes the wives of men who have left in order to work elsewhere (migration). Nearly all of the heads of household perform an economic activity.

The most common type of household in the study zone is characterised essentially by the dominance of "nuclear" families (father, mother, children). The average size of a household is 6 persons, with an average of 3 children per household.

## 6.7 Social organisation

The local society in the study zone is based on groups of generations and the place of social elders is culturally defined because of this. Whether in the region of Vakinankaratra or in the region of Alaotra Mangoro, elderly persons are thus considered to be persons of experience, “he who has lived, he who has seen.” Thus, it is important to specify that the Betsimisaraka society relies on the right of elders.

The resolution of conflicts is conducted at 3 levels:

- If the conflicts concern disputes between neighbours or domestic disputes, the parties in conflict have recourse to the traditional leaders. This practice is followed in all of the fokontany.
- If the conflict is not resolved at the level of the traditional leaders, the resolution is made at the level of the fokontany or at a higher level, such as the mayor.
- If the conflict is still not resolved at these levels, the parties in conflict may bring the case before the competent authorities, such as the gendarmes or the courts.

The great majority of the population affirms that they rely on dialogue as a mechanism for conflict resolution.

## 6.8 Gender approach

In general, both men and women participate in the activities that generate the household revenue (particularly agriculture) but in different proportions, as women are traditionally obliged to perform housekeeping and child-raising tasks.

Women also manage the family budget. The husband gives all of his income to the wife. The decision of how to spend the money from the revenue is made by discussion between husband and wife and the revenue is spent by common agreement.

## 6.9 The real estate system

The majority of the zone is the property of the state, which means that the majority of persons have no real estate title. One notes, nonetheless, some titled land or land with a real estate certificate, particularly in the zones near the major towns. The zone for the reservoir area, the dam and the plant is state owned and is occupied in a formal or informal manner by the population, generally notified among the village residents or at the level of the fokontany.

According to the investigations carried out, each household possesses at least one land parcel, a habitation or an agricultural parcel.

It is important to note that there are no particular real estate rules applicable in the buffer zone (known as the “protection zone”) of Marolambo Park except for the community management of the natural resources by the VOI (Vondron'Olona Ifotony - the local community management entity), which is not entirely respected and which explains the deforestation rate in the zone.

Two thirds of the population are aware of the existence of land management offices (70%) but only 30% have visited these offices. Access to land is becoming more and more difficult for the populations. The demographic growth together with regional migratory flows accentuate this situation.

## 6.10 Occupation of the soils

The influence zone is composed of approximately 30% diversified forest cover (natural forests and plantations). The non-forested zone is composed of approximately 38% savannah, 30% agricultural land and bare soil. The remainder consists of other types such as bodies of water. The occupation of the land is influenced by the presence of the Marolambo National Park and the transfer management zones which are located in the buffer zone known as the “protection zone.”

## 6.11 Infrastructures and public services

The Project zone is accessible by taking the RN7 (an asphalted road) until Antanifotsy. A track that is accessible by 4x4 or by truck but in poor condition connects the city of Antanifotsy with the commune of Belanitra. From Belanitra, a track accessible by motorcycle connects the zone of the dam and an existing pathway accessible by foot connects the dam to the powerplant site in Faravohitra. This entire route is difficult to access in the rainy season. The zone of the dam and the plant is generally characterised by the lack of tracks suitable for vehicles connecting the villages with the principal town. For the zone of Faravohitra, Antenina, Befotaka and its surroundings, the method of travelling consists of long foot hikes to places from which travel by motorcycle taxi is possible.

In the Project zone more than nine households out of ten do not have access to the principal public services (water, telephone, electricity). Only Antanifotsy has a connection to the national grid, a water network and access to the mobile telephone network. The mobile telephone network is more difficult to access the further one is from Antanifotsy. Thus, from Antenina, one has to walk for an hour to reach a point where text messages can be received / sent, and where calls are sometimes possible. Only the city of Antanifotsy is connected to the electrical grid of the JIRAMA, which is the public enterprise for distribution of water and electricity in Madagascar.

The level of education of the population is relatively low overall. In the study zone, the distance between the village and the primary school is in general less than 2 km. Each fokantany has a public or private (Catholic for the most part) primary school or a community school. The secondary schools are located in the major towns of the commune as concerns the middle schools, and the high schools are located in Tsinjoarivo, Antanifotsy and Ambohitompoina

The public health service in the Project zone includes one (1) District Hospital Centre in Antanifotsy, one (1) Basic Health Centre in each commune and two (2) pilot care centres (maintained by volunteers) in Befotaka and Antsahondra, respectively. These infrastructures are currently in poor condition and clearly insufficient for the zone as a whole. Isolated villages such as Faravohitra and Antenina suffer from this lack along with the lack of rapid means of access to reach the care centres.

## 6.12 Agricultural activities

Agriculture and animal raising are by far the principal activities (and thus the sources of revenue and means of subsistence) of the populations in the Project zone, followed by small-scale gold mining which is essentially practised 4 to 6 months per year, primarily during the dry season.

The majority of the peasants encountered produce subsistence crops in order to provide their own food. Among the subsistence crops are rice, maize, potatoes, yams, manioc and taro.

There are two dominant types of agriculture: *Tavy* farming (slash and burn farming on the slopes) and irrigated farming.

Animal raising is common, but generally at a very small scale. The common problems for animal raising in the study zone are the insufficiency of veterinarians, outreach, genetic improvement, assistance with animal health and the implementation of infrastructures for production and security problems (theft of cattle).

Fish farming is an activity that is starting to spread in the zone. There are some peasants from Antanifotsy to Befotaka who are making basins in their rice fields to raise fish, particularly tilapias and carps.

## 6.13 Fishing and hunting

In the study zone, the Onive River is the most important fishing site considering that it is the largest waterway in the zone. But this river has a high level of turbidity, which hinders fishing and prevents the population from practising this activity in a favourable manner. Fishing is thus an occasional source of food and a sort of recreation activity for the people who practise this, namely about 10% of the population residing in the study zone.

During focus group discussions with the local population, hunting in the zone of the Sahofika Project was not mentioned. However, biodiversity investigations conducted on the site noted the presence of traps in the forests.

## 6.14 Other economic activities

Artisanal activities are practised in the Project zone, particularly to produce construction materials or objects intended for utilitarian purposes.

In the Project zone, several mining sites were noted with various types of status: two mining permits, one small (artisanal) mining permit and exploration permits along the access trail and in the zones of the resettlement site. Gold is the principal mineral that is mined, but sapphires are also mined. The small operators are the most numerous.

The Project influence zone also has a valuable tourism potential, but the majority of it have not been developed yet or is difficult to develop, generally because of the difficulty of accessing the area. The site of Tsinjoarivo is the most remarkable tourist site in the vicinity of the Project. However, the number of tourists remains limited as only a few foreign tourists come to visit the location each year.

## 6.15 Employment and labour conditions

There is great disparity in the employment and labour conditions in the study zone. Almost all of the activities that generate revenues are in the informal sector. Certain households (from families that possess property or a monopoly) may generate good revenues, but the majority of the active population has limited revenues and means of subsistence deriving from the use of natural resources.

The absence of industrial activity and service companies in the zone has led to the fact that the skills required for professional jobs almost do not exist on the local market.

## 6.16 Household revenues and expenses

Households below the poverty level (households whose income does not meet the US $ 2 per day threshold - around 7,000 MGA / day) represent the large majority.

Of all of the households contacted in the influence zone, 84% of them have monetary revenue of less than 7,000 MGA/ day and thus are classified as poor. The households with a revenue of less than 1,400 MGA/ day and thus living in extreme poverty represent 17% of the population questioned.

The sale of surplus subsistence production allows households purchasing the basic food and goods required for daily life (soap, oil, salt, sugar, coffee, etc.). But families are often forced to sell their stocks even if these are not sufficient for the entire year. In effect, these sales are used either to pay for daily needs or to allow them to pay school fees, medications, etc. They must then purchase the food that they need during the beginning of the rain season period (November to January), the period when the price of rice is the highest.

It is generally starting from the month of August that the difficult period starts, meaning that the households have used up their agricultural production stock and prepare economic "survival" strategies. The major rice farming works also start in this period (ploughing, transplanting). This is a very difficult period for the majority of the population in Madagascar.

## 6.17 Vulnerabilities

The context of poverty and isolation of the Project zone requires paying particular attention to vulnerable persons and groups so that they do not face disproportionate impact, so that they have access to the project benefits and/or get the particular attention that their condition requires. In the study zone, the distribution of vulnerabilities is as follows:

- Persons suffering from chronic illness, mental illness and handicapped persons are estimated at less than 5%.
- Elderly persons (older than 65 years) are only 3% of the population.
- Women heads of household, widows or divorced women whose vulnerability is connected with the absence or the insufficiency of the support they receive are estimated at 11% of the population.
- Families (households) whose head of household is without or nearly without resources and in fact live in extreme poverty. 38% declared an annual revenue of less than 1,000,000 MGA.
- Literacy: 9% of the active population is without education.

## 6.18 Principal activities connected with water

The use of the surface water is the same upstream and downstream of the zone where the dam will be constructed. The river plays an important social role. It is the place for swimming and bathing for some, the location of daily activities for the women (washing laundry and kitchen utensils), a place of work for gold miners or fishermen.

The water points are frequented principally at mid-day. The children rush there once they leave school, the farmers take a rest there because it is too hot to work in the fields. The women come to collect water for the meals.

The underground water is used from wells and springs in the mountains. The wells in the villages are used for drinking water and for daily uses. A well generally belongs to one household but it is used by several families.

## 6.19 Cultural and cultual context

The society in the Project zone is a traditional society, where nearly 90% of the population follow and practise local habits and customs that are specific to the region. The Project influence zone is a rural area with populations belonging principally to the "Merina" and "Betsimisaraka" ethnic groups, which practise customs and activities encountered in the zones of the highlands and Betsimisaraka.

The most notable aspect concerns the “Fady” and other taboos which may prevent or hinder certain actions.

All of the sacred places have their “Fady” that are respected by the local population (whether or not they are believers).

The fady that are relevant in connection with the Project and that must be observed by everyone have been inventoried in the ESIA.

More than twenty cult sites distributed over various zones and which have variable significance have also been inventoried. Among the various sites inventoried are the "Doany" (traditional cult sites), tombs, memory sites, archaeological sites, natural heritage sites (protected zones).

## 6.20 Traffic assessment

Four sites for counting travellers were set up on the access trail between Antanifotsy and Faravohitra.

Monday, the market day in Belanitra, is the day when the traffic is highest. On this day, 2,610 persons were counted going in both directions, out of the 6,622 persons counted during the 7 days of counting, or 39.41% of the total.

Friday is the market day in Faravohitra. One notes that the traffic is highest between 8 and 11 am in the direction from Antenina to Faravohitra, and then from 2 to 5 pm in the return direction from Faravohitra to Antenina, which indicates that more than three hundred persons travel from the dam-reservoir zone to the plant site every Friday in order to take advantage of the market in Faravohitra.

## 6.21 Social context - the transmission line from the dam to Antananarivo

The corridor crosses three regions, four districts and twenty-six communes.

***Administrative zones crossed by the 2 km corridor***

<table>
<tr><th>Region</th><th>District</th><th>Commune</th><th>Axis</th></tr>
<tr><td>Alaotra Mangoro</td><td>Anosibe An'ala</td><td>Ambalaomby</td><td rowspan="2">Axis 2: Plant - Dam - Antanifotsy</td></tr>
<tr><td rowspan="3">Vakinankaratra</td><td rowspan="2">Antanifotsy</td><td>Belanitra, Ambohitompoina, Ambatomiady, Anjahamanga, Antanifotsy</td></tr>
<tr><td>Ampitatafika, Ambohimandroso</td><td rowspan="3">Axis 1: Antanifotsy - Tàna Sud</td></tr>
<tr><td>Ambatolampy</td><td>Ambohipihaonana, Behenjy, Andriambilany, Manjakatompo, Andravola, Ambatolampy, Tsiafajavona Ankaratra</td></tr>
<tr><td>Analamanga</td><td>Antananarivo - Atsimondrano</td><td>Ampitatafika, Alatsinainy Ambazaha, Bongatsara, Ampanefy, Fenoarivo, Soalandy, Tsiafahy, Ambalavao, Ampahitrosy, Antanetikely, Androhibe</td></tr>
</table>

The identification of sensitive elements carried out with the local authorities inventoried 853 sensitive sites along the corridor from Faravohitra to Antananarivo, including 431 tombs, 127 churches and 126 schools.

The area of the farm zones covered by the corridor are 37% of the farming zones. The residential zones represent approximately 3.5%.

The population consists primarily of the Merina ethnic group, plus migrants such as Betsileo, Sihanaka and Antandroy.

# 7 Description of Project Environment: Protected and internationally recognized areas

The current and future protected or internationally recognised zones that are near the Project zone or which are affected by the Project infrastructure (dam, access road, water conduit, reservoir, lines, etc.), consist of:

- The Marolambo National Park and the three zones under management transfer (VOI) in the Commune of Belanitra (Antenina, Fisoronana and Befotaka) located in the protection zone (the buffer zone which surrounds the core). The Project does not encroach on the central (core) zone of the Park;
- The New Protected Area (NPA) in the process of being created for Tsinjoarivo - Ambalaomby, which is currently under the status of Koloala (a concept of the Forest Administration for sustainable forest management for which an operating permit is issued through a bidding process) and thus subject to forest exploitation. The Sadabe NGO is the promoter for this NPA.
- The Important Bird Area (IBA) “Classified Forest of Onive.” The Asity Madagascar NGO is the reference entity for this IBA.

# 8 Description of Project Environment: Biodiversity

## 8.1 Inventory work

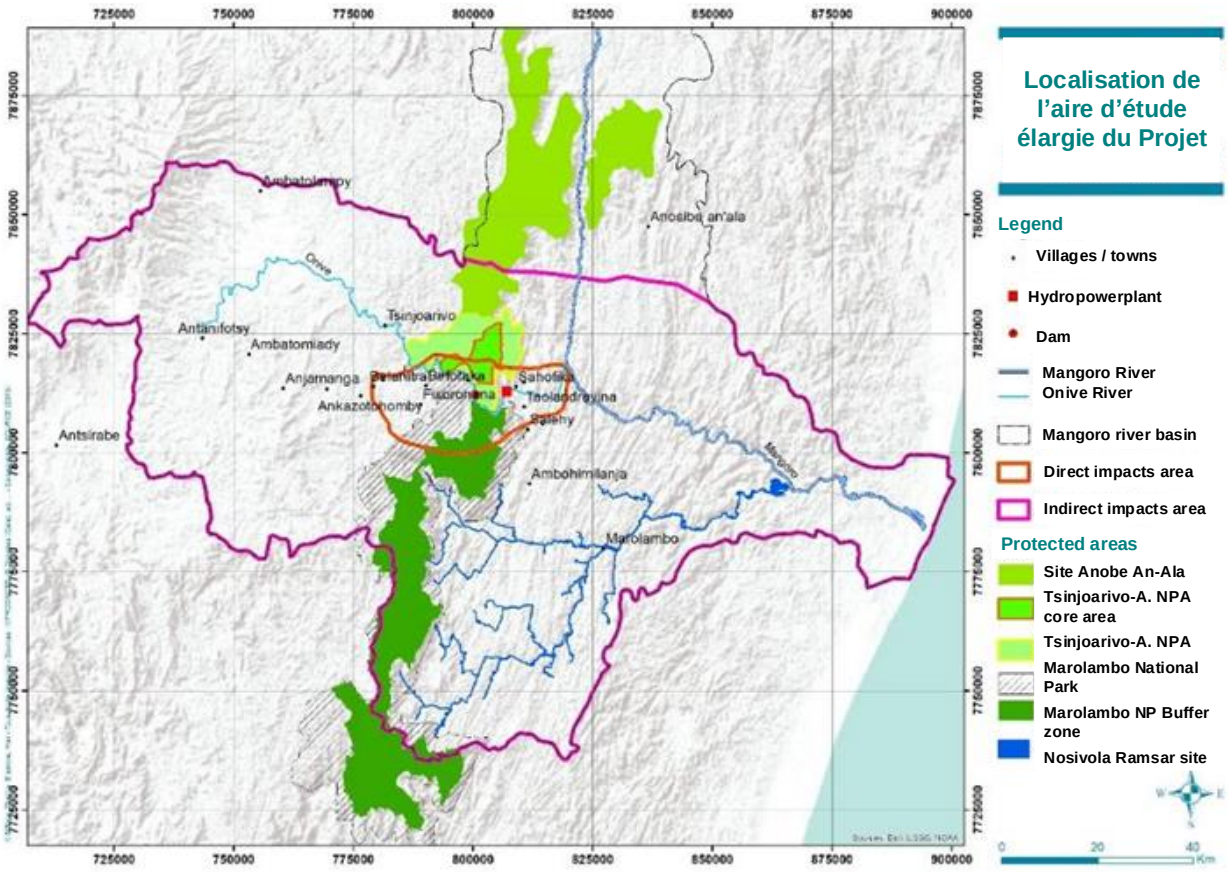
An assignment for social and environmental framing for the Sahofika Project was carried out in October 2017. It allowed the ESIA to be prepared and to assess the stakes for biodiversity in the Project zone. It was completed by a bibliographical analysis, mapping work for the habitats and detailed inventory assignments during the dry season and the rainy season in 2018.

## 8.2 Study areas for the hydropower development

The study area for the hydropower project was defined as follows:

- An **enlarged study area** which covers the sloping basin of the Onive and most of its tributaries upstream and downstream of the Project site, and which includes the detailed study area, the Southern portion of the sloping basin of the Mangoro, the priority areas for conservation and the protected areas such as the Marolambo National Park and the RAMSAR Nosivolo site.
- A **detailed study area** defined by the portion submerged by the Onive upstream of the dam, the areas affected by the works to install the infrastructure (dam, penstock, surge chamber, plant, etc.), the environment crossed by the access roads (RN7 to Dam and Dam to Plant), and the direct influence zones.

*Figure 2 - Study areas for the hydropower development zone*




## 8.3 Study area for the transmission line to Antananarivo

For the impacts related to the line on the modified habitats between the Project (powerplant and dam) and Belanitra, data were collected during the inventory phases in 2018 and were completed by inventories and mapping work up to Antananarivo in 2019.

## 8.4 Validation of the data collected

For flora, the Group of Specialists for the Plants of Madagascar (GSPM) was consulted to provide an independent opinion on the adopted methodological approaches, as well as the description of the results.

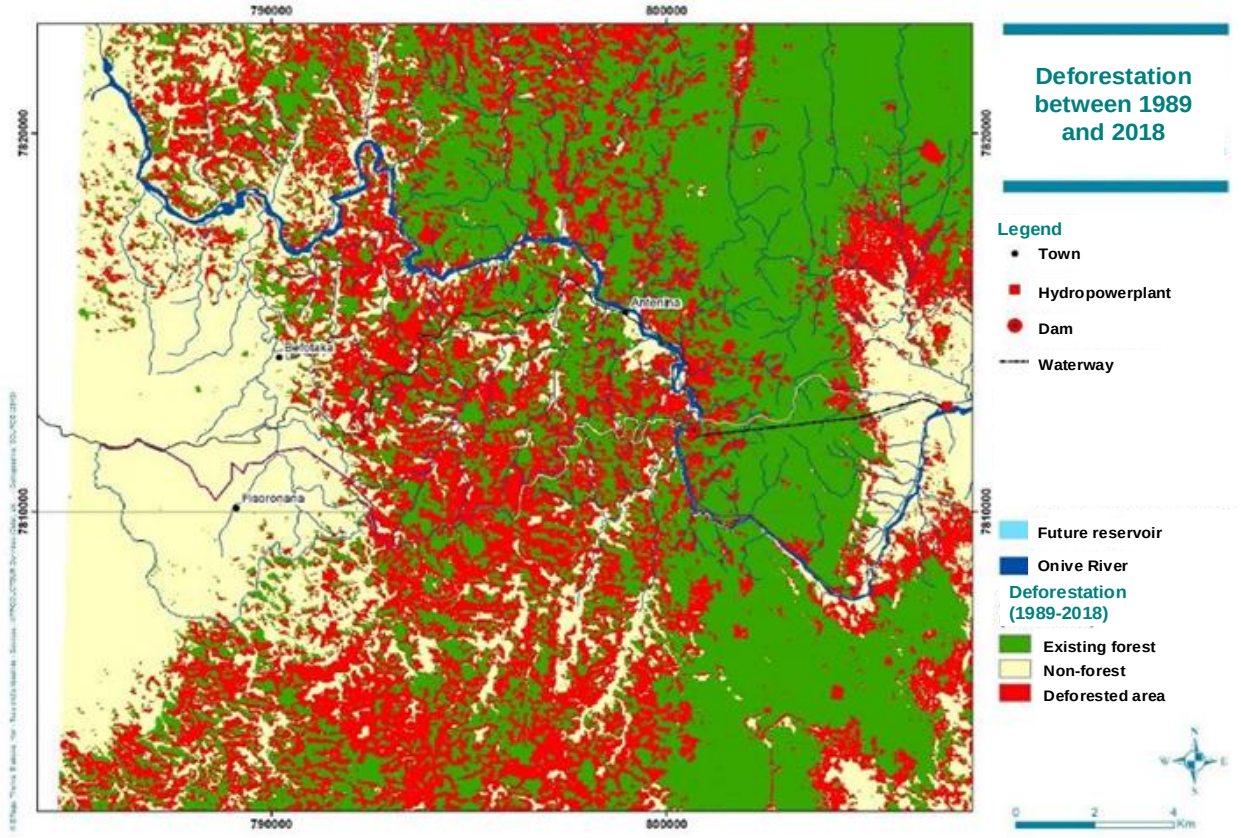
As for the terrestrial fauna, the Vahatra Association, which works in the area of development and reinforcement of scientific capacities (biology, ecology and conservation biology) and has a national and international reputation in the area of evaluating the biodiversity of Madagascar, was consulted.

## 8.5 Existing pressures on the ecosystems and the species

Deforestation is a major problem for Madagascar, with significant consequences for the conservation of biodiversity and the protection of ecosystems. The causes are:

- The practice of "Tavy" (slash and burn farming), which is a cultural method for the production of rice on slopes and which contributes to a subsistence economy.
- In rural and isolated areas, deforestation is a system that allows peasants to acquire land.

*Figure 3 - Deforestation in the Project zone between 1989 and 2018*




The other activities that generate pressure on the ecosystems are agricultural activities, gold mining and poaching.

## 8.6 Natural obstacles to ecological continuity

The natural obstacle to ecological continuity which is composed of the rapids between the dam and the hydropower plant is an important factor for certain species of fish and large shellfish, particularly migratory diadromous species. This zone of rapids consists in particular of very significant waterfalls. These waterfalls constitute a natural barrier for several species.

## 8.7 Characterisation of the terrestrial natural habitats

In the non-deforested part of the study zone, the altitude plays an important role and has considerable influence on the types of forest formations. One finds:

- 50-800 m of altitude: Dense Eastern canopy forest.
- 800-1450m of altitude: Dense humid forest of medium altitude.
- 1450-1800 m of altitude: Dense mountainous canopy forest and lichen woodlands.

## 8.8 Characterisation of the secondary terrestrial formations (“Savoka”)

The practice of slash and burn (“tavy”) and bush fires are the cause of the degradation of the forest in favour of secondary formations. The process of recolonising the environment and the type of succession of plants are not similar on the two slopes, particularly the Eastern part (Sahofika) and the Western part (Antenina and the dam).

## 8.9 Characterisation of the aquatic habitats

Because of the significant influence of human activities on its turbidity, and the significant number of exotic species of fish and crustaceans introduced into the Onive River and its tributaries, the aquatic habitat is considered to be a “modified” habitat over the entire Project zone, except in the heart of the forest, particularly at the level of the tributary Samoloetona, which may be considered to be a “natural” habitat.

## 8.10 Terrestrial flora

The flora of the study zone is composed of at least 611 species distributed among 340 genera and 93 families. The most represented families are:

- Orchidaceae (80 species);
- Rubiaceae (52 species);
- Poaceae (35 species);
- Fabaceae (26 species).

29 species of flora are registered on the red list of the IUCN. *Ravenea lakatra* (Arecaceae) is a variety of palm tree that is classified as being in critical danger of extinction (CR) and five other species are classified as being in danger (EN).

A total of 103 species belong to Annex II of the CITES which groups the species whose situation is not directly worrying, but which may be threatened if trade in their specimens is not controlled.

Finally, among the 251 threatened species published in the catalogue of the Group of Specialists for the Plants of Madagascar (GSPM), three are present in the study zone.

The threatened species in the study zone are mostly encountered in undisturbed forests (natural habitats). They are distributed in various topographical levels, such as small valleys, low slopes, mid-level slopes, peaks and high slopes.

The anthropisation of the habitats has moreover favoured the installation, development and propagation of invasive species in the natural environment, particularly in the modified non-forest habitations, such as young post-agricultural formations. A total of 20 invasive species of flora are inventoried in the zone.

In total, 14 species of flora require a critical habitat analysis because they meet at least one of the following criteria:

- Species listed as EN or CR by the IUCN or the GSPM;
- Species with a restricted area of distribution (<50,000 km²);
- Endemic species listed as NT or VU by the IUCN.

## 8.11 Terrestrial fauna - vertebrates

A total of 180 species of terrestrial vertebrates, including 37 species of amphibians, 27 species of reptiles, 85 taxa of birds and 31 species of mammals were inventoried in all of the study zones during the prospecting campaigns (dry and wet seasons). The majority of these species are endemic to Madagascar.

According to the IUCN status for these species of terrestrial vertebrates, 24 are threatened with extinction, including 2 species in critical danger (CR), 3 species in danger (EN), 9 vulnerable species (VU) and 10 near-threatened species (NT).

According to the CITES list, 33 species require particular attention, including 12 species in Annex I, 20 species in Annex II and one species in Annex III.

According to the Decree for National Protection of Wild Fauna (2006-400), 78 species of the 180 inventoried are in the category of protected animals (Category I, Class I-II), 5 species are harmful (Category II), 67 game species (Category III) and 30 species are not mentioned by the decree.

In total, 63 species of terrestrial vertebrate species (19 species of amphibians, 21 species of mammals, 14 species of birds and 9 species of reptiles) require a critical habitat analysis because they meet at least one of the following criteria of critical habitat:

- Species listed as EN or CR by the IUCN or the GSPM;
- Species with a restricted area of distribution (<50,000 km²);
- Endemic species listed as NT or VU by the IUCN.

## 8.12 Terrestrial fauna - Invertebrates

The flying insects in the zone are Orthoptera, Diptera, Coleoptera, Dictyoptera, Hymenoptera, Homoptera and Trichoptera. None of them has an IUCN conservation status or protection according to national legislation.

Twenty-six (26) species of Rhopalocera (diurnal butterflies) were inventoried during the assignment. Among these, 11 are forest species and 19 are endemic to Madagascar. None of the species is classified by the IUCN, however certain species are very sought-after for trade in insects. The specific composition of the Rhopalocera fauna is more or less similar among the study sites.

The soil and litter arthropods are dominated by Hymenoptera, Diptera and Coleoptera. None of the inventoried species is listed by the IUCN.

None of the terrestrial invertebrate species in the study zone meets the criteria to initiate a critical habitat analysis.

## 8.13 Terrestrial fauna along the transmission line from Belanitra to Antananarivo

Because of the very modified character of the habitats between Belanitra and Antananarivo, the biodiversity inventory along the transmission line between Belanitra and Antananarivo was focused on birds, which are the principal species exposed in the case of the installation.

Because of the absence of major migrating birds in the territory of Madagascar and considering the results of the inventories of the avian fauna and the bibliographical review, the bird species that may be impacted by the line are essentially birds of prey adapted to open areas. These species do not have a particular conservation status and do not activate the criteria relating to critical habitats.

## 8.14 Aquatic flora

Aquatic flora is not well described in Madagascar and no species is classified as In Danger or Vulnerable by the IUCN. During assignments in low-water periods, very few specimens were observed during the terrain studies.

The water hyacinth (*Eichhornia crassipes*), an invasive aquatic plant originating in South America, is present in Madagascar. It was not observed in the Project zone during the terrain studies, or along the Onive, or at the level of the small tributaries, even though the

species may occupy various bodies of water, such as rivers, irrigation canals, rice paddies and fishing areas. Thus, it does not represent a threat for the moment, but it could appear in the zone in the future.

## 8.15 Aquatic fauna

In total, there are 20 species of fish, of which 4 are endemic to Madagascar and 3 are indigenous, and there are 3 species of crustaceans that are endemic to Madagascar over the entire study area. The type of fish is relatively different between the upstream and the downstream of the rapids located upstream of the flow cut off by the hydropower project.

Among the 23 species of fish and crustaceans inventoried, there are:

- 7 species that are endemic to Madagascar;
- 3 indigenous species that are not endemic to Madagascar, including eels;
- 13 exotic species.

Only three species require a critical habitat analysis: two species of fish and one species of crayfish.

The populations of aquatic macro-invertebrates are low both in terms of abundance and diversity for the four stations that were sampled. The environment appears not to be very diversified and the trophic resources are probably limited.

# 9 Ecosystem services

The populations located upstream (near the dam and the reservoir, and in the Forest Corridor) are principally peasants who practice agriculture during the rainy season and gold mining, primarily during the dry season. Their lifestyle depends on using natural resources for construction, access to energy, access to medicinal plants, etc.

For the populations of Faravohitra and Sahofika, located approximately 5 km from the natural forest, in a landscape dominated by prairies, the wood exploitation activity is less significant. In fact, they are adapted to the resources available in their environment. The traditional huts and houses are constructed with a more significant use of clay and straw.

# 10 Evaluation and Mitigation of Physical Impacts

The impacts of the projects have been systematically assessed with the same methodology. First, the impacts of the Project on its physical environment (land, air, water, etc.) have been assessed. These physical impacts are described in this chapter. The way these physical impacts would translate into impacts on environmental or social receptors has then been assessed and is described in the subsequent chapters 11 and 12.

## 10.1 Hierarchy for the mitigation of impacts and residual impacts

The approach retained to define the mitigation measures in this chapter and in the following chapters follows the requirements of Madagascar legislation and the policies of the IFC and the AfDB, which require that the impacts are mitigated in the following manner (using the terms of the Madagascar legislation):

- As a priority, seeking to “Eliminate” the impact in order to avoid it,

- Secondly, if it is not possible to eliminate the impact, seeking to “Reduce” this as much as possible.
- If the measures to reduce an impact cannot make it insignificant, the impact remaining after the reduction is referred to as the residual impact and additional measures to mitigate this must be put in place in order to “Compensate” for it.

## 10.2 The infrastructures footprint

The overall footprint for the permanent infrastructures is approximately 1,061 hectares, of which 84% is occupied by the reservoir. The roads and the line infrastructures represent the second most significant area (15% of the total).

## 10.3 Borrow and spoil areas and temporary sites

Earthworks, work sites, borrow and spoil areas and excavations sites are zones that present a risk of erosion and the formation of ravines in the case of precipitation because of the modification of slopes, natural drainage conditions and land cover.

The control of erosion related risks will be subject to rigorous management, from the initial vegetation removal until replanting and final stabilisation of the sites in question.

Because Madagascar climate presents a very marked rainy season, the implementation of erosion control methods at the scale of a project such as Sahofika requires planning for managing the volumes of top soil and vegetation mulch, the creation of deposits and continuous monitoring of the work site.

## 10.4 Hydraulic impacts and downstream hydraulics

The filling of the reservoir area will be possible over a single season. The actual duration for filling will depend on the natural flow of the Onive at the time when the filling starts, and on the technical constraints applicable to the first filling (verification of the stability of the dam and the reservoir).

The diversion of a portion of the flow of the Onive for hydropower production will cause a reduction in the flow in the by-passed river reach which extends from the dam to the hydropower plant. A minimum flow of 5.7 $m^3/s$ will permanently be diverted from the dam to the by-passed river reach.

Downstream of the hydropower plant, the use of the reservoir to increase water availability during the dry season will cause a modification of the annual downstream regime: there will be more water during the dry season, since the reservoir will be used to maintain the downstream flow above 40 $m^3/s$. During very dry years (approximately once each seven years), if the reservoir reaches its minimal operating level, it will be possible that the flow over the turbines may not be constant, but will vary in the course of the day.

The daily heights of levels expected in the most unfavourable case (in a dry season, approximately only one year out of seven) are on the order of 50 cm. These variations will be anticipated (the operator will know that the minimum level for operating the dam will be reached) and the populations can thus be informed. Monitoring will be necessary in the initial years in order to verify the exact nature and location of the zones at risk.

## 10.5 Minimum flow

The relevance of the proposed minimum flow (5.7 $m^3/s$) was verified. The minimum flow will allow preserving the essential functions of the Onive River in the by-passed river reach. The monitoring of the Project must confirm this, particularly as concerns *Rheocles wrightae* and also to verify that the riverbed cannot easily be crossed by foot.

A slightly lower minimum flow (down to 4 $m^3/s$) may possibly serve the same functions and may be envisioned in the future, but not before monitoring at 5.7 $m^3/s$ is completed. A much lower flow (2 $m^3/s$ or less) will certainly not serve the functions and thus must be avoided. A higher minimum flow is not justified at present, but over the long term this may be necessary if developments such as climate change make this essential.

A minimum flow of 5.7 $m^3/s$ is thus deemed reasonable but has to be confirmed through monitoring, and an adjustment being possible over time between 4 and 8 $m^3/s$.

## 10.6 Impacts on the sediment regime

The impacts on the sediment regime are impacts which, in the case of large reservoirs, are spread over time and are progressive. Because of the operating method of the reservoir and the size of the hydropower development, the following dynamics for the sediment are expected in the reservoir.

- The finer sediment will remain in suspension and may travel across the reservoir without stopping.
- The heavier sediments will settle at the upstream end of the reservoir whereas the intermediary size sediment will settle on the bottom of the reservoir at a distance that is more or less far from the dam, depending on their weight and the hydrodynamics of the reservoir. The drawdown of the reservoir over the years will allow a portion of the sediment to migrate towards the dam, while others will remain definitively trapped in the reservoir.

The bottom valves at the dam and near the water intakes will allow the sediment that is deposited near the dam to be evacuated, so that this does not block the water intakes. The impact of the Project on the sediment regime is not associated with a significant or immediate risk. It does not require mitigation measures in itself, but it will be necessary to monitor its development in order to guarantee availability on the basis of a data base that is sufficient to monitor the development of the sediment regime.

## 10.7 Polluting emissions and discharges

**Noise, dust, atmospheric emissions:** The work site activities planned to be spread over 54 months involve a series of atmospheric emissions in the form of noise, dust and gas emissions, such as exhaust gas. These risks essentially concern the construction period. Once the operating phase is begun, the noise, dust and atmospheric discharges of the Project will be negligible. The mitigation of the risks connected with emissions of noise, dust and atmospheric discharges consists of:

- Putting in place measures that will allow these emissions to be reduced,
- Monitoring the level of noise, the air quality and the discharges on the basis of pre-established threshold values.

**Solid and liquid waste:** With more than a thousand workers at peak periods, the work site will generate each day several tons of waste and several dozen $m^3$ of waste water.

All solid and liquid waste will be collected, sorted and/or processed before being discharged in the environment (waste water must be treated, run-off or surplus water must be collected and decanted, water from the cleaning of machines and concrete mixers must be collected, decanted and processed) or placed in a definitive deposit (solid waste).

Since there is no sewage network or official discharge network in the Project zone, the Project will have to create its own installations and organise its own chain for collection and processing of wastes, starting with putting in place receptacles (trash bins, toilettes, etc.) at all of the work zones.

**Accidental pollution:** The site for the construction of the dam and the associated infrastructures may generate accidental pollution, as a result, for example, of accidental spills of hydrocarbons (oil leaks, poorly conducted tank filling, etc.) or toxic products (solvents, paint, varnish), dirty water used for cleaning, etc. The management of this risk shall be addressed by implementing preventive measures and corrective measures in the case of an incident.

## 10.8 Impacts related to climate change

In a context of climate change, one of the first expected consequences of the increase of energy available in the atmosphere is an increase in climate variability. The analysis of the specific risks connected with the Sahofika Project was conducted on the basis of available local and global data, using the methodology of the Climate Resilience Guide prepared by the IHA (International Hydropower Association) for hydropower the hydropower sector.

Measures for resilience and climate risks mitigation were proposed for each of the identified risks; they include in particular a detailed climate risk assessment to be undertaken for the Project, in line with the recent guidance issued by the International Hydropower Association. When defining these measures, the changing nature of the climate risk was taken into account: On the one hand, the knowledge of the zone of the Sahofika Project and particularly its hydro-meteorological context will considerably improve with the implementation of the Project. On the other hand, the knowledge of the consequences of climate change will also improve over time.

## 10.9 Emissions of greenhouse gases

The emissions connected with the construction and the operation of the Sahofika project have been estimated:

- The emission of greenhouse gases connected with the construction represent a carbon footprint estimated at 982,014 tons CO2eq, namely on the order of 1 million tons of CO2eq.
- The greenhouse gas emissions of the Sahofika reservoir have been estimated over a duration of 100 years. The emissions are concentrated in the first three years, due to the rapid degradation of the soft biomass. The cumulative greenhouse gas emissions over 100 years represent a total of 225,356 t CO2eq, essentially concentrated over the first years.

On the basis of an average annual production of 1,570 GWh and compared to the current average energy mix in Madagascar, the hydropower project at Sahofika will, over the first ten years, avoid the production of 7.14 million tons of CO2eq.

## 10.10 Impacts on water quality

The quality analyses carried out in connection with the ESIA showed a marked biological and chemical demand for oxygen, as well as concentrations of nutrients (nitrates and phosphates) that are sufficient to contribute to a possible eutrophication. The nutrients availability will increase due to the decomposition of the biomass submerged in the reservoir. However, the complete renewal of the reservoir water several times per year (on average 25 times per year) will help preventing generalised and continuous eutrophication of the water of the reservoir. Yet, the reservoir contains zones that, because of their configuration, will be less subject to renewal and thus might be more susceptible to eutrophication. In order to minimise the risks of eutrophication, it is planned to eliminate the vegetation in the most vegetated zones before filling with water.

Monitoring of the water quality in the reservoir and downstream of the plant will also be organised.

## 10.11 Dam break

The consequences of a dam break was assessed for the ESIA using a digital model for the discharges resulting from a dam break, using an unsteady one-dimensional model.

A one-hundred-year flood was taken as the initial condition and the modelling showed that several inhabited zones could be exposed to flooding even before the passage of a wave from the dam break. The passage of a wave from the dam break is rapid (a few hours) and because of the warm climate in Madagascar, the urgency to avoid victims in the case of a dam break would consists essentially in evacuating exposed persons to safe sites.

In the absence of a civil security structure in the country, the Project will put in place an early warning system which will allow the populations concerned to take shelter in the case of an exceptional flood, whether this is a natural flood or caused by a malfunction or a break of the dam. The additional risk caused by a potential dam break will thus be compensated by a reduction in the exposure of the populations to natural floods. This early warning system will require a means of communication. The Project will opt for a VHF (or equivalent) type of solution which will combine an alert system and opening up the populations thanks to the possibilities of vocal exchanges.

# 11 Evaluation and Mitigation of Social Impacts

This section assesses the way the physical impacts described in chapter 10 would translate into impacts on social receptors.

## 11.1 Working conditions

The main risks connected with the working conditions during the construction phase as well as during the operating phase are connected with the forms of illegal employment or discrimination that may develop along the sub-contracting chain. Compliance with Madagascar legislation and the IFC and AfDB principles must be ensured and monitored for all of the service providers involved in the Project. In with the context of the Project, the minimum age for workers will be 18 years (the national legislation allows labour starting from the age of 15).

## 11.2 Health and safety of the workers

The construction phase requires the performance of a range of activities which are all, to various degrees, associated with risks of accidents. Some of the activities that will be carried out on the work site are particularly at risk since they leave little margin for error or may have severe consequences, for example: working at heights, working in excavations or in confined areas, work on the electrical systems, work on pressurized systems, work on, above or in the water, the use of explosives, and the movement of heavy work site machinery.

For the construction phase, the EPC will be responsible for organising and managing the health and safety risks in the perimeter of the installations and the work sites. All of the persons entering these sites (workers, suppliers, visitors, employees of NEHO, etc.) must comply with the rules of the EPC and they must be clearly informed of these rules. The EPC will prepare a “Health and Safety Plan for Workers” with the objective of eliminating or minimising the risks of accident. It will be completed by an “Emergency Prevention and Preparedness Plan” intended to define the resources and the methods put in place to manage any urgent situation that may occur. The specifications for these two plans are set out below.

The EPC will also prepare a Plan for the Management of the Base Camp and the Workers’ Accommodations which will have the goal of providing the workers with a healthy living environment.

## 11.3 Safety of the communities

Access to the work sites will be prohibited to the public during the construction. The principal risks for public safety are in fact connected with the public/ Project interactions connected with the use of the public domain by the Project. The use of public roads by the vehicles of the Project and the disturbances generated or the risks of accidents with third parties are the main risks in this regard. The mitigation of the risks of accidents requires, on the one hand, the implementation of a specific management plan during the construction phase and, on the other hand, measures intended to minimise the interactions with third parties on the roads that will be under the control of the Project.

The risks for public safety during the operating phase are essentially connected with the operation of the hydropower development itself, and in particular any rapid variations in flow that may occur downstream of the dam or the hydropower plant because of the operation of the Project.

## 11.4 Health of the communities

During the construction phase, the principal risks for the health of the communities will be connected with (i) an increase in the incidence of AIDS and other sexually transmitted diseases; (ii) sanitary risks in the case of the development of slums or unhealthy establishments (gastro-intestinal diseases, diarrhoea, cholera) connected with anarchic installations and (iii) exposure to disturbances from the work site activities (noise, dust and atmospheric emissions), particularly along the circulation routes that may affect sleep or aggravate respiratory symptoms.

In the operating phase, the principal risk for health is the possible development of water-born diseases.

A series of measures for awareness raising, prevention and monitoring the risks for the health of the communities is included in the ESIA.

## 11.5 Local employment and influx of population

The construction of the Sahofika project and then the creation of the reservoir will cause the arrival of persons who have been hired in connection with the Project, or migrants seeking new economic opportunities. These migrants will for the most part be persons who abandon living conditions that they consider unfavourable or less interesting and who will come live in the Project zone because they have been hired or simply because they see an opportunity connected with the Project, without any specific guarantee of employment.

The direct need for labour for the Project is assessed at the peak at several hundred local unqualified labourers and is moreover a significant opportunity for the populations of the villages affected by the Project and the nearby villages, on the one hand in terms of direct gains (revenue) but also from the point of view of the experience that will be acquired by people employed on a major organised work site.

The influx of population will generate a series of risks:

- Insecurity, prostitution and violence towards women and young girls;
- Social conflicts;
- Conflicts connected with access to employment;
- Land conflicts;
- Increased pressure on natural resources;
- Risks of resettlement on the land acquired by the Project;
- Increased pressure on the basic services for the population;
- Change of lifestyles.

Measures to mitigate and manage these risks provided for in the ESIA include:

- Quarterly demographic monitoring in the zone;
- Awareness raising of the populations regarding issues and violence against women;
- The implementation of a clear, transparent and fair mechanism of recruitment, with the establishment of decentralised recruitment offices in order to avoid an accumulation of job seekers at the work site;
- Support to reinforce the public infrastructures;
- Sensitising to the cultural practices in the zone;
- Reinforced protection of the protected areas.

## 11.6 Cultural impacts

The risks of cultural and cult impacts are principally connected with possible archaeological discoveries, as well as interactions by the work site with cult-related sites or the tombs that are present in the region. On this last point, it is the linear infrastructures (roads and lines) that pose the main risks. The resettlement action plan describes the risks and the associated measures for the zone of the reservoir and the dam.

## 11.7 Impacts and mitigation measures - Transmission line corridor

The exact location of the line within the 2km corridor remains to be defined and, from a technical and social point of view, the Project will optimise the exact route of the transmission line in order to minimise the social and socio-economic impacts between Belanitra and Antananarivo, taking into account the sensitivities listed in the ESIA.

Environmental impacts of the transmission line from the dam to Antananarivo are expected to be mostly avoided, by avoiding forested areas. Outside these forested areas, the landscape is mostly constituted of modified habitats, with villages, agricultural land and slash & burn savannahs dominating. The impacts of the transmission line are therefore mostly expected to be related to the acquisition of land (for pylons and access roads construction) and compensations for agricultural losses.

# 12 Evaluation and Mitigation of Environmental Impacts

## 12.1 Evaluation and mitigation of terrestrial environmental impacts

### 12.1.1 Loss/ degradation/ disturbance of habitats

This type of impact concerns all of the habitats that are under or close to the Project infrastructures' foot print. The largest affected area is that of the reservoir which will mostly convert terrestrial habitats into aquatic habitats. The access road and the transmission line between the dam and the plant, including the access to the surge chamber also have an impact on forest areas considered to be critical habitats because (i) they host species of conservation interest and (ii) they are already threatened because of the deforestation and the overuse of natural resources.

### 12.1.2 Diversification and intensification of threats to fauna and flora

The opening of the access roads (to the dam and between the dam and the plant), the demographic caused by the influx of personnel and migrants will represent sources of threats for the fauna and flora. There is a risk of an increased demand for natural resources by the populations and a lack of respect of the ecosystem and biodiversity by those using the access roads opened by the Project.

### 12.1.3 Impacts on species / specimens of flora and fauna

The main risks for the species and the specimens are:

- Destruction of individuals of fauna and flora during the construction works.
- Fauna escaping the area due to disturbances caused by the Project (physical impacts).
- The possible introduction and proliferation of exotic invasive species.
- Risk of collision of bird species with the high voltage line.

### 12.1.4 Measures to avoid and reduce the risks

The measures that have been adopted by the Project to avoid and reduce the risks to the habitats and the exposed species of fauna / flora are as follows:

- Information and awareness raising programme for the population and the employees. This programme will be prepared with the managers or sponsors of the biodiversity conservation zones.
- Avoiding as much as possible the natural and critical habitats at the time of the definitive installation of the roads and the energy transmission line and the temporary sites in the most sensitive zones.
- Measures to preserve the ecological continuum for the fauna:
  - The transmission line will be buried for a length of 1.6 km where the chosen route crosses the widest forest area (the exact positioning is to be confirmed in the phase of the detailed studies).
  - The width of the routes (the continuous strip) will be limited to 5 m in the wooded zones in order to conserve as much as possible the continuity of the canopy.
  - Night traffic (between 20:00 and 06:00) between the dam and the plant will be prohibited for programmed or regular activities or for operations, and will be reserved for emergencies and exceptional circumstances.
- Avoiding or reducing the impacts on the specimens (flora and fauna) of species of conservation interest.
  - The identification, marking and precise location of protected species of flora or those which have a critical habitat with a view of avoiding them at the time of the actual layout of infrastructures in the forest zones.
  - The adaptation of the project footprint and activities with potential impacts in order to avoid negative impacts.
  - Sequenced land clearing and tree removal after the final installation of the infrastructures crossing the forest zones in order to have the fauna leave.
  - Minimising the risk of vehicles hitting fauna (traffic regulation, limited speed and sensitising the drivers).
- Fighting the introduction and propagation of exotic invasive species.
- Avoiding the use of local natural resources.
- Prohibiting fires and minimising the risk of fire.
- Support and assistance for the managers of the zones under biodiversity protection status. This measure will be detailed in cooperation with the entities concerned, the DGEF and the competent DREFs.
- Minimising light pollution.
- Protection measures for CITES species and combating poaching.
- Reducing the risks of bird collisions with the electric line (use of markers).

### 12.1.5 Mitigation measures for terrestrial biodiversity

The performance standards of the IFC and the AfDB require that the Project does not cause any net loss of biodiversity (natural habitats) and must generate a net gain for species and habitats considered to be “critical.” Because of these requirements, and considering the residual impacts of the Project after the avoidance / minimization measures described above, compensatory measures in connection with terrestrial biodiversity are necessary. The planned measures include:

- Restoration of damaged forest zones in areas adjacent to the Forest Corridor. The planned re-forestation effort will, over time, concern a surface area equal to twice the surface area actually impacted (or 432 ha, if the impacted area of 216 ha is confirmed).

- Support for the conservation of the natural forests of the Tsinjoarivo NPA and the Marolambo National Park. The Project will contribute to putting in place the Tsinjoarivo NPA and protecting the Marolambo National Park. The precise terms of this support remain to be defined, in partnership with the entities managing these protected areas and their various stakeholders (including the relevant public authorities) on the basis of an assessment of the loss of critical habitats on a species-by-species basis.
- Reforestation in the transfer management zones: With the improved access to the site and the operation of the infrastructures, population influx will be expected in the zone, in addition to the persons who will be relocated. The arrivals will surely increase the requirement for wood particularly for lumber and timber.

### 12.1.6 Measures for ecological monitoring

The construction phase and the infrastructure installation phase will continue over several years and will cause the destruction and/or degradation of certain habitats. For these reasons, ecological monitoring will be carried out in order to study changes to the habitats and the fauna and flora species of conservation interest.

## 12.2 Evaluation and mitigation of aquatic environmental impacts

### 12.2.1 Nature of the impacts

At the level of the reservoir and upstream of the future dam, the Project will change the hydromorphology of the river and consequently the habitat for the aquatic fauna and flora. The various facies of the river flows will be replaced by a still water body.

The presence of the dam will moreover create an obstacle to ecological continuity. Migrating species, in particular, may no longer be able to access the zones located upstream of the dam. Four (4) species are concerned, but at the scale of the populations, the construction of the dam will not put these species in peril, although it will constitute a potential additional element of fragmenting their habitat. None of these four species is considered a threatened by the IUCN.

The non-migrating species and particularly the species of conservation interest such as *Rheocles wrightae and Astacoides caldwelli* are not concerned by this issue. In fact, they do not migrate and may complete their entire life cycle downstream of the dam for *Rheocles wrightae* and in the tributaries for *Astacoides caldwelli*.

The reduction in the flow downstream of the dam will be notable in the dry season, when only the minimum flow (5.7 m3/s) will be diverted to the by-passed river reach. The reduction in the flow will cause a reduction in the aquatic habitat in the section concerned. However, highly threatened species only frequent the extreme downstream portion of the section in question (1.5 km long, just upstream the hydropower plant), since they cannot cross the waterfalls. The variations in the flow downstream from the hydropower plant that are connected with its operation may disturb aquatic species, but there is no evident negative impact and thus monitoring must be organised and this will be an occasion to improve knowledge of the ecology of the most sensitive species.

### 12.2.2 Proliferation of exotic invasive aquatic species

The creation of the reservoir will favour the least demanding species that present capacities for rapid development, particularly exotic invasive aquatic species, such as the common carp.

Moreover, the populations of indigenous crayfish are in decline nation-wide because of the degradation of their habitat, on the one hand, but also because of the introduction of exotic invasive species and fishing them for consumption and sale.

Sensitisation of fishermen in order to target exotic species as a preference is planned as part of the Project.

### 12.2.3 Mortality of the aquatic fauna in the structures

The water intake at the level of the dam may lead fish towards the penstock and then to the turbines, with certain death because of the height of the fall and the type of turbine used, regardless of the size or the development stage of the fish. This impact is however to be nuanced and taken into perspective with the fact that the water intakes are planned 33 m below the normal level of the reservoir. Consequently, fish will only be in the proximity and can only be drawn towards the water channel for the turbines during very dry years, when the reservoir is low. Moreover, there are no species that present a particular conservation issue in the Onive upstream of the dam.

### 12.2.4 Measures to avoid and reduce the risks

The operating phase of the development will be preceded by a testing phase and a gradual filling. When the reservoir is first filled, a test is planned using only the applied minimum flow. During this test, visual observations of the by-passed river reach and downstream of the plant will verify the continuity of the drainage and identify any singularities that may appear. Ichthyologists will be involved in this testing.

It is essential to maintain the minimum flow at all times in order to preserve the aquatic life in the by-passed river reach section. The value that was chosen for this stage (5.7 $m^3/s$) will ensure continual draining that forms a true river, but with a reduced size compared to the Onive in its natural state.

### 12.2.5 Compensatory measures addressing the aquatic and river environments

These measures concern species for which there exists a conservation concern. They include:

- Deepening and spread of scientific knowledge concerning *Rheocles wrightae* and *Rheocles sp. Ambatovy*. This measure is a prerequisite for any project for restoration in favour of the species. In fact, a bibliographic review underscored the lack of knowledge concerning these species.
- Targeted and adapted combat against exotic invasive species.
- Awareness raising of the local populations to target the capture of Exotic Invasive Species rather than threatened species (*R. wrightae*) and indigenous crayfish.

### 12.2.6 Biodiversity Action Plan

In addition to the mitigation measures described above, a Biodiversity Action Plan will be prepared by the Project in order to assure and verify the absence of net loss (and a net

gain where this is possible) of biodiversity for the species requiring a critical analysis of habitats identified in the ESIA.

The Biodiversity Action Plan will cover the construction and the operating period. It will be prepared in continuity of the ESIA and will include:

- A schedule and details for all of the actions relating to biodiversity protection.
- A schedule of support measures for the effective creation and operation of the Tsinjoarivo NPA.
- A detailed definition of the discrete management units introduced in the ESIA.
- An assessment of the risks of critical habitats loss or loss of biodiversity despite the avoidance / minimization measures described in the ESIA, by species and by taxon if this is relevant.
- A programme of additional mitigation and monitoring measures to achieve and verify the absence of net losses, defined in consultation with the managers / promoters of the protected areas near the Project, and with the civil society organisations involved in the conservation of species in Madagascar and more precisely in the environs of the Project zone.
- Justification of the additional measures with the public policies and programmes in progress or to come in Madagascar, paying particular attention to the measures that do not replace or duplicate the financing already present or planned.
- The definition of the qualitative or quantitative thresholds and temporal objectives for confirming the success of the actions implemented, or, on the contrary, indicating the failure of a mitigation measure and the need to implement corrective measures.

# 13 Evaluation and Mitigation of Cumulative Impacts

The analysis of the cumulative impacts is limited to the hydropower sector (including the line), as there are no other infrastructure projects or major programmes in the zone that may generate cumulative impacts with the Project. There is no risk of major cumulative impacts, but certain precautionary measures, particularly concerning informing the stakeholders, are proposed in the ESIA: these measures consist in making the information about new schemes available to the population and to the resettlement implementation teams, in order to avoid people being subject to multiple resettlement.

# 14 Stakeholder Engagement and Grievance Mechanism

A Stakeholder Engagement Plan, aiming at ensuring a meaningful information of the project's stakeholders, has been drafted in May 2019 and is presenting the information, consultation, and disclosure plan for documents or engagement activities that the promoter of the project, NEHO, has already realized so far and is proposing during the design and construction phases. It is intended to be updated according to the evolution of the project.

It has been conducted in compliance with Malagasy legislation, IFC Performance Standards and AfDB Operational Safeguards, in terms of consultation and information requirements in the frame of the E&S assessments.

This SEP first recalled the project and the applicable regulatory and legislative framework. Then, it gave an overview of the stakeholder consultations already conducted in the frame of the project, including the establishment of Community Liaison Officers (CLOs) on site.

The identification of stakeholders has started by defining them, then assessed impacts for each category of stakeholder, and finally differentiated affected parties and interested parties.

The SEP proposed thereafter a plan for the engagement of stakeholders, including tools and methods for consultation and information. The grievance mechanism system has been explained in detail. Finally, the roles and responsibilities afferent to each actor and reporting modalities have been proposed.

A Project-specific grievance redress mechanism is already in place. It includes CLOs based on a permanent basis in the affected communities, who gather grievances from affected people and process them on a daily basis. Grievances experienced to-date include census and inventory inaccuracies that require correction (and were corrected by inventory teams), and broader concerns related to the Project general impacts, particularly physical displacement, impacts to agricultural land, access, and environmental impacts.

All grievances are logged by CLOs, who gather basic information (complainant identification, reason for the grievance), and investigate it in the field where warranted. CLOs then pass the grievance with a resolution proposal if possible, to either the inventory team (if the grievance belongs in this category), or to NEHO management for resolution.

In case the initial resolution by NEHO is not accepted by the complainant, the grievance is escalated to the Local Resettlement Committee, which includes community and local authority representatives, whose operation is facilitated by NEHO and which can investigate the grievance in the field with the aggrieved parties, as warranted. In case the resolution proposed by that committee is again not accepted by the complainant, the grievance is escalated to the National Resettlement Committee, where it is again reviewed by members and a resolution is proposed.

A record of both stakeholder engagement activities and grievances is being held by the Project.

# 15 Community Development Plan

In order to facilitate the integration of the Project in its social environment, NEHO plans to put in place a series of measures to assist the community. During the construction phase, NEHO will conduct a programme to improve the collective infrastructures of the villages. In principle, this mechanism will function as follows:

- Budgets will be defined by NEHO.
- Rural electrification will be a priority.
- NEHO will organise meetings with representatives of the populations and the administration in order to identify the actions to be carried out using these sums.
- NEHO will have the possibility to refuse certain requests, particularly those relating to non-sustainable long-term infrastructures or those which only serve particular interests.

The expectations of the populations that were formulated during these various meetings and discussions in connection with preparing the ESIA essentially relate to access roads and rural electrification.

The development of the Project will certainly cause the construction of certain infrastructures necessary for the Project, the most obvious being the means of communication connecting the plant with the national road network.

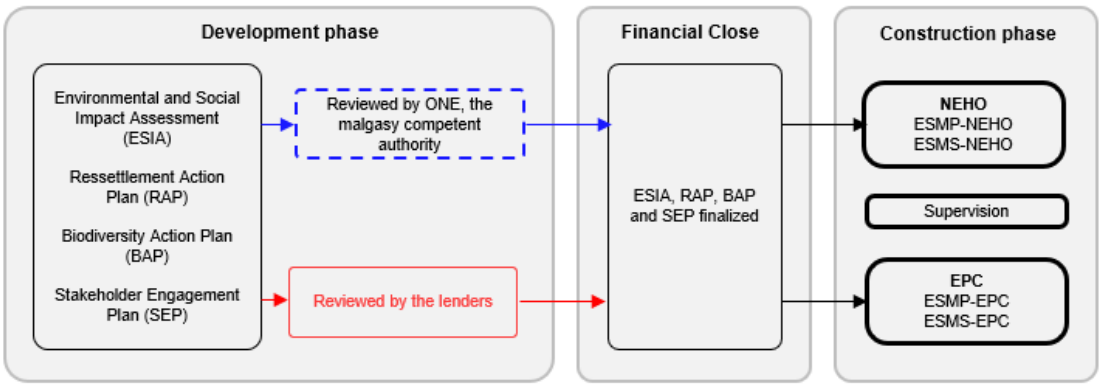
However, the Project is not intended to act as a substitute to the services of the State or to play the role of the operator of public infrastructures that it may have contributed to constructing. Thus, the institutional setting will be integrated in the definition of the infrastructures that are proposed, with a clear vision of responsibilities for each sub-project.

# 16 Environmental and Social Management Plan

The achievement of the environmental and social objectives depends on the implementation of the actions defined in this ESIA. NEHO is responsible for the correct implementation of these actions with regard to the competent Madagascar authorities, its shareholders and the lenders financing the Project.

Considering the fact that (i) the Project will be performed up to commissioning by a private company and by means of an EPC contract and (ii) a significant part of the environmental and social actions of the Project will be implemented during the construction phase by this company, it was decided to separate the Environmental and Social Management Plan into two parts:

- The EPC Environmental and Social Management Plan will be prepared and implemented by the EPC contractor.
- The NEHO Environmental and Social Management Plan will be implemented by NEHO. For this purpose, NEHO will develop a Social and Environmental Management System that is structured according to the ISO9001/14001 standards.




The ESMP uses a standard matrix, following the template required by ONE, the permitting authority. An extract from this matrix is provided hereafter, with examples of actions applicable to the construction phase:

| Risk/Impact | Mitigation measures | Indicators | Monitoring measure | Frequency | Responsible | Timeline |
|---|---|---|---|---|---|---|
| Hydropower scheme optimisation | Opti01: Optimisation of the excavations and fills volumes in order to minimize the volumes of spoils to be disposed permanently. | Volumes, characteristics and extraction or disposal sites of materials. | Technical note to be produced by the contractor and approved by NEHO before extraction or disposal sites are open. | before extraction or disposal sites are open | Technical note preparation : EPC<br><br>Approval: NEHO | During the construction phase |

| Risk/Impact | Mitigation measures | Indicators | Monitoring measure | Frequency | Responsible | Timeline |
|---|---|---|---|---|---|---|
| Downstream hydrological impacts | Aval01: Permanently release a minimum flow of 5.7m3/s downstream the dam. | Downstream flow never below 5.7 m3/s | Flow measurement during low flow season | During construction and commissioning | Implementation: EPC<br><br>Control: NEHO | From the beginning of construction until the end of commissioning |
| Liquid and solid wastes | Dech01: Preparation and implementation of a plan for the collection, treatment and management of solid and liquid wastes, following the principles described in the ESIA | Avoid the uncontrolled spread of pollutants, respect Madagascar legislation, and IFC requirements | Plan prepared and implemented | Continuous | plan preparation and implementation: EPC<br><br>Approval: NEHO | Preparation before construction<br><br>Implementation during construction |

# 17 Social and Environmental Monitoring

The environmental and social monitoring of the Project will be organised and managed:

- Internally by the Environmental and Social (E&S) team of NEHO, with support from specialized non-governmental organizations as relevant;
- Externally, by the ONE, as the competent authority in charge of the approval and monitoring of ESIAs.

The Environmental and Social Management System that will be prepared for the Project will describe the terms for this monitoring. However, the following principles have been determined:

- A monitoring committee for the Project will be put in place involving, on the one hand, (i) the managers and promoters for the protected areas and the VOIs and, on the other hand, (ii) independent and recognised experts. It will have access to the monitoring documents and will play a consulting role that will allow it to provide advice to the E&S team of NEHO responsible for monitoring.
- The monitoring will be focused on:
  - The monitoring of the actual implementation of the measures of the Environmental and Social Management Plan and the ESIA.
  - The identification and the definition of the adaptive measures that may be necessary if certain objectives of the Environmental and Social Management Plan are not reached.
  - The monitoring of the environmental and social legal and regulatory changes applicable to the Project and their correct implementation.

The monitoring programme will be reviewed and adapted for the operating phase.

# 18 Public Consultations

Public Consultations on the ESIA and RAP were carried out from 1st to 18th June 2019. These consultations followed a number of meetings that were held with the affected population during the ESIA and RAP preparation, which means they were already well aware of the Project.

The consultations took place in a peaceful atmosphere with a strong interest of the participants. The Consultations were effective in identifying / noting the views and comments of affected and affected stakeholders, as well as providing the necessary answers and clarifications.

The consultations were based on: (i) dispatching of a video accompanied by explanations, allowing stakeholders to visualize the project, (ii) a full presentation of the ESIA and RAP, (iii) exchanges and discussions and (iv) open-house meetings for villages affected by physical resettlement, allowing individual consultation for those wishing to discuss with the project outside community meetings. The individual interviews conducted during these "open-house" meetings were very interesting and beneficial for the population affected by the physical displacement.

24 changes and clarifications were made in the ESIA following public consultations and are listed in the last chapter of the ESIA. Social issues largely dominated the discussions.

A total of 606 people were registered during the consultations (children and adolescents were not registered), including 133 women and 473 men.

The main concerns that were raised by the population were related to economic and physical displacement, access to livelihoods, public infrastructures and graves.

The detailed programme of the consultation is provided hereafter:

| Date | Entity | Place |
|---|---|---|
| Sat 01 June | Consultation Sahofika - Ambalaomby / Mandroalina | Sahofika |
| Mon 03 June | Consultation Commune Tsinjoarivo | Chef-lieu de commune Tsinjoarivo |
| | Consultation Commune Belanitra | Chef-lieu of commune Belanitra |
| Tue 04 June | Consultation Antenina and Ankazomena, Antandrokomby | Antenina |
| Wed 05 & Thu 06 June | Open Day | Antenina |
| Thu 06 June | Consultation Fisoronana | Fisoronana |
| Fri 07 & Sat 08 June | Consultation Befotaka | Befotaka |
| | Open Day | Befotaka |
| Wed 12 June | Consultation in the Region Alaotra Mangoro | Moramanga |
| Fri 14 June | Consultation in the Region Vakinankaratra | Antsirabe |
| Mon 17 June | Consultations:<br>Asity Madagasikara: Morning<br>ONG Sadabe: Afternoon | Antananarivo |
| Tue 18 June | Consultation Wokrshops<br>Morning: Institutionals<br>Après-midi : NGOs | Antananarivo |

Details regarding the participation are provided in the following figure:

| Consultation | Date | Men | Women | Total |
|---|---|---|---|---|
| Fokontany of Sahofika | Sat 01 June | 63 | 5 | 68 |
| Commune of Tsinjoarivo | Mon 03 June | 11 | 0 | 11 |
| Commune of Belanitra | Mon 03 June | 3 | 0 | 3 |
| Fokontany Antenina | Tue 04 June | 141 | 43 | 184 |
| Fokontany Fisoronana | Thu 06 June | 80 | 20 | 100 |
| Fokontany Befotaka | Fri 07 June | 127 | 41 | 168 |

| | | | | |
|---|---|---|---|---|
| Region Alaotra Mangoro | Wed 12 June | 9 | 3 | 12 |
| Region Vakinankaratra | Fri 14 June | 20 | 16 | 36 |
| Asity Madagasikara | Mon 17 June | 0 | 1 | 1 |
| ONG Sadabe (with Rainforest trust) | Mon 17 June | 2 | 1 | 3 |
| Antananarivo, with institutions | Tue 18 June | 6 | 2 | 8 |
| Antananarivo, with NGOs | Tue 18 June | 11 | 1 | 12 |
| **Total** | | **473** | **133** | **606** |

# 19 Budget

The estimated cost for the implementation of the ESMP is provided hereafter. These costs do not include the operational costs of NEHO's E&S team:

| | **Construction (Euros)** | **Operation - 35 years (Euros)** | **Total (Euros)** |
|---|---|---|---|
| **ESIA without CDP, BAP and RAP** | 1 580 000 | 4 120 000 | 5 700 000 |
| **Community Development Plan** | 2 500 000 | tbd | 2 500 000 |
| **Biodiversity Action Plan** | 1 250 000 | 1 250 000 | 2 500 000 |
| **Total** | **5 330 000** | **5 370 000** | **10 700 000** |

The estimated cost of the Resettlement Action Plan is provided below:

| | **Total (Dollars)** |
|---|---|
| **Compensation of affected household assets (land, crops, buildings)** | 16 539 269 |
| **Compensation of affected community and other non-household owned assets** | 201 657 |
| **Resettlement site - Construction of community infrastructure** | 420 000 |
| **Resettlement site - Acquisition and development** | 5 060 000 |
| **Livelihood restoration** | 580 000 |
| **Implementation** | 2 295 000 |
| Contingency (10%) | 2 509 593 |
| **Total** | **27 605 519** |