My Ly - Nam Mo Hydropower JSC

Environmental and Social Impact Assessment

NAM MO 1 HYDROPOWER PROJECT

Volume I
Environmental and Social Impact Assessment
30 October 2017

ENVIRO-DEV
with Input from
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Volume I: ESIA

Environmental and Social Impact Assessment
Nam Mo 1 Hydropower Project

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LAYOUT OF THE ESIA REPORT

VOLUME I Environmental and Social Impact Assessment (ESIA)

VOLUME II Agreements, Approvals and Specialist Reports

- ANNEX 1 Agreements and Approvals
- ANNEX 2 Appendices, Specialist Reports on (a) Biology, and (b) Water Quality Resources

VOLUME III Social Baseline

- ANNEX 3 Social and Livelihoods Reports

VOLUME IV Communication

- ANNEX 4 Consultations before 2017 (pre-ESIA)
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VOLUME V Public Communication and Disclosure Plan (PCDP)

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ABBREVIATIONS AND ACRONYMS

Abbreviation/Acronym	
ACBP	Awareness and Capacity Building Plan
Project AI	Project Area of Influence
AP	Affected Person
CLO	Community Liaison Officer
CSR	Corporate Social Responsibility
CVC (crushing facility)	Conventional Concrete
dBA	Decibel A-weighting
DARD	Department of Agriculture and Rural Development
DIA	Direct Impact Area
DPC	District People's Committee
DONRE	Department of Natural Resources and Environment
E	East
E&S	Environmental and Social
ECC	Environmental Compliance Certificate
EHS	Environment, Health and Safety
EHSP	Environment, Health and Safety Plan
EIA	Environmental Impact Assessment
EMDF	Ethnic Minority Development Framework
EMS	Environmental Management System
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESMP	Environmental and Social Management Plan
EVN	Electricity of Vietnam
FGD	Focus Group Discussion
FI	Finance Institution
FPIC	Free and Prior Informed Consent
FS	Feasibility Study
FSL	Full Supply Level
Genco	EVN Generation Company
GoL	Government of Lao PDR
GoV	Government of Vietnam
GRU	Grievance Redress Unit
GRP	Grievance Redress Procedure
GRM	Grievance Redress Mechanism
ha	Hectare
HH	Household
HPP	Hydropower Project
IAA	Indirect Impact Area
IC	International Consultant
ICP	Informed Communication and Participation
ICS	Improved cooking stoves
IFC	International Finance Corporation
IFC PS	IFC Performance Standards
IFI	International Finance Institutions

Abbreviation/Acronym	
IIA	Indirect Impact Area
IP	Indigenous People
IUCN	International Union for Conservation of Nature
JSC	Joint Stock Company
KII	Key Informant Interview
kWh	kilowatt-hour
LAK	Laotian Kip
Lao PDR	Lao Peoples Democratic Republic
Lao SCB	Lao Statistics Bureau
MAF	Ministry of Agriculture and Forestry (Lao PDR)
MARD	Ministry of Agriculture and Rural Development
masl	meters above sea level
MIGA	Multilateral Investment Guarantee Agency
MOIT	Ministry of Industry and Trade
MOL	Minimum Operation Level
MONRE	Ministry of National Resources and Environment
mt/ha	metric ton per hectare
MVND	Million Vietnam Dong
MW	Megawatts
N	North
NC	National Consultant
NE	Northeast
NR7	National Road 7
NTFPs	Non-timber Forest Products
NTU	Nephelometric Turbidity Unit
NW	Northwest
PAF/PAP	Project Affected Family/Project Affected Person
PCDP	Public Communication and Disclosure Plan
PEC1	Power Engineering Consulting and Investment JSC
PECC1	Power Engineering Consulting Joint Stock Company 1
PGA	Peak ground acceleration
PO	Project Owner / Proponent
PPC	Provincial People's Committee
PPE	Personal Protective Equipment
PS	Performace Standard
RAP	Resettlement Action Plan
RCC	Gravity Rolled Compaction Concrete
RCMP	Reservoir Catchment Management Plan
REMLRP	Resettlement and Ethnic Minority Livelihoods Restoration Plan
RP	Resettlement Plan
RPF	Resettlement Policy Framework
S	South
SBZ	Safeguard Buffer Zone
SE	Southeast
STDs	Sexually Transmitted Diseases
SW	Southwest
T/L	Transmission Line

Abbreviation/Acronym	
TCU	True Color Unit
TIA	Tertiary Impact Area
ToR	Terms of References
TSS	Total Suspended Solids
USD	US Dollars
VND	Vietnamese Dong
W	West
WB	World Bank
WES	Waterways Experiment Station
WHO	World Health Organization

EXECUTIVE SUMMARY

The Project

The Vietnam National Power Development Master Plan for 2011-2020 (revised and approved on 18 March 2016) states that, there is an urgent need for more power with higher reliability and competitive electricity prices in all regions of Vietnam. One of the key changes in the revised masterplan is the emphasis on renewable energy development. –It is estimated that there will be approximately 235-245 billion kWh of commercial electricity in 2020 and 265-278 billion kWh of electricity will be produced or imported in the same year. The Ca River basin, where the proposed Project is located, is one of the main ones identified for renewable – hydropower energy sources.

The Nam Mo 1 Hydropower Project ('the Project') is a peaking project designed to have a capacity of 90MW with a storage reservoir of approximately 962ha (874.8ha of land). My Ly-Nam Mo Hydropower Joint Stock Company (JSC), a private Vietnamese enterprise was incorporated by Vietracimex to develop the Project.

The Project is situated in two of the nations in the Indochina region of Asia. Both the governments of Vietnam and Lao PDR have an agreement to develop hydropower projects on the Nam Mo River. Nam Mo River is one of the main tributaries of Ca River. Ca River is located in Nghe An Province of Vietnam and most of the left bank is within the Laos territory in Xiangkhoang Province.

My Ly - Nam Mo Hydropower JSC, the Project Proponent, later engaged Hydropower Engineering Consultancy and Construction Company to prepare the Feasibility Study in June 2012. An agreement between the two Governments was signed in 2016 which stipulates the cooperation of the two countries to develop the Nam Mo 1 HPP including its agreement terms on investment, construction, operation and management of the Project. After which, a more detailed FS has been carried out including procurement of primary permits such as national environmental clearances for both Lao PDR and Vietnam. One of the conditions of the agreement is the preparation of an Environmental Impact Assessment (EIA). Two national EIAs were prepared, one for each country and are subject to each country's respective national procedures and compliance. The approval from the Government of Vietnam was obtained on 20 November 2016, while that from Laos is pending.

My Ly-Nam Mo JSC, intends to acquire a loan to finance the development of the Project. The Proponent plans to apply for a political risk guarantee from the Multilateral Investment Guarantee Agency (MIGA, World Bank Group) to secure the loan. The National EIAs were found not to be compliant with MIGA policy thus requiring upgrading. One of the requirements for a loan agreement is to prepare an international Environmental and Social Impact Assessment (ESIA) based on MIGA Performance Standards.

My Ly-Nam Mo Hydropower JSC engaged ENVIRO-DEV (based in Norway) to develop the ESIA in accordance with the requirements of MIGA Performance Standards (2013). Logistics, input on previous works and field assistance was provided by the Power Engineering Consulting Joint Stock Company (PECC1, EVN).

The salient features of the ESIA of Nam Mo 1 HPP are summarized here.

Technical Characteristics

The main components and auxiliary work areas are all located in the Ta Ca Commune, Ky Son District, Nghe An Province, Vietnam (Table 1). These were proposed through optimization studies including dam structure, installed capacity, number of powerhouse unit, water head, and quantity and dimension of spillway gate, among other technical features (Table 2). The Project's direct impact area includes 11 villages in Vietnam and five villages in Laos that will be subjected to relocation (Figure 1).

Table 1 Salient features of Nam Mo 1 Hydropower Project

Project Location	Vietnam	Lao PDR
Region	North-Central Vietnam	North – East
Province	Nghe An	Xiangkhoang
District	Ky Son	Nonghed
Communes	Muong Tip, Muong Ai, Ta Ca, Nam Can	No commune unit is used in Lao PDR
Villages	Total of 11 villages to be relocated	Total of five villages to be relocated

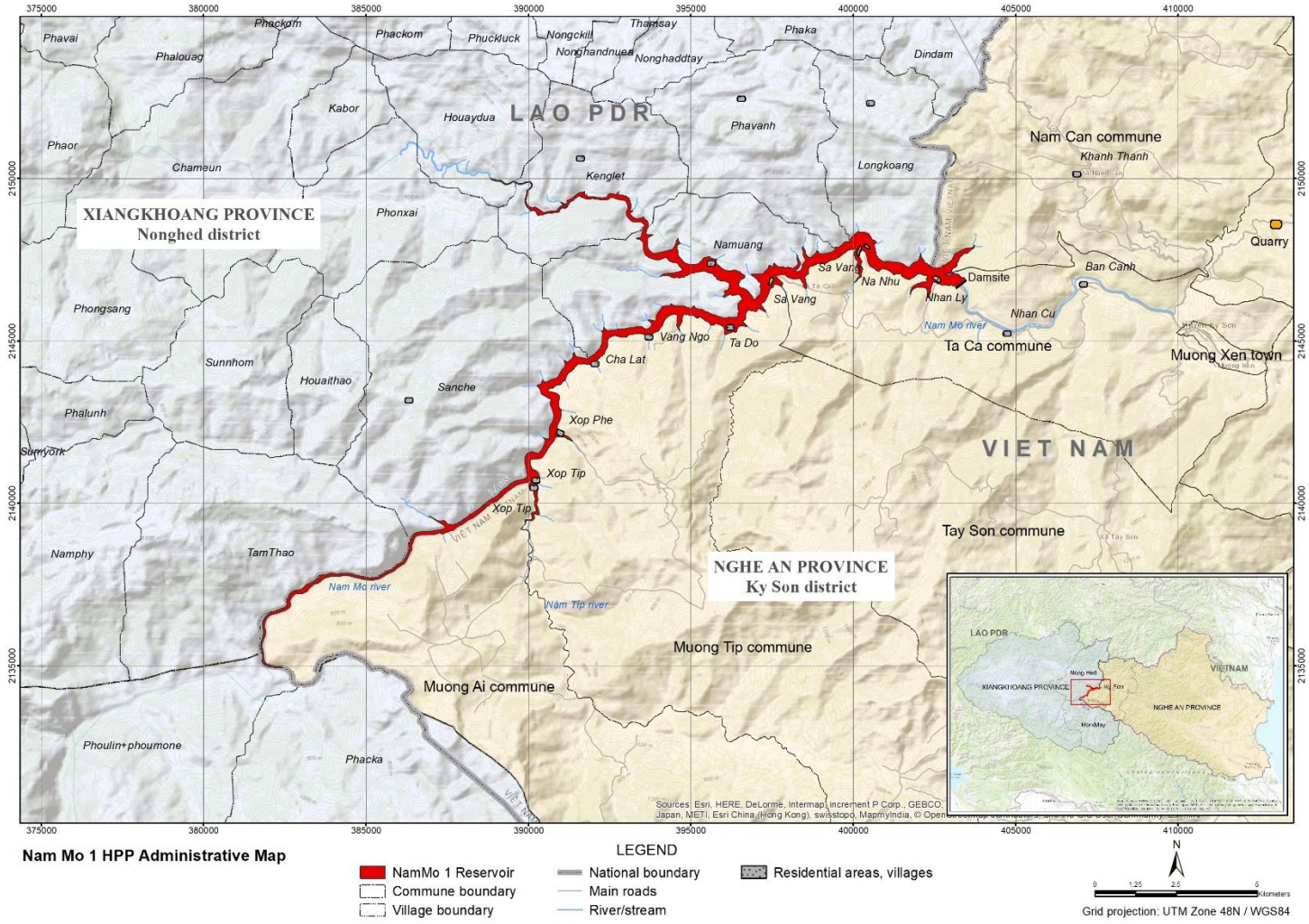


Figure 1. General map showing the Project location and the villages

The main features of the Project head works, reservoir and river are provided in Table 2.

Table 2. Main features of the Project

Project area	
Hydrology at intake	
Annual mean flow	65.5m^3/s
Other features	
Installed capacity	90MW
Firm capacity	17.5MW
Annual energy production	326.8GWh
a. Headworks	
Location Latitude / Longitude	Ta Ca Commune, in Vietnam N : 19^{o}24’44” E: 104^{o}04’46”
Dam type	RCC (gravity rolled compaction concrete)
Dam height	95.52m
Crest length / width	407.15m / 8m
Approximate reservoir length	33km
Calculated head	65m
Reservoir gross storage (total reservoir volume including dead storage)	272.1million m^3
Reservoir active storage	151.3million m^3
Reservoir Full Supply Level (FSL)	235m
Reservoir Minimum Operating Level (MOL)	215m
Reservoir area at FSL (full supply level)	962ha
Maximum powerhouse discharge	156.5m^3/s
Highest regulated water level	241.46masl
Lowest regulated water level	215masl
Spillway Sill elevation	4 bays (10mx12m each) 225m
Weir total length Stepped spillway – Step height/width	77.5m 12m / 10m
Distance of powerhouse from dam site	108m
Distance of tailrace from dam site	308m
Potential total length of river expected to be affected due to reservoir	33km length of reservoir
b. Headrace Tunnel	
Tunnel inlet elevation	202.25masl

During the construction of the dam, the river will be diverted through a tunnel. In addition to the construction of the dam, the tunnels and the power house, the Project will need new roads/upgraded roads, spoil tip areas, sand quarry areas, rig areas, permanent housing, temporary and labor camps, and transmission lines, among other areas, to complete the development. Some of these planned construction areas and structures will be permanent while others will be temporary. Transmission lines will be the subject of a separate ESIA and thus has not been included in this assessment. The construction areas (auxiliary works) are located clustered next to the dam site concentrating all activities. The only areas not located in the same site is the quarry.

Project site related roads. There are a number of district roads and local roads in the area that are linked to the main national roads. At necessary points in the project area, new project access roads will be built and connected to the existing road system. Most of these will be permanent roads, some will be upgrading of existing roads, and some may be temporary for use during the construction period. Permanent roads remaining will be 4.40km long and temporary construction area roads will be 1.65km long.

Quarry site. The Project will utilize the existing Pah Danh quarry for its source of rock aggregates. It is currently being operated by Phu Cuong Ltd. Company and has a valid extraction permit for 15 years. The Pah Danh quarry is approximately 6.5ha and located downstream of the dam site, approximately 14km in distance. Access to the quarry is through the Tay Nghe An Provincial road. Road surface will be rehabilitated to cater for delivery trucks to the project construction site. There are villages located along the access road to the quarry site: Phieng Pho (in Pha Danh Commune), Khanh Thanh (in Nam Can Commune), Son Thanh, Cau Am, Binh Son, Ban Canh, and Nhãn Cù, all are located in Ta Ca Commune.

Spoil disposal areas. The Project proposed two disposal areas with a total area of 13.57ha to accommodate the estimated spoil materials from the various excavation works for construction. Details on amounts needed will be assessed during the detailed design phase. The disposal areas will be a temporary functional area of the Project, until the construction ends or until the area contains spoil at maximum volume capacity. Some of the disposal areas are designed to support structures (e.g., employees' accommodation) once the required height and flatness are achieved. The disposal areas will also be shaped and managed to maintain good and safe conditions such as slope, height and flatness.

Operation of plant. It is envisaged that the Project will store excess water in the reservoir during high flow to be utilized during low flow. The height of the dam will be 95.52m above the existing river bed and the FSL will be 235masl creating a reservoir length of 33km with a total volume of 272.1Mm^3. The water will be diverted through a twin tunnel down to a power station located adjacent to the dam. The water will be released back in the river, 200m downstream of the power station and 308m of the dam site. Note though that the release comes within the reservoir of the existing Nam Mo HPP, located downstream of this proposed Project (Nam Mo 1 HPP). In fact, the proposed location of the damsite is still within the tailend of the existing Nam Mo HPP reservoir.

The Plant is optimized for maximum energy generation throughout the year. During the dry season, the Plant will run only as a peaking plant during daytime, while in the wet season, the Project will generate approximately 24-hours at full capacity. Details on planned operation are provided in the next section on salient features.

The dam will create a reservoir that will extend up to 33km upstream and will impact 16 villages, 11 in Vietnam and 5 in Laos (communes of Muong Ai, Muong Tip, Ta Ca and Nam Can in Vietnam and Nonghed districts in Laos). The flow in the river between the dam and the outlet, will be reduced, particularly during the dry season, and the river will be subjected to daily flow fluctuations due to the peaking operation of the power plant. All these operational impacts need to be assessed considerably during the detail design to ensure that the operational criteria for Nam Mo HPP downstream is not compromised.

The proposed Project is planned with installed capacity of 90MW. Based on the planned installed capacity, the total annual energy generation in an average year will be

approximately 326.8GWh. Nam Mo 1 HPP has an active storage volume of 151.3Mm^3 and is a long-term regulation reservoir.

Environmental flow. Releasing of water flow for environmental requirements and downstream users is a new concept in Vietnam. A relevant regulation, the national technical regulation on hydraulic structures for design (**QCVN 04-05 – 2012/BNNPTNT)** provides the requirement for minimum flow for HPP's, and the minimum flow (environmental flow) shall be equal to the average flow of the river during dry season, with frequency of 90%.

The case of this Project however is complex because an existing HPP is located downstream and the proposed damsite is located within the tailend of its reservoir, which is not unusual in Vietnam. The minimum environmental flow should also consider the operational criteria of the existing HPP, which is governed by EVN.

At an ecological perspective, a minimum average monthly flow increasing from 1.55 to 2.06 m^3/s down the river course of the dam would be required. This discharge considered more than sufficient for the maintenance of adequate wetness conditions to support the ecosystems that may exist in the boulder bed river, riparian vegetation, water resources, and fisheries. Provision shall be made to release such quantum of water which is higher or either at least 15% of the average minimum flow. In the case of Nam Mo 1, human use of the water is low, except for fisheries. The final operation regime will be confirmed during the detail design phase and should include consultation with the downstream HPP (operated by EVN).

Construction manpower. The estimated required manpower for construction is approximately 1750 persons. Ten to fifteen percent of the total estimated work force is expected to be local. In addition, an influx of new settlers and small businesses will normally establish themselves at such large construction sites. Unregistered persons and "camp followers" could come to the area, whose numbers should be held at a minimum. Temporary and permanent camps will be constructed to provide accommodation for the workers and it is envisaged that the design is in-line with MIGA's standards with reference to IFC/EBRD Guidance Note on Worker's Accommodation.

Construction schedule. Start of construction is assumed to be 2018, i.e. preferably at the beginning of the dry season, and last for four years. The construction schedule is based on the construction procedures and corresponding rates of progress described in the Feasibility Report.

The development of the hydropower Project will commence with detailed technical design of the Project works and the elaboration of the environmental and social plans, including all safeguards at the pre-construction phase. The construction will essentially start once the resettlement implementation process is complete. It is possible that a staggered resettlement time-line may be employed with the households closest to the dam relocating before the construction commences, given that the ones further away will be affected when the reservoir is filled. Regardless of timing of physical relocation, all agreements for resettlement must be completed before construction begins.

Physical environment

General topography. The Nam Mo River basin within the Project stretch is characterized by a rugged terrain with sharp variation in elevation. The few flat or gentle-sloped lands by the river banks, are either used as settlements and/or cultivation areas. Most of the settlements and agricultural lands are on hill slopes and at small flat highland areas. Areas with gentle slopes are used for agriculture, while the steep areas are common grazing lands, cropland or covered with limited secondary forests. Within the Project Area of Influence (AI), the elevation ranges from minimum of 171masl to maximum of 977masl. The average elevation of the river stretch is 328masl. Slopes range from 20^o - 50^o.

Land use in the Project Area of Influence. The land use analysis shows that the Project's Direct Impact Area (DIA) and proposed buffer zone (for reducing erosion and safety reasons) is highly influenced by human activities. Approximately 86% of the total area of

the DIA of 1042ha is vegetated (Table 3). Approximately 38% of the vegetation cover in the DIA comprises of a combination of mixed forests (Figure 2).

Table 3. Major land use and cover of Project Direct Impact Area

No	Land cover (land take of Project)	Permanent area (ha) – DIA		Temporary (ha) ** In DIA	Total (ha)	Buffer area (ha)
		Reservoir	Main works*			
I	**Vegetation**	**764.6**	**21.3**	**49.69**	**835.59**	544.20
a	*Forest*	*378.7*	*7.5*	*11*	*397.2*	*295.5*
b	*Secondary scrub*	*159.5*	*1.1*	*17.9*	*178.5*	*108.4*
c	*Shrub/bamboo/cultivated/ uncultivated land*	*226.4*	*12.7*	*20.79*	*259.89*	*140.3*
II	**Other lands**	**110.2**	**0.7**	**3.18**	**114.6**	*13.3*
III	**River/stream**	**87.2**	**2.2**	**2.4**	**91.8**	*1.7*
	Total	**962.0**	**24.2**	**55.27**		*559.20*
	Project land take without proposed buffer				**1,041.99**	

*Main works include dam and associated structures, powerhouse and permanent project facilities
**Temporary area includes disposal sites 1-4, auxiliary area 1-3, and roads

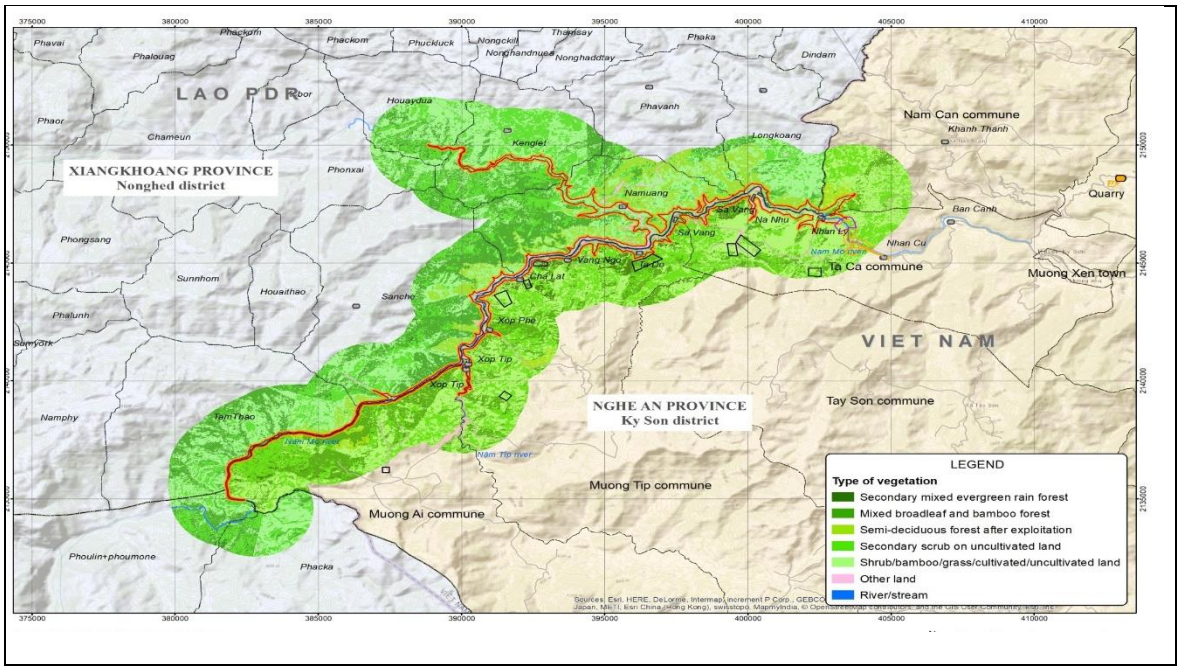


Figure 2. Land use map of Nam Mo 1 HPP Project Area of Influence

Precipitation and seasonality. The mean annual rainfall in the Project area is estimated at 1400mm. History of flooding has been reported in the Ca River basin (e.g., May 1989). Annual rainfall changes along the Ca River basin as indicated in the following records:

- 1100 - 1700mm - Upstream area, where the Project construction will be;
- 1800 - 2500mm - Middle reaches of Ca River; and
- Over 2500mm - Downstream reaches

Vietnam has a remarkably diverse climate conditions because of its location where there is a wide range of latitudes and altitudes. It is divided into three climate zones, north, central

and south. The south facing mountain slopes are warmer and attract more precipitation than those facing north. The Project is located in north central Vietnam, and therefore experience a cooler condition. The seasonal climatic pattern (e.g., distinct winter and summer seasons) observed within the Project site is similar throughout the basin, differing only in degree due to the wide variations in elevation and exposure. The rainy season starts in May and ends in October with peak rainfall in July/August contributing to about 80% of the total annual rainfall. The rest of the year is referred to as the dry season, with November to February being the driest.

Lao PDR has less variation in climatic conditions and is characterized by two distinct seasons, the wet and dry. Part of the Project reservoir area in Laos is dominated by both southwest and northeast monsoons forming the two climate regime, the wet and dry seasons similar to that in Vietnam. The annual rainfall distribution is approximately 80% from May to September, 10% from October to December and about 10% from January to April.

Geology. The proposed dam site is considered as the optimum location with favorable condition in terms of engineering geological conditions. The IIA rock zone can support the foundation at a design of 95.52m high concrete dam, where rock zone/layer to be excavated is not more than 10m. The permeability of overburden and bed rock also pass the design requirement.

The geological mapping has also shown that the slope stability in the reservoir area is mainly controlled by the geological structures, as would be expected. Steep areas with slopes in excess of 45 degrees will be at risk of erosion. Such areas can be observed within the Project area. There is however very thin overburden and rock foundation is considered stable.

Earthquake and hazard assessment. The construction site is relatively close to an active grade-2 fault line about 1.65km from the Ca River fault zone. Based on the preliminary seismic investigation, the faultlines within the Project area may generate an intensity 4 or 5 (PGA = 245cm/s^2) and trigger a 6.75 magnitude earthquake. The dam therefore has been designed to withstand the predicted earthquake magnitude, and the detail design will need to explicitly address this need.

Hydrology and sediment transport. Nam Mo River is one of the five main tributaries of the Ca River system. It has a total catchment area of about 3,970km^2, and the Project will cover about 2,492km^2 of the basin. Water level and discharges from 1969 to present at Muong Xen hydrological gauging station, downstream of the damsite, was used to estimate the annual flow at the Project. Adjusted to the damsite location, annual flow series arriving to Nam Mo 1 HPP was simulated. The annual flow discharge at the planned dam site is 65.5m^3/s.

Sedimentation. Annual sediment load at Nam Mo 1 HPP was estimated based on the sediment load and water discharges measured at Cua Rao gauging station for the period 1961 to 2009. Based on this exercise, the average annual bed load at the damsite is 205x10^{6}m^3. At this rate, sediment deposition at the reservoir over the years once the Project is operational was also estimated and indicated that on the 5th year of operations, the reservoir has been filled up with 25.8Mm^3, occupying about 9.48% of the storage area, assuming that no dredging has been done.

Water quality. The water quality of Nam Mo River within the stretch of the Project area has no indication of industrial pollution, except from the tributaries coming from the Laos territory, where elevated turbidity is visual which was attributed to the gold mining activities upstream of the river. Most of physo-chemical properties and heavy metal concentrations conform to the national water standards, except for Total Suspended Solids (TSS), which is higher that the national standard. Traces of coliform, although still within the national water standard were also reported. This is expected when domestic sewage is haphazardly disposed off along the rivers and stream. In addition, raising of animals along the river banks is also common at the Project site.

Drinking water is sourced from spring. Results showed that all physical and chemical parameters tested for drinking water quality at the Project site fall within the limits set by the GoV, GoL and WHO, except for the levels of coliform bacteria, which should be 'nil' to be considered suitable for drinking water. The presence of coliform in all samples indicated contamination from human excreta. These stations were located downstream of the settlements/villages suggesting that sanitation is lacking in the community.

Air quality. Air quality at the Project area is typical of a rural environment and no indication of air pollution. However, movements of vehicles in the earthen road along the Project area are expected to cause dust pollution. The thick dust layer observed on the tree leaves and vegetation in these areas signifies the dust pollution in the air. There is no mechanized stone crushing plant in the area but the local people along with their children are known to be crushing stones along the rivers and rivulets. Typical of rural areas, burning firewood for cooking meals has been the main source of air pollution at the household level. Exposure to indoor air pollution increases the risk of illnesses such as respiratory tract infections, pneumonia, chronic obstructive pulmonary disorder asthma and lung cancer.

Noise and vibration. Background noise in the Project area is low and inherent to a rural area where population density is low with limited economic activity (e.g., limited traffic noise, absence of industrial and/or commercial activities). Area where potential elevated noise may occur is the quarry site at Pha Danh where blasting and operation of excavator, loading and hauling activities are carried out during operations. However, at the time of measurement, the quarry was at a break so noise level was low at 52.5dBA and below allowable limits (QCVN 26:2010/BTNMT and IFC Guidelines).

Biological Environment

Vegetation. Ta Ca Commune has altogether 3,871ha of forest land of which 1,885ha is classified as Protection Forest and 1,896ha as Protection Forest. Production forest area has been allocated to households for planting trees and some fast growing Acacia, teakwood species, *Melia azedarach* (Chinaberry) and *Chukrasia tabularis* (Indian mahogany) are planted. However, most of the Production Forest area has been converted and is farmed with rain-fed upland paddy, maize crop and cassava due to the lack of arable land. Protection Forests have poor quality due to past illegal exploitation and now are covered with secondary forest vegetation and tropical grassland.

Local households collect and depend on a regular supply of wild vegetables, bamboo shoots, mushrooms, *Auricularia auricula-judae (*Jew's Ear, an edible fungus), and herbal medicines such as "củ xa nhân", smilax roots and *Ganoderma lucidum* (nấm Linh Chi) from Protection Forest. They also hunt wild animals such as wild boars, birds, wild chickens, squirrels, *Muntiacus muntjak (*barking deer) and mice for food, although wild boars and barking deer are now very few.

Muong Tip Commune has 3,416.2ha Protection Forest and 2,922ha Production Forest. About 3.3ha Production Forest was allocated to each households for tree plantation, however these are converted to swidden farming. There are very few trees planted, among them are *Melia azedarach* (Chinaberry)*, Acacia spp., Erythrophleum fordii* (a legume species)*,* and *Chukrasia tabularis* (Indian mahogany).

Muong Ai Commune has 4,200ha Protection Forest and 625ha Production Forest, averaging 1.5ha of Production Forest allocated per household. Similar to the two villages, Production Forest is allocated to households for planting trees but almost all of the allocations are converted into swidden farmland for growing upland crops such as rice, maize and cassava. In swidden farmland, villagers intercrop *Melia azedarach, Acacia spp., Chukrasia tabularis* and *Erythrophleum fordii*. Protection forests on the other hand are mostly covered with bamboos, rattans and bushes. In general, the quality of vegetation is poor due to over exploitation over the years. Similar to the two villages, the forest is source of food and medicine. The forest also provide wild animals as additional source of protein food.

Xiangkhoang Province in Laos, covers an area of 15,880km^2 and has a mountainous topography. The proposed reservoir area is source of timber, forest products and is used

for agriculture, and the situation is similar to that in Vietnam. It is noted that there are areas with mature trees in Laos mainly in steep and inaccessible sites including cliffs.

Forests are categorized as Protection Forest, Conservation Forest and Production Forest[1]. Because of the low population density in Laos, Protection and Conservation Forests are in better condition than in Vietnam. Villagers are not allowed to harvest forest products other than timber for house construction from these forests, but can harvest non-timber forest products like wild vegetables and other edible products from the Production Forest while some areas are used for upland farming such as upland rice and maize. The Vietnamese obtain timber from the Laos side.

Forest vegetation systems in the Project area. Forests close to the settlements and near the Project areas were heavily exploited and farmed without terraces using the swidden agriculture system. Typical for swidden agriculture, once soil fertility diminishes, the villagers abandon the farm and move to a new tract of land and the exploited forest was left to regenerate and restore naturally. Such areas gradually turn into grassland, scrubland and secondary forests.

Type of vegetation in reservoir and construction areas. Forest vegetation in the proposed reservoir area and construction areas is given in Table 5.. The Project will acquire 1,042ha of land and about 80% of this total area is forested or have some forest vegetation. About 52.8% of the 559.1ha proposed buffer zone area has secondary forest vegetation, 25% is grassland and the rest are composed of the stream and other landuses (See Table 3).

Table 4. Vegetation types and land use in direct impact area

No	Vegetation types	Permanent area (ha)		Temporary (ha) **	Total (ha)	Buffer area (ha)
		Reservoir	Main works*			
	Total vegetated area	**764.60**	**21.3**	**49.1**	**835**	**544.10**
I	Secondary Mixed Evergreen Rain forest	*98.2*	*0*	*0.4*	*98.6*	*68.2*
II	Mixed Broadleaf and Bamboo forest	*128.5*	*4.8*	*10.6*	*143.9*	*126.7*
III	Semi-deciduous Forest	*152.0*	*2.7*	*0*	*154.7*	*100.5*
IV	Secondary Scrub on Uncultivated land	*159.5*	*1.1*	*17.9*	*178.5*	*108.4*
V	Grass/shrub/bamboo/cultivated and uncultivated land	*226.4*	*12.7*	*20.2*	*259.3*	*140.3*

Main works include dam and associated structures, powerhouse and permanent project facilities

[1] Temporary area includes disposal sites 1-4, auxiliary area 1-3, and roads

Biodiversity status. There are 420 vascular plant species from 328 genus and 117 families recorded in the 20 sampling sites. Biodiversity in the Project area is low since most of the vegetation has been disturbed. The secondary evergreen mixed rain forest has medium diversity while the secondary forest grown on uncultivated land, mixed broad leaf bamboo forest and predominant bamboo forests are of low biodiversity value. In general, number of tree species in the reservoir area is higher than in the proposed construction areas.

Regeneration, standing volume and total biomass. Regeneration in secondary forests is good, with more than nine species of hardwood species regenerating in the proposed reservoir. Regeneration in the proposed construction areas is lower than in the reservoir area. There is species similarity between these two Project areas with an exception of few

[1] LAO Law of Forestry, 2007

species which were not recorded in the reservoir area. Table 5 summarizes the type of forests and its estimated organic biomass at the proposed reservoir and auxiliary areas.

Table 5. Estimated organic biomass above ground in the reservoir area

Type of Forests	Reservoir		Construction sites		Buffer zone	
	Area (ha)	Biomass (mt)	Area (ha)	Biomass (mt)	Area (ha)	Biomass (mt)
Secondary mixed evergreen rain forest	98.2	5,892	0.4	24	68.2	4,092
Mixed broadleaf and bamboo forest	128.5	3,849	15.4	462	126.7	3,801
Semi-deciduous forest	152.0	7,600	2.7	135	100.5	5,025
Secondary scrub on uncultivated land	159.5	1,910	19.0	228	108.4	1,301
Grass/shrub/bamboo/ cultivated and uncultivated land	226.4	1,132	32.9	165	140.3	701
Total	**764.6**	**20,383**	**70.4**	**1,014**	**544.1**	**14,920**

Species of conservation importance. There are two species of concern namely the *Drynaria fortunei* (Gu Sui Bu), an epiphytic herb species native to East Asia and the tree species *Hopea mollissima (a Dipterocarp species)* an endemic hardwood to Vietnam and Yunan –China, naturally growing in the evergreen rain forest. The former is listed as endangered species in the Red Data Book of Vietnam, 2007[2] while the latter is recorded as regionally extinct in the IUCN[3]. *Drynaria fortunei* is known as traditional Chinese medicine for bone healing. These species are disappearing because of deforestation and habitat degradation.

Wildlife species. Mammals in the Project area include 13 rodent species *(Rodentia)*, 6 bat species *(Chiroptera)*, six carnivore species, and one insectivores. These animals are mainly distributed in area where forest is in good condition, usually above 500masl. Small mammals, rodents and bats are abundant in the proposed dam site and auxiliary areas.

The reservoir area comprises mainly of secondary forest, bamboo forest, scrub land and grass land. Since wildlife are dependent on their habitats, wildlife population in the Project area did not exhibit a diverse population as compared to where forest is in good condition. There are no large size animals/species or rare species reported in the reservoir area instead, animals of small size such as the civet (*Viverridae)*, weasel (*Mustelidae)*, tree squirrel (*Sciuridae)*, rats (*Muridae)*, bamboo rats (*Rhizomyidae)* were reported to occur.

There are also bird species which include wild chicken (*Gallus gallus)*, woodpecker (*Piciformes)*, rollers (*Coraciidae)*, kingfisher (*Alcedinidae)*, drongo and *Muscicapidae.* Reptiles and amphibians reported to be present include the agama (*Agamidae)*, ground dragon *(Physignathus cocincinus)*, gecko *(Gecko gecko)*, and some species of frog. Species of conservation interest are given in Table 6.

[2] Red Data Book of Vietnam (2007)

[3] IUCN – International Union for Conservation of Nature – IUCN Red list of Threatened Species

Table 6. List of species of conservation interest

No	Scientific name	Common name	Vietnamese name	Vulnerability status[4]		
				Vietnam Red Data Book	IUCN	Decree 32/2006
1	Mammals					
	Nycticebus bengalensis	The Bengal Slow Loris	Cu li lớn	VU	VU	IB
	Macaca mulatta	Rhesus monkey	Khỉ vàng	LR		IIB
	Felis bengalensis	Leopard cat				IB
2	Reptiles					
	Gekko gecko	Gecko	Tắc kè	VU		
	Physignatus coccincinus	Chinese water dragon	Rồng đất	VU		
	Varanus nebulosus	Clouded monitor	Kỳ đà vân	EN		IIB
	Varanus salvator	Water monitor	Kỳ đà hoa	EN		IIB
	Ptyas korros	Indochinese ratsnake	Rắn ráo thường	EN		IIB
	Ptyas mucosus	Oriental ratsnake	Rắn ráo trâu	EN		IB
	Bungarus fasciatus	Banded krait	Rắn cạp nong	EN		IIB
	Naja naja	Indian or Asian cobra	Rắn hổ mang	EN		IIB
3	Birds					
	Falco severus	Oriental hobby (a falcon)	Cắt bụng hung			IIB
	Psittacula alexandri	Red breasted parakeet	Vẹt ngực đỏ			IIB
	Copsychus malabaricus	White rumped shama	Chích chòe lửa			IIB

Use of forest plants, animals and forest ecosystem services. Out of the total 420 vascular plant species recorded in the Project area, 149 of them are medicinal plant species, fuelwood and timber species, edible plant species, ornamental plant species, rattan and bamboos species and others, or combination of the uses. There are 60 medicinal plant species of high value naturally growing in the project area while 57 species are used for timber and fuel wood. The villagers have always used and are highly dependent on the forest as source of their fuel-wood, timber, fodder and forage, medicines, religious rituals and food.

The wildlife species in the mixed forest types are all consumed and these include the yellow monkey (*Macaca mulatta)*, wild pig (*Sus scrofa)*, muntjac (*Muntiacus muntjak)*, wild cat and big bamboo rat (*Bandicota indica)*. It is also habitat for bird species from the families of

[4] IUCN. 2016. The IUCN Red List of Threatened Species; VU = Vulnerable; VNRB. 2007. Vietnam Red Data Book; VU=Vulnerable; LR = Lower Risk; Decree 32/2006/ND-CP. Management of Endangered, Precious and Rare Species of Wild Plants and Animals; IB= Prohibiting collection and use for commercial purposes; IIB= Restricting exploitation and use for commercial purposes

drongo, crow, fly eating bird, honey eating bird, Chinese laughing-thrush, cock and turtle bird. Reptile and amphibian species that are found here include *Physignathus cocincinus*, *Varanus nebulosus*, cobra (*Naja naja)*, *Trimeresurus albalabris*, species of family tortoise *Emydidae*, and Gecko (*Gekko gecko)*. Secondary forest types also have good habitat for small mammals from the orders of rodents and bats; bird species, reptiles and amphibians like *Physignathus cocincinus*, *Ptyas mucosus*, *Bungarus fasciatus*, *Bungarus candidus and Naja naja*.

Habitats along Nam Mo River, streams, swidden farming area and the village area. Areas along Nam Mo River and the adjacent streams, swidden farming areas, settlement areas and along road alignment provide habitat for mammals which are also eaten regularly as a free source of protein: such as the black tail rat (*Crocidura attennata)*, mosquito eating bat (*Java Pipistrellus javanicus)*, mice (e.g., *Rattus flavipectus)*, rat (*R. norvegicus) and* bird species such as milky stork (*Egretta garzetta)*, fly stork (*Bubulcus ibis)*, Milky necked stork (*Amaurornis phoenicurus)*, big kingfisher (*Megaceryle lugubris)*, small kingfisher (*Ceryle rudis)*, wolly necked stork (*Halcyon chloris)* and *Alcedo atthis.* Some reptiles, the gecko water snake, amphibians such as family Ranidae, family Rhacophoridae (tree frogs), Microhylidae (small frogs) and some insects (butterfly) were recorded in this habitats.

Fish species and diversity. There were 80 fish species from 18 families and six orders recorded in the Nam Mo River and the streams joining it. Fish living in streams are normally small fish species, preferring rapid water and high oxygen content. Typical stream fish species are those such as *Acheilognathus lamensis, Garra poilanei, Puntius semifasciolatus* (Gold barb, known for aquarium trade)*, Misgurnus anguillicaudatus* (Oriental weatherfish)*, Pseudobagrus virgatus, Pareuchiloglanis nebulifer*, *Monopterus albus* (Asina swamp eel)*, Anabas testudineus* (Climbing perch)*, Oreochromis mosambicus* (Mozambique tilapia) and *Oreochromis niloticus* (Nile tilapia).

Eight species have high economic value and most of them except *Onychostoma lepturus* (Thintail Shoveljaw carp) are less common in the river. Two species, *Anguilla marmorata (Giant mottled eel)* and *Bagarius rutilus* (Sisorid catfish) are classified as vulnerable, according to the Red Data Book of Vietnam (Table 7). None of these high valued fish species are found in streams.

Table 7. Fish species of high economic value in Ca River

SN	Fish species	Ca River	Stream
1	*Anguilla marmorata*	+	-
2	*Spinibarbus denticulatus*	+	-
3	*Cyprinus rubrofuscua*	+	-
4	*Onychostoma lepturus*	++	-
5	*Hemibagrus guttatus*	+	-
6	*Cranoglanis henrici*	+	-
7	*Bagarius rutilus*	+	-
8	*Channa striata*	+	-

Migratory fish species. *Anguilla mamorata* is a long distance migratory fish species, migrating downstream to sea for feeding. This species is considered to be of high economic value, vulnerable and is now less frequently seen in the river. The existing Nam Mo HPP dam downstream of this proposed Project (Nam Mo 1 HPP) has already obstructed its movement to the sea. Its habitat has been fragmented and a small population is now adapting to this new environment, and is likely to disappear overtime.

Vulnerable species. Of the 80 fish identified, five species are listed as Vulnerable (VU) according to the IUCN Red List (Table 8) while two on the Vietnam Data Red Book (VNRD)[5].

Table 8. List of vulnerable wildlife species

SN	Scientific name	Common name	Vietnamese name	Vulnerability status	
				VNRB[6]	IUCN[7]
1	*Bagarius rutilus*	catfish	Cá Chiên	VU	VU
2	*Acrossocheilus annamensis*	carp	Cá trốc		VU
3	*Bangana lemassoni*	carp	Cá Rầm xanh		VU
4	*Hemibagrus guttatus*	catfish	Cá Lăng		VU
5	*Anguilla marmorata*	Marbeled or giant mottled eel	Cá lệch, cá Chình hoa	VU	VU

Fisheries. Fishing is not a main occupation of the people in the Project area. However, most of the households do fishing regularly for their household consumption. Men, women and children go for fishing. Men use boat and cast net, while women and children use baskets for fishing. Families take a day off to go to streams for fishing with basic fishnets and baskets. Sometime they stop the flow on streams, dewater and do fishing. Some villagers also use poisonous leaves in a stream section. Also, although it has been prohibited, the use of electrofishing is still being practiced. Even with the various fishing methods, fish catch is reported to be low, at about 1-3 kg average per day, while on a good day catch could increase to 5-10 kg/day. The species caught are: *Cyprinus rubrofuscua*, *Carassius auratus*, *Hemiculter leucisculus*, *Oreochromis niloticus*, *Oreochromis mosambicus*rô, *Monopterus albus*, *Spinibarbus denticulatus and Glyptothorax quadriocellatus.* Some people also catch crab, shrimp and mussels for household consumption. Fish farming is not a prevalent practice in the Project area although small ponds were noted. These are only for small-scaleproduction and not for large commercial purposes.

Social environment and livelihoods

Inundation area. The Nam Mo 1 HPP reservoir at FSL will have an elevation of 235m and an inundation area of 962ha. The area is upland forested area with steep slopes, the river is in most parts rocky with high current. Several isolated villages are located along the river close to the river bank and are in the proposed reservoir inundation area.

Nine villages in Vietnam and one village in Laos are expected to be inundated by the Nam Mo 1 HPP reservoir. Added to the villages that will be inundated, are land areas in two villages in Nam Can commune in Vietnam and four villages in Laos. Table 9 summarizes the affected villages.

[5] Kottelat, M., 2001. Freshwater fishes of northern Vietnam. A preliminary check-list of the fishes known or expected to occur in northern Vietnam with comments on systematics and nomenclature. Environment and Social Development Unit, East Asia and Pacific Region. The World Bank. 123 p.

[6] Red Data Book of Vietnam, 2007

[7] IUCN. 2016. The IUCN Red List of Threatened Species; VU = Vulnerable

Table 9. List of villages in the reservoir area expected to be relocated and villages with land that will be potentially loss/inundated.

Commune/Districts	Villages to be relocated	Villages with land loss
Vietnam		
Muong Ai Commune	Zop Tip	-
Muong Tip Commune	Zop Tip	-
	Xop Phe	-
	Cha Lat	-
	Vang Ngo	-
	Ta Do	-
Ta Ca Commune	Sa Vang	-
	Na Nhu	-
	Nhan Ly	-
Nam Can Commune		Tien Tieu
		Khanh Thanh
Laos		
Nonghed District	Namuang	Sanche
		Kenglet
		Phavanh
		Longkoang

The four villages in the Nonghed District, Laos that will potentially loss their land are located faraway from the Nam Mo River and separated from it by a steep mountainous terrain. However, according to the ASA ESIA Report (Aug 2016), land along the river is associated to these four villages either ownership or management. The riverside in these areas is steep and probably not in an active use by the named villages. The affected areas, their status and utilization have to be investigated during the detail design phase.

The affected villages and administrative areas can be seen in the map in Figure 1.

Project construction areas. Main works and auxiliary work sites are located in Ta Ca Commune and will be in the midst of the planned Project construction areas.

Downstream stretch. Nhan Cu village in Ta Ca Commune is located 2.1km downstream of the Project's proposed damsite and therefore will be potentially affected by reservoir water regulations and dry season low flow. However, Nhan Cu is also along the stretch of the existing Nam Mo HPP reservoir area, downstream of Nam Mo 1 HPP.

Socio-economic and cultural features of the affected villages

Population ethnicity and poverty. Almost all the people in the Project areas in both countries originate from different ethnic groups/minorities[8]. In the Vietnamese area they are Thai and Kho mu ethnic minority people and in Laos, Kho mu and Thai[9] with their own identity, language and cultural features. Most villages are inhabited with one ethnic group and people have family ties with each other. The ethnic groups in Vietnam and Laos are related to each other, some people have moved across the national border and settled

[8] In Vietnam, the Government recognises a total of 54 ethnic groups, of which the Kinh (Vietnamese) is the majority population with 87% of the national population, and all the other groups are defined as ethnic minorities. In Laos, the national population is divided into three broad categories of 49 ethnic groups, and the term ethnic minority is not used.

[9] Another spelling "Tai", and also reported as Lao Loum, which is the larger ethnic group. In Laos, people are ethnically divided into three main groups: (1) The Lao Loum, who are also called the Lao Thai or the Lowland Lao, who make up approx. 75% of the population in the country; (2) Lao Theung, the midlands people, consisting of 58 sub-groups, among them the Kho mu; and (3) Lao Soung, the highland people consisting of the Hmong and Yao as the main sub-groups and making about 10% of the national population (sources: http://minorityrights.org/minorities; https://www.luangprabang-laos.com/The-people-tribes-and-ethnical).

down on the other side, and villagers have regular social and economic interaction with each other over the border river.

All the households in the affected villages are extremely poor, under or just above the poverty line as defined by the GoV[10] and the GoL[11].

Infrastructure and services. The affected villages are located remotely and can be reached either by boat in the Nam Mo River or along soil roads that are hardly vehicle accessible year round. Local people mainly travel either by wooden boats, on foot or by motorcycles. In most villages only a few households if any own a boat, however due to the existing Nam Mo HPP that has disrupted river transportation by cutting off the waterway, boat transportation is not commonly used.

All the villages to be affected by Nam Mo 1 HPP in Muong Ai and Muong Tip communes are connected to the national electricity network, while the households in Ta Ca Commune lack grid electricity and each household has a micro-hydropower (so-called pico) generator. Namuang village in Laos has grid electricity.

Household water is led from tributaries and mountain streams to water tanks in villages that have been constructed through government or donor programs. Household water for cooking, drinking and washing is taken from these water tanks. Additionally, villagers use the Nam Mo River and its tributaries for washing and bathing, as well as for watering animals.

Health and sanitation. Hygienic conditions in the remote villages are in general, very poor. Most villages lack toilets, and the existing ones are very rudimentary. Pigs, poultry and dogs roam freely around in the villages. Villages lack any rubbish disposal system, and litter is found anywhere in and outside the village including the riverside. The general standard of knowledge about health, hygiene and nutrition is very poor and based on tradition. Both ethnic minority men and many elder women smoke, and men often get drunk drinking home-brewed alcohol.

No health services are available in the villages, and the distance to commune or district health center is too long and costly for people to travel. Health problems are treated with medicinal plants, herbs and fungi collected in the forest. Most common health ailments include headache, diarrhea, fever, respiratory infections, itchy eyes, and gynecological problems. Most often babies are delivered in the villages, and women seldom attend any birth-controls/health check ups during pregnancy. Most children are vaccinated in the villages through monthly mobile vaccination services provided by the commune health center, and few cases of infant or maternal deaths are reported.

Food and nutrition. Upland rice is the main cultivation crop and the staple food of all the affected people. Forest and river provide the resource base for other daily food. Women collect wild growing vegetables, roots, bamboo shoots and mushrooms in the forest several times every day for household food. Men hunt rats, birds and bamboo rats for food on a daily basis. Another main protein source base is the river: Men fish with nets from boats and shore, while women fish with baskets, and even children are collect snails and shrimps in the shallow waters. Poultry with chicken and ducks is kept not only for selling but also for family food. Pigs are eaten more seldom at special occasions, during annual celebrations and family festivities such as weddings. Food is prepared on open fire, and both men and women collect firewood in the forests.

[10] The official poverty line 2016–2020 issued through the GoV Decision No. 59/2015/QD-TTg *Promulgating multidimensional poverty levels applicable during 2016-2020* is for urban areas 900,000VND/capita/month and for rural areas 700,000VND/capita/month. 1USD≈22,700VND (22 Sept 2017).

[11] The official poverty line 2010–2015 issued through the Decree No.285/PO *Poverty and development standard 2010-2015* is for country level 192,000 LAK/capita/month, for urban areas 240,000 LAK/capita/month and for rural areas 180,000 LAK/capita/month. 1USD≈8,300LAK (22 Sept 2017).

Education. According to the Vietnamese government standard, there is a kindergarten and a primary school in every village, and in Laos, there are primary schools in villages as well. Secondary boarding school is located in the commune center in Vietnam, and in Laos each village group has a secondary boarding school. Many ethnic minority children drop out of school after primary school or during the secondary school, and very few, if any, continue to high school that is located in the district center.

In the villages, the ethnic minority people use their own ethnic language in everyday communication. Women regularly have lower education level than men, because girls drop out of school early during the secondary school in order to help their families with household work. Many elder ethnic minority women are not able to communicate fluently in the national language, and in some villages up to 90% of the elder women are illiterate.

Livelihoods. All the inhabitants in the Project areas are farmers living on low-productive rain-fed upland rotational swidden agriculture, combined with forest resources utilization, fishery and livestock breeding. Many households do not have sufficient food year round. In some villages 50% of the households lack rice during the period from March to August, prior to the annual harvest. Apart from upland rice, all farmers cultivate maize and cassava for animal fodder. Vegetables and fruit trees are grown on riverbanks, but in many areas the land along the Nam Mo River is too steep and rocky to allow cultivation activities.

Ky Son is a rural district and an overwhelming majority of the inhabitants in its 21 communes are farmers living on upland agriculture and forestry. Cultivable land resources are limited and main part of agriculture takes place in the upland areas. Table 10 below provides an overview of land use in the three communes to be affected by the Nam Mo 1 HPP.

Table 10. Land use in Muong Ai, Muong Tip, Ta Ca and Nam Can communes

SN	Land Use	Commune			
		Muong Ai	Muong Tip	Ta Ca	Nam Can
1	**Agriculture land (ha)**				
	Wetland paddy	54	3	40	NA
	Other annual crops	13	38	24	NA
	Perennial Crops	0	0	34	NA
	Total	**67**	**41**	**98**	
2	**Forest land (ha)**				
	Protection Forest	4,200	3,416	1,885	NA
	Production Forest	625	2,922	1,896	NA
	Special use land	0	96.5	0	NA
	Total	**4,825**	**6,434.5**	**3,781**	
	Total land area (ha)	9,190	12,470	6,443	NA
	Households	420	517	1,037	812
	Population	2,442	2,998	4,779	4,270

Source: PECI, 2017. Livelihoods Survey Report – Nam Mo 1 HPP ESIA (April 2017), Land use Plan of Village, Keng Du Commune 2015.

Implementation of the Project will require relocation of 10 villages (see Table 10 above) consisting of 502 households. In addition, six villages with 246 households (initial count at this stage) may potentially lose their land. Altogether they cultivate 1505ha of upland farm and 97ha wetland paddy crop annually. Under the rotational farming system, they grow 559ha of maize, 380ha of cassava and 188ha of other crops including peanuts, ginger,

pumpkin and taro (Table 11). The estimated livestock population reared in the three communes is 3,374 cattle, 1,819 buffaloes, 6,965 pigs, 1,294 goats, and 12,307 poultry, including ducks.

Table 11. Estimated area under crop cultivation in Project influenced communes

Commune	House holds	Population	Estimated area planted with crops (ha)					
			Upland rice	Wetland rice	Maize	Cassava	Others	Total
Muong Ai	420	2442	805	54	289	110	163	1421
Muong Tip	888	4349	450	3	110	120	15	698
Ta Ca	1037	4779	250	40	160	150	10	610
Total	**2,345**	**11,570**	**1,505**	**97**	**559**	**380**	**188**	**2,729**

Source: Areas according to the commune's statistics; area measured by the CPC

There are 15,040ha of forests in the three communes in Ky Son District (Table 12). In villages, people have encroached on Production Forest for upland cultivation. Agriculture cultivation covers 206ha, based on field data collected in January 2017. It is to be noted that there is encroachment of the different forest types, particularly Production Forest areas, for agriculture, which are not reported. The data from commune usually does not match the actual land under agriculture – largely so in typically swidden agricultural areas.

Table 12. Agricultural and forest land of the Project influenced communes of Ky Son District, Vietnam

Agriculture and forest land	Commune (ha)			
	Muong Ai	Muong Tip	Ta Ca	Total
Agricultural land	67	41	98	206
Production forest	625	2992	1896	5443
Special land use	0	96.5	0	96.5
Protection forest	4200	3416	1885	9501
Households	420	517	1037	2786
Population	2442	2998	4779	4270

Source: PECC1, Commune Livelihoods Reports for Nam Mo 1 HPP ESIA, April 2017. Land use data (productionis based on commune level statistics (2010).

Upland rice is the major crop grown in the Project AI, production is about 1.2 to 3mt/ha. Wetland rice is more productive at 2.5-3.3mt/ha. The villagers also plant cassava and maize and contributes to the farm production in the community. Table 13 summarizes the productivity of farm products in the different Project villages. In terms of production, cassava has the highest yield among the crops.

Table 13. Productivity of farm crops in Project villages

Commune	House holds	Population	Productivity (mt/ha)					
			Upland rice	Wetland rice	Maize	Cassava	Others	Total
Muong Ai	420	2442	1.1-3.0	2.0-3.0	2.5-3.0	18-20	1.9- 2.0	25.5-31
Muong Tip	888	4349	1.3-3.0	2.5-3.0	4.0-5.5	18-20	9.13-9.15	34.93-40.65
Ta Ca	1037	4779	1.3-3.0	4	2.5-4.0	17-20	0.12-0.16	24.92-31.16
Total	**2,345**	**11,570**	**1.2-3.0**	**2.5-3.3**	**3.0-4.2**	**17.6-20**	**3.71-3.77**	**28.9 - 34.27**

Source: Areas according to the commune's statistics; area measured by the CPC.

Livestock breeding is the most important livelihood after farming for people in the remote villages. All households have chicken and geese for family food, pigs are grown mostly to be sold but also to be eaten at special occasions as festivity food in the village. Animal diseases and deaths are not uncommon, especially among pigs and chicken that are roaming freely in the villages, and epidemics and cold weather kill even cattle. Animal deaths are reported to be more common in the villages in Vietnam, where veterinary services appear to be less available than in Laos, where villagers' knowledge in animal breeding appears to be somewhat better than in the Vietnamese villages. Most families have a few cows and some households even have buffaloes, which both are kept entirely for selling to generate cash. Together with goats, kept by some farmers, these livestock graze on riverbank grasslands and forests near the upland fields. Animals can roam freely because there are no wildlife predators in the nature.

Forest resources are the crucial base for the daily food and provide approximately 50% or more of the livelihoods of the people in the riverside villages. Non-timber forest products (NTFPs) are important for household food, medicine supply and economy. Women collect bamboo shoots and wild-growing vegetables and mushrooms every day for family food. Some NTFPs like mushrooms, bamboo shoots and medicinal herbal plants are sold to traders. Men collect firewood and do logging of timber that is both used for construction of houses, other structures in the village and sold to traders. Hunting of birds, rats, bamboo rats, squirrels and snakes is done regularly for household food, mainly with crossbows and traps. Wild boars are hunted during the harvest season near the upland fields.

Nam Mo River is another source of livelihoods for the villagers. Most of the households have boats and fish for household food on a daily basis. In addition, they sell fish when the catch is large enough; fish is dried and salted and also made into fish sauce to be sold later. Men fish with nets both from boats and from the shore, women and children use baskets, and also collect shrimps, snails and moss in the shallow river. Fish is an important protein source for the inhabitants along the river. Riverbanks, in some places are also used for home gardening, and these areas serve as pasture for animals as well. However, large parts of the river and riverbanks are rocky and many areas are steep, where riverbank cultivation is not possible. The river is used for transportation but has been limited by the construction of the Nam Mo HPP, the existing plant downstream of this Project.

Due to the remote location and poor transportation infrastructure **trade and business is very limited**. There are no commune markets, only a district market in the district town. In most villages, there are one or two petty (sundry) shops selling daily consumer goods like rice, salt, fish sauce, drinks, sweets and gasoline. Mobile Vietnamese traders visit villages in both countries for buying and selling goods.

There are very few available non-agricultural labour opportunities. Both permanent and seasonal labour migration of mostly young men and women but even entire families is very common both in Vietnam and in Laos.

Cultural heritage. People in the villages to be affected by the Nam Mo 1 HPP along the Nam Mo River mainly belong to the ethnic minority groups of Kho mu and Hmong. Forest and river provide their needed resources and form the context for their material and spiritual culture. The local worldview contains gods/spirits related to different elements and places in nature. Every family respects its household gods/spirits and ancestors' spirits.

The physical elements of the spiritual culture include spirit forests which are usually located at some distance (about 1km or more) from the village. People are not allowed to utilize forest resources in the spirit forest, however, cattle graze there. Death ceremonies are related to the river, and village graveyard is often located near the river. Each village has a village worship place that is importantly located under the biggest tree in or outside the village. In some villages there is a small wooden spirit house in place, while in some villages only a small wooden platform is used for offerings. Annual ceremonies take place there twice a year, the month of the year depending on the ethnic group residing in the village. Ceremonies are typically connected to the cultivation cycle in the upland fields.

Gender roles and issues. In the Project-area villages, women work in upland fields, in forest and by the river, side by side with men in the livelihoods activities. Women in the ethnic minority villages have in general, lower education level than men. Elder women are often illiterate and cannot fluently use and understand the national language. Especially the Kho mu and Hmong girls drop out of school early, in order to help their families with household work and livelihoods activities. It is common for these girls to get married when 14-15 years. Women are less mobile than men, and they rarely travel outside their village and livelihoods activity areas. Men are decision makers in the village, and women are not customed to speak up or express their opinions in meetings. Due to the low educational level and limited knowledge of ethnic minority women, it is difficult for them to learn new skills for improving their livelihoods and living conditions.

Major reasons for prevailing poverty. There are very few available livelihoods opportunities apart from upland cultivation combined with livestock breeding, fishing and forest resources utilization. The available production land is located in high areas with deep slopes, and in the Vietnamese territory, where the available land is not sufficient for the farming population, pressure on land is therefore high. Erosion and poor soil quality also contribute to very low field yields. Cultivation methods are manual, seeds are local, farmers lack fertilizers and there are no soil improvement methods, which lead to low productivity with hardly enough food for household annual consumption. Every year, many households in the Project-area villages lack rice during the months before the annual harvest.

Cultivation is rain fed and there are no irrigation systems. Agricultural and livestock services are very deficient in Vietnam. In Laos, veterinary services appear to be better available and consequently, animal mortality is lower than in Vietnam. Support and advice from the commune/district is lacking, seeds are not provided at an optimal time, seeds provided are often that of high-fertilizer demanding varieties and farmers lack sufficient skills to take care of the animals that they receive through government development programs.

Villages are remote, far away from the district center both in Laos and in Vietnam, and poor road infrastructure affects people's mobility and market access. Market infrastructure is undeveloped with the only available markets in the district towns. Most villagers rarely visit the district center, and women do not even go to the commune center or village group center more than 1-2 times per year. Mobile traders buy agriculture and forest products from farmers in the villages for low prices and sell them household goods for high prices.

All the affected people are ethnic minorities who use their own language in everyday communication. Many elder people are illiterate and the general educational level is low, especially in the Vietnamese villages. Many people are not fluent in the national language and lack ability to take opportunities for health, hygiene, livelihoods or other living standards improvements. Still many children in Vietnam drop out of secondary school in order to contribute to the economy of their poor families. Children grow up with deficient education which further hampers their capacity to avail new opportunities to escape poverty.

Project impacts

Land and households

Land loss. A total of 1600ha of land will be used by the Project (see Table 3). This will include mainly agricultural, different forest assemblages and grassland. The wildlife and plant resources will be lost permanently, while some areas in the auxiliary areas, although used only during construction phase, the change will be permanent.

Villages to be inundated. The reservoir is expected to inundate nine villages in Vietnam and one village in Laos that have to be relocated. The table below summarises the number of households and people count and their ethnicity in each of the villages that will be affected.

All the households in the affected villages are extremely poor, under or just above the poverty line as defined by the GoV and the GoL.

Table 14. Villages in the reservoir inundation and construction areas of Nam Mo HPP to be relocated

Nam Mo 1 HPP Villages to be relocated				
Village	**HH**	**Population**	**HH poverty %**	**Ethnicity**
Muong Ai Commune - Vietnam				
Xop Tip	16	84	88	Kho mu
Muong Tip Commune - Vietnam				
Xop Tip	29	146	86	Kho mu
Xop Phe	76	360	78	Kho mu
Cha Lat	16/29*	92/166	100	Hmong
Vang Ngo	17/47**	130/356	85	Hmong, Kho mu
Ta Do	99	556	97	Kho mu, Thai***
Subtotal Muong Tip Commune	237/280	1,284/1,584		
Ta Ca Commune – Vietnam				
Sa Vang	97	510	100	Kho mu, 6 HHs Thai
Na Nhu	67	360	100	Kho mu
Nhan Ly	51	275	100	Kho mu
Subtotal Ta Ca Commune	215	1,145		
Total to be relocated - Vietnam	**468**	**2,513**		
Nonghed District - Laos				
Namuang	34	224	77	Kho mu
Total to be relocated - Laos	**34**	**224**		
Total Nan Mo 1 HPP	**502**	**2,737**		

* Village consists of 2 hamlets, one by the river with 16 HHs, and the other higher up with 13 HHs.

** Village consists of 2 hamlets, commune centre is in the lower hamlet and will be inundated.

***5 Thai HHs relocated in 2006 from Ban Ve HPP.

Village land to be inundated. Added to the villages that will be inundated, land in the area of two villages in Nam Can commune in Vietnam are within the proposed reservoir area. In Laos, four villages that are located far from the river have land areas along the river. The villages that will lose land in the reservoir can be seen in Table 15.

Table 15. Villages in Vietnam and Laos with land areas to be inundated by Nam Mo 1 HPP

Nam Mo 1 HPP Villages with Land Losses					
Village	**HH**	**Pop.**	**HH poverty %**	**Ethnicity**	**Impact**
Nam Can Commune - Vietnam					
Tien Tieu	170	420	61	Hmong	Production land and Protection forest area by the river
Khanh Thanh	76	386	74	Kho mu	Land to be inundated: 9ha Protection forest and abt 25ha cultivation land, fishponds, fruit trees, grassland belonging mainly to CPC Vice chair, and to three other HHs.
Nonghed District - Laos					
Sanche			These villages are located far away from the Nam Mo River and separated from it by a steep mountainous terrain. However, according to the ASA ESIA Report (Aug 2016), land along the river is associated to these four villages (ownership or management). There is no information in the ASA report about the type of land and its utilization. The riverside in these areas is steep and probably not in an active use by the named villages. The affected areas, their status and utilization have to be investigated during the detail design phase.		
Kenglet					
Phavanh					
Longkoang					

Xop Tip Village in Vietnam subject to relocation

Construction area impacts. Ta Ca Commune with 2,513 Kho Mu and Thai ethnic minority people in 468 households is located approximately 1km downstream of the river from the planned dam site and in the midst of the project construction areas. This village will be highly impacted of the planned workers' camp with estimated 1,750 workers next to it, and of all the construction transportations in the road along the village border as well as of dust, noise, pollution and material disposal from the dam construction in the vicinity of the village.

Downstream water regime. It is estimated that downstream villages of the planned damsite will be potentially affected by the low flow during dry season and fluctuation from the reservoir water regulation. Nhan Cu village in Ta Ca commune is located 2.1km downstream of the proposed dam and therefore will be potentially affected. However, Nhan Cu is also along the stretch of the existing Nam Mo HPP reservoir area, downstream of the proposed Nam Mo 1 HPP.

Physical losses due to reservoir inundation and dam construction

Loss of private property. Affected households will lose their private houses and attached assets.

The structures include:
(i) family home;
(ii) barns for preserving agricultural products;
(iii) fences around the house;
(iv) Some villages have connection to the electricity grid, and those who don't, have their own micro-hydro generator; and
(v) private boats that are used for fishing and river transportation.

Loss of land. The land to be inundated consist of:
(i) residential land that each household has a land certificate on;
(ii) land used for production: (a) upland cultivation land; (b) home garden; (c) riverbank cultivation land;
(iii) forest that is utilized for: (a) timber logging for house construction and for selling; (b) hunting animals for household food and for selling; (c) collecting NTFPs at a daily basis for household food, such as wild growing vegetables, bamboo shoots, mushrooms; (d) collecting firewood; and
(iv) animal grazing land.

Loss of public infrastructure. The reservoir will inundate public infrastructure in villages and adjoining areas, including:
(i) village access road;
(ii) inter-village roads;
(iii) water supply system with water tanks and water pipes leading water from streams to villages;
(iv) electricty supply;
(v) schools;
(vi) village cultural house;
(vii) commune centre with government offices and health clinics; and
(viii) border guard stations.

Loss of cultural heritage. All the villages have areas that are of cultural and spiritual importance. The reservoir will inundate:
(i) village spirit forest located at some distance from the village in a Protection forest area;
(ii) graveyard located outside village; and
(iii) village worship place under a big tree with a small wooden spirit house or altar for offerings.

Non-physical losses due to reservoir inundation and dam construction

Loss of access to livelihoods resources. The Project will inundate land, forest and water areas that are used for household livelihoods. The reservoir and dam construction will also cut accessibility to areas with livelihoods resources such as cultivation and forestry areas across the reservoir lake. Moreover, the HPP will disturb aquatic resources (amount of fish, shrimps, snails and other crustaceans) and wildlife that are important for households' food security in the Direct and Indirect Impact Areas.

Loss of access to transportation. Due to available road access in all the affected villages and the shallow and rocky structure of the river in many areas, the Nam Mo River is moderately used as a transportation way by the villages to be affected by the reservoir inundation. The existing Nam Mo HPP downstream the planned Nam Mo 1 dam has already affected accessibility, so that villagers can no more travel by boat to the district town as they used to do before the Nam Mo dam construction. River transportation of agricultural products, timber and NTFPs currently takes place in a limited scale in the planned reservoir and downstream area. People also cross the river for visiting relatives and for working in Laos.

Major constraints in agriculture

Farming system. The Project AI has a mountainous terrain and the people living there are ethnic minority people who rely on subsistence farming for their livelihoods. The area for wetland paddy and for perennial crops is limited. Farmers grow rain-fed crops on swidden land on slopes located mostly in production forests. They harvest one crop per year and leave the land to fallow between two to four years. On sloping land without terraces, animals or machines cannot be used for ploughing land and therefore farming operations are done manually. Farmers use local seed materials except maize and farming technology has not improved over the years. Many farmers do not grow vegetable because they prefer to collect wild-growing vegetables for home consumption in the forests. Crops are grown as monoculture, but peanuts, ginger and other crops grown in small areas are also intercropped with cassava and maize. Agriculture extension service is deficient.

Soil fertility. There is no intervention observed in improving swidden cultivation in the Project AI. This agriculture practice is not sustainable: The period of keeping land fallow after cultivation to rejuvenate soil fertility is very short (not sufficient for the soil to recover) due to demand for farming the land again. Fertilizers are not used, except occasionally in maize cultivation, and there is no system of compost making. Legumes are not grown as main crop or as an inter-crop which could gradually build up soil fertility. In upland agriculture, annual cropping without reasonable improvement measures rapidly degrades soil. Farmers indicated poor crop yields due to low soil fertility.

Climate change. Crop yields are highly varying, and farmers reported reduced yields due to unfavorable weather conditions and long periods of droughts. Yield of the hybrid maize is only 40-50% of its potential. Failures of harvest were reported by villagers. Climate change effects will be more profound for crops growing on swidden land because these crops grow under natural conditions and wholly depend on rainfall and temperature regimes, which are gradually changing.

Livestock feeds and fodder. All the livestock reared are of undescribed local breeds adapted to free-ranging system and low level of nutrition and management. Farmers reported shortage of fodder for ruminants during winter months, and in some villages an acute shortage was observed. Some farmers rearing hybrid pigs buy commercial livestock feeds. Nutrition level has to be improved for livestock development and better yields.

Animal health service. Livestock health status is in general, poor and high mortality in pigs and poultry was reported. Animal health service is not easily available, and if available, it is costly and of poor standard. Farmers are not trained and lack knowledge in disease treatment. In some villages, farmers are aware of prevention methods such as vaccination, but the lack of veterinary services makes it very difficult for them to improve their livestock farming.

Livelihoods – linkages and dependence

Currently, livelihoods of the local communities in Laos and Vietnam in the Project AI depend upon forest, water and land resources, the later in the form of swidden (shifting cultivation) agriculture (Figure 3**).** Forest dependence is high, forests providing protein resources, edible and medicinal plants, vegetables, materials for household energy, construction and other use, and animal protein through small mammals, birds, rodents, lizards and amphibians. Water resources provide free protein through fishes and aquatic insects. Apart from daily food, both these resources are helpful in generating some occasional cash through sale of small mammals and rodents. Livestock is another source of animal protein (mainly poultry) and of cash income through sale of live animals. However, animal health services are poorly available and animals are often lost in disease outbreaks. Swidden agriculture is less productive but provides carbohydrates in the form of rice as a staple food, while maize and cassava are grown for livestock fodder. Rice production is, however, not sufficient for yearly consumption needs for the poor families, and food security is a serious aspect influencing Project Affected Person (PAP) lives and wellbeing. This livelihoods scenario among the ethnic minorities/groups will continue resulting in deterioration of forest and other land in use until changes are brought to the practices used and sustainable

processes are put in place. The Nam Mo 1 HHP Project affecting the above resources will have detrimental effects on livelihoods of the people living in the Project DIA. In the context of livelihoods, forest resources are significantly more important than fisheries, livestock and crop farming as these provide a reliable and available source of food and other products.

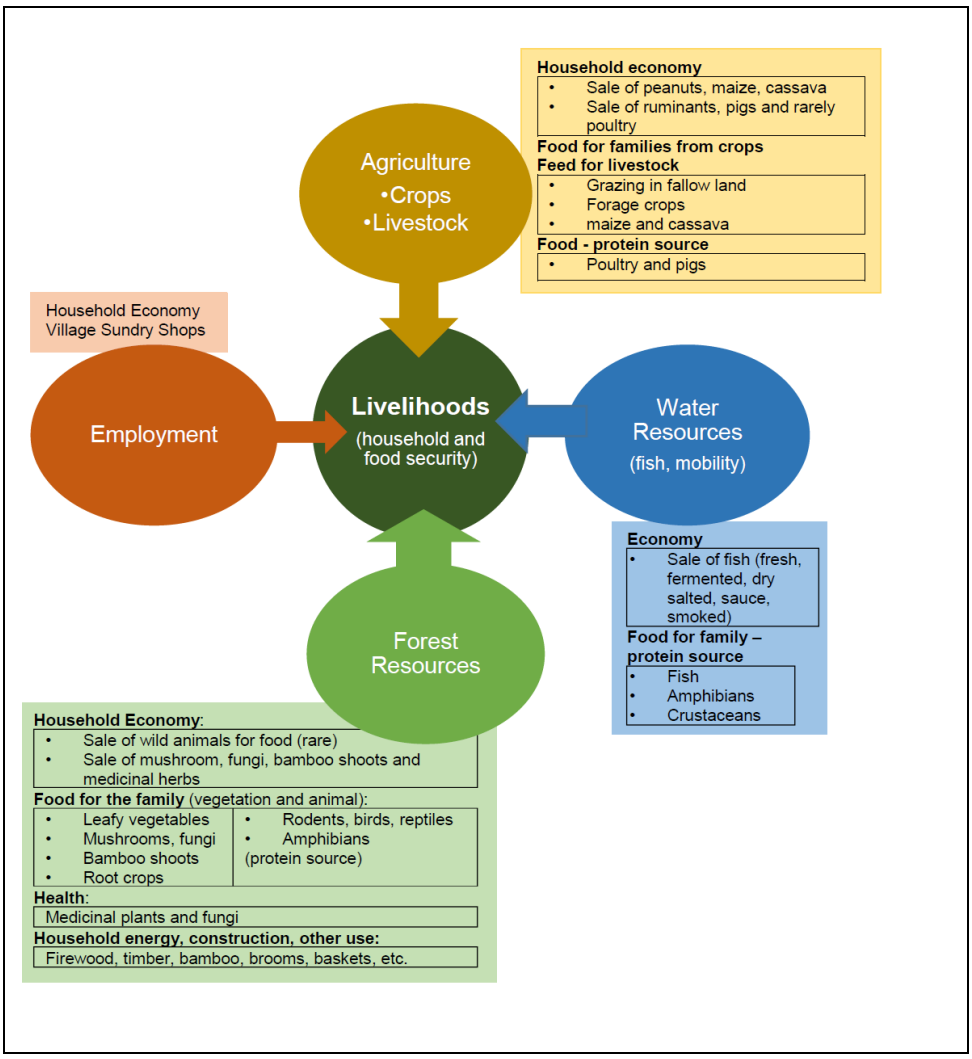


Figure 3. Livelihoods of Project affected households are dependent primarily on forest resources followed by upland agriculture and the water resources of the river.

Biodiversity

The terrestrial ecosystem, mainly forests and grasslands and aquatic ecosystems and their quality in the form of water resources in rivers, as a function of river's catchment, provide a good habitat for wildlife and aquatic life including fish. Biodiversity of forest vegetation and wildlife are inter-related, and serve to provide products for humans, enriched soil (after a few years or regeneration) for agriculture and work to reduce siltation through providing a more stable land cover than, for example, grasslands do. In the Nam Mo 1 HPP area, biodiversity of forest vegetation, a growing secondary forest vegetation after exploitation or developing through a progressive forest succession on uncultivated fallow land is comparatively low but growing. This has resulted in riverine locations of habitats where biodiversity of wildlife is limited to smaller size mammals, e.g., rodents and bats, and reptiles and amphibians. A past long period of exploitation of mature forests has depleted larger wildlife and timber resources. Short - to long - distance migratory fish species and resident species make-up the existing fish biodiversity, however a dam (Nam Mo HPP) operating downstream from the proposed Nam Mo 1 HPP has already impacted upward movement of migratory species, particularly for spawning. Nonetheless, the presence of 80 fish species and several other aquatic species in Nam Mo River indicate that the biodiversity has not deteriorated significantly.

Both the terrestrial and aquatic ecosystems in the Project area provide tangible food products and some cash flow for the ethnic minority communities. The communities in the project area depend more on forest resources including wildlife and aquatic resources, fish and other, for their livelihoods than on crop farming which is restricted mainly to rice. The food resources from the forests are vital, for daily needs and during lean periods when food is insufficient. In general, a hydropower project disturbs the ecosystem, and as in the case of Nam Mo 1 HPP, it will affect significantly the product availability from the forests and rivers to the local people. The mitigation suggested is meant to minimize impacts due to the land-take of the Project through proposing forest conservation, biodiversity restoration, fish monitoring and agriculture enhancement measures linked to community involvement.

Cumulative Impacts

Cumulative impacts are those that result from the incremental impact of the Project when added to existing, planned and reasonably predictable future projects and developments. The cumulative impacts of the propsed Project have been assessed based on the principles outlined in the IFC Guidance Notes (2012). It aims to better understand the impacts of the existing HPP and planned HPPs within the Ca River cascade system, together with this Project.

While there is currently limited quantitative data on some receptors available to make a fully informed cumulative impact assessment, the assessment nevertheless looked at different vital ecosystem and social attributes aspects such as biodiversity, critical habitats, sensitive receptors, livelihood and ecosystem services.

The Nam Mo 1 HPP is planned on the Nam Mo River, one of the major tributaries of the Ca River. During the preparation of this ESIA, there are hydropower projects either existing, underconstruction or planned on the Nam Mo River. Upstream are three HPPs namely Nam Mo 3 (operational), Nam Mo 2 (Under construction) and Nam Mo 1 (same name of this Project, located in Laos). Downstream of the Project are the Nam Can 2 (in operation), Nam Mo (in operation) and Nam Cun (under construction).

The proposed location of the Nam Mo 1 damsite is within the reservoir tail of the existing Nam Mo HPP, and therefore there is an overlap between the two HPPs. The additive impacts are therefore expected to be minimum. The current fishing activities are not expected to be altered due to Nam Mo 1. It would be necessary to monitor the river water levels and river use during the dry season as the regulation of both the planned Nam Mo 1 HPP with respect to Nam Mo HPP will be done at the detail design phase.

The length of the planned Nam Mo 1 HPP reservoir is expected to sustain a range of fish species and serve for fishing needs. This is the case in other reservoirs in the region and elsewhere in Vietnam.

Ecosystem services

Ecosystem Services (environmental services) are the benefits that people derive from the ecosystems and includes four types: provisioning, regulating, cultural and supporting services. In the case of Nam Mo 1 HPP the most relevant types are those provisioning services commonly referred to as natural resources, e.g., water, food and fuel contributing to the human well-being, being central to livelihoods in the DIA and IIA. In order of decreasing relative contribution to livelihoods and importance, the ecosystems services including provisioning, cultural, recreation are from:

- Forest and forest-bamboo (food sources mainly rodents, snakes, birds; medicinal plants; firewood, wood for construction);
- Land (agriculture for rice production, cash crop (peanuts) and feed (maize and cassava) for livestock, some grazing of livestock; vegetation cover that provides for soil and slope stability in Project direct and indirect impact areas); and

- Water (fish, crustaceans; transport; cultural importance linked to rituals related to burials and spirits; bathing).

The dependence on forest and forest-bamboo ecosystems is high and its contribution is directly contributing to provision of food sources, especially protein in the form of rodents and snakes. Many HH make daily collections for food sources from forest ecosystems. The areas that will be inundated will result in a loss of core nutrition and protein source. The water resources of the river are important sources of fish for many villages located in the planned inundation area (direct impact area, reservoir). This ecosystem service will change in composition and will need to be managed if the reservoir is to be used as a source of fish. The river which is currently free flowing and is used to travel across the river and along the river, although moderately. Burial ritual related sacrifice (chickens) is performed with the river serving as pathway for spirits.

There are intimate livelihoods links with forests, the Nam Mo River and uplands which all provide ecosystem services to the local communities. Ecosystem services and their dependence is high and the loss is significant. The conservation and sound management of forest ecosystems and sustainable use of agricultural and grazing land is required in the relocation areas, so that the ecosystem services are available. The river provisioning services may be lost, except for fish in the form of aquaculture or reservoir fishing.

Communication

Previous consultations. The Proponent and hired national consultants in Vietnam and Laos have had several meetings with the local authorities at commune and village levels about the proposed Project during 2012-2016. People in the villages to be affected by the Project have also been informed about the possibility of the HPP in a few instances. These consultations were not arranged in a manner to allow informed consultation and participation of the project affected people and cannot be considered as part of the Informed Communication and Participation (ICP) process.

ICP process initiated. The Free, Prior, and Informed-Consent (FPIC) was initiated in June 2017 when a Vietnamese communication team hired by the Proponent according to advice from and designed by the International Consultant undertook informed consultations in all the villages to be affected by the HPP. Villagers were provided information about the planned Project, its impacts and proposed mitigation measures using communication methods that were understandable for them. Their questions, opinions, views and concerns on the project impacts and proposed mitigation measures were discussed and recorded in a village consent document in each village to be relocated. In those villages that will lose riverside land but not be relocated, the consultant had similar consultations with the Village leader.

The FPIC consultations showed *broad community support* for the Project and agreements were obtained through the consultations. Main concerns of communities are presented below.

Main concerns from the affected people. People in all the villages to be relocated agreed in principle to the relocation, but some of them expressed concerns and had alternative suggestions for the proposed relocation site. Relocation site and the available land and water resources there were the most important criteria for the affected villagers to agree to the relocation. Other concerns and suggestions that commonly came up in the consultations include:

- Compensation payment should be made in maximum of two larger payments and not in several smaller ones, and the payment should be made in full before relocation;
- Affected households should receive compensation payment directly from the Proponent, not through commune or village government authorities;
- Request that people will screen the proposed relocation site together with the project planning team in order to verify the location, land and water availability, etc.;

- Request that people are involved in the design and relocation of the village, location of graves and spirit forest;
- House placement direction is important and depends on each ethnic clan;
- Forest protection and management and the income it brings to local people is important, and should not be disrupted by the relocation;
- Land use certificates have to be issued on the new location to all households; and
- There has to be a monitoring and compliant (grievance) system, and villagers should be involved in the monitoring.

These and other expressed concerns are to be addressed by the Proponent in follow-up community consultations..

Mitigation and enhancement measures

Specific and general measures have been proposed to mitigate impacts. Below are flow charts of the key plans for managing social, environmental and resettlement impacts. Elaboration of the key plans spanning all programs are provided in the ESIA and Environment and Social Management Plan (ESMP), Resettlement and Ethnic Minority Livelihoods Restoration Plan (REMLRP) and the Public Communication and Disclosure Plan (PCDP). A resettlement policy and entitlements framework is proposed in the REMLRP.

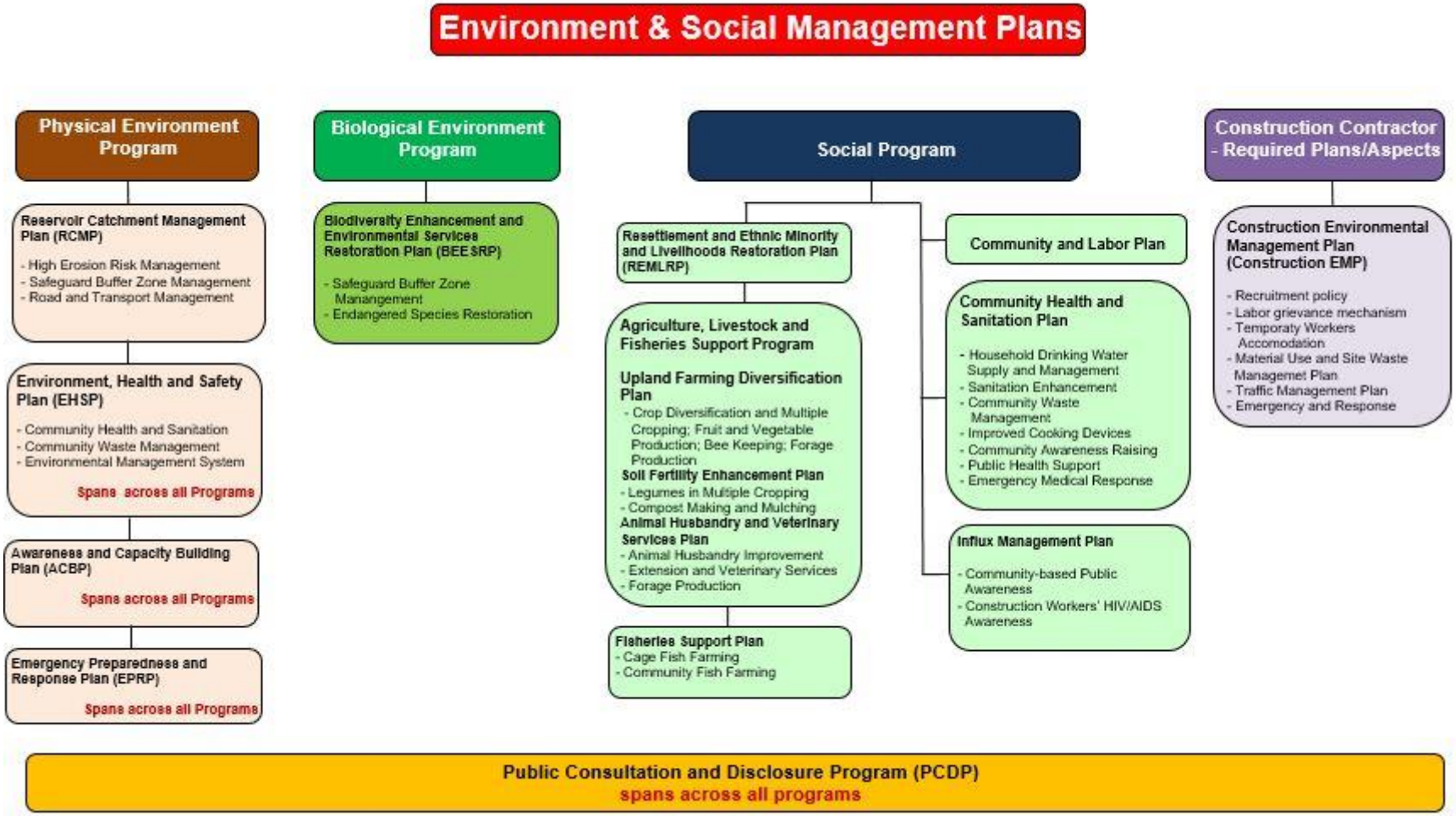
Physical and biological impacts of hydropower projects can be significant and permanent and if proper mitigation is not conducted at the appropriate time, consequences can be dire. Similarly, the loss of land and properties and the displacement of population from their settlement areas are probably among the major social and cultural impacts of the Nam Mo HPP. As part of the project optimization process a number of measures have been taken to minimize the social and ecological footprint of the Project. The main Programs are:

- Physical Environment Program;
- Biological Environment Program; and
- Social Program.

In addition, requirements for the construction contractor are eluded for initial guidance to the Proponent.

Grievance Redress Mechanism. The proponent has to establish in the project planning phase a Grievance Redress Mechanism (GRM) consistent with the MIGA Performance Standard 1. The GRM will provide the PAP clear and practical mechanism to express their complaints and concerns about the project's social and environmental performance. The GRM will allow the Proponent to receive and address any issues on land acquisition, compensation and relocation from the relocated people and host communities. The GRM will also allow the Proponent to address complaints from people in the Indirect Impact and Tertiary Impact Areas who may be affected due to the project activities and activities related to the presence of the Project. The GRM will allow issues to be raised in a timely fashion, and include a mechanism designed to resolve disputes in an impartial manner.

The GRM should be based on the local community organization and be culturally appropriate and understandable for the affected people. It is an integral part of the PCDP. Prior to relocation, the GRM should be adapted to the local community organization structure.


Environment & Social Management Plans
Physical Environment Program
Reservoir Catchment Management Plan (RCMP)
- High Erosion Risk Management
- Safeguard Buffer Zone Management
- Road and Transport Management
Environment, Health and Safety Plan (EHSP)
- Community Health and Sanitation
- Community Waste Management
- Environmental Management System
Spans across all Programs
Awareness and Capacity Building Plan (ACBP)
Spans across all Programs
Emergency Preparedness and Response Plan (EPRP)
Spans across all Programs
Biological Environment Program
Biodiversity Enhancement and Environmental Services Restoration Plan (BEESRP)
- Safeguard Buffer Zone Manangement
- Endangered Species Restoration
Social Program
Resettlement and Ethnic Minority and Livelihoods Restoration Plan (REMLRP)
Agriculture, Livestock and Fisheries Support Program
Upland Farming Diversification Plan
- Crop Diversification and Multiple Cropping; Fruit and Vegetable Production; Bee Keeping; Forage Production
Soil Fertility Enhancement Plan
- Legumes in Multiple Cropping
- Compost Making and Mulching
Animal Husbandry and Veterinary Services Plan
- Animal Husbandry Improvement
- Extension and Veterinary Services
- Forage Production
Fisheries Support Plan
- Cage Fish Farming
- Community Fish Farming
Community and Labor Plan
Community Health and Sanitation Plan
- Household Drinking Water Supply and Management
- Sanitation Enhancement
- Community Waste Management
- Improved Cooking Devices
- Community Awareness Raising
- Public Health Support
- Emergency Medical Response
Influx Management Plan
- Community-based Public Awareness
- Construction Workers' HIV/AIDS Awareness
Construction Contractor - Required Plans/Aspects
Construction Environmental Management Plan (Construction EMP)
- Recruitment policy
- Labor grievance mechanism
- Temporaty Workers Accomodation
- Material Use and Site Waste Managemet Plan
- Traffic Management Plan
- Emergency and Response
Public Consultation and Disclosure Program (PCDP)
spans across all programs

Social and environmental planning and management, monitoring and auditing

The application of mitigation measures, monitoring, and environmental audit of the proposed Project have been recommended to ensure the validity of impact prediction, effectiveness of mitigation measures and sustainable social, economic and cultural development of the local and adjacent community. The measures proposed are expected to be formulated in detail during the pre-construction (design phase) of Nam Mo 1 HPP. A Social and Environmental Management Division has been proposed to manage and implement the proposed ESMP and the REMLRP under the Proponent's management. The ESMP and REMLRP will be linked to the social mitigation and enhancement measures undertaken under the same division. Similarly, a PCDP and GRM have been proposed for the Proponent's management. An organizational structure and program has been proposed for the ESMP and other safeguard documents. Note that the mitigation measures may change after the public consultations are held during the pre-construction phase.

The proposed PCDP sets the principles and procedures as required according to MIGA PS 1 and PS 7 for an ICP process during the project planning, implementation and operation monitoring to ensure the FPIC of the Project affected ethnic minority/groups communities in Vietnam and in Laos.

Conclusion

The Nam Mo 1 HPP is planned along a stretch of the Nam Mo River, one of the main tributaries of the Ca River at the border of Vietnam and Laos. The technical feasibility of the Project has been performed for an installed capacity of 90 MW.

The main anticipated negative impacts of the Project include:

(i) the loss of land and assets of Project Affected People due to land permanently acquired and used by the Project both in Laos and Vietnam;

(ii) resettlement and social change;

(iii) changes related to the loss of Production and Protection forests, agricultural land and associated wildlife habitat;

(iv) changes related to the change of the river into a reservoir affecting connectivity/transport and fisheries;

(v) loss of forest-river related ecosystem services affecting livelihoods which are dependent on these systems.

The main anticipated positive impacts of the Project include:

(i) Increase in mobility and accessibility to the affected villages and Project area in general due to improved roads and provisions of new roads to the villages. This may trigger positive impacts on livelihoods, in making markets accessible, easier access to health care and other services;

(ii) Restoration of forest-grassland areas so that the vegetated areas improve in quality, such that sediments are reduced, availability of forest products are assured overtime and wildlife habitat is increased. This will ensure that ecosystem services are enhanced, maintained and is sustainable;

(iii) Improvement in agricultural methods and products whereby food insufficiency does not occur;

(iv) Improved energy availability and use, better cooking methods and electricity; and

(v) Increase in well being is expected, provided proposed measures are implemented.

Mitigation and enhancement measures on potential social-cultural, forest, agricultural, biological and physical impacts are proposed to minimize the effects and therefore enhance community well being and forest-agriculture central to livelihoods. Measures include, among others, plans for livelihood restoration, immediate catchment management, ecosystem services enhancement, health and safety measures. The measures proposed in the ESMP will help minimize the ecological footprint of the Project. Safeguard documents include the REMLRP and ESMP guided by the PCDP. An adaptive management process should be adopted to adjust plans according to findings from monitoring, consultations, and audits. A Social and Environment Division (SEMD) of Nam Mo 1 HPP will administer the ESMP through the establishment of a Social and Environmental Management Unit (SEMU).

CHAPTER 1 INTRODUCTION

1.1 The Project

The Project is situated in two of the nations in Indochina or the Southeast Asian region, bordered by China, Myanmar, Thailand and Cambodia. Laos (also Lao PDR) is land locked. Both the governments of Vietnam and Lao PDR have an agreement to develop hydropower projects on the Nam Mo river. Nam Mo River is part of the Ca river system and is located in Nghe An Province of Vietnam and parts of it is within the Lao PDR territory in Xiangkhoang Province. This is an essential part of Vietnam's master plan for a hydropower power cascade development along the Ca river system.

In March 2016, a meeting between the two governments took place to craft the terms of the agreement and content of the cooperation[12] (Annex 1.1). Prior to the meeting there had been numerous studies to determine the feasibility of the hydropower scheme. Further detailed studies were carried out after the signing of the agreement.

The Nam Mo 1 Hydropower Project was designed to have a capacity of 90MW with a storage reservoir of about 962ha development. My Ly - Nam Mo Hydropower Joint Stock Company (JSC), a private Vietnamese enterprise was incorporated by the Vietracimex (a Vietnam based enterprise) to develop the Project. One of the conditions of the agreement between Vietnam and Lao PDR is the preparation of an Environmental Impact Assessment (EIA). Two national EIAs were prepared, one for each country and are subject to each country's respective national procedures and compliance.

My Ly-Nam Mo JSC, the project 'Proponent' intends to acquire a loan to finance the development of the project. The Proponent plans to apply for a political risk guarantee from the Multilateral Investment Guarantee Agency (MIGA, World Bank Group) to secure the loan. The National EIAs were found not to be compliant with MIGA policy thus requiring upgrading. One of the requirements for a loan agreement is to prepare an international Environmental and Social Impact Assessment (ESIA) based on MIGA Performance Standards[13].

This ESIA Report presents an assessment of the potential environmental impacts associated with the Nam Mo 1 Hydropower Project in Nghe An Province, Vietnam ('the Project').

[12] The First Negotiation Round. Agreement Between the Government of the Lao Peoples Democratic Front and the Government of the Socialist Republic of Vietnam. 11 March 2016 (Vol. 11, Annex 1.1).
[13] MIGA standards are identical to that of IFC. MIGA also applies IFC's Guidance Notes (2012).

1.2 The Project Proponent

My Ly - Nam Mo Hydropower JSC is a special purpose company/enterprise that has been set up by Vietracimex in Vietnam to develop the Project. The Proponent involved in the development of the Project and this ESIA is:

Project Proponent
Name of Proponent: **My Ly - Nam Mo Hydropower Joint Stock Company (JSC)** Representative: Mr. Nguyen Tien Phong Position: Deputy General Director Headquarters: No. 148 Nguyen Sy Sach street, Hung Dung ward, Vinh city, Nghe An Province, Viet Nam Working office: No. 926 Bach Dang road, Thanh Luong Ward, Hai Ba Trung District, Ha Noi City. Telephone: +84 (04) 36334194; - Fax: +84 (04) 36334194: Tax code: 2901444639

1.3 The International ESIA consultant and supporting teams

The International Consultants Team responsible for the ESIA is managed by a Norwegian based company, ENVIRO-DEV, 2510 Tylldalen, Norway. Org. No. 988 903 620. (env-dev@online.no)

National teams providing input and support

The National Consultant Team which assisted with logistics, field work in the local language and interpretation/translation of the earlier reports/data (technical feasibility) in Vietnamese, and maps is Power Engineering Consulting Joint Stock Company (PECC1; Tax Code: 01100100953), an affiliate of EVN (Electricity of Vietnam), Vietnam. Address: Km 9+200 Nguyen Trai Street, Thanh Xuan Nam Ward, Thanh Xuan District, Hanoi.

The independent National Consultant Team under the direction of ENVIRO-DEV for informed communication and participation processes was headed by Ms. Vu Thi Hien (ID034154001218), Room 11.21, Floor 11, Bac Ha Lucky Building, No. 30, Pham Van Dong St.; Cau Giay district, Hanoi, Vietnam.

1.4 Purpose of this document

The purpose of this report is to present the environmental and social assessment carried out for the Project in compliance with the requirements of MIGA.

The specific objectives of the ESIA are:

1. Identify and establish the current environmental (physical and biological), social, and economic conditions of the Project's Direct Impact Area (DIA), including permanent structures and construction areas;
2. Describe the Project and its associated activities and identify potential impacts to the environment within the Project's Area of Influence (AI). Similarly identify environmental and social conditions that may have an impact to the proposed Project and its design;
3. Evaluate potential impacts of the Project including factors such as magnitude, extent and duration of the impacts and the affected elements such as the Project Affected People/Community (PAP) and the natural environment;
4. Identify potential mitigation measures to avoid and minimize the impacts including compensation costs, if avoidance is not feasible;
5. Assess the best alternative Project and measures; and
6. Formulate an environmental and social management plan and key safeguard frameworks.

1.5 Report structure

The report is structured to generally conform to the preferred outline for international environmental and social assessments. It has 10 ten volumes, the main report and the annexes. Volume 1- Main Report (the ESIA) has 17 chapters while Volume II – Annexes contains supporting documents such as copy of agreements, relevant permits and approval issued to the Project, and appendices to the biological chapter and Specialists reports. Chapter 3 and 4 present the technical basis of the project Project while chapters Chapters 5-10 provide the approach taken for the ESIA, baseline environments, key cross-cutting aspects and the communication conducted. The impact assessment and mitigation are covered in chapters Chapters 11-12 and culminate in the Environment and Social Managament Plan (ESMP) and monitoring needs in chapter Chapters 13 and 14, respectively. The references are provided in chapter Chapter 15 followed by the list of key individuals involved in the Project and a brief concluding chapter make up the last two chapters. Volume III covers the social baseline and Volume IV the records of communication conducted. The following volumes V-VII provide the main safeguard and management plans, while Volumes VIII to IX are executive summaries in three languages.

Volume I **Main ESIA report has the following chapters:**

- Chapter 1 - Introduction
- Chapter 2 - Policy, guidelines and legal instrumental framework
- Chapter 3 - Project description
- Chapter 4 - Analysis of alternatives
- Chapter 5 - Approach
- Chapter 6 - Physical characteristics
- Chapter 7 - Biological characteristics
- Chapter 8 - Social and livelihoods characteristics
- Chapter 9 - Cross-cutting issues
- Chapter 10 - Communication, participation and disclosure
- Chapter 11 - Impact assessment and mitigation
- Chapter 12 - Summary of mitigation, enhancement and safeguard measures
- Chapter 13 - Environmental and Social Management Plan
- Chapter 14 - Monitoring matrix
- Chapter 15 - References
- Chapter 16 - Teams involved
- Chapter 17 - Conclusion

Volume II **Agreements, approvals and specialist reports**

- Annex 1 Agreements and approvals
- Annex 2 Appendices, specialist reports on (a) Biology and (b) Water quality

Volume III **Social baseline**

- Annex 3 Social and Livelihoods Reports

Volume IV **Communication**

- Annex 4 Consultations before 2017
- Annex 5 ICP process reports

Volume V **Public Communication and Disclosure Plan (PCDP)**

Volume VI **Resettlement and Ethnic Minority Livelihoods Restoration Plan (REMLRP)**

Volume VII **Environmental and Social Management Plan (ESMP)**
Volume VIII **Executive Summary – Vietnamese**
Volume IX **Executive Summary – Lao**
Volume X **Executive Summary – English**

CHAPTER 2 POLICY, GUIDELINES, & LEGAL INSTRUMENTAL FRAMEWORK

This Chapter outlines the main standards and guidelines that were used as benchmarks for the ESIA and safeguard documents that will be developed. These were also used in assessing the adequacy of the data and information collected for the ESIA.

2.1 International standards and guidelines

The Project is Category A under MIGA's Policy on Environmental and Social Sustainability (2013). It is expected to have potentially significant adverse social and environmental impacts that are diverse, irreversible, or unprecedented.

The Project Developer, My Ly-Nam Mo Hydropower JSC, was asked to prepare and submit to MIGA the ESIA, a Resettlement Policy Framework (RPF) and Ethnic Minority Development Framework documents prior to the decision of the loan from the Bank.

MIGA has a Sustainability Policy and set of Performance Standards (PSs) on Social and Environmental Sustainability (2013) (Table 2.1) and has been the reference of this ESIA. . The PS[14] highlights the significance of managing environmental, social and health issues during the life of a project. They identify the need for an effective social and environmental management system that is dynamic and continuous, 'involving communication between the client, its workers, and the local communities directly affected by the Project'. They require 'thorough assessment of potential social and environmental impacts and risks from the early stages of project development and provides order and consistency for mitigating and managing these on an ongoing basis'.

The PS strengthen the significance of successful community engagement through disclosure of project-related information and consultation with local communities on concerns that directly affect them. Through the PS, MIGA necessitate clients to engage with affected communities through disclosure of information, informed consultation and participation, in an approach commensurate with the risks to, and impacts on, the affected communities. MIGA PS also refers to the Guidance notes (2012) supporting each of the PS and are available on the IFC website and were also utilized[15].

Table 2.1 Summary of MIGA Performance Standards

MIGA Performance Standards (2013)	Brief description
Performance Standard 1 Assessment and Management of Social and Environmental Risks and Impacts	Identify and assess social and environmental impacts, both adverse and beneficial, in the Project's area of influence. Avoid, or where avoidance is not possible, minimize, mitigate, or compensate, for adverse impacts on workers, affected communities, and the environment. Ensure that affected communities are appropriately engaged on issues that could potentially affect them.

[14]https://www.miga.org/projects/environmental-and-social-sustainability/performance-standards/, see also reference to IFC guidance notes linked to the performance standards listed here. These are similar to the ones of MIGA sister organization IFC.

[15]http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/performance+standards/environmental+and+social+performance+standards+and+guidance+notes

MIGA Performance Standards (2013)	Brief description
	Promote improved social and environment performance of companies through the effective use of management systems.
Performance Standard 2 Labor and Working Conditions	Establish, maintain and improve the worker-management relationship. Promote the fair treatment, non-discrimination and equal opportunity of workers and compliance with national labor and employment laws. Protect the workforce by addressing the child labor and forced labor. Promote safe and healthy working conditions, protect and promote health of workers.
Performance Standard 3 Resource Efficiency and Pollution Prevention	Avoid or minimize adverse impacts on human health and the environment. Avoid or minimize pollution from project activities. Promote the reduction of emissions that contribute to climate change.
Performance Standard 4 Community Health, Safety and Security	Avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances. Ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.
Performance Standard 5 Land Acquisition and Involuntary Resettlement	Avoid or at least minimize involuntary resettlement wherever feasible by exploring alternative project design. Mitigate adverse social and economic impacts from land acquisition or restrictions on affected person's use of land by: (i) providing compensation for loss of assets at replacement cost; and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. Improve or at least restore the livelihoods and standards of living of displaced persons. Improve living conditions among displaced persons through provision of adequate housing with security of tenure and resettlement sites.
Performance Standard 6 Biodiversity Conservation and Sustainable Natural Resource Management	Protect and conserve biodiversity. Promote the sustainable management and use of natural resources through the adoption of practices that integrate conservation needs and development priorities.
Performance Standard 7 Indigenous Peoples (IPs) *NOTE: the term Ethnic Minorities is used in this ESIA and associated documents for consistency*	Ensure that the development process fosters full respect for dignity, human rights, aspirations, cultures and natural resource-based livelihoods of IPs. Avoid adverse impacts of the Project on communities of IPs, or when avoidance is not feasible, to minimize, mitigate or compensate for such impacts and to provide opportunities for development benefits, in a culturally sensitive manner.

MIGA Performance Standards (2013)	Brief description
with the national terminology.	Establish and maintain an ongoing relationship with the IPs affected by the project throughout the life of the Project. Foster good faith negotiation with and informed participation of IPs when projects are to be located on traditional or customary lands under use by the IPs. Respect and preserve the culture, knowledge and practices of IPs.
Performance Standard 8 Cultural Heritage	Protect irreplaceable cultural heritage from the adverse impacts of project activities and support its preservation as well as promote the equitable sharing benefits from the use of cultural heritage in business activities.

The framework under which an MIGA ESIA is undertaken cascades down from the performance standards to a set of EHS - there is a general IFC EHS Guideline and a series of industry specific guidelines (World Bank Group; IFC 2007). For this Project, the Proponent have required that the following guidelines in addition to the performance standards need to be adhered to, as relevant (Table 2.2).

Also relevant is the IFC guidance note on worker's accommodation (IFC and EBRD.2009. Workers' accommodation: processes and standards. A guidance note by IFC and EBRD)[16]

Table 2.2 Summary of IFC EHS Guidelines

IFC EHS (2007)	Brief Description
Environment	
Air Emissions and Ambient Air Quality	This guideline provides an approach to the management of significant sources of emissions, including specific guidance for assessment and monitoring of impacts. They are: (1) Ambient Air Quality, (2) Point Sources, (3) Fugitive Sources, (4) Mobile Sources – Land-based (5) Greenhouse Gases (GHGs) and, (6) Monitoring.
Energy Conservation	This guideline complements the industry specific emissions guidance presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines by providing information about common techniques for energy conservation that may be applied to a range of industry sectors. This guideline includes (1) Process Heating, (2) Process Cooling and, (3) Compressed Air Systems.
Wastewater and Ambient Water Quality	This guideline provides information on common techniques for wastewater management, water conservation, and reuse that can be applied to a wide range of industry sectors. This guideline includes (1) General Liquid Effluent Quality, (2) Wastewater Management and, (3) Monitoring.
Water Conservation	Water conservation programs should be implemented commensurate with the magnitude and cost of water use. Water conservation measures may include water monitoring/management techniques; process and cooling/heating water recycling, reuse, and other techniques; and sanitary water conservation techniques.

[16] http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_gpn_workersaccommodation

IFC EHS (2007)	Brief Description
Hazardous Materials Management	The overall objective of hazardous materials management is to avoid or, when avoidance is not feasible, minimize uncontrolled releases of hazardous materials or accidents (including explosion and fire) during their production, handling, storage and use. The objectives of the guideline are (1) General Hazardous Materials Management, (2) Preventive Measures, (3) Control Measures and, (4) Management of Major Hazards.
Waste Management	These guidelines apply to projects that generate, store, or handle any quantity of waste across a range of industry sectors. It provides specific guidance for Waste Management Facilities. This guideline applies to Waste Management, Hazardous Waste Management and Monitoring activities associated with the waste management.
Noise	This section addresses impacts of noise beyond the property boundary of the facilities. This guideline applies noise prevention, mitigation measures and monitoring.
Contaminated Land	This section provides a summary of management approaches for land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances. The steps to be taken: (1) Risk screening, (2) Interim risk management, (3) Detailed quantitative risk assessment and, (4) Permanent risk reduction measures.
Occupational Health and Safety	This section provides guidance and examples of reasonable precautions to implement in managing principal risks to occupational health and safety. Preventive and protective measures should be introduced according to the following order of priority: Eliminating the hazard by removing the activity from the work process. Examples include substitution with less hazardous chemicals, using different manufacturing processes, etc.; Controlling the hazard at its source through use of engineering controls. Examples include local exhaust ventilation, isolation rooms, machine guarding, acoustic insulating, etc.; Minimizing the hazard through design of safe work systems and administrative or institutional control measures. Examples include job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration, etc.; Providing appropriate personal protective equipment (PPE) in conjunction with training, use, and maintenance of the PPE.
Community Health and Safety	This section complements the guidance provided in the preceding environmental and occupational health and safety sections, specifically addressing some aspects of project activities taking place outside of the traditional project boundaries, but nonetheless related to the project operations, as may be applicable on a project basis. This section complements includes (1) Water Quality and Availability, (2) Structural Safety of Project Infrastructure, (3) Life and Fire Safety, (4) Traffic Safety, (5) Transport of Hazardous Materials, (6) Disease Prevention and (7) Emergency Preparedness and Response.
Construction and Decommissioning	This section provides additional, specific guidance on prevention and control of community health and safety impacts that may occur during new project development, at the end of the project life-cycle, or due to expansion or modification of existing project facilities. This guideline applies to Environment; Occupational Health and Safety and Community Health and Safety.

2.2 Relevant policies, guidelines, permits/licenses and procedures of Vietnam and Lao PDR

2.2.1. Vietnam

This section describes the local legislations, standards and guidelines in Vietnam which are relevant to the Project. Table 2.3 presents the key policies while Table 2.4 lists the various permits, both primary and secondary permitting required in Vietnam.

Table 2.3 List of key policies and regulations of Vietnam

Policy and guidelines/regulations	Description
Environment Protection Law 55/2014/QH13 (23 July 2014)	The Environmental Protection Law (EPL) of Vietnam provides an umbrella framework for environmental management and protection of the country and has the latest revision in 2014. The primary authority to carry out the mandate is the Ministry of Natural Resources and Environment (MONRE). At the provincial level, the Provincial Department of Natural Resources and Environment (DONRE) is the operating unit for overall environmental management. The Law has the relevant decrees as follows: **Decree 29/2011/ND-CP (18 April 2011).** This decree provides regulations on strategic environmental assessment, environmental impact assessment and environment protection commitment/plan. It spells out the need for an EIA for various project developments. The above decree was used as reference by the Project during the preparation of the local EIA. ***The Project was granted its government consent and was issued the Decision of Approval from MONRE on 20 November 2015.*** **Decree No. 18/2015/ND-CP (14 February 2015)** In 2015, this decree was issued and supersedes Decree 29/2011/ND-CP, above. This new circulation expands the list of projects which requires environmental and social impact assessment, and therefore has no impact on the Project's approval. **Figure 2.1** shows the EIA procedures.
Land Law No. 45/2013/QH13 (29 November 2013)	This law spells out the States authority and responsibilities on land regimes. It provides the regulations on unified management of land and land-uses, land ownerships and land use rights as well as obligations of land owners/users. Relevant decrees: **Decree No 43/2014/ND-CP (01 July 2014)** Regulates the compensation, allowances, resettlement in case of land acquisition.

Policy and guidelines/regulations	Description
	Decree No. 47/2014/ND-CP (15 May 2014) Regulations on compensation, support, and resettlement upon land expropriation by the State.
Law on Forest Protection and Development **No 29/2004/QH11** **(3 December 2014)**	This law provides for the management, protection, development and use of forests and forests resources, forest owner's rights and obligations. It is MONRE which is responsible for the management and protection of biodiversity and forest environment. Relevant decrees **Decree No 32/2007 (30 March 2006)** Decree on the implementation of Law on Forest Protection and Development **Decree No 333/2010 (19 March 2010)** Decree on the Forest Protection – this decree defines the principles, procedures, management and sustainable use protection forests. **Circular Letter No.24/2013/TT-BNNPTNT** Circular issued by Ministry of Agriculture and Rural Development (MARD) where it provides the requirements when forests are converted to other land uses/purposes (e.g., off-sets). **Decree No 99/2010/ND-CP and its amendment Decree No 14/2016/ND-CP**. Policy on payment for forest environmental services. This decree and its amendment spell out the forest services that require payment, obligations of forest services provider and users, including rate of payment.
Law on Water Resources No. 17/2012/QH13 **(21 June 2012)**	This law outlines principles and responsibilities relating to water resources. A relevant regulation, the national technical regulation on hydraulic structures for design (**QCVN 04-05 – 2012/BNNPTNT)** provides the requirement for minimum flow for HPP's. Minimum flow (environmental flow) shall be equal to the average flow of the river during dry season, with frequency of 90%.
Biodiversity Law, No. 20/2008/QH12 (13 March 2008)	Pursuant to the 1992 Constitution of the Socialist Republic of Vietnam, which was amended and supplemented under Resolution 51/2001/QH10 dated on December 25, 2001 of the 10th National Assembly, the 10th session; this Law stipulates biodiversity conservation and sustainable development. **Decree No. 65/2010 (11 June 2010)** Detailed regulation and guidance on the implementation of some articles of the Law on Biodiversity.

In Vietnam, there are three stages of project development namely:

Stage 1 – Investment Preparation

Stage 2 – Investment Implementation

Stage 3 – Project Hand-over

Table 2.4 lists the permits and licenses required for each stage of the Project development.

Table 2.4 List of permits and licenses required for Nam Mo 1 HPP in Vietnam

No.	Permits and licenses	Required by:	Permit status (obtained /applied for/ to apply for)	Remarks
Stage 1 – Investment preparation (Pre-FS and FS stage)				
1	Master Plan VII	MOIT	Obtained 21 July 2016; amended 23 November 2016 to include Nam Mo 1 HPP	
2	Investment Decision (Approval of FS)	MOIT	Obtained 28 February 2017	
3	EIA Decision Approval	MONRE	Obtained 20 November 2015	The EIA included in-principle approval of tree and reservoir clearing, including water use but a detailed plan will need to be prepared and approved by relevant authority as part of the EIA approval compliance.
3	Compensation Framework and General Resettlement plan	Provincial People Committee (PPC)	Submitted in review	
4	Quarry Permit	PPC	To be applied for	
Stage 2 – Investment Implementation				
4	Detailed plan for Compensation and Resettlement	PPC/District People Committee (District PC)	To be applied for	
5	Land permit/Land use for Construction	PPC	To be applied for	
6	Construction permit	PPC	To be applied for	
7	Power Purchase Agreement	EVN	To be applied for	
Stage 3 – Project Handover				
Stage 3 is the period for performance and completion of the Project - from commencement of construction activities until Project delivery. During this period, Project's compliance to various commitments are monitored. Construction phase is estimated to be completed within a four year period under the supervision of the PPC.				

2.2.2. Lao PDR

Relevant key policies and guidelines and list of permits and licenses of Lao PDR are shown in Table 2.5 and Table 2.6

Table 2.5 List of key policies and guidelines of Lao PDR

Policy and guidelines/Regulations	Description
Environmental Protection Law No 29/NA 2012 (amended version)	The Environmental Protection Law (EPL) is the principal legal framework for environmental management of development projects in Lao PDR. This law was first promulgated on 3 April 1999 and was amended in 2012. It establishes the structure for unified environmental management with the aim of preserving the environment and making rational and sustainable use of natural resources. It defines the principles, regulations and measures related to environmental management, monitoring of protection, control, preservation and rehabilitation activities. It also aims to provide balance between social and natural environment, to sustain and to protect natural resources and public health; and contribute into the national socio-economic development and reduction of global warming. The Ministry of Natural Resources and the Environment (MONRE) is the primary agency responsible for the implementation of this law. In December 2013, two Ministerial Decrees were passed to implement the provisions of Article 21 (Initial Environmental Examination-new) and Article 22 (Environmental Impact Assessment -revised) of the EPL. These were: **Ministerial Instruction No 8030/MONRE 17 Dec 2013** - Process of Environmental and Social Impact Assessment of the Investment Projects and Activities **Ministerial Instruction No 8029/MONRE 17 Dec 2013** – Process of Initial Environmental Examination of Investment Projects and Activities. These decrees maintain the distinction between IEE and EIA processes. It aims to ensure uniformity in carrying out IEE/EIA for investment projects. The EIA procedures is shown in Figure 2.2 below. The EIA review process for the Project is still on-going. **MONRE (2010) Environmental Guidelines for Biomass Removal from Hydropower Reservoirs.** This guideline provides a step by step procedure on the preparation of biomass removal plan, which is a requirement in the EIA. The biomass removal plan aims to assess water quality and GHG emissions when building the reservoir. **Environmental Quality Standards No 2734/PMO MONRE 2009**. Consists of the following standards: Water Quality, Soil Quality, Air Quality, Noise Quality including pollutants emission standards.
Policy for Sustainable Hydropower Development in Lao PDR, 2015	Policy No.561/CPI 7 June 2015 - - This policy requires the conduct of a comprehensive EIA for all hydropower projects, including cumulative impacts for transboundary projects.

Policy and guidelines/Regulations	Description
	The EIA requires the inclusion of Watershed and Water Resources Plan and Monitoring. The policy also states the need for a comprehensive social impact assessment to safeguard the interest of the Project Affected People (PAP) and shall include a transparent consultation, taking into consideration ethnic's languages (if applicable), resettlement and just compensation, and gender development plan. It also states the revenue and benefit sharing through community funds.
The Forestry Law, 2007	The amended Forestry law outlines principles and responsibilities relating to all forest resources, including soil, flora, fauna, water, living and non-living resources. All forest land is owned by the State and has the authority to give user rights to communities in return for sustainable management of the resource. The Law outlines a nationwide forest classification system, under the Ministry of Agriculture and Forestry, which demarcates land to reflect its values for preservation and development. Forests in Lao PDR are classified into three primary categories: Protection forest, Conservation forest, and Production forest. Relevant Decrees of the Forest Law: Decree on Protection Forest No 333/PMO, 2010 Section 6 Chapter 31 spells the responsibility of project developers. Developers are required to set up a Forest and Forest Resources Development Fund for forest rehabilitation and shall be 1% of their annual income. Forests affected from road development and transmission lines requires 100% offsetting. Ministerial Regulation No. 0112, 2008, Regulation on Logging and Reservoir Clearing. Issued by the Ministry of Agriculture and Forestry, this regulation provides principle on logging and clearing forests from preparation to implementation including the responsible agencies
The Land Law, 2003	The Land Law was enacted on 23 October 2003. The law describes the system of land tenure, with all lands as the property of the nation, and remains under the control of the Government of Lao PDR. The law also recognizes and protects private land use rights. These rights can be transferred, granted by the state, or inherited, provided taxes payable on the land have been paid. This law provides an important framework for any land compensation, as despite the lack of title ownership, the land use rights are a trade able commodity. The land classification administration is also important for determining the various categories of land use within the project area. The overall responsibility for land administration is the National Land Management Authority. **Decrees relevant to Land Law**: Implementing decree on Land Law (2008) – this decree relates to the management, protection, use and development of land in an efficient, peaceful and fair manner. **Decree 84 on Compensation and Resettlement (5 April 2016)**

Policy and guidelines/Regulations	Description
	Provides detailed guidance to issues on resettlements and fair and equitable compensation. This decree provides a range of compensatory mechanisms required to ensure Project Affected Peoples (PAPs) are not worse off in terms of their socio-economic conditions. This includes consideration of economic, social, cultural and environmental aspects of the potential impacts of the proposed development. The decree also provides direction for community participation in the development of sound policies and procedures for implementing a compensation package.
Law on Electricity 2011	The Ministry of Energy and Mines (MEM) is the responsible agency for framing polies and strategies for the energy sector, while the Institute of Renewable Energy Promotion (IREP) under MEM oversees the implementation of renewable energy, energy efficiency and rural electrification programs in Lao PDR. The law also requires that EIAs be prepared for hydroelectric dams, along with budget estimates for environmental mitigation measures.
The Law on Natural Heritage, 2005	This law outlines the procedures for artifact discovery, archaeological excavations, and the rights of the Ministry of Information and Culture in the ownership and preservation of items of cultural, natural and historical heritage.
The Law on Water and Water Resources, 1996	This law outlines a similar approach with all water and water resources remaining the property of the State. If relevant approvals are gained by an applicant seeking to use water resources, individuals or entities may attain water use rights. Article 29 stipulates a range of responsibilities for all water users, including the preservation of water resources, the efficient use of water, and the responsibility to maintain water quality, including the environmental and aesthetic qualities of water bodies.

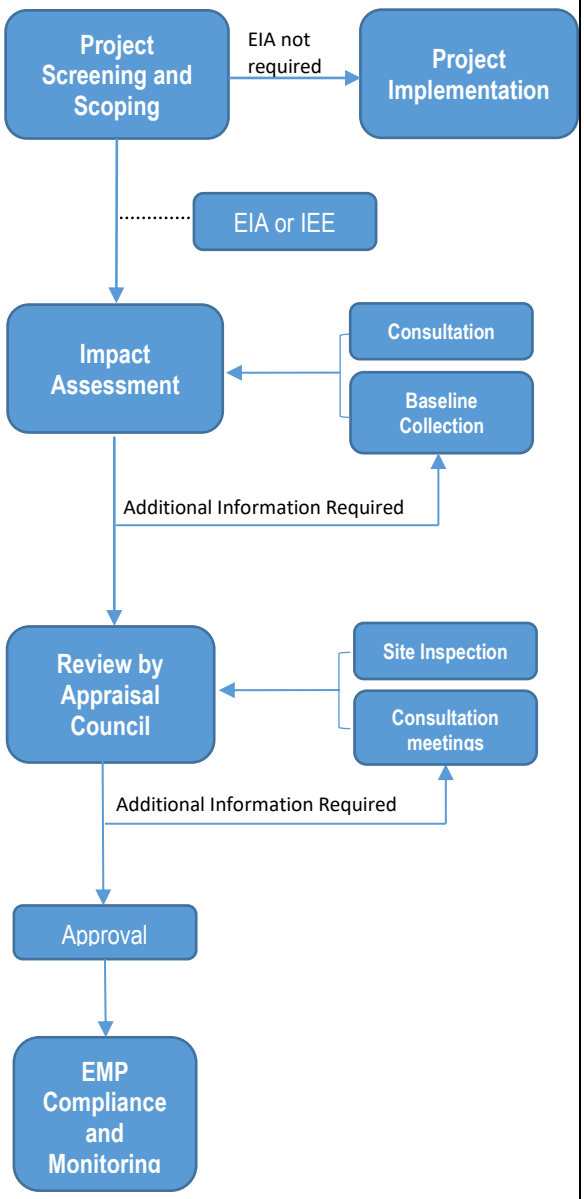
Most of the infrastructures will be located within Vietnam territory, and thus permits to be secured in the Lao PDR territory is limited and is presented in Table 2.6 below.

Table 2.6 List of permits and licenses required for the Nam Mo 1 HPP in Laos.

No.	Permits and licenses	Required by:	Permit status (obtained /applied for/pending)	Remarks
1	Environmental Compliance Certificate (ECC)	MONRE	In process	
2	Biomass removal plan/Tree cutting permit	MONRE	To be applied for once ECC is granted	
3	Resettlement plan	MONRE and Provincial	To be applied for	

2.3 Environmental and Social Impacts Procedures in Vietnam and Lao PDR.

The main steps of the GoV EIA are listed below.



Project screening and scoping
The Proponent (or its Environmental Consultant) determines if an EIA is required based on the screening criteria and project classification described in Decree 29/2011 ND-CP (and its update Decree No. 18/2015/ND-CP). This process is carried out during the feasibility study period. MONRE is not involved in the screening and scoping phase and does not approve the Teams of Reference (TOR) for the EIA. MONRE's involvement in the process commence when the EIA report is submitted (Article 23). Based on the complexity of the proposed project, it will be classified whether it will require an Environmental Impact Assessment (EIA) or an Initial Environmental Examination (IEE).

Impact assessment.
Proponent/Consultant prepares the EIA report with reference to requirements of Decree 29/2011 and Circular 26/2011/TT-BTNMT. Baseline collection will be carried out to establish baseline environmental profile. Consultation with the commune will be done, where a copy of the EIA report will be submitted to the commune for their assessment. A response from the commune signifying their acceptance or denial of the Project is expected within 15 days upon receipt of the EIA report.

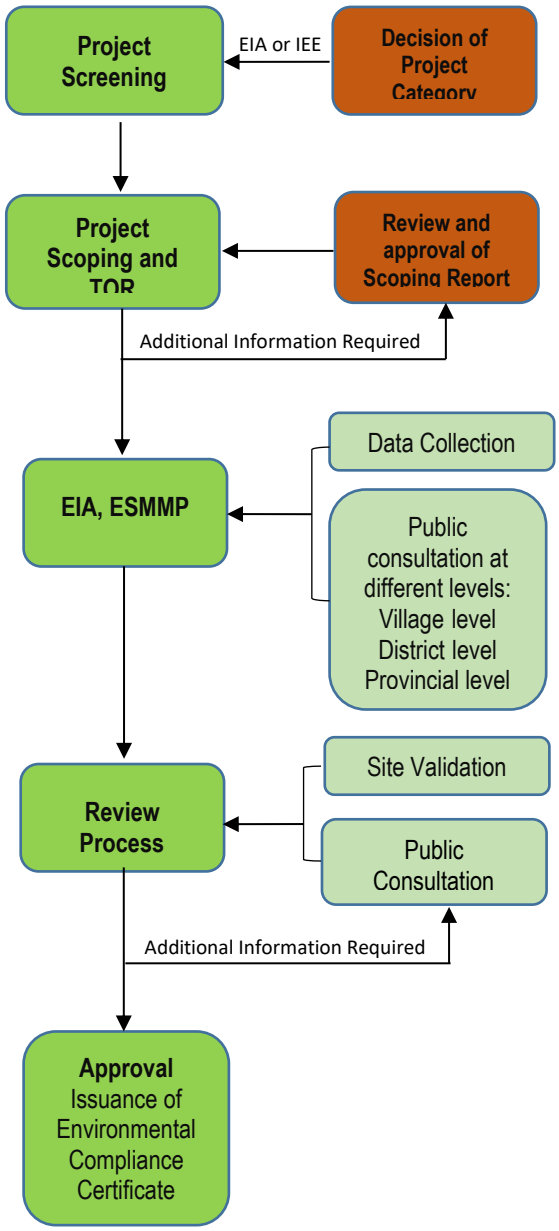
Review.
There are two stages of review. First stage is by the appraisal authority (the EIA Report Assessment Authority, in this case MoNRe), to determine the completeness of the document. Once approved by the Appraisal Authority, the Appraisal Authority convenes a committee (the EIA Report Assessment Council) for the final substantive review. The review process if appraised by MoNRE (as in the case of this Project) takes 45-60 days. Once the EIA report has been appraised and deemed complete, decision must be provided within 15 days.

Approval. If all requirements are met, approval is granted to the Project Proponent.

Environmental Monitoring Plan (EMP) Implementation. Once the project commences, the EMP is implemented, and monitoring for compliance is carried out all throughout the project cycle.

Figure 2.1. The EIA process in Vietnam

The EIA procedure in Lao PDR.



Project screening. The Project Developer (or its Environmental Consultant) submits an investment application to MoNRE, based on the criteria and project classification stated in Decree 112/PM. MoNRE will issue a decision whether the Project shall undertake an EIA or an IEE.

Project scoping. The Project Developer prepares a Scoping Report and detailed Terms of Reference (TOR) for the preparation of the EIA/IEE for approval by MoNRE. Within 15 business day, a decision of the approval of the TOR is issued.

EIA and ESMMP. Once TOR is approved, Preparation of the EIA Report, together with the Environmental, Social Management and Monitoring Plan (ESMMP) commence. Data collection is carried out to establish baseline profile, in conjunction with community consultations which starts at the village level. Continuing stakeholder consultation is being carried out at different levels, with the assumption that issues and concerns raised during these consultations are inputted in the draft EIA.

Review process. The review process includes an initial assessment to the completeness of the document. If deemed complete, within **10 days** upon submission of one set of document, the Proponent is advised to submit at least 15 copies more of the document for substantive review. When Final EIA report is ready, a technical review is done and a final public consultation at the provincial level is carried out. The review process takes **95 business days**.

Approval. When the EIA is satisfactory completed based on the guidelines, an Environmental Compliance Certificate (ECC) is issued. The ECC is valid for two years and therefore projects should be implemented within the period, otherwise a justification shall be made to request for an extension.

Figure 2.2. EIA procedures of the Government of Lao PDR

2.4 Resettlement guidelines and procedures in Vietnam and Lao PDR

The Land Law (2013) is the principal legal regulation that prescribes the land use rights and land management in Vietnam. It provides the regulations on unified management of land-uses, land ownerships, and land-use rights as well as the obligations of land owners/users.

Land are acquired for various purposes such as for national interest or economic development. The Land law also details guidelines on land acquisition, compensation,

support and resettlement. There are two relevant decrees that further details regulation on resettlement and compensation namely Decree No 43/2014/ND-CP (01 July 2014) and Decree No. 47/2014/ND-CP (15 May 2014). The former regulates the compensation, allowances and resettlement in case of land acquisition while the latter spells out the regulations on compensation, support, and resettlement upon land expropriation by the State.

The Social section and Volume VI discuss the resettlement framework for the Project while Figure 2.3 shows a typical steps for land acquisition, compensation and resettlement process:

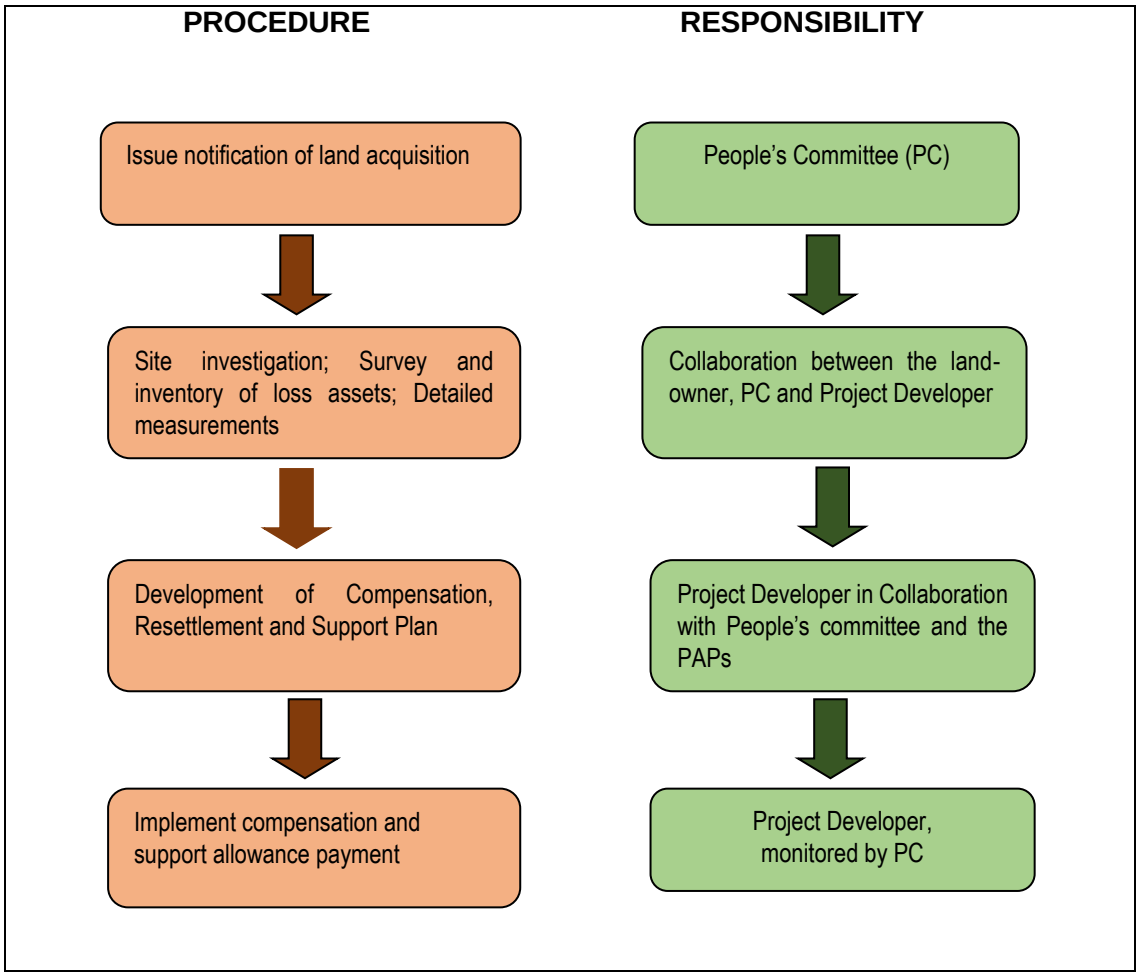


Figure 2.3 Land acquisition, compensation and resettlement process in Vietnam

In Laos, the main law that prescribes the compensation and resettlement for development projects is Decree No.84. This decree provides the principles, regulations and standards on management and monitoring of compensation losses as well as the management of resettlement activities. It aims to ensure that affected people are compensated, resettled and are assited with permanent livelihood alternatives, and therefore leads to improved living conditions, to be better off or to be at the same level as they were before the development. It also aims to ensure that the development project constibutes to a sustainable development of the community in particular and the nation in general. Figure 2.4 below presents the process of resettlement in Laos.

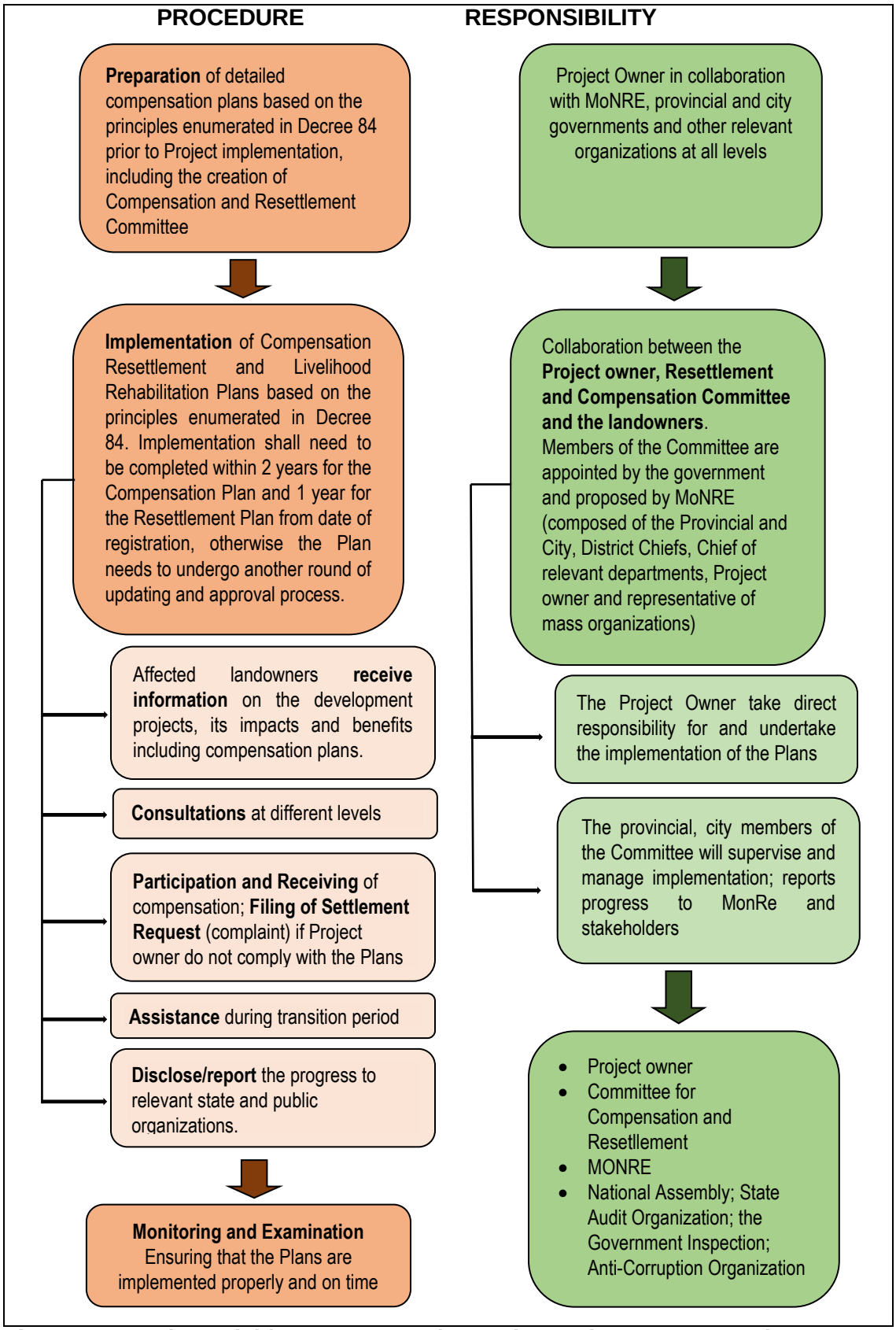


Figure 2.4 Land acquisition, compensation and resettlement process in Lao PDR

2.5 International Conventions ratified by Vietnam and Lao PDR

Vietnam is a party to the following conventions:

- The UNESCO World Heritage Convention (acceptance 19 October, 1987);
- Ramsar Convention on Protection of Wetlands (accession, 20 January 1989);
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (accession, 13 March 1995);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, also known as the Washington Convention) (accession, 20 January 1994);
- Convention on Biological Diversity (ratification,16 November 1994);
- Cartagena Protocol on Bio-safety to the Convention on Biological Diversity (accession, 21 January 2004)
- Kyoto Protocol to the United Nations Framework Convention on Climate Change) (ratification 25 September, 2002);
- Paris Agreement to the United Nations Framework Convention on Climate Change (Signatory, 15 April 2016);
- Mekong River Commission Agreement on the Cooperation for the Sustainable Development of the Basin (Entry into force, 5 April 1995); and,
- International Plant Protection Convention (Food and Agriculture Organization of the UN), (Contracting Party).

Lao PDR is a signatory to several international conventions and treaties. Those potentially relevant to the Project are listed below:

- The UNESCO World Heritage Convention (ratification 20 March, 1987);
- Ramsar Convention on Protection of Wetlands (accession, 28 September 2010);
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (accession, 21 September 2010);
- Convention on Biological Diversity (accession,20 September 1996);
- Cartagena Protocol on Bio-safety to the Convention on Biological Diversity (accession, 3 August 2004);
- Kyoto Protocol to the United Nations Framework Convention on Climate Change (ratification, 6 February 2003);
- Paris Agreement to the United Nations Framework Convention on Climate Change (Signature, 18 April 2016) ;
- Mekong River Commission Agreement on the Cooperation for the Sustainable Development of the Basin (Entry into force, 5 April 1995);
- International Plant Protection Convention (Food and Agriculture Organization of the UN, (Contracting Party); and,

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (accession, 1 March 2004).

2.6 Communication and public consultation

The Governments of both Lao PDR and Vietnam require consultations with Project Affected People (see policies above). In practice, the degree of communication and sharing of information varies from almost none to simple provision of leaflets and a public hearing. In this Project international practices was employed where sharing of information, two-way communication, representativeness among stakeholders and responsiveness to stakeholders was a core work approaches to the work. Meaningful consultations were held (see Communication section and Volume IV Annex 5). MIGA requirements served as a key benchmark.

2.7 Institutional framework

Various government agencies at national and local levels involved during project preparation and implementation of hydropower development projects in Vietnam and Laos are described here. National level agencies are described at ministerial and department levels, and local agencies at district and commune levels. Major environmental and social activities of Nam Mo 1 HPP and the responsible organizatuons are given in Table 2.7 for Vietnam, while Table 2.8 describes those in Laos.

Table 2.7 Major environmental and social activities of Nam Mo 1 HPP in Vietnam

No	Activities	Responsible organizations
1	Environment and social assessment and management	Ministry of Natural Resources and Environment (MONRE); Department of Natural Resources and Environment (DONRE)
1.1	ESIA preparation and approval	MONRE DONRE
1.2	ESIA implementation including monitoring	MONRE DONRE
1.3	Agriculture Development	Ministry of Agriculture and Rural Development (MARD) Department of Agriculture and Rural Development (DARD)
1.4	Forest conservation and improvement	MONRE/MARD DONRE/DARD
1.5	Fisheries	MARD DARD
2	Pollution prevention such as air, water and noise pollution control, hazardous material management, and waste management	Ministry of Trade and Industry Ministry of Natural Resources and Environment (MONRE)
3	Biodiversity conservation and natural resources management	MONRE
4	Health and safety	Ministry of Health (MOH) Department of Health (DOH)
5	Land acquisition, compensation and involuntary resettlement	Agency for Land Management *Peoples Committee*
6	Welfare of indigenous community	Committee for Ethnic Minorities Affairs Ministry of Education and Training (MOET)

No	Activities	Responsible organizations
		Department of Education for Ethnic Minorities
7	Preservation of cultural heritage	Ministry of Culture, Sports and Tourism
8	Labor working condition	Ministry of Labour –Invalids and Social Affairs (MOLISA) *Department of Social Protection*

Table 2.8 Major environmental and social activities of Nam Mo 1 HPP in Lao PDR

No	Activities	Responsible organizations
1	Environment and social assessment and management	Ministry of Natural Resources and Environment (MONRE); Department of Natural Resources and Environment (DONRE)
1.1	ESIA preparation and approval	MONRE
1.2	ESIA implementation including monitoring	MONRE
1.3	Agriculture Development	Ministry of Agriculture and Forestry
1.4	Forest conservation and improvement	Ministry of Agriculture and Forestry
1.5	Fisheries	Ministry of Agriculture and Forestry
2	Pollution prevention such as air, water and noise pollution control, hazardous material management, and waste management	MONRE
3	Biodiversity conservation and natural resources management	Ministry of Agriculture and Forestry
4	Health and safety	Ministry of Health
5	Land acquisition, compensation and involuntary resettlement	
6	Welfare of indigenous community	Lao Front for National Construction (LNF), Department of Ethic Affairs
7	Preservation of cultural heritage	Ministry of Information, Culture and Tourism
8	Labor working condition	Ministry of Labour and Social Welfare

CHAPTER 3 PROJECT DESCRIPTION

3.1 General overview

The National Power Development Master Plan for the 2011-2020, which was revised and approved on 18 March 2016, pointed to the need for more power with higher reliability and competitive electricity prices in all regions of Vietnam. Based on the master plan, there will be approximately 235-245 billion kWh of commercial electricity in 2020 while the expected production required is to be 265-278 billion kWh. In order to ensure national energy security, mitigate climate change, protect the environment, and promote socio-economic development renewable power sources are to be prioritized.[17] Other main sources of power will include thermal, solar, wind and coal.

One of the sites identified for hydropower development is in the Ca River. Ca River is one of the largest rivers in Vietnam and originates from Houaphanh and Xiangkhoang Provinces in Lao PDR, passing across Nghe An Province in Vietnam before it joins the eastern sea. Several studies have been carried out to determine the suitability of the river and its tributaries (including Nam Mo River) for hydropower development including the Master planning of a hydropower project cascade by Power Engineering Consulting Joint Stock Company as early as 2001. In 2011, Vietnam-Laos Economic Co-operation Corporation was assigned by the Vietnamese government to identify private investors for the development of Nam Mo 1 HPP as specified in letter No 8181/VPCP-QHQT (16/11/2011).

In the following year, My Ly - Nam Mo Hydropower JSC was formed by Vietracimex to develop the Nam Mo 1 HPP and later engaged Hydropower Engineering Consultancy and Construction Company to prepare the Feasibility Study (FS) in June 2012.

An agreement between the GoL and the GoV was signed in 2016 stipulating the cooperation of the two countries to develop the Nam Mo 1 HPP including its agreement terms on investment, construction, operation and management of the project. After this agreement, a more detailed FS has been carried out including procurement of primary permits such as national environmental clearances for both Lao PDR and Vietnam..

3.2 Project location and accessibility

Nam Mo 1 HPP (90 MW) is planned on the Nam Mo River located in the boundary area of Vietnam-Lao PDR in Nghe An Province, district of Ky Son in the northern part of central Vietnam. It is a tributary of the Ca River.

The main components (dam, powerhouse, spillway, intake, etc.,) and auxiliary areas are located around 1km from the Vietnam - Lao PDR border in Ta Ca commune, Ky Son district, Nghe An province, Vietnam (Table 3.1, Table 3.2; Figure 3.1, Figure 3.2).

The catchment area down to the proposed dam site is 2,492km^2, while the total length of reservoir is approximately 33km. The first 1km long passage of the reservoir is located in Vietnam territory. The middle passage of the reservoir is 32km length and is located on Vietnam - Lao PDR boundary line, in which the right bank of the reservoir is located in Nghe An province, Vietnam and the left bank of the reservoir is located in Xiengkhoang province of Lao PDR. The tail end of the reservoir about 1.6km is located within Laos territory.

[17]The Prime Minister of Government. (2016). Decision on the Approval of the Revised National Power Development Master Plan for the 2011-2020 Period with the Vision to 2030.

Table 3.1 Administrative areas and the number of villages affected by the planned Nam Mo 1 HPP

Hydro-power Project	Country	Province	District	Commune	Number of villages resettlement affected by project/total number of villages in the commune	Project Components planned in commune*
Nam Mo 1	Vietnam	Nghe An	Ky Son	Muong Ai	1 / 8	Reservoir Proposed resettlement areas
				Muong Tip	5 / 9	Reservoir Proposed resettlement areas
				Ta Ca	3 / 10	Reservoir, Main work and auxiliary work sites Proposed resettlement areas
				Nam Can	2 / 6	Reservoir
	Laos	XiangKhoang	Nonghed	None (*)	5 / 8	Reservoir Proposed resettlement areas

**There is no commune level in Lao PDR.*

The tentative locations of the main project components are presented in Table 3.2.

Table 3.2. Dam and powerhouse location

Project Component	Latitude	Longitude	Location (commune)
Proposed dam site	19.414 19.411098	104.081122 104.076923	Ta Ca
Proposed powerhouse	19.413465 19.412305	104.079384 104.081262	Ta Ca
Tailrace outlet	19.41228 19.41104 19.410251	104.080281 104.081137 104.080906	Ta Ca

Source: PECI, 2017 (updates)

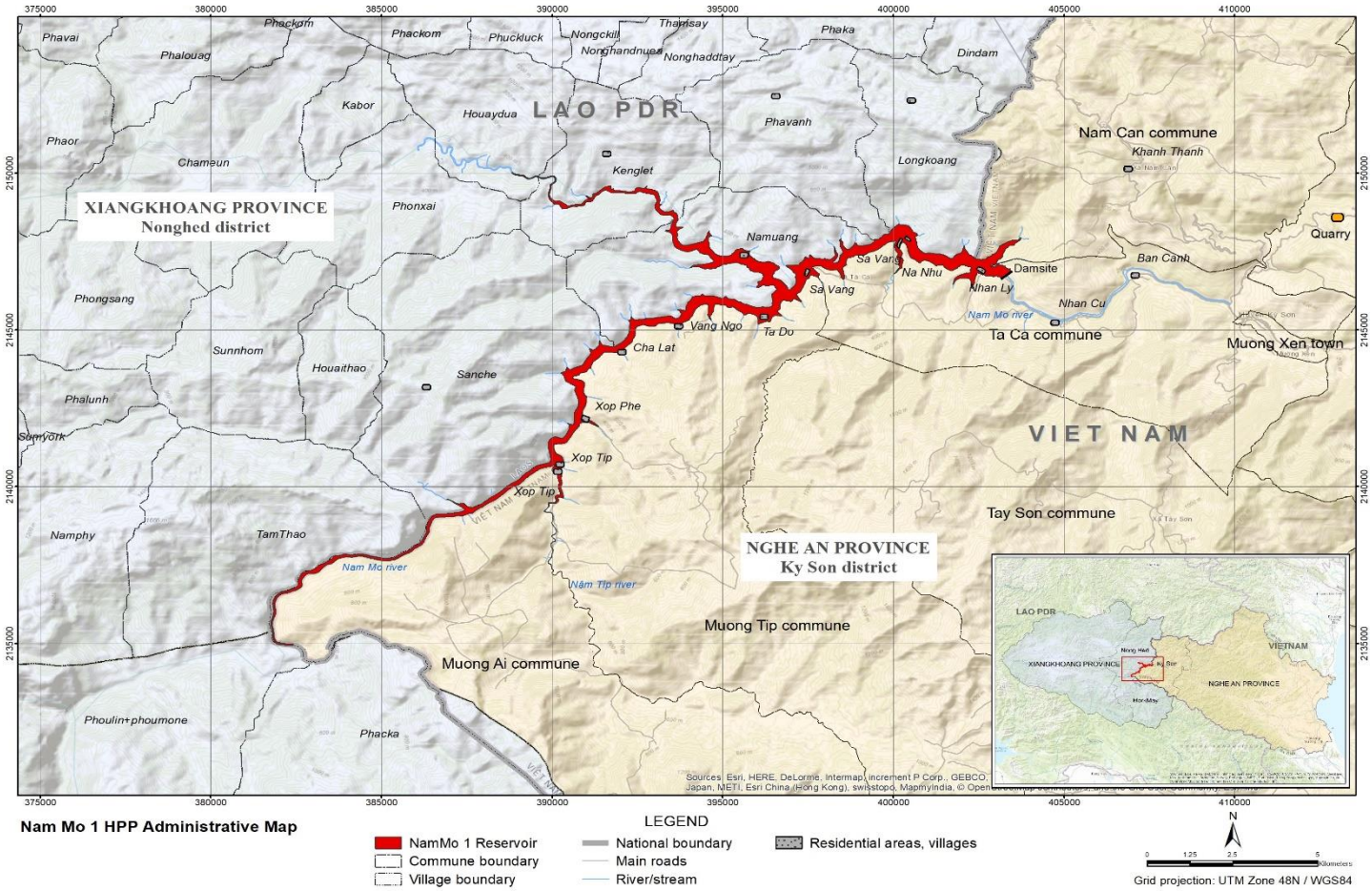


Figure 3.1 General Map showing the Project location and affected villages

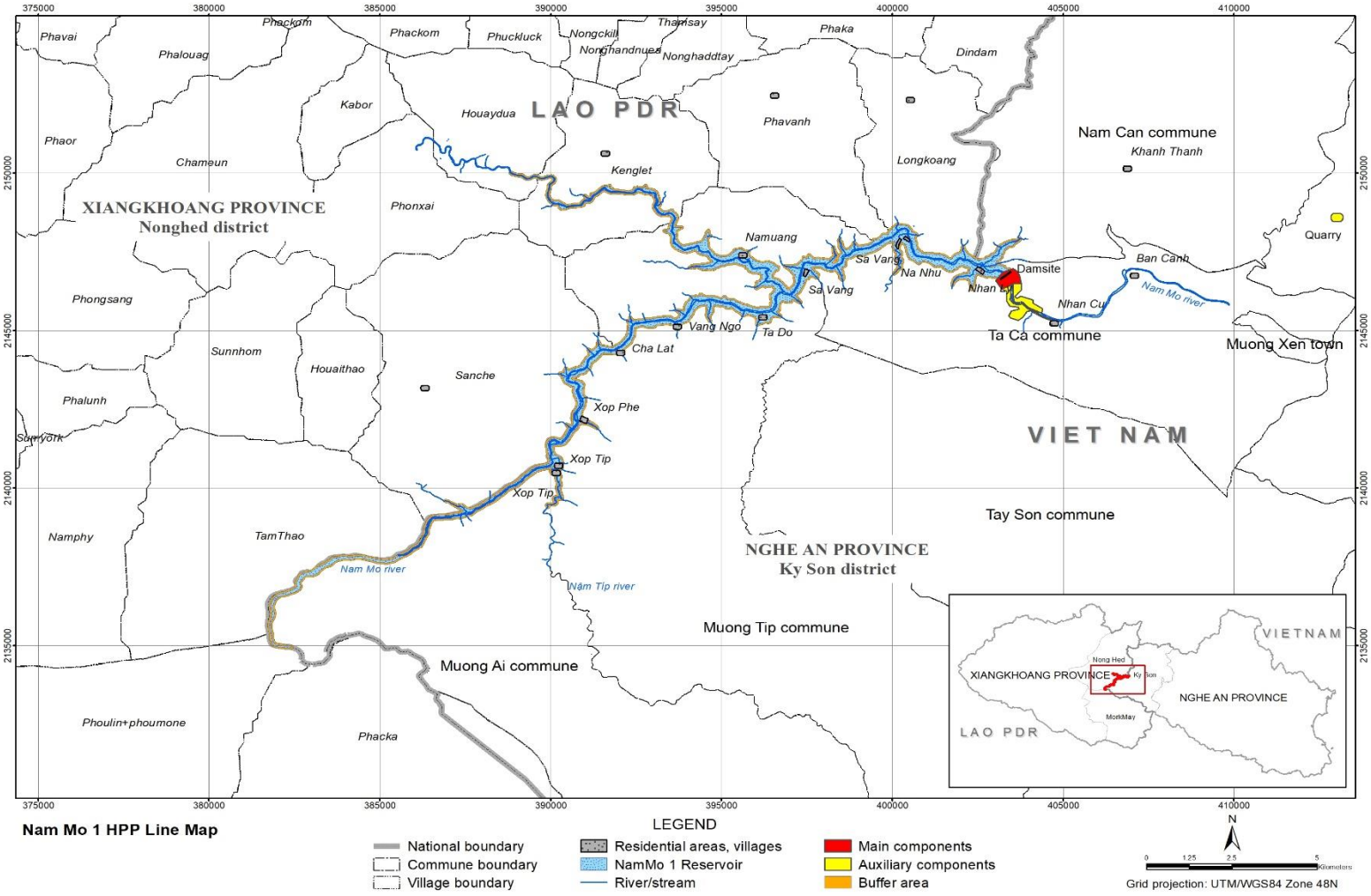


Figure 3.2 Line map showing the Nam Mo 1 HPP reservoir and auxiliary areas

3.3 Project location and areas to be affected

Nam Mo 1 Hydropower Project with the planned dam site and all the project works are located in Ta Ca commune in Ky Son District, Nghe An Province in Vietnam. Added to Ta Ca commune, the upstream Muong Tip and Muong Ai communes in the same district as well as one village in Nonghed District in Xiankhoang Province in Lao PDR will be affected by the HPP. In Vietnam, two villages in Nam Can commune are expected to lose land areas to the reservoir, and in Laos land areas of five villages will be affected by the reservoir inundation.

These areas are among the most remote and poorest ones in the two countries. They lie isolated in a forested mountainous international border area providing local people with few livelihoods options apart from upland cultivation and utilization of forest and aquatic resources. Social and livelihoods services delivery, trade and market access are deficient due to poor transportation infrastructure with most villages connected with earthern roads that are not vehicle accessible year-round.

Almost all the people in the Project area of impact in both countries originate from different ethnic groups/minorities[18] with their own identity, language and cultural features. The ethnic groups in Vietnam and Laos are related to each other, some people have moved across the national border and settled down on the other side, and villagers have regular social and economic interaction with each other over the border river.

3.3.1. Nghe An Province and Ky Son District overview

Nghe An province is located in North-Central Region of Vietnam, bordering in the East to the South China Sea, in the West to Lao PDR, in the North to Thanh Hoa and in the South to Ha Tinh Province. Nghe An has a total area of 16,493km^2, of which about 12,000km^2 is forest. The area is administratively divided into 17 rural districts, 3 district-level towns and Vinh city which is the province capital and the economic and cultural centre of the North-Central region of th country, located about 300km south of Hanoi, the capital of Vietnam. The province population in 2014 was 3,037,400 people, making an approximate population density of 180 persons/km^2. However, the province has vast remote forested areas where population density is very low, among them the Nam Mo 1 HPP area.[19]

Nghe An is part of the Truong Son Mountain Range, and 83% of its area is mountainous terrain with a descending slope from North-West to South-East with many mountains, hills, rivers, streams, and small valleys. The highest point is Pulaileng Peak (2,711m) in Ky Son District. The province area has an abundant system of rivers with a total length of 9,828 km. The largest river is the Ca River (also known as Lam River and Nam Nho River), which originates in Laos. Nghe An has a 82 km long coastline with many ports and significant industries around sea transport and fishery.

Ky Son is a rural district in the northwestern part of Nghe An Province, located along the national border to Kouan District in Houaphanh Province and to Nonghed District in Xiangkhoang Province in the Lao PDR. Ky Son is a remote and mountainous district with

[18] In Vietnam, the Government recognises totally 54 ethnic groups, of which the Kinh (Vietnamese) is the majority population with 87% of the national population, and all the other groups are defined as ethnic minorities. In Laos, people are ethnically divided into three main ethnic groups: (1) The Lao Loum, who are also called the Lao Thai or the Lowland Lao, who make up approx. 75% of the population in the country; (2) Lao Theung, the midlands people, consisting of 58 sub-groups, among them the Kho mu; and (3) Lao Soung, the highland people consisting of the Hmong and Yao as the main sub-groups and making about 10% of the national population. The term ethnic minority is not used. (sources: http://minorityrights.org/minorities; https://www.luangprabang-laos.com/The-people-tribes-and-ethnical). Majority of the villages to be affected by the Nam Mo 1 HPP are located in Vietnam, villagers have relatives in both countries and belong to the same ethnic group. Therefore the Vietnamese term ethnic minority is used for the project-affected people.

[19] https://www.vietnamonline.com/destination/nghe-an.html

21 communes and 70,061 inhabitants[20], most of them originating from the ethnic minority groups of Thai, Kho mu and Hmong. The total area is 2,095 km^2 consisting mainly of forest. Muong Xen town is the administrative centre of the district. Ky Son is among the 62 poorest districts of Vietnam and eligible for special government development programs for poor and underdeveloped areas. Great majority of the population is farmers living on upland cultivation and utilizing the available abundant forest resources. The mountainous terrain sets limitations to infrastructure development, and there are many remote villages without year-round vehicle accessible roads, electricity and clean water supply. The most remote ethnic minority villages are living in extreme and persisting poverty.

3.3.1.1 Ta Ca Commune

Ta Ca Commune has totally 11 villages, three of which along the Ca River in the planned reservoir area. The total population in the commune[21] is 4,779 people in 1,037 households (average HH size 4.6 persons). According to the GoV classification[22], 54% of the population is living under the poverty line, but according to the Commune Chairman, the three villages to be affected by the HPP are all the poorest ones in the commune with 100% household poverty. Great majority of the commune inhabitants are ethnic minority people: Thai and Kho mu are the largest groups and together make 85% of the total population, Hmong is the third ethnic minority group, equal in size with the Kinh (Vietnamese) majority people.

The total land area of the commune is 6,443ha[23], 2748ha (43%) of which is classified as agricultural land and 2,233ha (35%) as forest. 1,461(23%) ha is reported as residential land. Totally five villages in the commune depend on the Nam Mo River, but hydropower development has affected their river use, especially fishing. Even tributaries, where people are fishing, are reported to be affected by water fluctuations. Local fishing has reduced due to hydropower development in the river. The Nam Mo HPP is located downstream the planned Nam Mo 1 dam site, which will be located 1.2km within the reservoir of the Nam Mo HPP. The village of Nhan Cu that is located downstream the planned Nam Mo 1 dam site, has been affected by the Nam Mo reservoir.

3.3.1.2 Muong Tip Commune

Muong Tip commune is located upstream Ta Ca commune. The total population in the commune[24] is 2,998 people in 517 households (average HH size 5.8 persons). Muong Tip is like Ta Ca one of the poor and remote communes in Vietnam: According to the GoV classification, 78% of the population is poor. All the inhabitants are Kho mu, Hmong and Thai ethnic minority people. There are nine villages in the commune, and five of them (Xop Tip, Xop Phe, Cha Lat, Vang Ngo and Ta Do) are expected to be affected by the planned Nam Mo 1 HPP. This means that the HPP will have a major impact on the entire commune.

The total land area of the commune is 12,370ha[25], which is mainly protection forest. People in the commune are all farmers. Farmers in the villages to be affected by the HPP practice rotational upland swidden agriculture as their major livelihood. Upland rice, maize and cassava are the most important cultivated crops.

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[20] Data from 2013 provided in Nghe An Province official website: http://nghean.gov.vn/wps/portal/na_english

[21] Data from Ta Ca Commune Chairman 10. Jan 2017.

[22] The Vietnam official poverty line 2016–2020 issued through the GoV Decision No. 59/2015/QD-TTg Promulgating multidimensional poverty levels applicable during 2016-2020 is for urban areas 900,000VND/capita/month and for rural areas 700,000VND/capita/month.1 USD=22,700 (Sept 2017)

[23] Data from Ta Ca Commune Annual Report 2016

[24] Data from Muong Tip Commune Chairman 13. Jan 2017.

[25] Data from Muong Tip Commune Cadastral officer 13. Jan 2017.

3.3.1.3 Muong Ai Commune

Muong Ai commune is located upstream Muong Tip commune, and one village along the river, Xop Tip[26], is expected to be inundated by the Nam Mo 1 HPP reservoir. There are totally 2,442 people in 420 households (average HH size 5.8 persons) in the commune, all originating from the ethnic minority groups of Kho mu, Hmong and Thai. All the 16 households with 84 people in Xop Tip village to be affected by the HPP are Kho mu.

There are totally nine villages in the commune, but three of them, Xop Tip, Xop Phong and Huoi Phong are administratively one village with one Village leader and one Secretary of the Cell of the Party. Xop Tip village, to be affected by the Nam Mo 1 HPP, used to be part of Huoi Phong village. In 2000 some of the villagers moved closer to the main road and established Xop Tip Village of Muong Ai. The current location of the Muong Tip village is close to the river, so villagers can do fishing, however, the main reason for their voluntary move there was to be close to the road that was opened in 2000.

The total land area in the commune is 9,190ha, of which approx. 54% (4,951ha) is agricultural land. In 2016 the commune has provided land use certificates for households' residential land. Riverside land is not used for cultivation apart from home gardening, but the land is used for animal grazing. People in the commune are farmers living mainly on upland rotational agriculture, combined with livestock breeding, hunting and utilizing non-timber forest resources. There is labour migration of especially young people to China and Malaysia, and especially women go to work in textile industry or in coffee and rubber production in Ho Chi Minh City, Lam Dong, Dak Lak and Gia Lai provinces.

3.3.1.4 Nam Can Commune

Major part of Nam Can commune is located further up from the Ca River with only approx. 4km of land along the river in the commune area. There are no villages in this area along the river, but the riverside land has been allocated to Tien Tieu and Khanh Thanh villages. According to the commune Cadastral office, there is both upland production land, production forest, and grassland for breeding buffaloes, cows and goats along the river. Good natural forest next to the river is used for animals grazing, and animal breeding takes place in the protection forest areas as well.

There are six villages in Nam Can commune with a total population of 4,270 people in 812 households (average HH size 5.3 persons). All the local inhabitants are Hmong, Kho mu and Thai ethnic minority people. 55% of the population is living under the poverty line as stated by the GoV.

3.3.2. Xiankhoang Province and Nonghed District

Xiankhoang Province is located in the eastern Lao PDR. The total area is 15,880 km^2 and borders to Vietnam in the East, Houaphan Province to the Northeast, Bolikhamsai Province to the Southeast, and Vientiane in the Southwest. The terrain is mountainous with large forest areas and many rivers. Apart from floodplains, the largest area of level land in the country is located in the province's Xiangkhouang Plateau. This area is characterized by rolling hills and grassland with an average altitude of 1,300m. Phou Bia, the highest mountain peak in Laos (2,820 m), rises at the southern side of the plateau. In 2015 the population was 244,684 people. Phonsavan is the province capital. The province is administratively divided into 8 districts, among them Nonghed where Namuang village that will be inundated by Nam Mo 1 HPP is located.

3.3.3. Direct impact area of the project

Totally nine villages in Vietnam and one village in Laos are expected to be inundated by the Nam Mo 1 HPP reservoir and have to be relocated. In Muong Ai commune the village of

[26] The name of the village is the same as the name of one of the villages also to be affected by the reservoir in the neighboring Muong Tip commune.

Muong Tip with 16 households and 84 people need to be relocated. In Muong Tip commune Xop Tip village with 146 people in 29 households, in Xop Phe village with 360 people in 76 households, and in Ta Do village 556 people in 99 households need to be relocated. Two villages in Muong Tip commune consist each of two hamlets and one hamlet in each village will be inundated: Cha Lat village with 92 people in 16 households (of the total 166 people in 29 households) and Vang Ngo village with 130 people in 17 households (of the total 356 people in 47 households) need to be relocated. Moreover, Muong Tip commune centre is located in Vang Ngo village next to the river, so the commune office and commune health centre will be inundated as well.

In Ta Ca Commune three villages will be inundated and have to be relocated: Sa Vang village with 510 people in 97 households, Na Nhu village with 360 people in 67 households and Nhan Ly village with 275 people in 51 households.

In Nonghed District in Laos, the village of Namuang will be inundated. The village has 224 people in 34 households that have to be relocated.

All the affected villages are extremely poor with great majority of the people living under the national poverty line[27] and the rest of the village households being near-poor. Table 3.3 below presents an overview of the villages that will be inundated in the reservoir area of the Nam Mo 1 HPP.

Table 3.3 Villages in the expected reservoir inundation area of Nam Mo 1 HPP to be relocated[28]

Nam Mo 1 HPP Villages to be relocated				
Village	**HH**	**Pop.**		**Ethnicity**
Muong Ai Commune - Vietnam				
Xop Tip	16	84		Kho mu
Muong Tip Commune - Vietnam				
Xop Tip	29	146		Kho mu
Xop Phe	76	360		Kho mu
Cha Lat	16/29*	92/166		Hmong
Vang Ngo	17/47**	130/356		Hmong, Kho mu
Ta Do	99	556		Kho mu, Thai***
Subtotal Muong Tip Commune	237/280	1,284/1,584		
Ta Ca Commune - Vietnam				
Sa Vang	97	510		Kho mu, 6 HHs Thai
Na Nhu	67	360		Kho mu
Nhan Ly	51	275		Kho mu
Subtotal Ta Ca Commune	215	1,145		
Total to be relocated - Vietnam	**468**	**2,513**		
Nonghed District - Laos				
Namuang	34	224		Kho mu

[27] The Laos official poverty line 2010–2015 issued through the Decree No.285/PO Poverty and development standard 2010-2015 is for country level 192,000 LAK/capita/month, for urban areas 240,000 LAK/capita/month and for rural areas 180,000 LAK/capita/month. 1USD≈8,300LAK (22 Sept 2017).

[28] The population, poverty and ethnicity data is based on information collected during the baseline data collection in January 2017 from commune officials, village leaders and villagers participating in FGDs. Population data was reconfirmed during FPIC consultations in villages to be relocated in June 2017. The impact assessment is based on all the available information and observations made in the project areas.

Nam Mo 1 HPP Villages to be relocated				
Village	**HH**	**Pop.**		**Ethnicity**
Total to be relocated - Laos	**34**	**224**		
Total Nan Mo 1 HPP	**502**	**2,737**		

* Village consists of 2 hamlets, one by the river with 16 HHs, and the other higher up with 13 HHs.

** Village consists of 2 hamlets, commune centre is in the lower hamlet and will be inundated.

***5 Thai HHs relocated in 2006 from Ban Ve HPP.

Added to the villages that will be inundated, land areas in the area of two villages in Nam Can commune in Vietnam are within the reservoir area. In Laos, four villages that are located far from the river have land areas along the river. The villages that will lose land in the reservoir can be seen in Table 3.4 below.

Table 3.4 Villages Vietnam and Laos with land areas to be inundated by Nam Mo 1 HPP

Nam Mo 1 HPP Villages with Land Losses					
Village	**HH**	**Pop.**	**HH poverty %**	**Ethnicity**	**Impact**
Nam Can Commune - Vietnam					
Tien Tieu	170	420	61	Hmong	Production land and protection forest area by the river
Khanh Thanh	76	386	74	Kho mu	Land to be inundated 9ha protection forest and abt 25ha cultivation land, fishponds, fruit trees, grassland belonging mainly to CPC Vice chair, and to 3 other HHs.
Nonghed District - Laos					
Sanche			The residential areas of these villages are located far away from the Ca River and separated from it by a steep mountainous terrain. However, according to the ASA ESIA Report (Aug 2016), land along the river is associated to these four villages (ownership or management). There is no information in the ASA report about the type of land and its utilization. The riverside in these areas is steep and probably not in an active use by the named villages. The affected areas, their status and utilization have to be investigated during the detail design phase.		
Kenglet					
Phavanh					
Longkoang					
Tam Than			Reservoir tail end, same as above		

3.4 Salient features of the Project

Table 3.5 provides the salient features of the proposed Nam Mo 1 HPP followed by the reservoir operation rules. The project works are located in the Vietnamese territory.

The main components and auxiliary work areas are all located in Ta Ca Commune, Ky Son District, Nghe An Province, Vietnam. These were proposed through optimization studies including dam structure, installed capacity, number of powerhouse unit, water head, and quantity and dimension of spillway gate, among other technical features.

The main components of Nam Mo 1 HPP are as follows:

- Reservoir: submerged area corresponding to Full Supply Level (FSL) is 962.04ha and gross storage is 272.1 million m^3;

- Dam: Gravity rolled compaction concrete (RCC) with rock foundation (layer IIA). The dam has crest width of 8m and crest length of 241.50m.
- Spillway: Ogee type integral in dam with 4 bays, dimension of 10mx12m. Sill elevation is 225m with energy dissipation through flip bucket.
- Intake: It is a reinforced concrete structure integral in RCC dam on right bank with 2 bays with dimension of each bay at 4.5m x 4.5m. Each bay is equipped with maintenance gate and emergency gate. Sill elevation is at 202.75m.
- Headrace tunnel: Reinforced concrete structure with steel lining and length of 103.7m and inner diameter of 4.5m.
- Powerhouse: Surface type, reinforced concrete structured with 2 generating units (45MW each), with total installed capacity of 90 MW. The dimension of open part of powerhouse is 53.7m x 15.4m.
- Tailrace channel is located behind the powerhouse: 206.3m long, bottom sloping 0%, bottom elevation 150m, bottom width 16m, and the channel slope is supported by concrete.
- Management and operational building: to be located on access road connecting from NR7 (National Road 7) to the powerhouse, about 4.4km long.
- The 220kV out-door switchyard is located on the right bank at an elevation of 169.50m, and with a dimension of 95mx50m. The station includes 220kV switchgear, fire-proof equipment, cable trench system and internal road.
- The double 220kV Transmission Line (T/L) connecting from Nam Mo 1 switchyard to TL 220kV My Ly Tương Duong Substation is expected to be 25 km long.
- Time schedule: The project is proposed to be constructed in 5 years including 1 year for preparation and 4 years for construction.

Details of the dam and spillway of Nam Mo 1 HPP are shown in

Figure 3.3 and main features are listed in Table 3.5.

Table 3.5. Salient features of Nam Mo 1 Hydropower Project

Project location	**Vietnam**	**Lao PDR**
Region	North-Central Vietnam	North – east
Province	Nghe An	Xiangkhoang
District	Ky Sơn	NongHed
Communes	Muong Tip, Muong Ai, Ta Ca, Nam Can	No commune unit is used in Lao PDR
Villages	Total of 11 villages	Total of 5 villages
Nearest national high way	NR7	NR7 and NR 6
Project area		
Hydrology at Intake		
a. Catchment area		2.492km²
b. Annual mean flow		65.5m³/s
c. Maximum recorded discharge		8,591m³/s
d. Minimum recorded discharge		1,361m³/s
e. Design discharge		3,825m³/s
Other Features		
Installed capacity		90MW
Firm capacity		17.5MW
Annual energy production		326.8 millionkWh
a. Headworks		
Location Latitude; Longitude		Ta commune in Vietnam, N: 19°24'44"; E: 104°04'46"
Dam type		RCC (gravity rolled compaction concrete)
Dam height (above existing river bed)		95.52m
Crest length / width		407.15m / 8m
Approx. reservoir length		33 km
Calculated head		65m
Reservoir gross storage (total reservoir volume including dead storage)		272.1million m³
Reservoir active storage		151.3million m³
Reservoir FSL		235m
Reservpir MOL		215m
Reservoir area at FSL (full supply level)		9.6207km²
Maximum powerhouse discharge		156.5m²/s
Highest regulated water level		241.46masl
Lowest regulated water level		215masl
Spillway, Weir length		Curvature surface of WES type
Distance of powerhouse from dam site		108m
Distance of tailrace from dam site		308m

Potential total length of river expected to be affected	33km length of reservoir
b. Headrace Tunnel	
Tunnel inlet elevation	202.25masl

3.5 Main dam and related facilities

3.5.1. Main Dam

The main dam shall be a gravity concrete structure using the RCC technology. Dam foundation shall be located on rock foundation (layer IIA) with the following specifications: Crest width is B = 8m; slope of upstream face is m = 0.4 from elevation 176m; slope of downstream is m = 0.89; crest elevation of dam is 241.5m. The total length of dam is 407.15m including 6.05m of integral spillway, the left dam abutment is 170.43m long, while right dam abutment is 176.22m which includes 29.1m of integral intake. The dam base elevation at the deepest location is 152.00m which corresponds to the maximum height of dam at 95.52m. The dam foundation will be grouted by cement curtain. Grouting will be done to consolidate dam up to rock layer with 3Lu. Excavated slope of foundation pit is consolidated by masonry rock and rock excavated slope of foundation pit is protected by grout concrete (Figure 3.3)

Figure 3.3 The main dam reservoir

3.5.2. Spillway

The spillway for the dam, which will provide controlled release of flows to the Nam Mo 1 River will be of the Waterways Experiment Station (WES) type and consists of four bays with dimensions of 10m (width) x 12m (height) and a sill elevation at 225m. It will be operated by radial gate controlled by hydraulic cylinder with energy dissipater (flip bucket and plunge pool set at 136m elevation) to mitigate the impact downstream of the dam. The spill way is designed for 7010^3/s (1000-year probability) flood discharge in fully open conditions.

3.5.3. Diversion culvert

The diversion culvert is located at the bottom of dam section on the left bank, along, where the culvert foundation shall be laid on layer IB. The diversion culvert has a reinforced concrete structure. The culvert comprises of two outlets with the following dimensions: width of 4 m, height of 6 m and a length of 107 m. Bottom elevation of the culvert will be designed at 154 m with maximum calculated discharge at P=5% (frequency) is estimated as 1,002.6m^3/s. Gates shall be erected by a mobile crane, after calibrating it will be opened fully before closing the diversion culvert; a hydraulic cylinder will be used serving for lifting and closing the culvert.

3.5.4. Intake

The intake is a reinforced concrete component located at the right bank and is founded fully on RCC concrete of the main dam. Sill elevation of intake is designed at 202.25 m to take maximum calculated discharge required by two units Q = 156.5 m^3/s when reservoir is at its Minimum Operating Level (MOL) of 215 m. The intake comprises of 2 bays to take water into two intake chambers connecting 2 penstock in order to reduce dimension of maintenance gate. Each chamber is equipped with an emergency maintenance flat gate with dimensions of 4.5 (wide) x 4.5 (height) m. These gates are operated by hydraulic cylinders which are able to operate under water flow condition. The intake is protected by a trash-rack. The bar-pitch velocity is limited to $v \leq 1$m/s. To minimize the trash-rack dimension, right at the location of the trash-rack, intake bays will be divided into 2 smaller parts by means of piers in the middle. By such way, each intake bay will be equipped and protected by 2 trash-rack segments. The trash-rack is inserted in vertical slots, and operated by a gantry crane. Behind the maintenance gate at the intake, there is a transitional section transiting from a rectangular section to a rounded section to fit with the penstock. This section is made of reinforced concrete structure, lined with steel. Dimension of intake inlet is designed with hydraulic curves shapes to minimize loss at inlet, sill elevation is designed to ensure taking water with no turbulent whirling funnels created in at the intake. The top of intake is designed at an elevation of 241.5 m

3.5.5. Penstock / Headrace tunnel

The penstock (or headrace tunnel) conveys the water safely to the powerhouse and is designed to have minimum head losses. The penstock is 103.7m long, connecting from a rectangular section (4.5m wide x 4.5m height m) to a rounded intake section with a diameter of 4.5m . The beginning section of 0.76m long is horizontally set with a penstock axis of 205m, following is curvature section whose a curvature radius of 13.5m, then to a straight section of 60.84m length running against the downstream face of the dam with a slope coefficient of 0.89m and a curvature section with a radius of 13.5m, and it finally leads into a horizontal section connecting to the spiral case set elevation of 150.5m. Upstream of powerhouse it is set at an elevation of 169.0m so penstock at this elevation is exposed, beneath this elevation the penstock will be located within a embanked earth/rockfill block.

3.5.6. Powerhouse

The powerhouse is located at the right bank of Nam Mo river, about 108m downstream of the dam site at the end of headrace tunnel. Natural ground elevation at the powerhouse is 180m. The powerhouse is a reinforced concrete structure to be founded on IIA rock

foundation and comprise of two units (45MW each) vertical shaft with Francis turbines and a metal spiral case. Total installed capacity is 90MW.

Basing on the minimum Tail Water Level (TWL) of 167.1m when powerhouse operates at 60%Qmax per unit, the turbine is planned at an elevation of 150.5m. Floor elevation is at 169 m with dimension of 15m x 18m designed to sustain flood frequency of P=0.1% corresponding to 167.1m. The unit axis spacing is defined as 13.6m, width of machinery hall is 13.9m, machinery hall elevation at 158.2m, with dimension of 13.9 m x 34.7m.

The master control room is located at elevation 169m with a noise proof grass wall. It is also equipped with a gantry crane serving to operate the downstream gate. The powerhouse is a reinforced concrete structure and ensures a watertight surrounding wall.

3.5.7. Tailrace

Tailrace channels the used water from the powerhouse back to Nam Mo river. Since the powerhouse is located adjacent to river bank, its length is approximately 181.4m.

3.5.8. Transmission line system and 220kV switchyard

Switchyard shall be placed at an elevation of 169 m located on right bank along the access road to powerhouse. The proposed location is characterized by a sloping topography and therefore excavation is necessary. The switchyard is about 100m from location of the powerhouse. Outdoor switchyard is planned with the following dimensions, 12.5m x 29.5 m. The 220kV transmission line of Nam Mo 1 HPP shall be directly connected to the 220kV My Ly - Ban Ve TL, which is about 25 km in length.

3.5.9. Management and operation house

Operational and management house will be located at the operational access road from NR7 about 2.108km from powerhouse.

3.5.10. Workers' camp

Temporary and permanent camps will be constructed to provide accommodation for the 1,750 construction worker's and later for the permanent employees. The accommodation will be located near the power station complex area. It will occupy approximately 2.04. hectares.

The accommodation will have to be designed to provide basic services such as minimum space, water supply, lighting and ventilation, adequate sewage and garbage disposal system, appropriate protection against heat, cold, damp, noise, fire and disease carrying animals, adeaquate sanitary and washing facilities, cooking and storage facilities. In addition, basic medical facilities and road systems shall also be provided.

3.6 Auxiliary facilities

During the construction of the dam, the river will be diverted through a tunnel. In addition to the construction of the dam, the tunnels and the power house, the project will need new roads/upgraded roads, spoil tip areas, sand quarry areas, rig areas, permanent housing, temporary and labour camps, and transmission lines, among other areas, to complete the project (see Table 3.6 and Figure 3.4).

Some of these planned construction areas and structures will be permanent while others will be temporary. The project structures and activity areas proposed and those assessed in this ESIA are listed in Table 3.6 and Table 3.7. The potentially affected river stretch has been assessed for impacts particularly for river water quality, aquatic ecology and fisheries. Transmission lines will be the subject of a separate ESIA and thus has not been included in this assessment.

The construction areas (auxiliary works) are located clustered next to the dam site concentrating all activity. The only areas not located in the same area are the quarries. The construction layout map provides details on the location of all the work areas (Figure 3.4). Table 3.6 lists the auxiliary construction works and its specifications and the approximate areas each structure will occupy.

Table 3.6. Auxiliary construction works of the Nam Mo 1 HPP

No. on Construction Layout map	Salient Parameters	Specifications	Area (ha)
1	Crushing facility for RCC and aggregate stockpile area (RCC – roller compacted concrete)	340 m^3/h	8.00
2	Crushing facility CVC (Conventional Concrete) (250t/h)	550 m^3/year	0.27
3	RCC facility	350 m^3/h	1.07
4	RCC conveyor system	350 m^3/h	0.00
5	Concrete facility at dam, powerhouse areas	180 m^3/h	0.17
6	Steel reinforcement facility at headworks, waterway areas	22 T/ca	0.50
7	Steel formwork facility at headworks, waterway areas	60 Ton	0.15
8	Pre-casted concrete yard	-	0.15
9	Maintenance facility and parking area for construction equipment	290 trucks	0.36
10	Workshop for hydro-mechanic erection	2,300 T/year	0.66
11	Workshop for electrical-mechanic erection of the powerhouse	2,100 T/year	0.92
12	Laboratory of the headworks, waterway	-	0.28
13	Explosive dynamite warehouse for headworks, waterway areas	30 Ton	5.80
14	Petroleum warehouse for dam, waterway areas	350 Ton	0.18
15	Technical material warehouse (Project Management Board's (PMB) warehouse)	-	0.36
16	Water, power facilities for dam areas	-	0.14
17	Provision power	1000 KVA	0.05
18	Sand stockpile area at headworks, waterway areas	34,000 m^3	0.72
19	Rubble stockpile area	250,000m^3	1.40
20	Disposal area No.1	500,000m^3	4.33
21	Disposal area No.2	2,000,000m^3	9.24
22	Substations	8.820 KVA	0.07
23	Technical water treatment station at dam, powerhouse areas	2,450 m^3/day. night	0.02

No. on Construction Layout map	Salient Parameters	Specifications	Area (ha)
24	Technical water treatment station at auxiliary area	110 m^3/day. Night	0.02
25	Pump & treatment station of household waste water	190 m^3/day	0.02
26	Office of Contractor at the dam, waterway area	150 persons	0.31
27	Housing and office of PMB, Specialists, Engineers	-	0.70
28	Housing area for dam, waterway workers	1750 persons	1.34
29	Clinics at dam, waterway areas	10 wards	0.12
30	Post office	-	0.03
31	Police station	6 people	0.13
32	Fire station	2 trucks	0.07

Source: PECI, 2015. Feasibility study. for Nam Mo 1 HPP, PECI (in Vietnamese)

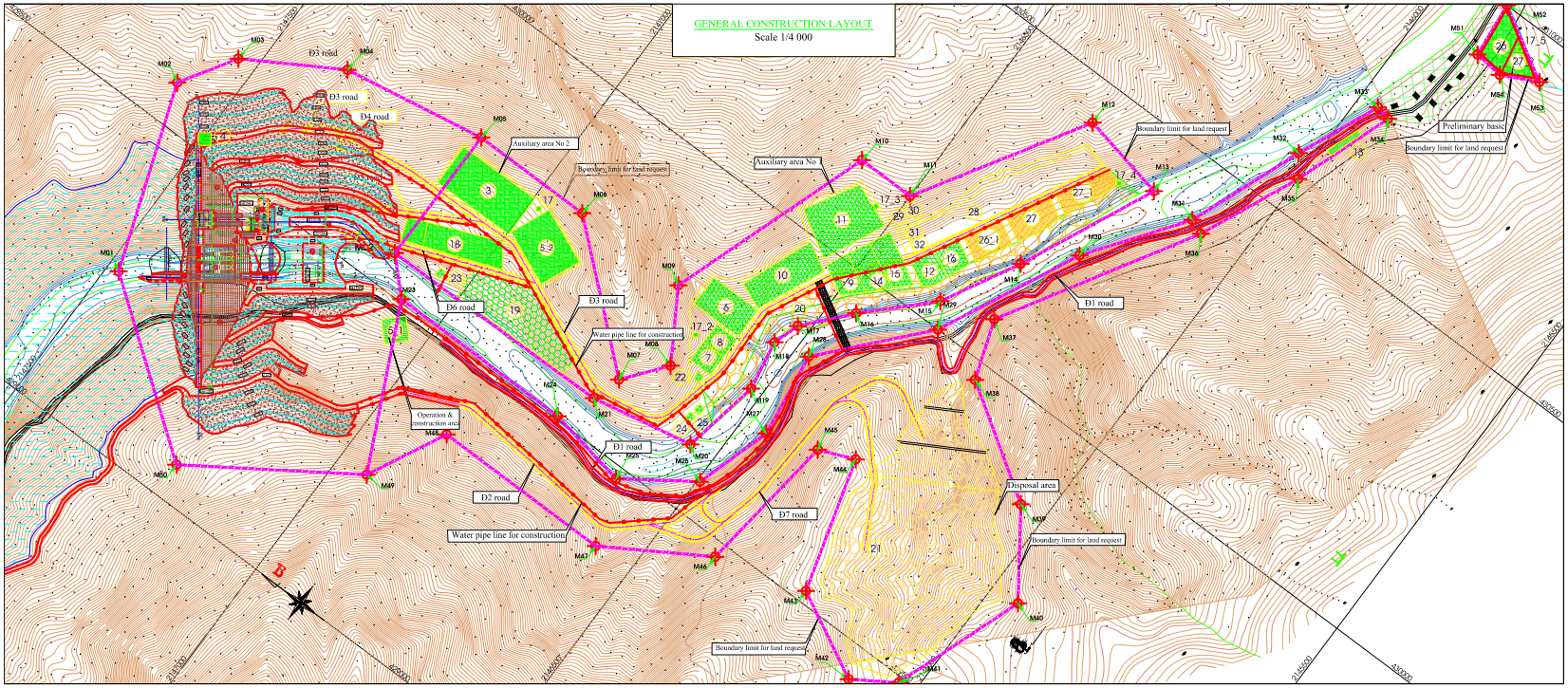
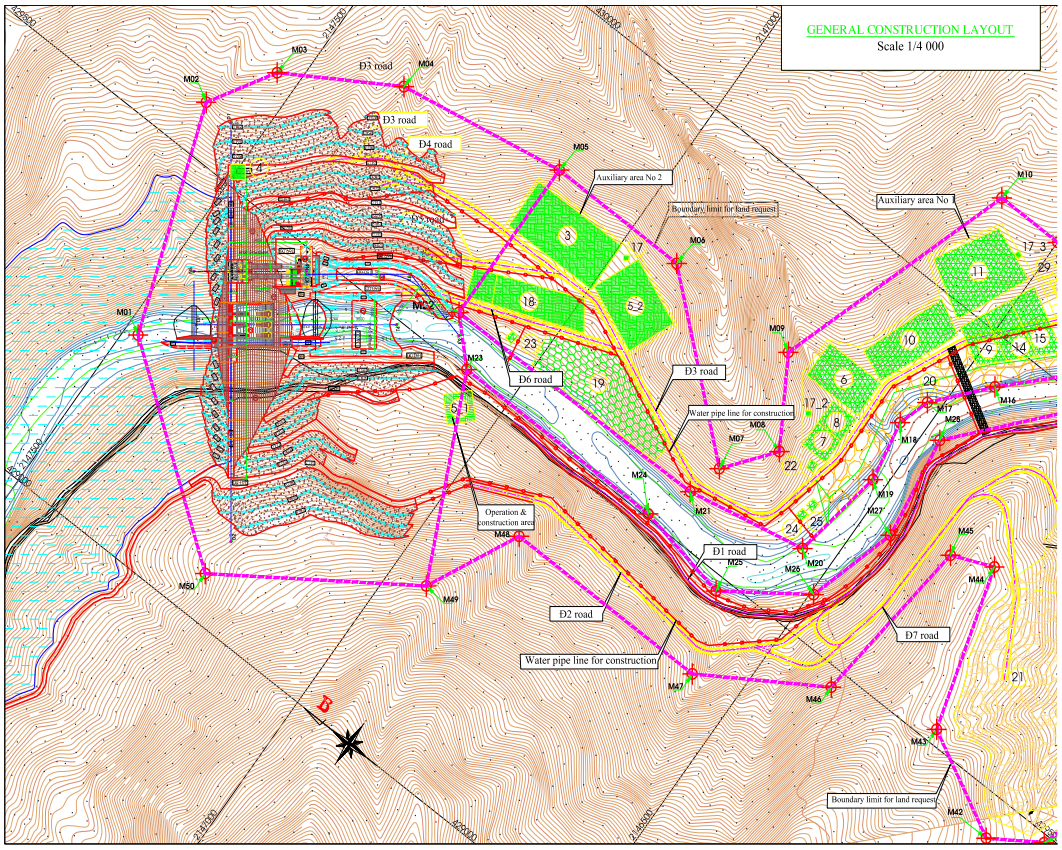
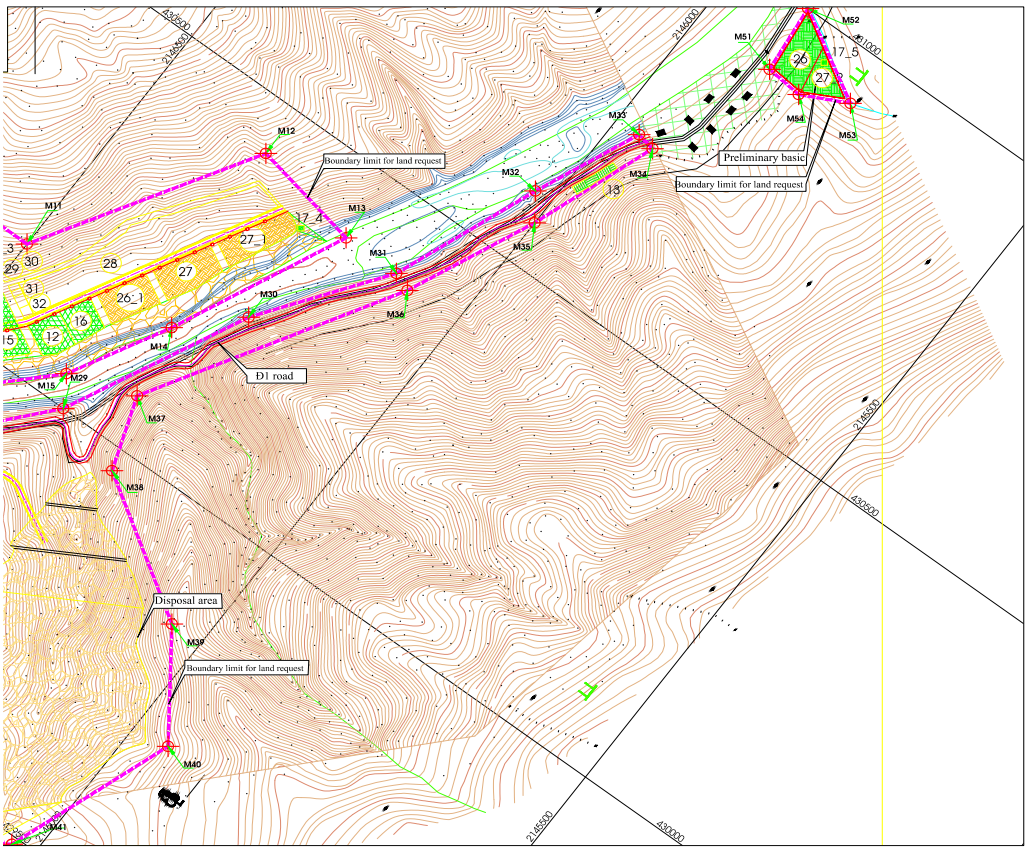


Figure 3.4. (a) Detailed construction project layout showing project structures and activity areas. (b-c) close up panels of the construction layout with specific areas numbered.

b. construction project layout



c. construction project layout



3.6.1. Roads

Access to Nam Mo 1 Hydropower Project area in Vietnam and Lao. Nam Mo 1 HPP is located in Ta Ca commune, Ky Sơn district, Nghe An province about 250km from Vinh City, via the (i) National Road 1A (NR1A) of 40km section and on to (ii) the National Road 7 (NR7). The NR7 goes though Do Luong town to Hoa Binh town, Tuong Duong district and is 201 km before getting on (iii) 8km of inter-commune, inter-village roads to the planned construction site. The NR1A has been designed as a grade III plains road (delta road[29]). NR7 has a surface width varying from 3.5 to 7 m and is made of asphalt gravel.

In order to serve the construction and operation of the project, 12 km of road alignment of the NR7 to the project site shall be upgraded and rehabilitated. This length of the road is in addition to the within project area road (see Table 3.7). Access the Nam Mo 1 HPP in Laos is from Houaphanh province to Kouan district to villages. Many of the roads are difficult to access by large vehicles, motorcycles are used in many cases especially during the rainy season.

Project site related roads. There are a number of district roads and local roads in the area that are linked to the main national roads. At necessary points in the project area, new project access roads will be built and connected to the existing road system. Most of these will be permanent roads, some will be upgrading of existing roads, and some may be temporary for use during the construction period (Table 3.7,Figure 3.4).

Internal access road within the project site is 6.05km long, consists of a 4.4km construction/operational road and a 1.65km construction road. There are three construction/operational roads namely D1, D2 and D3. These roads will be used during project construction and will be upgraded and rehabilitated to be operational road at the end of construction period. There are four main construction roads namely from D4 to D7. These construction roads will cease operation once construction is completed.

Traffic between the two banks shall be via a bridge with a load of HL93 (HL 93 Loading)[30]. The bridge will allow for movement for construction between the right and left banks during both flood and dry seasons.

Table 3.7. Project site related roads for the construction and operation phases

No	Road name	Length (km)	Location of road and linkages	Status, needs for project /
A	*Construction and Operation Phase Roads (see Figure 3)*	*4.40*		
1	Road D1	2.00	Access road to powerhouse	Permanent Existing inter-village road needs to be upgraded for project
2	Road D2	0.65	Road to crest dam at right bank (R/B) 244m	Permanent New
3	Road D3	1.75	Road to crest dam at left bank (L/B) 244m	Permanent New
B	*Construction road*	*1.65*		
4	Road D4	0.1	Connecting road D3 to EL 225m on R/B	Non-permanent

[29] Classification in the GoV

[30] Bridge design load used in Vietnam (HL93 loading) in Bridge design standard 22TCN-272-05

No	Road name	Length (km)	Location of road and linkages	Status, needs for project /
5	Road D5	0.2	Connecting road D3 to EL 187m on L/B	New Within project site roads (alignment and dimension will be finalized during the detail design phase)
6	Road D6	0.35	Connecting road D3 to EL 160m on L/B	
7	Road D7	1.0	Connecting road D1 to Disposal area No. 2	
8	Bridge	0.14	Bridge connecting the two banks	
	Total	6.05 km		

Source: Feasibility study. 2015. Chapter 12. Technical Summary Report, Nam Mo 1 HPP PECI (in Vietnamese)

Near the reservoir, dam area and power station complex area, permanent and temporary camps and infrastructure will be constructed, with corresponding project access road systems. Along the Ca river valley, from the reservoir down to the outlet there are no access tunnels to the main tunnel that will be constructed.

Some of the existing roads are in need of repair, and an upgrading is envisaged. It is also anticipated that all roads will need maintenance and upkeep during the construction period, and that new permanent roads will be handed over to the district road department in good condition.

3.6.2. Quarry site

The project will utilise the Pah Danh quarry site for its source of rock aggregates. Rock aggregates will be needed as rockfill for the construction of the main dam and other infrastructure. It is estimated that the project will need 1Mm^3 of aggregates and 0.45 Mm^3 of crushed sand[31].

The Pah Danh quarry is currently being operated by Phu Cuong Ltd. Company and has a valid extraction permit for 15 years[32]. The project will purchase from Phu Cuong Ltd. Com for its aggregate requirements. Table 3.8 summarizes the basic characteristics of Pah Dahn quarry and Plate 3.1 shows photos of the existing quarry.

Table 3.8. Basic characteristics of the Pha Danh quarry

Properties	Characteristics
Area	6.5 ha
Estimated reserve	3,456,154 m^3
Resources available	Aggregates and sand
Elevation	530 m

[31] Source: PECI, 2015. Feasibility Study of the Nam Mo 1 HPP; PECC2, 2016. Technical Design of the Nam Mo 1 HPP.

[32] Phu Cuong Ltd. Com. holds Business Certificate No. 2900598788; dated 30/7/2014, valid for 15 years.

Plate 3.1. The Pah Danh quarry operated by Phu Cuong Ltd Company.

Location and access. Pah Danh quarry is located approximately 14km downstream from the dam site, in Pha Khao and Pha Danh communes, Ky Son district, Nghe An province (Figure 3.5). It is accessible through the NR7 (national road) and the Tay Ngeh An road (provincial road) where the whole stretch is a combination of paved and gravel road with some steep and sharp curves. Surface road will be upgraded to cater for delivery trucks to the project construction site. The existing roads are 5.5m to 7.5m in width and therefore land reclaim is not anticipated since the road Right of Way (ROW) is secured. There are bridges along the route in Son Thanh and Cau Am villages that might require upgrading, subject to the detailed survey on a later stage to evaluate their load capacity to be able to cater heavy trucks.

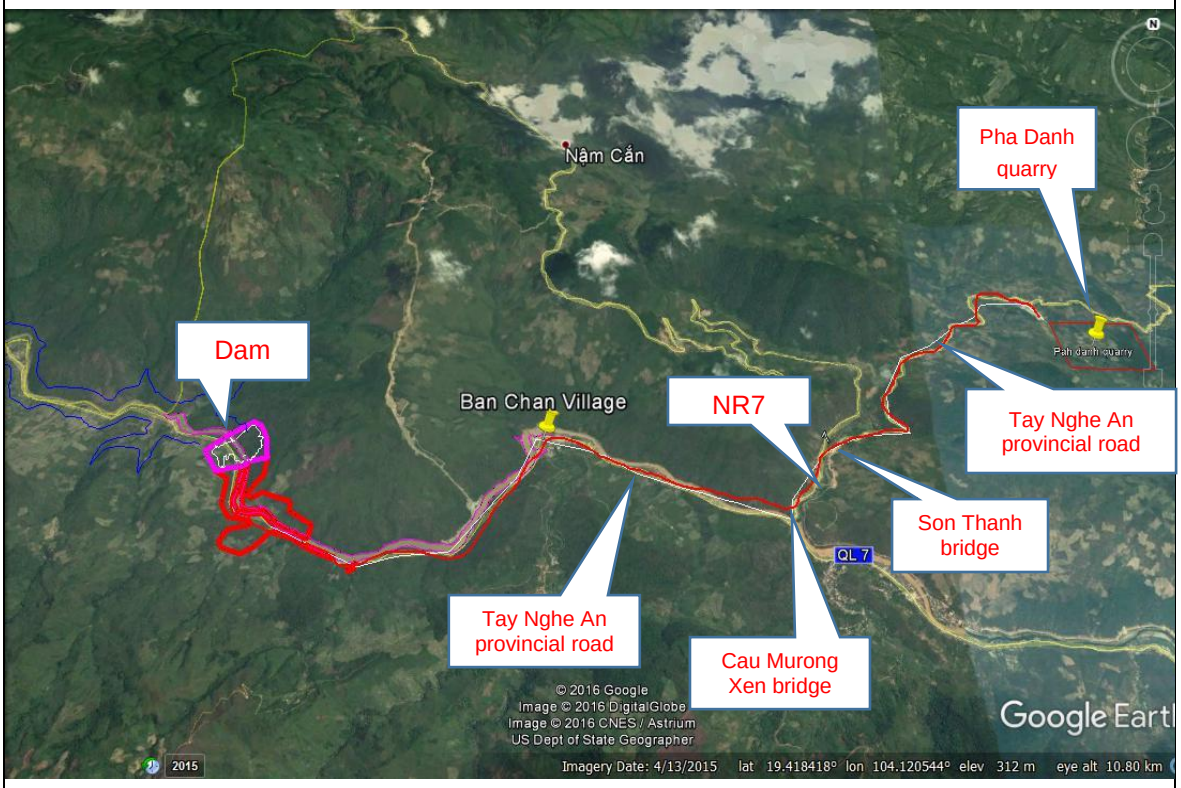


Figure 3.5. Locations of Pha Danh quarry planned for use for the Nam Mo 1 HPP

Physical and biological characteristics. Vegetation is composed of a mix of secondary forest and open areas.

Villages. There are villages located along the stretch of NR7 namely: Phieng Pho (in Pha Danh Commune), Khanh Thanh (in Nam Can Commune), Son Thanh, Cau Am, Binh Son, Ban Canh, and Nhãn Cù, all are located in Ta Ca Commune, part of Ky Son District, Nghe An Province.

3.6.3. Spoil disposal areas

The project proposed two disposal areas with a total area of 13.57 ha with a capacity of 2.5 Mm^3 for the spoil materials from the various excavation works for construction.

The disposal areas will be a temporary functional area of the Project, until the construction ends or until the area contains spoil at maximum volume capacity. Some of the disposal areas are designed to support infrastructures (e.g., employees accommodation will be built on Disposal Area no.2) once the required height and flatness are achieved. The disposal areas will also be shaped and managed to maintain good and safe conditions such as slope, height and flatness.

3.6.4. Transmission lines

The project will have a 220kV transmission line and will approximately run for 25km from the project's switchyard to My Ly Tương Duong Substation. The environmental assessment of the transmission route is covered in a separate EIA (GoV).

3.7 Operation of Plant

It is envisaged that the Project will store excess water in the reservoir during high flow to be utilized during low flow. The height of the dam will be 95.52m above the existing river bed and the full supply water level will be 235masl creating a reservoir length of 33km with a

total reservoir volume of 272.1Mm^3. The water will be diverted through a tunnel with a length of 103m down to a power station located adjacent to the dam. The water will be released back in the river, 210m downstream of the power station and 108m of the dam site.

The dam will create a reservoir that will extend up to 33km upstream of 16 villages (commune of Muong Ai, Muong Tip, Ta Ca and Nam Can of Ky Son district, Nghe An province). The flow in the river between the dam and the outlet, will be considerably reduced, particularly during the dry season. Below the outlet, the river will be subject to daily flow fluctuations due to the peaking operation of the power plant. Due to the existing Nam Mo 1 downstream which will have its reservoir going beyond the Nam Mo 1 dam site, the release for water from power plant may be buffered by the reservoir water (this will need to be monitor).

The plant is optimized for maximum energy generation throughout the year. During the dry season, the Plant will run only as a peaking plant during daytime, while in the wet season, the Project will generate approximately 24-hours at full capacity. Details on planned operation are provided in the next section on salient features.

The recommended Project is planned with installed capacity of 90MW. Based on the planned installed capacity, the total annual energy generation in an average year will be approximately 326.8GWh.

3.7.1. Basic criteria for reservoir operation

The basis for the income calculations is the value of the amount of energy which can be delivered during an average year. The base input in the modelling are as follows:

- The total installed power capacity is 90MW, with 2 generating units at 45MW each.
- The energy production is simulated for maximum energy.
- There is no requirement for minimum generation per day or period determined at this stage[33].
- Generation during day time (peaking price period) will be given priority. Generation during off-peak periods will only take place when there is more water than required for 12 hours generation at full capacity.
- The time for uploading and downloading will be determined during the detail design phase.

Nam Mo 1 HPP has an active storage of volume of 151.26 Mm^3, and is a long-term regulation reservoir. Power production is calculated based on following principles:

Operation period 1: In flood season (e.g., ~July through October). In this period, the reservoir supplies water for power generation and stores water for use in the dry season. The plant shall operate in full capacity to take advantage of flow and reduce surplus water release to downstream. At the end of the flood season, the water level of reservoir is expected to be at Full Supply Level (FSL) at 235m.

Operation Periods 2: Transition to low flood/dry season (e.g., ~November to December). During this period, transition to the low flood season when there is still sufficient water available, the plant will be operated at a monthly capacity less than the installed capacity to ensure that to the end of dry season, the water level in the reservoir reaches annual discharge water level at 218m.

Operation Period 3: Low flood/dry season (~January to June). During the low flood season with less water, the reservoir will provide additional water for the plant to operate

[33] Now, will be required by MOIT in detail design phase.

normally, but ensuring the guaranteed level of 215m MOL. At the end of the dry season, the water level of the reservoir will be lowered under the annual discharge water level, the reservoir will be taken partially or fully based on the regulated storage to ensure supplying stable power at guaranteed level. In this case, the water level at the end of the low flood season will fluctuate between annual discharge water level at EL = 218m and MOL at EL = 215m.

In case the water level of reservoir at the end of the low flood season is lowered to the MOL, the power supply to the system may not achieve the guaranteed level.

The operation of Nam Mo 1 HPP is expected to be at 90% efficiency for it to be economically viable. The annual operation is divided into three operation periods. The periods will have to be adjusted each year to the actual flow situation:

Flushing period

There will be no flushing regime decided at this phase although sediment loads are predicted (see physical environmental chapter). In this Project, bottom culverts will be used in case of emergencies. No special flushing tools are prepared.

3.8 Activities during construction

This section provides an overview of the construction phase. Project activities related to the construction are:

- Road construction;
- Construction of camps (Permanent and temporary);
- Dam construction including excavation of loose overburden down to rock and major concrete works. The dam construction will require construction materials from sites located, as much as possible close to the river;
- Stabilization works in the reservoir area;
- Underground works – tunnel from intake to powerhouse;
- Excavation and concrete works at the outlet area;
- Installation of electromechanical equipment in the aboveground power house; and
- Construction of transmission line from the powerhouse area to 220kV Nam Mo 1 HPP substation (not a subject of this ESIA).

The works will be characterized by heavy construction machinery and trucks in the main project areas, transportation of heavy equipment as well as cement and other construction materials.

Goods imported from overseas shall be transported by sea line to Cua Lo port, and then transported by road to the construction site on NR1A and NR7. Domestic goods depending on type of goods shall be transported by inland road railway or navigation way or sea line to Vinh City then transported to the project site

Aggregates and sand used for the project will be exploited from Pah Danh rock quarry. Other materials such as steel, dynamite, petroleum, welding sticks, etc. shall be purchased from Vinh city and transported to the site.

3.8.1. Construction material

Potential construction material sources were observed along the banks of the Nam Mo river. Both banks consist of alluvial deposits which are good source of sand, aggregate, riprap and filter materials. All alluvial deposits contain boulder- mixed silty sand. Some bands of rather pure sand have been identified within the deposits. The deposits consist in average of about 70-80% coarse aggregate (gravels to boulders) and about 20-30% fines (silt to sand).

Aggregates required for the construction will be sourced from the Pha Đanh quarry, approximately 15km from the project area. Crushing will be done at the quarry area. Sand will also be crushed here for the sand requirements.

In addition, the spoil from tunnel excavation will be used for coarse aggregates and hard core dam materials. They will be utilized as aggregates for road building, construction material for the dam and other structures, as well as stabilizing masses in the reservoir. The balance will be deposited in pre-determined spoil areas (see Figure 3.4)

Mainly, the materials are categorized as coarse aggregates (gravel and boulder materials), fine aggregates (sand) and clay materials (cohesive soils). Sand demand for civil works on the whole Project shall be about 78Mm^3. Table 3.9 lists the estimated quantities of construction materials needed for the Nam Mo 1 HPP.

Table 3.9. Quantities of construction material estimated for the Nam Mo 1 HPP

No.	Material	Unit	Quantity
1	Concrete (RCC 820 10^3m^3, others 124 10^3m^3)	10^3m^3	944.0
2	Ballast	10^3m^3	1.070.0
3	Rock utilized (from rock excavation at site)	10^3m^3	129.0
4	Sand	10^3m^3	450.0
5	Backfill soil	10^3m^3	130.0
6	Cement	10^3tấn	115.9
7	Steel	ton	4,955.6
8	Fly-ash for RCC (puzolan)	10^3 ton	123.0

3.8.2. Construction power

For the construction phase it is necessary to establish a reliable temporary power supply to the site at all access points and construction areas. The total peak power demand has not been finalised but will be distributed along the site from the uppermost camps and the dam, down to the outlet. The supply must be reliable at all times, with no power cuts which could delay the work progress.

Number of sub-stations supplying construction power for the site consists of 14 stations with to total capacity of 630 KVA (Figure 3.4;Table 3.2)

Power supply for construction shall be from 35kV transmission line connecting with 35KV accessed at Ta Ca commune.

3.8.3. Construction manpower

The estimated required manpower for construction, including required accommodation facilities is shown in Table 3.10 below. In addition, an influx of new settlers and small businesses will normally establish themselves at such large construction sites. Unregistered persons and “camp followers” could come to the area, whose numbers should be held at a minimum.

Table 3.10. Assumed project personnel and building numbers for implementation

Staff and Workforce:	
Technical and administrative staff	210 people
Workforce, (temporary, migrating):	1750 people
Workforce (local):	10-15 % of the total work force (to be decided)
Total	1960
Required housing for project personnel includes:	
Permanent houses of various sizes and standards	More details at the detail design phase.
Temporary housing *	
Social clubs	
Workshops and storage facilities	
Water supply and sewage treatment plants	
Guard houses / Police / Health	
Offices, etc.	

* It is assumed that a number of the temporary housing will mainly be erected with small rooms/ multiple beds for workers. These houses may be demolished, moved, or converted into other uses once the project is completed.

** In addition, other structures related to the contractor's equipment, concrete mixing plants, storage areas, container parks, parking areas, buildings for explosives storage at several points and other various small service buildings.

It is assumed that all houses will have cooking facilities. All houses and major building will have water supply, toilets and sewage systems.

3.8.4. Construction schedule

Start of construction is assumed to be 2018, i.e. preferably at the beginning of the dry season, and last for 4 years. The Construction schedule is based on the construction procedures and corresponding rates of progress described in the Feasibility Report. The rates on which the scheduled rock excavations are based on assumption of two 8-hour shifts per day, seven days per week. Dry season at project area is from beginning of Nov to end of June while flood season is only four months (July to end of Nov).

During the first year of construction, water will be diverted via the natural river. On the second year, water will be diverted through a cofferdam to construct a diversion culvert. As rainy season commences, water will then be diverted through the diversion culvert. On the 3rd year, water can also be diverted through the uncompleted spillway at elevation 214m in addition to the diversion culvert. By the end of 4th year, the spillway is expected to be completed and will be fully used during flood season.

On the basis of the quantity of civil works and scheme for the construction diversion, construction schedule is shown in Table 3.11 below:

The development of the hydropower project will commence with detail technical design of the project works and dam and the elaboration of the environmental and social plans, including all safeguards. The construction will essentially start once the resettlement implementation process in complete. It is possible that a staggered resettlement time line may employed with the households closest to the dam relocating before the construction commences, given that the ones further away will be effected when the reservoir is filled. Regardless all agreements for resettlement must be completed before construction begins.

Table 3.11. Construction schedule

Hydropower Development: Detail Design, ESMP-REMLRP elaboration and Construction Activities	Before construction	Year 1	Year 2	Year 3	Year 4
Detail Design and Elaboration of the Environmental and Social Management and Action Plan and REMLRP					
Commencement of construction works					
Closing Nam Mo river					
Closing of diversion culvert - impounding reservoir					June
Commissioning of Generating Unit 1					Sept
Commissioning of Generating Unit 2					Oct

CHAPTER 4 ANALYSIS OF ALTERNATIVES

For greenfield developments like hydropower projects, alternative analysis is considered as an integral part of ESIA. Alternative analysis is primarily governed by factors such as energy needs, technical feasibility, economic viability and both permanent and non-permanent impacts to the biological and human environments. The aim is to minimize environmental and social risks. The Proponent is also to consider feasible alternative project designs to avoid or minimize physical and/or economic displacement, while balancing environmental, social, and financial costs and benefits, paying particular attention to impacts on the poor and vulnerable. The following rational and alternatives are considered for the development and ESIA study of Nam Mo 1 HPP.

4.1 Growing Energy Demand in Vietnam and Project Province

In order to ensure national energy security, mitigate climate change, protect the environment, and promote socio-economic development, coal-fired electricity is imported less, and renewable power sources, including multi-purpose projects on hydropower source development, are prioritized. The Ca River basin is one of the main ones identified for hydropower development in Vietnam. Ca River is one of the largest rivers in Vietnam and originates from Houaphanh and Xiangkhoang Provinces in Lao PDR, passing across Nghe An Province in Vietnam before it joins the Eastern Sea at Vinh city. One of its tributaries is the Nam Mo River.

The **National Power Development Master Plan** for the 2011-2020 (revised March 2016 calls for more power and reliability in supply all over Vietnam. The Master Plan projects approximately 235-245 billion kWh of commercial electricity in 2020. Particularly, the Master Plan proposes an increase in the total capacity of all renewal energy forms including hydropower (Table 4.1). The proportion of the hydroelectricity of the total energy source in the country is expected to rise to approximately 29.5% in 2020. Of all types of renewable energy, hydropower is expected to contribute to the share of production of approximately 20.5% in 2025 and approximately 15.5% in 2030[34]. Other main sources of power planned are thermal, solar and wind.

Table 4.1 Sub-targets for Renewable Energy: share of electricity production and installed

Type	Capacity and Production	2020	2025	2030
Wind	Total Capacity (MW)	800	2,000	6,000
	Electricity production (%)	0.8	1	2.1
Hydropower	Total Capacity (MW)	21,600	24,600	27,800
	Electricity production (%)	29.5	20.5	15.5
Biomass	Electricity production (%)	1	1.2	2.1
Solar	Total Capacity (MW)	850	4,000	12,000
	Electricity production (%)	0.5	1.6	3.3

[34]The Prime Minister of GoV (2016) Decision (18 March 2016, Decision No. 428/QD- TTg) on the Approval of the Revised National Power Development Master Plan for the 2011-2020 Period with the Vision to 2030 and summary information report "Vietnam Power Development Plan for the period 2011 –2020 Highlights of the PDP 7 revised (GIZ). The Prime Minister approved the adjustment of National Power Development Plan VII (referred to as PDP 7 rev) for the period of 2016 – 2030 with the vision to 2030. Compared to the PDP 7 of July 2011, the most obvious changes in the PDP 7 rev is a stronger emphasis on Renewable Energy development.

4.1.1. Energy demand forecast in Vietnam and projection based on current demand and consumption values

Demand Growth: During 2005–2014, average annual growth in electricity demand was 12.1%, electricity consumption increased from 45.6 terawatt-hours (TWh) to 128.4TWh, and peak demand grew from 9.5 gigawatts (GW) to 22.2GW. Per capita electricity consumption increased from 156 kilowatt-hours (kWh) in 1995 to 983 kWh in 2010 and to 1,415kWh in 2014. The total installed and operating generation capacity in Vietnam was 11.6GW in 2005 and 34.1GW in 2014, an average annual growth of 12.6% in generation additions[35].

In 2014, **power consumption** by sector was as follows: industrial (53.9%), residential (35.6%), commercial (4.8%), agriculture (1.5%), and other sectors (4.3%). The industrial sector is the largest consumer of electricity and also the most important sector economically, projected by 2015 to account for 41% of GDP, 29% of the workforce, and 87% of export revenues[36].

Demand Forecast: Demand for electricity is expected to grow at an average of 10.5% per annum during 2016–2020, and 8.0% per annum during 2021–2030. Electricity consumption is projected to reach 234.6TWh in 2020 and 506.0TWh by 2030, representing a fourfold increase by 2030 compared with the consumption in 2014. The peak demand is estimated to reach 42.1GW by 2020 and 90.7GW by 2030 to supply the projected power consumption. Table 4.2 shows key indicators with respect to power demand, production, and consumption for the period 2005–2014 (actual) and also shows projections up to 2030[37].

Table 4.2 Electricity deand: actual and projected

Electricity Demand: Actual (2005-2014) and Projected (2015-2030)

Item	2005	2009	2014	2015	2020	2025	2030
Annual demand (TWh)	45.6	76.0	128.4	141.8	234.6	352.3	506.0
Annual generation (TWh)	53.6	86.9	145.5	161.3	265.4	400.3	571.8
Maximum demand (GW)	9.5	13.9	22.2	25.3	42.1	63.5	90.7
Per capita consumption (kWh)	549.0	873.0	1,415.0	1,560.0	2,545.0	3,610.0	4,950.0

GW = gigawatt, kWh = kilowatt-hour, TWh = terawatt-hour.

Source: Government of Viet Nam. 2015. *Revised Power Development Plan 2011–2020*. Ha Noi.

Access to Electricity: Vietnam has made remarkable progress in expanding access to electricity, with percentage of households without electricity decreasing from 50% in 1995 to 2% in 2014. This has also been one of the drivers for rapid growth in the demand for electricity in the past. The communities that are not yet connected to the grid are mainly in

[35] https://www.adb.org/sites/default/files/institutional-document/178616/vie-energy-road-map.pdf; Government of Viet Nam, Viet Nam Electricity. 2014. Annual Report. Ha Noi

[36] Government if Viet Nam, Ministry of Industry and Trade. 2015. Revised Power Development Plan for the 2011–2020 Period with the Vision to 2030 (Revised PDP VII). Ha Noi

[37] The Government of Viet Nam, Ministry of Industry and Trade. 2014. Report on Rural Electrification. Ha Noi. (in https://www.adb.org/sites/default/files/institutional-document/178616/vie-energy-road-map.pdf)

the less developed and sparsely populated mountainous areas. Providing universal access to electricity is a top priority of the government's power subsector development agenda[38].

4.1.2. Demand and consumption in Nghe An Province

Energy demand in Nghe An Province in Vietnam is fairly high and has increased remarkably. According to Nghe An Power Company (EVNNPC-PC Nghe An), the province's consumption has raised from 1,063 billion kWh in 2007 to 1,485 billion kWh in 2011. Together with that, annual electricity loss has also grown, from 8.37% in 2007 to 10.75% in 2011[39].

Electricity consumption of Nghe An province has been increasing, especially in summer due to higher demand of cooling facilities such as air conditioners and fans. In August 2017, the consumption was 11.5 million kWh/day and maximum capacity of the power system was 567Mw. This was higher than the highest consumption and capacity in 2016 (10,1 million kWh and 499Mw respectively)[40].

Currently, the national electricity system does not cover some remote regions in Nghe An Province (242 villages). With the plan of covering 100% villages by 2020 electricity consumption will be higher[41].

Power cuts and insufficiency frequently occurs, especially during the dry season, affecting livelihoods, production systems and wellbeing (for example, water pumps do not work to provide water for plant nurseries or to operate pumping fans in shrimp ponds; no domestic cooling or fans on hot days or cooking with electrical appliances especially for staples (rice) due to low or fluctuating power supply)[42].

The development of Nam Mo 1 HPP will contribute to the demand for electricity first an foremost to the region and to Vietnam.

4.2 Without the project alternative

Under the "without project" scenario, there will be no contribution to the national energy requirements. The energy demands for economic development in Vietnam are high and increasing with time. Enhancing energy security requires installation of additional hydropower projects. The "without project" alternative would not be in-line with economic development planning and might hinder economic, environment and livelihood enhancement which is expected to result from the Project. Implementation of reservoir project like Nam Mo 1 HPP will also mitigate hydrological and meteorological risks, e.g., flash floods. The reservoir may also help to humidify the environment in the river system particularly in the dry season.

Implementation of the Nam Mo 1 HPP would make electricity available to rural areas and trigger local development activities and small-scale industrial development, and as a result may enhance local and regional economy contributing to the regional and national demand for electricity.

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[38] https://www.adb.org/sites/default/files/institutional-document/178616/vie-energy-road-map.pdf

[39] http://nangluongvietnam.vn/news/vn/bao-ton-nang-luong/nghe-an-tang-cuong-quan-ly-nha-nuoc-ve-su-dung-nang-luong-tiet-kiem-va-hieu-qua.html

[40] http://www.baonghean.vn/kinh-te/201708/nghe-an-nang-nong-san-luong-dien-tieu-thu-tang-ky-luc-2834423/

[41] http://www.baonghean.vn/kinh-te/201708/nghe-an-nang-nong-san-luong-dien-tieu-thu-tang-ky-luc-2834423/

[42] http://www.baonghean.vn/kinh-te/201706/dan-vat-va-ngay-nang-nong-vi-dien-qua-yeu-2818558/

However, if the proposed Nam Mo 1 HPP is not implemented, there will be no Project-induced loss of forest, cultivated area, habitat changes, relocation of villages and other Project-induced environmental and socio-economic impacts.

4.3 Without forest loss and relocation of villages alternative

The “without forest” and “without relocation of villages” scenario will not allow for the implementation of this Project. This alternative would require to decrease the dam height and reservoir FSL significantly which would result in significant reduction of electric power generation and would be economically unsustainable. It means that the Project cannot be built without taking forested lands and avoiding the relocation of villages. If the HPP is not developed there will be less contribution to the electicity demands of the region and particularly to the less populated areas, projected in the national energy plan. The growing population in the region and development will not have enough power in the next decade and that may lead to out-migration and generally halting growth. The Project is required for continuing the economic growth in the region and Nghe An province, which remains home to some of the poorest communities in Vietnam.

4.4 Alternative forms of electricity generation

Besides hydropower plants, other forms of potential power generation include thermal (use of fossil fuels), biomass, solar and nuclear power. Thermal generation is not a good choice as fuel sources must be imported at high cost. In addition, the generation of greenhouse gases as a result of operating thermal power plants contributes to global warming and air emissions associated with thermal generation are problematic. Nuclear power is an expensive and very complex energy generation system with a number of technical, safety and environmental challenges. Currently, possibility of installing nuclear power plant in Vietnam is low. Renewal energy development is a priority of the GoV.

4.5 Alternatives to project design, structures, location and layout

4.5.1. History of Project alternatives

The main feasibility report of Nam Mo 1 HPP dated January 2015 (PECI, 2015) presented alternatives. There were three alternatives proposed. The location of the river being at the Laos-Vietnam border is a primary consideration in terms of security, therefore all planned surveys (for alternatives), locations of planned alternatives for permanent and non-permanent infrastructure were agreed by the Proponent and design team that at least a one- km-distance from the boarder would be maintained in the planning. The project design team also had to comply with the GoV Law on Forest and Forest Development of 2004 and related acts/regulations which called for minimizing forest land take. Similarly, the impacts on households living in the potential area of influence must be minimized.

4.6 Alternatives to Project design, structures, location and layout

4.6.1. History of project alternatives

The main feasibility report of Na Mo 1 HPP (PECI, 2015) summarized the proposed alternatives. There were three alternatives proposed. The location of the river being at the Laos-Vietnam border is a primary consideration in terms of security, therefore all planned surveys (for alternatives), locations of planned alternatives for permanent and non-permanent infrastructure were agreed by the Proponent and design team that at least a 1km distance from the border would be maintained in the planning. The Project design team also had to comply with the GoV Law on Forest and Forest Development of 2004 and related acts/regulations which called for minimizing forest land take. Similarly, the impacts on households living in the potential area of influence must be minimized.

4.6.2. Proposed alternatives

The GoV National EIA approved in 2015 was based on a given project design such as dam height, reservoir size, maximum water level in reservoir, etc. (Alternative 2, the preferred alternative; see details in Chapter 3 of this Report). Nam Mo 1 HPP in Vietnam with an installed capacity of 18MW is operational since 2013 and it is located 5.1km downstream of the proposed Nam Mo 1 dam site (this Project). The end of the Nam Mo reservoir extends beyond the proposed dam site of this Project (see Section 11.7 Cumulative section). There is another HPP with the same name, Na Mo 1 HPP, in Laos with an installed capacity of 55MW for which the technical feasibility and EIA has been completed. The proposed dam site in Laos is located 18km upstream from the Laos-Vietnam border. It is not clear at this stage how far would the end of the reservoir (of this Project) from proposed damsite of the Nam Mo 1 HPP in Laos.

Salient features of Alternatives 1, 2 and 3 and their impacts on physical biological and social environments are summarized in Table 4.3 based on those reported in the feasibility report (PECI, 2015).

Three alternatives were planned in locations with suitable topology and narrow stretch of the valley. There were no marked differences between the locations, with Alternative 1 (upstream) located 500m upstream from the Alternative 2 (recommended site). Alternative 3 was located 650m downstream of Alternative 2. Alternative 1 was rejected due to its close location to the border and partly due to location very close to a fault. Alternatives 2 and 3 were considered further and Alternative 2 was preferred based on location, lower levels of impacts on social and environmental aspects as well as economic reasons. The feasibility report states that the maximum economic benefit would come from Alternative 2 where the investment per unit cost (per kW) would be smaller than Alternative 3.

Table 4.3 Impacts on environment and social aspects of alternative capacity options

No	Features / Aspects	Project Alternatives and known specifications		
		Alternative 1	Alternative 2 [1/]	Alternative 3
1	Headworks and reservoir			
A	Dam location	650m upstream of Alternative 2	Recommended location	500m downstream of Alternative 2 Closest to downstream then under construction Nam Mo HPP, and greatest extent of infringement into its reservoir.
B	FSL	230masl	235masl	240masl
C	Dam type	RCC	RCC	RCC

No	Features / Aspects	Project Alternatives and known specifications		
		Alternative 1	Alternative 2 [1/]	Alternative 3
D	Geological features	Located at a fault in a hollow trace at the left bank	No faults next to location, located 1.3km from the Song Ca fault downstream.	Located 0.8km from the Song Ca fault (SC2-1a)
E	Border location (security issues)	Located at the border gallery strip where legal aspects would require special consideration.	Is located about 1km from the Laos border, giving no legal issues.	Is located 1.5km from the Laos border giving no legal issues.
		Alternative abandoned due to above reasons.	*Compared further*	*Compared further*
F	Estimated reservoir and main civil works area (ha)		*1006.98*	*1137.71*
	Reservoir area		961.68	1092.41
	Main civil works		45.30	45.30
G	Temporary work area (ha)		37.7	37.7
2	Households likely affected			
A	No of estimated households to be likely relocated	133	152	244
3	Land cover			
A	Total land cover (ha). Based on vegetation maps, year not reported.		*961.68*	*1092.41*
	Water surface		83.13	97.09
	Bamboo forest, mixed bamboo forest		131.44	172.90
	Secondary forest		379.10	419.10
	Grassland		78.90	113.70
	Shrubland		289.11	289.62
4	Relative environmental and social impacts compared			
A	Resettlement		No of households to be resettled is lower than Alternative 3	
B	Forest land (including protection forest land)		Affected forest area estimated is less than Alternative 3	
C	Fishing		Stretch of river affected is shorter than that in Alternative 3.	Water surface area potentially use for fishing is more than Alternative 2

[1/] Considered during national EIA preparation for Na Mo 1 HPP in Vietnam territory issued by PECI 8/2015 and was approved by Vietnam Government on 20/11/2015.

4.7 Technologies and implementation procedure

The power plant will be designed and built with sound technology. Construction methodology will be based on intensive technologies of construction equipment and maximum utilization of local resources to the extent possible. This is to ensure lowest possible cost for project development and the quality of works undertaken. Priority should be given to the recruitment of local people, which will minimize the need for large areas of temporary camps. It will also reduce firewood and timber requirements, enhance local skills development and the economy, and foster good relations between the Project and local people. Surface blasting will be conducted during daylight using detonators of limited capacity. This will minimize the impact on local topography, structural damages in nearby settlements, wildlife/domestic animal movement and other unnecessary disturbances to local communities. Locally available materials with simple engineering structures such as gabions will be used for slope stability.

4.8 Use of raw materials

The construction materials such as cement, iron and other materials will be supplied from within Vietnam, and materials such as aggregates, sand, and stones are available in the Project area. Other heavy machines and equipment, turbines etc. are to be imported and transported to the site which is connected by highway.

Sources for some aggregate materials have been located in the area (see section on quarry). Excavated materials such as from headworks and tunnels will be used as construction materials, if found suitable

CHAPTER 5 APPROACH

5.1 Introduction and objectives of the ESIA

The ESIA report is prepared in accordance with the standards of the Multilateral Investment Guarantee Agency (MIGA) and internationally accepted practices. MIGA uses a process of environmental and social categorization to reflect the magnitude of risk and impacts of a project. Based on the project categories, the Nam Mo 1 HPP is classified under **Category A.** Category A Projects are business activities with potential significant adverse environmental or social risks and/or impacts that are diverse, irreversible, or unprecedented[43].

This study also refer to the IFC Environmental, Health and Safety (EHS) Guidelines where their applicability was tailored to the hazards and risks established for the Nam Mo 1 Project. The general EHS guidelines includes:

1. Environmental: Air emissions and ambient air quality (Ambient air quality, Greenhouse gases), Energy conservation, Wastewater and ambient water quality, Water conservation, Hazardous materials management, Waste management and Noise pollution;
2. Occupational health and safety: General facility design and operation, Communication and training, Physical, chemical, biological and radiological hazards, Personal protective equipment (PPE), Special hazard environments and monitoring;
3. Community health and safety: Water quality and availability, Life and fire safety, Traffic safety, Transport of hazardous materials, Disease prevention, Emergency preparedness and response; and
4. Construction and decommissioning: Specific guidance on prevention and control of community health and safety impacts on environment and occupational health & safety.

The purpose of the ESIA is to:

- Establish the baseline condition within the Project area;
- Identify and evaluate environmental and social risks and impacts of the Project;
- Adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize[44], and, where residual impacts remain, compensate/offset for risks and impacts to workers, affected communities, and the environment;
- Promote improved environmental and social performance of the Proponent through the effective use of management systems;
- Promote and provide means for adequate engagement with affected communities throughout the Project cycle on issues that could potentially affect them and to ensure that relevant mitigation measures are proposed; and
- Ensure that the grievances from affected communities and external communications from other stakeholders are responded to and managed appropriately.

Figure 5.1 illustrates the impact assessment process in the Project cycle.

[43] Environmental and Social Policy and Procedural Guidelines for Projects in International Development Association (IDA) countries financed jointly by World Bank and IFC based on IFC Sustainability Framework (June 19, 2012).

[44] Acceptable options to minimize will vary and include: abate, rectify, repair, and/or restore impacts, as appropriate.

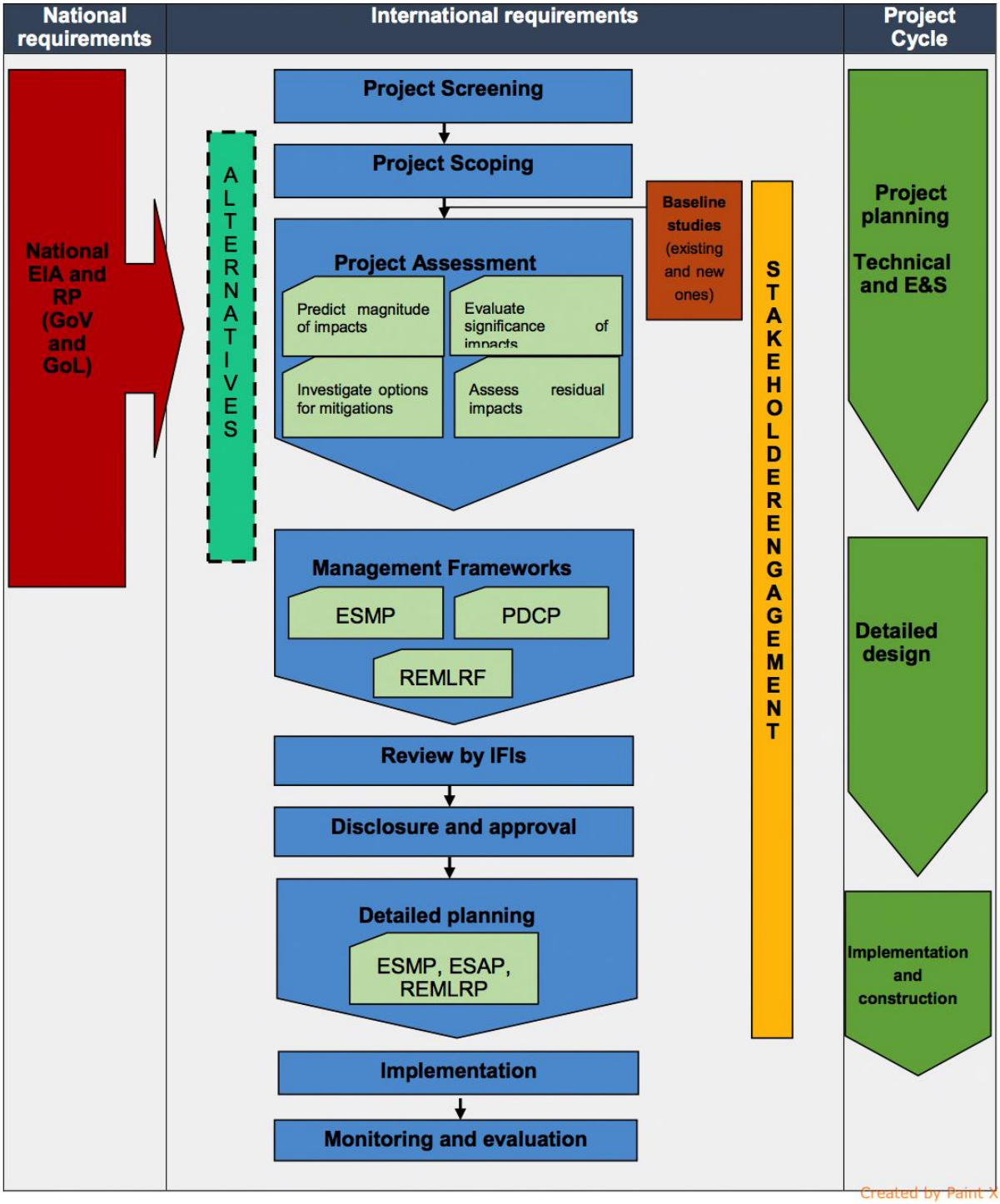


Figure 5.1 The ESIA process

5.2 Outlining of baseline and collection methods

Baseline characterization was based on review of existing reports/literature, review and gap analysis of previous studies reporting on the Nam Mo 1 HPP (Table 5.1) and conducting field work and information gathering using participatory approaches in 2017. Existing baseline data and information of Nam Mo 1 HPP were reviewed and a description of the data gaps and required work was prepared and included in a rapid Scoping Report[45]. Based on the Scoping Report, specific baseline data and information on environmental and social resources in the Project AI were collected for this ESIA and the Free, Prior, and Informed Consent (FPIC) process carried out in 2017 (Table 5.1). FPIC (MIGA PS 7) was carried out as indigenous people (ethnic minorities) will be affected by the proposed Project – subject to relocation, loss of land and assets, cultural/spiritual sites and livelihoods.

The key works reporting on baseline prior to 2017 are included in the Table 5.2 below.[46] The additional work in 2017 included gathering data on physical (e.g., land-use, water quality); biological (e.g., flora, fauna and aquatic) and social (e.g., economic and cultural characteristics).

Table 5.1 Field surveys and public consultation done for Nam Mo 1 HPP

Subject /Theme	Date /Period	Location	Methods / Approach Sample size (no) / area (ha)	Where reported / How used (reference)	Conducted by
Physical characteristics					
Water quality	December 2015; April/May 2016 March 2017	Ca River/ Nam Mo River	Grab sampling 3-4 sampling stations per sampling event	Section 6.8.2 Water quality section	PECI
Soil quality	December 2015	Upperstream of damsite; Xieng Tren village; quarry site	Grab sampling; 3 stations	Section 6.8.3 Quality of soil environment	PECI
Biological characteristics					
Vegetation survey	2012, May 2017	Within the proposed reservoir area following Ca River	Transect line 20 sampling sites	Section 7.3. Forest vegetation; Annex 2[47]: (this report)	PECI Institute of Ecology Biology Resources, Hanoi (IEBR)
Wildlife survey	2012 May 2017	MyLy and Keng Du Communes	Interviews and FGDs, Visual	Section 7.4 Wildlife resources	ASA PECI
Fisheries survey	May 2017	Along Ca River	13 sampling sites	Section 7.5 Aquatic ecology	PECI IEBR
Social characteristics					
Socio-economic features,	2012, 2015	DIA in Vietnam	Statistical data collection,	EIA 11/2015	PECI

[45] PECCI and ENVIRO-DEV. December 01, 2016. Scoping Report and Terms of Reference for ESIAs of My Ly and Nam Mo 1 Hydropower Projects.
[46] ENVIRO-DEV. March 30, 2017. Nam Mo 1 Hydropower Project, Progress Report of the ESIA.
[47] Institute of Ecology. April 2017. Biology Resources Report on Biology System.

Subject /Theme	Date /Period	Location	Methods / Approach Sample size (no) / area (ha)	Where reported / How used (reference)	Conducted by
general impacts and mitigation measures			meetings with district and commune level representatives and village leaders		
Major socio-economic impacts on villages and proposed relocation and compensation in general terms	2015	Inundation area in Vietnam	Methodology reported: using maps, statistics, legal documents and development plans; meetings with gov staff; site survey, quick interviews with PAP	General Resettlement Plan 09/2015	Nghe An Forestry Planning Division
Baseline socio-economic and cultural overview and general project impacts, general principles of consultation	2016	Inundation area in Laos	Methodology reported: Village and household surveys, focus groups	ESIA 08/2016 contains very little and general information about the villages to be relocated, no reporting on consultations undertaken. Limited survey in each affected village as attached excel file.	ASA Consultant
Project and its impacts, GoV compensation policies; Socio-economic features of PAP	07/2016	DIA in Vietnam and Laos	(1) Meetings with commune and village representatives to present the Project and its impacts, Gov compensation policies, proposed mitigation measures, and to get participants agreement to the HPP. (2)Household baseline survey among 25% of affected HHs,	Summary table prepared for Project Scoping Report 10/2016 and Chapter 8 Annex 2 Table A in Progress Report March 30, 2017.	PECC1 and PO

Subject /Theme	Date /Period	Location	Methods / Approach Sample size (no) / area (ha)	Where reported / How used (reference)	Conducted by
			focused on land and assets.		
Social, economic/ livelihoods, health, education, cultural baseline information; PAP knowledge and views of the planned HPP	07–21 Jan, 2017	DIA in Vietnam and Laos	Baseline socio-economic and cultural information collection using participatory methods (5 thematic FGDs, 4 types of KIIs, and interviews with commune gov offices). All affected villages in DIA (reservoir and downstream) were sampled and commune offices were visited in all affected communes.	Volume I-Chapter 8 and Volume III in this ESIA.	NC (PECC1) under direction of IC (ENVIRO-DEV)
Communication – consultations[48]					
FPIC process	09-16 Jun, 2017	Inundation area in Vietnam and Laos	Participatory village consultation with all HHs invited in each village to be relocated and with village leader in each village losing land to reservoir; map, written and spoken information about the Project, its impacts and proposed mitigation provided and discussion with the PAP about them, HHs' views and concerns	Volume I-Chapter 8 and Volume IV-Annex 5 in this ESIA.	Independent consultant group under direction of IC (ENVIRO-DEV)

[48] Communication in this table include only those consultations conducted where a two-way exchange took place and records are present. In the history of this project this ESIA study is the only process which included two-way communication including participatory and FPIC processes. Other details are provided in Chapter 10.

Subject /Theme	Date /Period	Location	Methods / Approach Sample size (no) / area (ha)	Where reported / How used (reference)	Conducted by
			documented, agreement/ disagreement to relocation signed by village leader in each affected village.		

Reference: Institute of Ecology Biology Resources (IEBR). April 2017. Report on Biology System.

Since 2011, Nam Mo 1 HPP have been subjected to a number of studies after the completion of the Plan of Hydropower Cascade Development in Ca River basin[49]. The Plan was approved by the Ministry of Industry and Trade (MOIT) of Vietnam. There were a series of relevant studies conducted to characterize the Project, presented below (Table 5.2). These studies have received legal permission/acceptance from both Vietnam and Lao PDR. These studies were reviewed in the scoping report and the data, where acceptable is used in this study.

Table 5.2 Chronology of key works performed on the Nam Mo 1 HPP

No.	Month/ Year	Name of report	Status	Prepared by
I	**Technical documents:**			
I	12 / 2015	Feasibility Study Profile for Nam Mo 1 hydropower project includes:	Submitted to MOIT, Vietnam	See below
1		*Volume 1: Summary report*		PECI, Vietnam
2		*Volume 2: Main report*		PECI, Vietnam
3		*Volume 3: Meteo-hydrological conditions*		PECI, Vietnam
4		*Volume 4.1: Hydro-energy, and hydro-economic analysis*		PECI, Vietnam
5		*Volume 4.2: Financial analysis*		PECI, Vietnam
6		*Volume 5: Total investment cost*		PECI, Vietnam
7		*Volume 6: Report on assessment of earthquake hazard level*		Geological Institute - Vietnam Institute of Science and Technology
8		*Volume 7: Transmission line from Nam Mo 1 hydropower plant to Vietnam national power grid.*		PECI, Vietnam
9		*Geographical condition*		Geological professional - Institute of Drilling Technology, Vietnam
II	**Social and environmental documents:**			
10	3/2017	Progress Report, ESIA Nam Mo 1 HPP	Approved	ENVIRO-DEV

[49] Decision No. 6110/QD-BCT dated 23/11/2011 by Ministry of Industry and Trade (MOIT) on approving My Ly and Nam Mo HPPs of the Plan of Hydropower Cascade Development in Ca River basin.

No.	Month/ Year	Name of report	Status	Prepared by
11	8/2016	ESIA Nam Mo 1 HPP- ASA, Laos	In review by GoL	ASA consultant, Lao PDR
12	8/2015	EIA report Nam Mo 1 HPP, Vietnam	Approved by MONRE, GoV 20/11/2015	PECI, Vietnam
13	8/2015	Resettlement Plan Report, Nam Mo 1 HPP, Vietnam	In review by Nghe An Province, GoV	Nghe An consultant, Vietnam
14	5/2017	Biology report for Nam Mo 1 HPP, Vietnam & Lao PDR	Completed	IEBR, Vietnam
16	6/2017	Water Quality Report for Nam Mo 1 HPP, Vietnam and Lao PDR	Completed	PECI, Vietnam

5.3 Definitions used in this study

The ESIA process focuses where the Project involves activities that are likely to generate environmental and social impacts. These include construction of dam and its various associated structures, powerhouse and tail race facility, auxiliary facilities, quarrying, muck disposal, construction of waste storage, and other related activities as described in Chapter 3. There could be unplanned but predictable developments caused by the Project that may occur later or at a different location. Below are some of the terms and their definitions as used in this study.

Project Area of Influence (AI) - Environmental and social risks and impacts are identified in the context of the Project's AI. The Project areas identified are as follows:

- Direct Impact Area (DIA)

a) Project structure and activity area: These include construction and associated facility sites; access roads, quarry sites, spoil disposal area, and physically high risk areas. Both permanent and temporary areas used by the Project fall under this category.

b) Inundation area: This is the area covered by reservoir at operation level. This is a permanent impact area where the local inhabitants will lose their land and assets on land, and physical and productive infrastructure and facilities. There could be irreversible losses to natural resources.

c) Low flow area: It includes the stretch of the Nam Mo river between the dam site and the tailrace outlet where the flow may be significantly reduced during Project operation. The impacts are assessed in relation to the aquatic ecosystem, natural habitat and fisheries, and any river related livelihood and cultural activities

d) Water level fluctuation stretch: The riverine area between the tailrace outlet and the first river confluence is included in the 'high flow fluctuation stretch'. Since the precise operation is not finalized and will be done so during the detailed design phase this will need to be assessed later.

e) Safeguard Buffer Area: A buffer zone of at least 50m from the water body. No annual crops that could trigger soil erosion and landslides or mass movement should be grown in this buffer zone. Details of such a zone shall be designated during the detailed ESMP.

- Indirect Impact Area (IIA)

Indirect project impacts on biodiversity or on ecosystem services upon which livelihoods of affected communities are dependent. There could be some habitat

fragmentation. Project districts and communes are categorized as indirect project areas.

I. Project Affected Persons (PAP)

Families or households in the direct or indirect impact areas whose land, properties or livelihoods may be affected due to construction or operation of project components are considered as 'Project Affected Families (PAF)'. The members of these families or households are considered as Project Affected Persons (PAP). In this ESIA the term "Project Affected Families" or "Project Affected Households" follows MIGA terminology and thus is not limited to those subjected to physical displacement. Project Affected Families include, depending on the case, those affected by:

a) the involuntary taking of land resulting in:

- relocation or loss of shelter;
- loss of assets or access to assets; or
- loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or

b) the involuntary restriction of access to legally forested areas, designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

c) the involuntary restriction of traditional social-culture activities.

More detailed characterization of PAPs and PAFs is provided in the Resettlement and Ethnic Minority Livelihood Restoration Plan (Volume 6- REMLRP).

II. Tertiary Impact Area (TIA)

Along roads beyond the project impact areas. Tertiary impacts may be related to transport routes, boomtowns, camp followers (especially at small townships and villages), health and safety, and exploitation of natural resources.

Ecosystem services as defined by MIGA PS are the benefits that people including businesses derive from the ecosystems and includes four types: provisioning, regulating, cultural and supporting services. The most frequently described are those provisioning services commonly referred to as natural resources, e.g., water, food and fuel. The consideration of ecosystem services is a key requirement of the MIGA PSs. By definition, ecosystem services contribute to human well-being (de Groot et al. 2010[50]). But while some ecosystem services directly contribute to human well-being or project performance, others do so indirectly by supporting other services. For example, fish/cattle production —a final service—typically provides a direct value to human well being through income, subsistence, and/or culture. In contrast, fodder production—an intermediate service—contributes to human well-being indirectly by supporting livestock production. In the context of the Nam Mo 1 HPP, ecosystem services may include:

- Land (grazing of livestock; places of cultural significance; agriculture; vegetation cover that provides for soil and slope stability);
- Water (fishing; irrigation; transport).
- Forest (food sources; medicinal plants; firewood, wood for crafts/construction).

[50] de Groot, R., B. Fisher, M. Christie, J. Aronson, L. Braat, J. Gowdy, R. Haines-Young, E. Maltby, A. Neuville, S. Polasky, R. Portela, and I. Ring. 2010. "Integrating the Ecological and Economic Dimensions in Biodiversity and Ecosystem Service Valuation." Chapter 1: 9-40 in P. Kumar (editor) The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan.

Ecosystem services will be assessed through the ESIA process.

5.4 Impact and risk assessment approach

5.4.1. Risks and impacts

Table 5.3 Impact characteristics, definitions and designations

No.	Characteristic	Definition /Description	Designations and definition
1	Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect)	Direct Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., land take, river stretches, between occupation of a plot of land and the habitats which are affected).
			Indirect Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
			Induced Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
2	Extent	The “reach” of the impact (e.g., the stretch of the river and tributaries, or that which is confined to a small area around the Project footprint, projected for several kilometers, etc.).	Local
			Regional (defined on a receptor/resource specific basis)
			International
3	Duration (defined on a resource / receptor specific basis)	The time period over which a resource / receptor is affected.	Short-term/temporary impacts are those lasting for short duration 3-5 years after Project completion
			Medium-term impacts are those lasting for 5-15 years after Project completion
			Long-term impacts are those lasting for more than 15 years
			Permanent impacts that are a result of change, loss or due to the Project
4	Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	No fixed designations; intended to be a numerical value and relative comparison based on similar type coverage at a larger scale for example. Usually designated as Small, Medium, or Large
5	Frequency	A measure of the constancy or periodicity of the impact	No fixed designations; intended to be a numerical. Usually designated as Lower or Higher

No.	Characteristic	Definition /Description	Designations and definition
6	Likelihood (pertains only to unplanned events, traffic accidents, operational leaks, strikes/ protests)	Using a qualitative (or semi-quantitative, where appropriate data are available) scale. A measure of the degree to which the unplanned event is expected to occur. It is not the degree to which an impact or effect is expected to occur as a result of the unplanned event (i.e., uncertainty).	Unlikely. The event is unlikely but may occur at some time during normal operating conditions.
			Possible. The event is likely to occur at some time during normal operating conditions.
			Likely. The event will occur during normal operating conditions (i.e., it is essentially inevitable).
7	Magnitude / Degree of Impact	Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor.	Positive, Negligible, Small, Medium or Large Magnitude is a function of the following impact characteristics explained in the process of describing and defining the likely impact: extent, duration, scale, frequency and likelihood.
8	Sensitivity /Vulnerability /Importance	It describes the vulnerability status of impact	Small/Low, Medium or High
9	Significance (overall impact)	The significance for a given impact on resource/receptor	Negligible, Minor, Moderate or Major

		SIGNIFICANCE: Vulnerability, Sensitivity or Importance of resource/Receptor		
		Low	Medium	High
Magnitude/Degree of impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Figure 5.2 Designation of magnitude and significance

5.4.2. Mitigation and enhancement

MIGA Performance Standards 1-8 ensure management of environmental and social risks and impacts due to Project implementation. Project shall avoid, or where avoidance is not possible, minimize, mitigate, or compensate, for adverse impacts on workers, affected communities, and the environment.

Mitigation measures are classified as:

Preventive measures: some potential adverse impacts may be reduced or eliminated before occurrence by introducing preventive measures which promote proven environment management techniques/practices such as health awareness and health programs.

Compensatory measures: actions that are undertaken to compensate for unavoidable adverse impacts such as release of compensatory flow, rehabilitation of displaced people, forest plantation etc.

Corrective measures: actions implemented to reduce adverse impacts to acceptable levels such as installation of pollution control device, construction of fish ladder.

The ESMP will consist of the set of mitigation measures, monitoring and institutional measures to be taken during project construction and operation to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels.

5.5 Communication

The Project has had a history of various parties having presence at the affected villages over time (since 2011 at least). Local communities have been subjected to surveys and received information from Proponents, government representatives, technical personnel (working for the proponents, e.g., surveyors, geologists) and those carrying out surveys for the GoV and GoL EIAs and national Resettlement Plans.

The ESIA IC for this study reviewed in detail all previous consultations available (where accessible and recorded). Most previous work focused on high level consultations (at the district level, commune) or village level committees and villages heads. Little was communicated to communities, particularly in the form that the ethnic minorities were informed. Informed Consultations and Participation (ICP) is not a requirement of the national EIA process.

Given this, the ESIA consultant opted to conduct a detailed set of participatory consultations for gathering baseline information. These consultations started with village information meetings leading into thematic focus group discussions (FGD) and key informant interviews (KII). These data and observations led to baseline characterization and verification, and the planning of the FPIC process. In discussion with MIGA, the FPIC process was carried out. This led to the development of the PCDP and planning for future project related consultations – covering the project cycle. The Proponent is responsible for carrying out all future consultations.

5.6 Proponent responsibility

The Proponent is responsible to manage environmental and social risks and impacts so that development opportunities are enhanced[51]. The Proponent will manage environmental and social performance including Land Acquisition and Involuntary Resettlement, Pollution Prevention, Conservation and Sustainable Management of Natural Resources, and

[51]Source: https://www.miga.org/projects/environmental-and-social-sustainability/performance-standards/, see also reference to IFC guidance notes linked to the performance standards listed here. These are similar to the ones of MIGA sister organization IFC.

Community Health, Safety, and Security. The Proponent will ensure that all the prescribed / recommended mitigation measures are implemented in time and their performance monitored.

Impacts on these resources by Project activities are quantified and proper mitigation measures are recommended to reduce adverse impacts and to improve quality of environmental and social resources. Accurate baseline data indicate changes brought by Project on environment resources. Additional data may be needed during the detailed elaboration of the environmental and social plans, often requiring specific meetings with the local/regional authorities and affected communities.

5.7 Limitations

The ESIA was able to address all themes that needed upgrading from the national EIAs. The limitations in social-economic, cultural, livelihoods and biological baselines were largely overcome by conducting field studies during January - March 2017 and verified where needed during June 2017.

There are some themes however which may have benefitted from more baseline data which were not possible to collect due to technical and time constrains. Some issues surfaced during the assessment of data collected for this study and deeper study of previously collected information/data which were not possible to assess properly. Specific areas that require further addressing are (i) longer-term fish biology and adaptability knowledge in the reservoirs and river stretches downstream the dam (a study is proposed), (ii) climate change aspects, (iii) forest management techniques used and (iv) detailed physical mapping of villages. It is expected that these will be part of the detailed development of environmental and social management plans and safeguards which are proposed in this ESIA.

CHAPTER 6 PHYSICAL CHARACTERISTICS

6.1 Topography and land use

6.1.1. General topography

The Ca River basin within the Project stretch is characterized by rugged terrains with sharp variation in elevation. The few flat or gentle-sloped lands by the river banks, are either used as settlements and/or cultivation areas. Most of the settlements and agricultural lands are on hill slopes and at flat highland areas. Areas with gentle slopes, are often used for agriculture, while the steep terrains are either covered by grazing lands, some crop lands or limited secondary forests.

Within the stretch of the Project, the elevation ranges from minimum of 171masl, to maximum of 977masl. The average elevation of the stretch is 328masl. The histogram of the digital elevation based on Google Earth shows that most of Project area is within the 200-500masl elevation range (Figure 6.1).

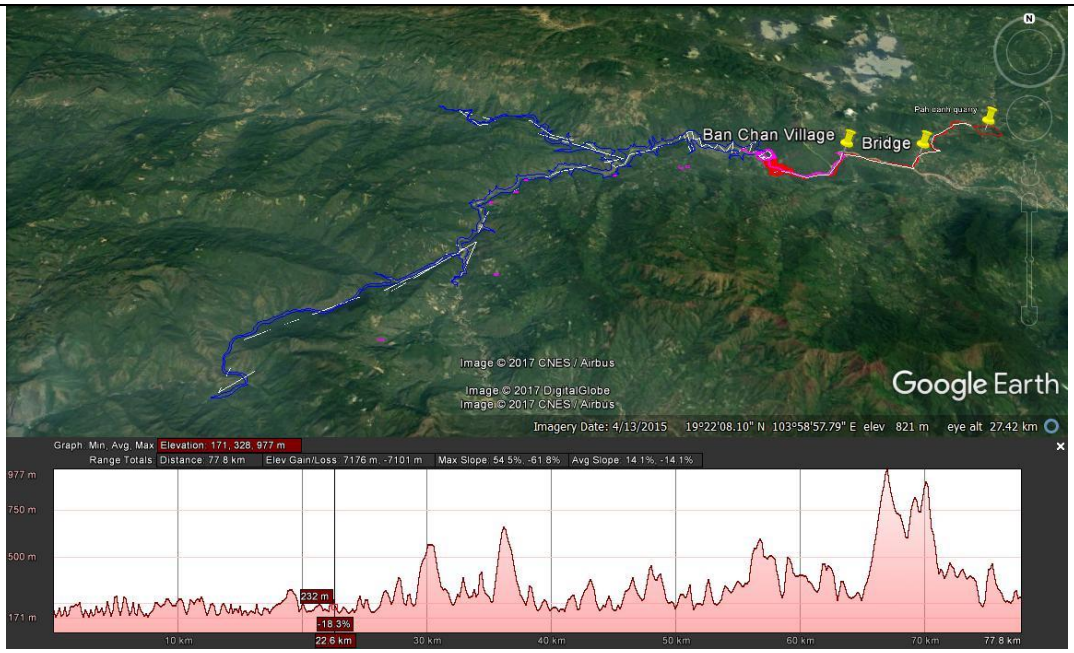


Figure 6.1 Elevation range of the Project area

Project area is characterized by the following types[52]:

Erosive-denuded relief

This type of relief occupies almost all of the study area. This relief is developed mainly at the mountain slopes and on top of the mountains creating fairly a slope topography of 30-50º. This relief is dissected strongly by faults and river networks.

Accumulated relief

This relief include the non-classified alluvial and proluvial deposits (apQ) and non-classified Quaternary eluvia, deluvial formation (deQ). The former comprising of cobble, boulders, gravel, sand, loam and clay, distributed along river, stream sections and narrow valley

[52] PECI, 2015, Feasibility Study

where topography is rather flat, while the latter is comprised of of aggregates, quartz, sand, siltstone, red clay that are lateritised irregularly. This topography is formed on sloping surface along mountain slopes towards rivers and streams.

6.1.2. Land use in the Project Area of Influence

The land use analysis shows that the Project's Direct Impact Area (DIA) and proposed buffer zone (for reducing erosion and safety reasons) is highly influenced by human activities. Eighty six percent of the total area of the DIA of 1042ha is vegetated (Table 6.1). Approximately 38% of the vegetation cover in the DIA comprises of a combination of mixed forests (Figure 6.2).

Table 6.1 Land use of the Project Influenced Area

No	Land Cover (land take of Project)	Permanent Area (ha) – DIA		Temporary (ha) ** In DIA	Total (ha)	Buffer Area (ha)
		Reservoir	Main works*			
I	**Vegetation**	**764.6**	**21.3**	**49.69**	**835.59**	544.15
a	*Forest*	*378.7*	*7.5*	*11*	*397.2*	*295.5*
b	*Secondary scrub*	*159.5*	*1.1*	*17.9*	*178.5*	*108.4*
c	*Shrub/bamboo/cultivated/ uncultivated land*	*226.4*	*12.7*	*20.79*	*259.89*	*140.3*
II	**Other lands**	**110.2**	**0.7**	**3.7**	**114.6**	*13.3*
III	**River/stream**	**87.2**	**2.2**	**2.4**	**91.8**	*1.7*
	Total	**962.0**	**24.2**	**55.2**		*559.1*
	Project Land Take without buffer				**1,041.9**	

*Main works include dam and associated structures, powerhouse and permanent project facilities

**Temporary area includes disposal sites 1-4, auxiliary area 1-3, and roads

Permanent area to be affected by the Project is 1,545.42ha and about 62% of which will be inundated while only 1.6% will accommodate the main works area or where the infrastructures will be. Note though that 36% (559.15.8has) will be the buffer zone and will be enhanced by the Project. Table 6.2 presents the type of vegetation that will be affected by the permanent and temporary occupied area of the proposed Project.

Table 6.2 Vegetation in the proposed Nam Mo 1 HPP inundation and safeguard buffer areas, and Project structures and facilities

No.	Occupied area	Total area (ha)	Occupied area of each vegetation type (ha) (8 vegetation types in the vegetation map)						
			I	II	III	IV	V	VI	VII
A	**Permanent area = 1545.42ha**								
1	Submerged area	962.07	98.23	128.52	152.02	159.5	226.4	110.2	87.2
2	Buffer zone area	559.15	68.22	126.72	100.51	108.4	140.3	13.3	1.7
3	Main works area	24.2	0	4.8	1.1	1.1	12.7	0.7	2.2
B	**Temporary area = 52.27ha**								
1	Auxiliary Area No.1	16.67	16.67	0	2.1	0	8.67	2.6	1.4

No.	Occupied area	Total area (ha)	Occupied area of each vegetation type (ha) (8 vegetation types in the vegetation map)						
			I	II	III	IV	V	VI	VII
A	**Permanent area = 1545.42ha**								
2	Auxilliary Area No.2	8.08	8.08	0.4	4.4	0	1.18	1.6	0
3	Disposal No. 3; Construction road	29.97	*29.97*	0	4.1	0	8.05	16.04	1.78
4	Others	0.55	0.55	0	0	0	0	0.55	0
C	**Quarry**	**6.5**							

Source: PECC1, 20 May 2017

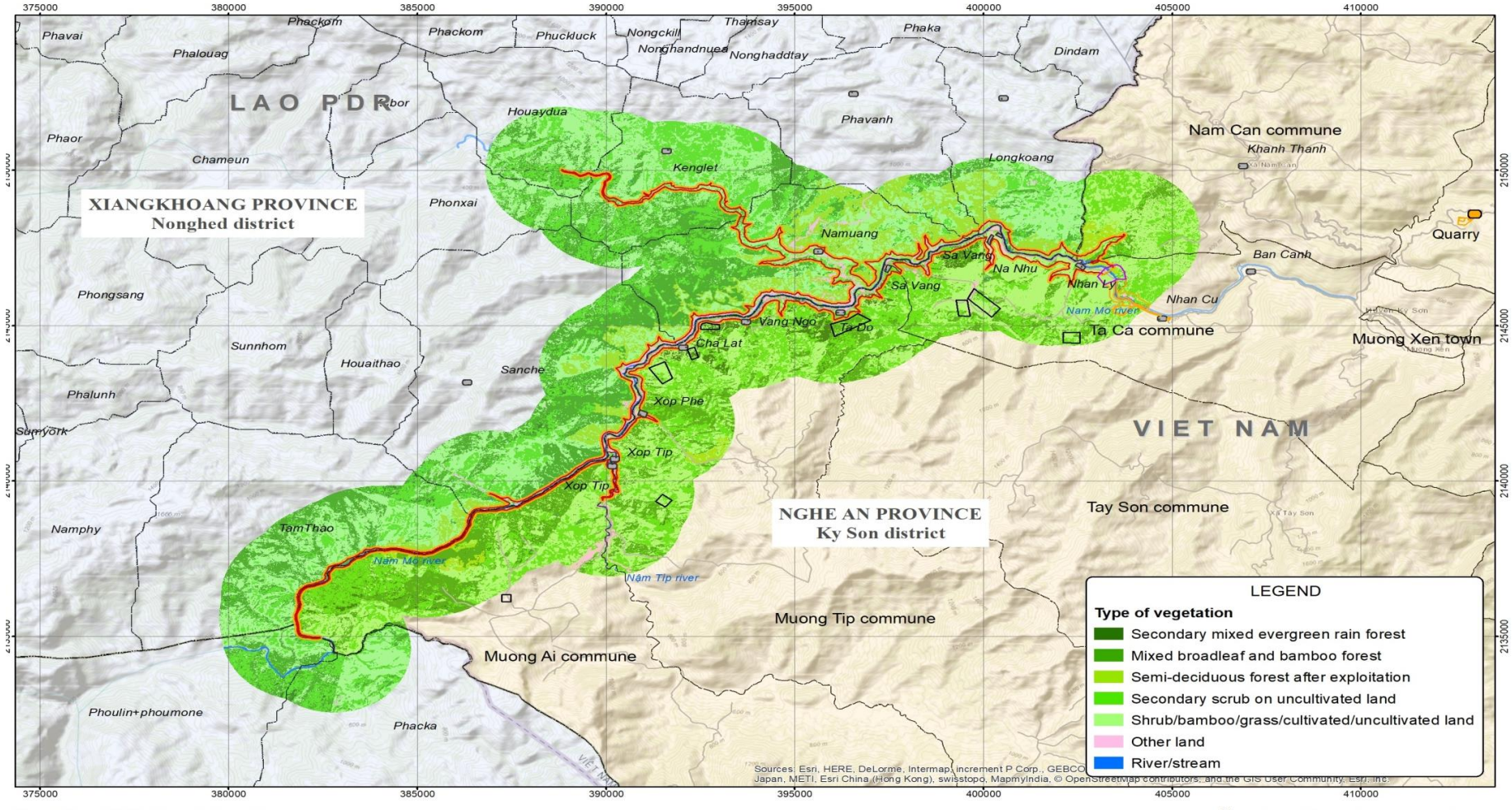


Figure 6.2 Land use map of Nam Mo 1 HPP Project Area of Influence (Source: Cục Viễn thám Quốc gia, satellite image, 2014)

6.1.3. Topology and land use of the Project Area of Influence

Topology of the reservoir and buffer zone

The elevation of the reservoir is approximately 235masl. The elevation range of the buffer zone starts from 235masl up to 285masl. Essentially the buffer zone forms a 50m width riparian strip around the reservoir, except in the upper edges.

Topology of the Project structures and activity areas

The Project components are distributed at elevation 160masl up to 258masl. The elevation ranges of each of the Project components are presented below (Table 6.3).

The river basin at the damsite has a U-shaped form with the sloping and symmetric mountains on both sides. It is about 40-50m wide. The river-bed elevation is approximately 150masl. Some rocks are exposed along the river bank. Overburden on both abutments is quite thick and few outcrops are exposed.

Table 6.3 Elevation range of the Project structures and activity areas

Code	Project structures and activity areas	Elevation masl	
		Max	Min
1	Crushing facility for RCC and aggregate stockpile area		
2	Crushing facility		
3	RCC facility	210	230
4	RCC conveyor system	248	258
5.1	Concrete facility at dam	164	196
5.2	Powerhouse areas	194	228
6	Steel reinforcement facility at headworks, waterway areas	162	186
7	Steel formwork facility at headworks, waterway areas	164	186
8	Pre-casted concrete yard	164	186
9	Maintenance facility and parking area for contruction equipment	162	178
10	Workshop for hydro-mechanic erection	164	186
11	Workshop for electrical-mechanic erection of the powerhouse	180	208
12	Laboratory of the headworks, waterway	162	170
13	Explosive dynamite warehouse for headworks, waterway areas	172	180
14	Petroleum warehouse for dam, waterway areas	162	178
15	Technical material warehouse (Project management Board's warehouse)	162	178
16	Water, power facilities for dam areas	162	170
17.1	Provision power 1	223	225
17.2	Provision power 2	190	196
17.3	Provision power 3	200	204
17.4	Provision power 4	160	166

Code	Project structures and activity areas	Elevation masl	
		Max	Min
17.5	Provision power 5	165	170
18	Sand stockpile area at headworks, waterway areas	178	204
19	Rubble stockpile area	162	190
20	Disposal area No.1	152	162
21	Disposal area No.2	168	230
22	Substations	168	174
23	Technical water treatment station at dam, powerhouse areas	162	166
24	Technical water treatment station at auxiliary area	161	163
25	Pump & treatment station of household waste water	161	163
26.1	Office of Contractor at the dam, wateray area	162	170
26.2	Office of Contractor at waterway area	170	180
27	Housing and office of PMB, specialists, Engineer	160	176
27.2	Housing and office of PMB, specialists, Engineer	170	180
28	Housing area for dam, waterway workers	170	184
29	Clinics at dam, waterway areas	178	184
30	Post Office	174	178
31	Police station	171	174
32	Fire station	169	171

6.2 Meteorology

6.2.1. Vietnam

Vietnam has a remarkably diverse climate conditions because of its location where there is a wide range of latitudes and altitudes. The seasonal climatic pattern (e.g., distinct winter and summer seasons) is similar throughout the basin, differing only in degree due to the wide variations in elevation and exposure. Vietnam is divided into three climate zones, north, central and south. The south facing mountain slopes are warmer and attract more precipitation than those facing north. In winter, continental wind patterns are generally from the northeast and there is little precipitation.

6.2.1.1 Climatic conditions at the Project area

The Ca River catchment area in general, and the Nam Mo HPP catchment area in particular are located within the tropical monsoon climate region where climate regime is influenced by the topographical conditions. Climate in the region falls under the North-Central Region influenced by the East Truong Son mountain range.

The moonsoon tropical climate is affected by the following:

- Asian continental air mass is active during the period from September to March. The weather is characterized by cold and dry air during winter months. Light rains starts during the middle until the end of winter season.
- The Equatorial Pacific air mass is active from May to October. The characteristic of this air mass is hot and humid, causing much rain.
- Tropical Indian air mass with Southwest wind is active in May, June, July and August, July being the strongest month. The weather characteristic of this air mass is hot, dry and little rain. This is also the period when wind from Lao acts the fiercest in the area.

6.2.1.2 Temperature

The nearest gauging station is in Tương Dương station (Hoa Binh town, Tương Dương district, Nghe An province, Vietnam), which is about 46km from the Project site. The mean annual ambient temperature at this station is 23.7^{o}C. At Vinh station (Vinh city, Nghe An province, Vietnam), which is about 299km from the Project site, mean annual temperature is 23.9 ^{o}C. Winter lasts from December to March, January being the the coldest month. Temperature during winter season ranges from 17^{o}C - 21^{o}C and absolute minimum is 1.7^{o}C (Tương Dương station 1/1974).

Summer lasts from May to August when temperature ranges from 27^{o}C - 29^{o}C, where the hottest month is July. The maximum temperature recorded at Tương Dương station was 42.7oC (May,1966).

Table 6.4 Typical air temperature at Tương Dương Station

Characteristic	Temperature ^{o}C												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Average	17.9	19.3	22.0	25.4	27.4	28.1	28.0	27.3	26.2	24.0	21.0	18.2	23.7
Max	36.7	37.8	40.8	42.0	41.6	40.0	41.2	39.0	36.4	38.2	36.7	36.0	42.0
Min	5.7	8.4	6.0	14.9	19.9	20.8	22.0	22.1	18.4	14.9	10.8	2.8	2.8

Source: PEC1, 2015 Feasibility Study for Nam Mo 1 HPP

6.2.1.3 Rains

During a year, rainfall is distributed in two seasons: The rainy season starts in May (starting is usually periodic and light, picking up gradually to end of July/August) and ends in October with rainfall volume contributing to about 80% of the total annual rainfall. The rest of the year is referred to as the dry season, with November to February being the driest.

The mean annual rainfall in the Project area is estimated at 1400mm. History of flooding has been reported in Ca River basin (e.g, May 1989). Annual rainfall changes along the Ca river basin as indicated in the following records:

- 1100 - 1700mm - Upstream area, where the Project construction will be;
- 1800 - 2500mm - Middle reaches of Ca river; and
- Over 2500mm - Downstream reaches

Some of the highest rainfall records are 788mm at Đô Lương and 684mm at Dừa station (27 Sept 1978). The rainfall measured for three continuous rainy days reached 958mm at Đô Lương, 809mm at Dừa and 749mm at Yên Thượng stations, which resulted to the big flood in Ca River in 1989.

The maximum daily rainfall corresponding to the design frequency in the Project area is taken from Muong Xen gauging station (Table 6.5).

Table 6.5 Maximum daily rainfall at various frequencies, Muong Xen Gauging station.

P (%)	0.1	0.2	0.5	1	3	5	10
Xp (mm)	241.5	226.6	206.3	191.9	166.4	154.7	138.6

Source: PEC1, 2015, Feasibility Study, Nam Mo 1 HPP

Note: Xp: Maximum daily rainfall corresponding to designed frequencies

The number of rainy days during a year recorded at Muong Xen gauging station is listed in the table below:

Table 6.6 Number of rainy days during a year, Muong Xen, gauging station

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	**Total**
No of days	1	2	4	9	13	13	13	16	12	9	3	1	97

Source: PEC1, 2015, Feasibility Study, Nam Mo 1 HPP

6.2.1.4 Wind

The predominant wind direction was taken at the Tuong Duong gauging station and presented in Table 6.7. The highest wind speed recorded at Tương Dương is 25 m/s, in 1975. A higher record is noted however at Vinh station at 40 m/s in 1982, 1987, 1989 and 1990. Vinh station is 258m from the Project site while Tuong Duong si approximately 46km from the Project site and closer to the site. The highest wind speed at Tuong Duong Station was used for the construction design. Wind speed with their respective frequencies are indicated in Table 3.10

Table 6.7 Frequency and wind direction at Tương Dương gauging station (%)

Frequency	Calm	N	NE	E	SE	S	SW	W	NW
(%)	54.6	2.35	4.06	15.2	9.76	1.54	1.23	6.60	4.66

Source: PEC1, 2015, Feasibility Study, Nam Mo 1 HPP

Table 6.8 Maximum wind velocities with frequencies, Tương Dương gauging station (m/s)

P(%)/Direction	N	NE	E	SE	S	SW	W	NW	No direction
V2	18.1	16.4	19.8	16.9	13.2	17.1	25.6	25.5	27.8
V4	15.6	15.1	17.8	15.7	12.00	15.2	22.8	22.6	25.3
V10%	12.2	13.1	14.9	13.8	10.3	12.5	18.7	18.6	21.8
V25%	8.70	10.9	11.9	11.7	8.30	9.40	14.1	14.1	17.8
V50%	5.90	8.70	9.4	9.6	6.50	6.70	10.0	10.0	14.1

Source: PEC1, 2015, Feasibility Study, Nam Mo 1 HPP

6.2.1.5 Humidity

Similar with temperature, Tuong Duong is slightly affected by the Northeast wind and rain patterns, therefore humidityis relatively lower than in other areas. Annual relative humidity at Tương Dương weather station is 82%, while other nearby stations recorded relatively higher humidity: Vinh at 85.1%, Đô Lương at 85.3% and Tây Hiếu at 85.6%.

Table 6.9 shows that the average humidity during dry months are the lowestThe humidity record at Tuong Duong is similarly used for the construction design.

Table 6.9 Relative humidity recorded at Tương Dương gauging station (%)

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Humidity (mean)	82	81	79	79	79	80	81	84	85	86	86	84	82
Humidity (min)	21	20	19	21	20	30	33	40	34	37	27	24	19

Source: PEC1, 2015, Feasibility Study, Nam Mo 1 HPP

6.2.2. Lao PDR

Lao PDR has less variation in climatic conditions and is characterized by two distinct season, the wet and dry. Part of the Project reservoir area in Laos is dominated by both southwest and northeast monsoons forming the two climate regime, the wet and dry seasons. The southwest monsoon from Indian Ocean, brings the rainy season and is from May to September. With the retreat of the southwest monsoon by October, rain decreases rapidly and signals the start of dry season from October to April. With the transition of the northeast monsoon from mainland China it also signals the start of cold months from November until February.

Table 6.10 shows the meteorology recorded at Kouan District, where part of the Project is located in Lao. The Kouan District is the neighboring district to Nonghed and has been used as the reference in the feasibility study.

Table 6.10 Climatic characteristics of Kouan District, Lao PDR

Parameters	1 Jan 2016		1 April 2016		3 June 2016	
	07:00h	13:00h	07:00h	13:00h	07:00h	13:00h
Temperature (°C)	6	20	19	32	24	32
Wind (mph)	3 E	5 E	3 SW	8 WSW	2 SW	3 SW
Humidity (%)	94	37	77	31	86	57
Pressure (mb)	1023	1020	1011	1007	1009	1006

Parameters	1 Jan 2016		1 April 2016		3 June 2016	
	07:00h	13:00h	07:00h	13:00h	07:00h	13:00h
Rain (m)	0	0	0	0	0.4	2.2
Cloud cover (%)	2	5	7	11	68	29

Source: ASA Power Engineering Co. Ltd, ESIA, 2016; PEC1, 2015, Feasibility Study, Nam Mo 1 HPP

6.2.2.1 Rainfall

The annual rainfall distribution is approximately 80% from May to September, 10% from October to December and about 10% from January to April. Average monthly rainfall at Xiengkhouang, Houaphanh and Luang Prabang Provinces neigbouring Nonghed is shown in (Table 6.11). The distance from Xiangkhouang, Houaphanh and Luang Prabang provinces to the Nam Mo 1 HPP are 120km, 91km and 230 km, respectively.

Table 6.11 Average Rainfall in Xiengkhoang, Houaphanh and Luang Prabang Provinces, Lao PDR

Month	Rainfall (mm)		
	Xiengkhouang	Houaphanh	Luang Prabang
Jan	10.57	5.69	11.32
Feb	14.73	15.71	16.93
Mar	55.02	39.05	36.35
Apr	142.34	97.94	19.47
May	195.13	212.11	154.42
Jun	187.93	177.39	186.62
Jul	283.36	222.78	241.70
Aug	296.92	295.11	286.04
Sep	157.07	187.71	187.77
Oct	64.33	89.30	98.83
Nov	21.06	22.04	29.40
Dec	7.55	9.35	12.32
Annual	1436.02	1379.18	1339.16

6.3 Geology and soils

The Geological Department, Institute of Drilling Technology have investigated the Project area including the proposed headwork and waterways. Based on the investigation the engineering geological condition at the Project site is summarized as follows:

At the proposed area of the damsite, riverbed has a U shaped with gentle and symmetrical slopes. Overburden on both banks is thick with few exposed rocks. Soil strata in the damsite area is characterised by overburden of 3-10m in thickness. Bedrock is mainly shale, sericite shale, sericite quart shale, sandstone and quarzite intercalated with each other. Each layer is described below:

Layer 1c: Mixture of boulder and pebbles, gravel mixed with sand. Medium dense structure. The thickness is 5-8m. Originated from alluvial deposit (aQ).

Eluvial, deluvial layer and zone of intensively weathered rock (edQ+IA1): Clay-heavy loam, mixture of grit (15-30% grit) fragments of bedrock, in yellowish grey and yellowish brown color, quartz and locally with small, hard boulders. Thickness is 3-10m.

Zone of strongly weathered rock (IA2): Weathered rock has been stained totally compared to fresh rock. Weathered products are fragments from hard to soft mixed with medium semi-loam, yellowish grey and yellowish brown in color. This layer is less seen at damsite. Thickness is about 2-3 m.

Weathered rock (IB): Rock is yellowish grey and brownish grey in color. Rock has been stained outside while the kernel may still be fresh. It is usually strongly fractured, joint's surface is normally opened and covered by Fe. Bearing capacity of rock is not regular. Thickness of 7-10 m, even up to 20m.

Fractured rock (IIA): Rock is slightly weathered, fresh, slightly stained or stain is not yet visible. Rock is hard, slightly fractured and strength of the rock is not homogeneous.

Relatively intact rock (IIB): Rock is fresh and hard. Rock is almost non-fractured, or slightly fractured. At river bed, surface of IIB layer is quite shallow

According to the regional geological map (Figure 6.3). the geological setting in the Project area is described as follows:

Paleozoi Era

Ca River Formation (O_3 - S_1 sc). Nam Mo 1 damsite is located within the Upper layer of Ca River formation, characterised by clay limestone, redish limestone, brown lime siltstone intercalated with manga layers.

Huoi Nhi Formation (S_2 - D_1 hn). This formation is characterised by gray sandstone (small to medium grain), sandstone, interbeds of thin layer of ash gray and grayish gray siltstone, and dark gray shale, about 540m thick. Above this layer is mainly fine sediments with thin layer of blackish gray shale, thin layer of dark gray powder mixed with gray sandstone (medium grain), about 260m thick.

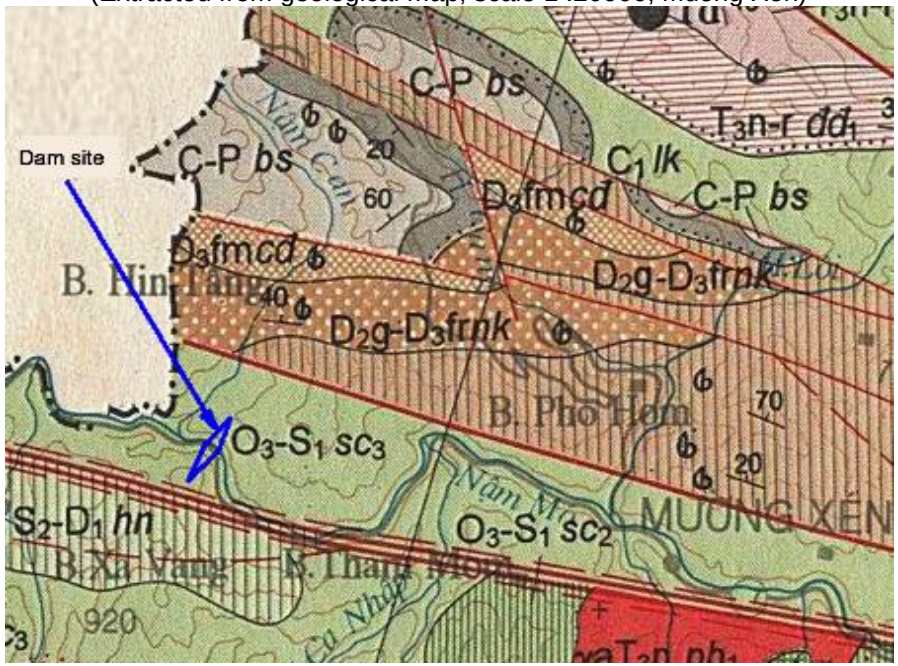
Huoi Loi Formation (D_2 hl). This formation consists of shale, claystone, siltstone, clay lime, limestock of thin bedding and is 700-800m thick.

Nam Can Formation (D_2g-D_3fr nk). This formation consists of limestone and silicious limestone and is 500-600m thick.

Cat Dang Formation (D_3fm cđ). This formation consists of clay limestone, redish limestone, brown lime siltstone intercalated with manga layers and is 100-300m thick.

REGIONAL GEOLOGICAL MAP

(Extracted from geological map, scale 1 :20000, Muong Xen)



SYMBOLS

$D_3fm\ cd$ Cat dang formation: clay limestone, redish limestone, brown lime siltstone intercalated with manga layers. Thickness 100-300m

D_2g-D_3frnk Nam can formation: limestone, silicious limestone, thickness 500-600m.

$D_2\ hl$ Huoi Loi formation: shale, claystone, siltstone, clay lime, limestock of thin bedding, thickness 700-800m

S_2-D_1hn Huoi nhi formation: shale, siltstone, sandstone, thickness 750m.

$O_3-S_1sc_3$ Upper formation of Ca River formation: shale, sand-siltstone, gritsstone, thickness 900-1000m

$O_3-S_1sc_2$ Middle formation of Ca River formation: sericite schist intercalated with black foliated siltstone, sandstaone, limestone, thickness 1000-1200m

Tectonic fault.

River, streams.

Geological boundary.

Strike and dip angle.

Figure 6.3 The regional geologic map

The Project area is within the Truong Son or Phu Xam Xum – Truong Son textural zone, north of Ca River. The characteristics of this textural zone in terms of tectonic and fault system are described as follows:

- *Ma River grade-2 fault zone:* Main fault follows a NW-SE direction. There are some auxiliary short faults nearly parallel to it.
- *Ca River Neotectonic grade-2 fault zone:* From NE side of Xiengkhouang (Laos), via Muong Xen town, along each river section of Nam Mo river and Ca river and expand to the sea. Mainly it has NW-SE direction to sub- latitude.
- *That Thon - Na Kay grade-2 fault zone* is from Xiangkhoang to Quang Tri.
- *Khe Bo - Nghi Xuan grade-3 fault zone* is separated from Ca river fault at Khe Bo with a NW-SE direction.
- *Rao Nay grade-3 fault zone* in NW-SE direction, via Huong Son town to Cua Gianh seaport.
- *Ky Son* grade-3 fault in nearly sub-latitude starts from the east side of Xiangkhoang to Ky Son, Vietnam and stops when meeting the Ca River fault.
- *Xieng Lip* grade-3 fault is a branch of Ca River fault in sub-latitude.

Figure 6.4 shows the fault system in the Project area.

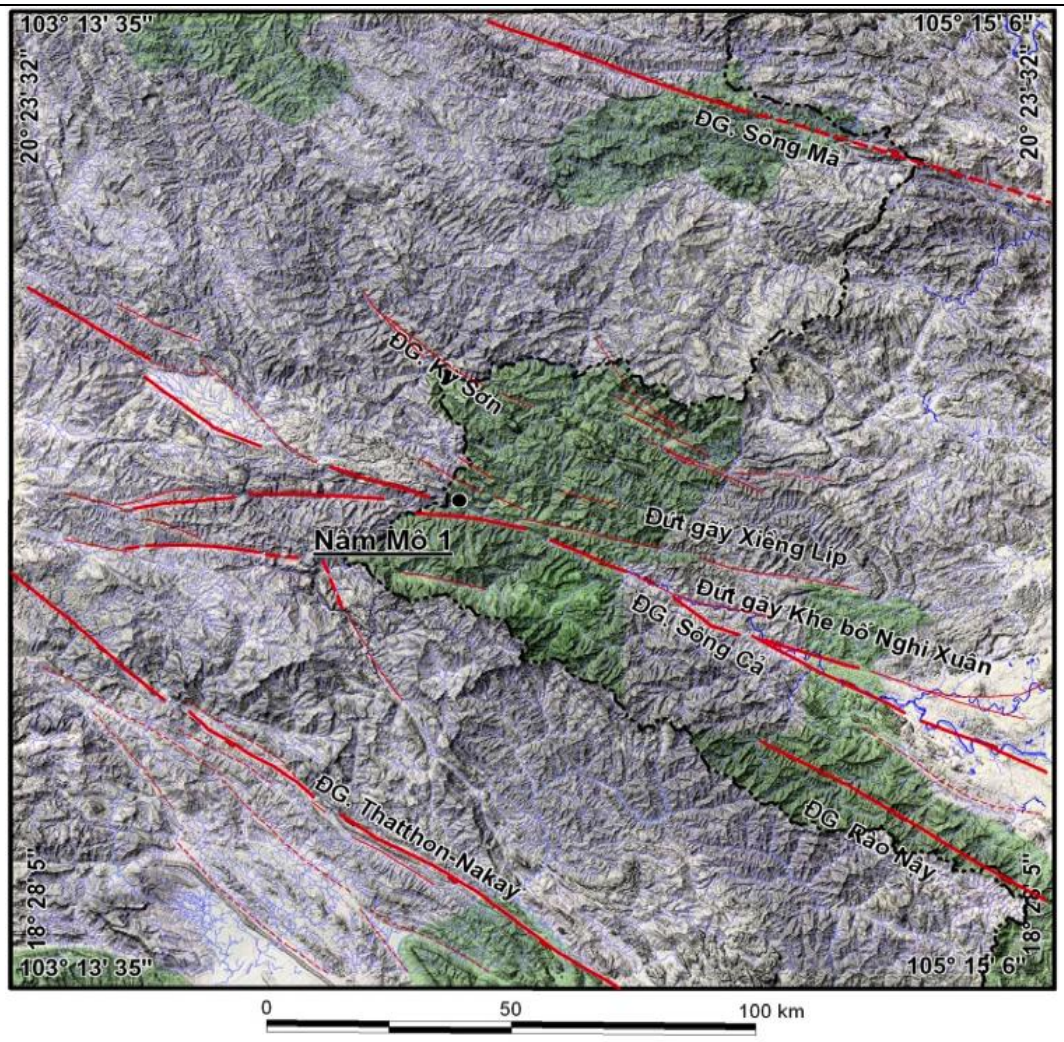


Figure 6.4 Location map of active faults in the Project area

6.4 Erosion, landslides and slope stability

The geological mapping has shown that the slope stability in the reservoir area is mainly controlled by the geological structures, as would be expected. Steep areas with slopes in excess of 45 degrees will be at risk of erosion. Such areas can be observed within the Project area. There is however very thin overburden and rock foundation is considered stable.

6.5 Earthquake and hazard assessment

Based on the preliminary seismic investigation for the Nam Mo 1 HPP[53], the faultlines within the Project area may generate an intensity 4 or 5 (PGA = 245 cm/s^2) and trigger a 6.75 magnitude earthquake. The dam therefore has been designed to withstand the predicted earthquake magnitude.

Within the region, there are many tectonic fault zones that have shown seismic activivities manifested at recent events such as: A 5.5 magnitude earthquake occurred in Ca river fault in 1957; a 4.6 and 4.7 magnitude in 2005 at the same Ca river faultline; and a 3.2 magnitude in Ky Son zone at Quy Hop in 2012.

6.5.1. Earthquake risk

Preliminary assessment of a triggered earthquake at the Project site, with potential of causing seismic faults and earthquake hazard to Nam Mo 1 HPP has been studied by the Geological Institute in 2012, including the condition of foundation in dam site area. Selecting Design earthquake MDE as M=6.75 of seismic section SC2-3a, PGA = 245 cm/s^2, of seismic section QP3-2.

Estimating the assumed increased stress for Nam Mo 1 reservoir when impounding with maximum head of 89 m: δ_{xmax} within 6.9 bar; τ_{xymax} about 2.18 bar; d_{max} < 33.3cm. Comparing with Hoa Binh reservoir: head 117m: δ_{xmax} =5.0 bar; τ_{xymax}=2.0 bar; d_{max} = 32.2cm (triggered earthquake M=4.8 had occurred).

In fact, stress causing earthquake is from 300 bar to 1000 bar. Thus, stress in Nam Mo 1 reservoir is very small, <1%. It plays a structural role of pushing up and only meaningful when natural stress reaches to limit.

Based on statistical records of regional earthquake before 2012, there is only one earthquake recorded at M=5.5 so if a triggered earthquake happens it will be less than 5.5 (maximum earthquake of seismic section SC2-1a.

Basing on the statistic data of UNESCO, it was found out that: triggered earthquake happens only with the presence of the following three conditions: (i) reservoir storage must be more than $10^9 m^3$; (ii) reservoir must be deeper than 90m; and (iii) soil rock conditions in reservoir and surrounding area is divided by tectonic fault and intensively differential.

Thus, under such conditions and comparing to the parameter conditions of Nam Mo 1 reservoir, with the moderate faults (grade IV and V) existing in the Project area, may generate slight triggered earthquake. But if summarizing all mentioned conditions, it can be assessed that Nam Mo 1 reservoir after impoundment will have no possibility of triggered earthquake.

In fact, some larger reservoirs than Nam Mo 1 has been assumed with triggered earthquake (Hua Na, Khe Bo, Ban Ve, Hoa Binh, Tuyen Quang HPP, etc.) but so far no triggered earthquake has happened.

The construction site is relatively close to an active grade-2 fault line about 1.65km from the Ca River fault zone. While the dam has been designed to withstand a potential strong earthquake, more detailed study and monitoring will be carried out. This will include monitoring of rock deformation, landslide in the lake, electromagnetic fields and groundwater quality.

[53] Geology Institute – Institue of Science and Technology of Vietnam, December 2012, Earthquake Hazard Assessment Nam Mo 1 HPP

6.6 Hydrology and sediment transport

6.6.1. Hydrological features of Ca river

6.6.1.1 Topographic characteristics

The Ca river (Song Ca in Vietnamese while Nam Non in Lao) with an approximate length of 531km and an area of 27,200km^2 is a major river in mainland Southeast Asia. It originates from Mt Muong Mut in Lao PDR, flowing northeast - southeast crossing Lao PDR's Xiangkhouang Province, Vietnam's Thanh Hoa, Nghệ An, and Hà Tĩnh provinces and finally drains into the Gulf of Tonkin, on the North Central Coast of Vietnam. The coastal riverine lowlands have a relief features similar to those of the Red River - there's a wide stretches of alluvium and predominately with small undulation. There is a high population density in the river's delta region, particularly near Vinh city.

The Ca river, being a main river is fed by five tributaries namely Nam Mo, Giang, Hieu, Ngan Sau ang Ngan Pho rivers (Table 6.12 and Figure 6.5). The highest point of the river is at 2620masl at Nam Mo tributary while its lowest point is at the river mouth in Cua Hoi at 0masl. It is bordered by the Chu and Bang river basins in the North, Mekong basin and Truong Son mountain range in the West, Gianh river basin in the South, and Bung river, Cam river basin and the South China Sea in the East. Of the total area of 27,200km^2, 17,730km^2 accounting for 65% is found in Vietnam. The rest (35%) belongs to Lao PDR territory.

Table 6.12 Ca river system

Name of river	Length (km)	Catchment area (km^2)	Highest Peak (m)	Slope (%)
Ca (main river)	531	27,200	1800-2000	18.3
Tributaries				
Nam Mo	173	3,970	2620	25.7
Giang	77	1,050	-	17.2
Hieu	228	5,340	2452	13
Ngan Sau	135	2,060	1047	28.2
Ngan Pho	70	1,070	1136	32.5

Source: http://hywr.kuciv.kyoto-u.ac.jp/ihp/riverCatalogue/Vol_06/VietNam-9_Ca_river.pdf

Figure 6.5 The Ca River Catchment

Nam Mo river, where the Project is located is one of the main tribuary of the Ca river system. It originates from the high mountain range of Xiangkhouang, Lao PDR with the height of over 2250m, flowing to the main Ca river in Xa Luong Commune, near Hoa Binh Town, Tuong Duong District, Nghe An Province. The length of the river is 173km with a total catchment area of 3970km2, in which 1540km2 (about 40%) is found in Vietnam while the rest is in Lao PDR.

Currently, there are existing, under construction or planned reservoirs within Nam Mo river and includes Nam Mo 3, Nam Mo 2, Nam Mo 1, all located within Laos territory. Downstream of the proposed Project, there is the Nam Can 2, Nam Mo 1 Nam Cun and Ban Ang in Vietnam territory. Some of these rivers are relatively proximal to the proposed Project and are therefore further discussed in section 9.5 Cumulative Impacts.

The topographic characteristics of the basin to Nam Mo 1 damsite are indicated in the table below:

Table 6.13 Topographic characteristics of Nam Mo 1 damsite

Characteristics	Unit	Value
Basin area	km^2	2492
Length of main river	km	106
Average height of the basin	m	960
Average width of the basin	km	23.5

Source: PEC1, 2015, Feasibility Study of Nam Mo 1 HPP

6.6.1.2 Vegetation cover

Vegetation in Ca River basin is quite diverse. The basin area covered by forests accounts for about 50% mostly lying in Lao PDR's territory and the mountainous districts of Nghe An in Vietnam. The forests in Lao PDR have been protected and has limited human impacts mainly due to their small population, inaccesibility and slower economic activities. The forest area in Vietnam's territory decreases fast due to high population growth in the mountainous areas.

6.6.1.3 Annual flow

Water level and water discharges at Muong Xen hydrological gauging station (Figure 6.6), downstream of the Project was used to estimate the annual flow for Nam Mo 1 HPP. Data for water level and discharge from 1969 to 2011 were used. Adjusted to the damsite location, annual flow series arriving to Nam Mo 1 HPP was interpolated using the following formula:

$$Q_{0\ (Nam\ Mo)} = (F_{NamMo} / F_{MoungXen}) \times (Q_{Moung\ Xen}) \times (X_{NanMo} / X_{MoungXen})$$

Where:

Q_o(in m^3/s) - Annual mean discharge
F – ($km^{2)}$Catchment area
X – (mm) Precipitation data

Based on the above exercise, the average annual flow for Nam Mo 1 is 65.5m^3/s. Annual flow at various designed frequencies is presented below.

Table 6.14 Average annual flow, Nam Mo 1 HPP

Damsite	F (km^2)	N (year)	Qo (m^3/s)	Wo (10^6m^3)	Cv	Cs	Qp(m^3/s)		
							10%	50%	90%
Nam Mo 1	2492	43	65.5	2067	0.29	4Cv	91.0	62.0	44.9

Source: PECI, 2015, Feasibility Study
Note: **Qo (m^3/s)** - Annual mean discharge; **Wo (10^6m^3)** - Annual mean total runoff volume; **Cv** - Coefficient of variation; **Cs** - Coefficient of deviation and **Qp(m^3/s)** - Discharge corresponds to the designed frequencies.

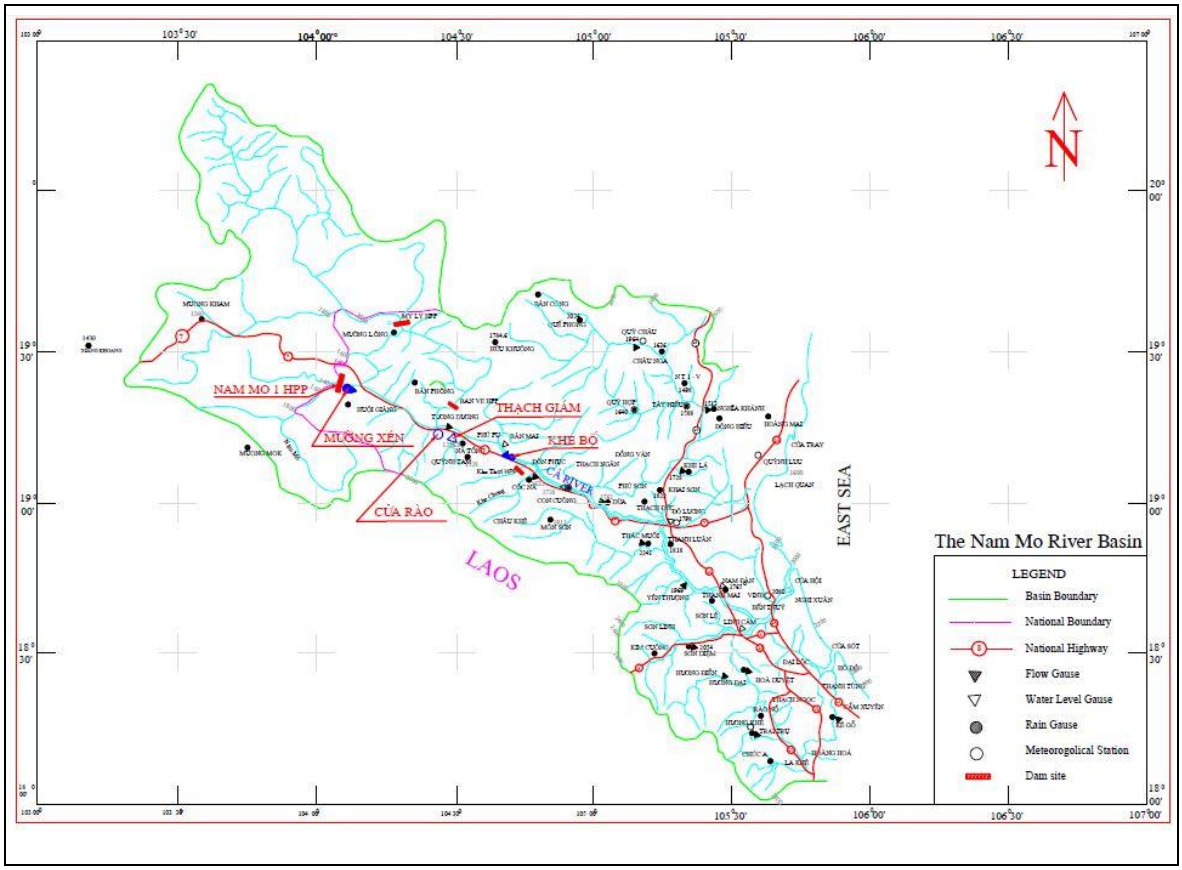


Figure 6.6 Locations of the Weather Stations

6.6.1.4 Flood flow

Water level and water discharges at Muong Xen hydrological gauging station, downstream of the Project was used to estimate the annual flow for Nam Mo 1 HPP. Data for water level and discharge from 1969 to 2011 were used. Adjusted to the damsite location, annual flow series arriving to Nam Mo 1 HPP was interpolated using the following formula:

$$Q_{0\ (Nam\ Mo)} = (F_{NamMo} / F_{MoungXen}) \times (Q_{Moung\ Xen}) \times (X_{NanMo} / X_{MoungXen})$$

Where:

Q_o(in m^3/s) - Annual mean discharge
F – (km^2)Catchment area
X – (mm) Precipitation data

Based on the above exercise, the average annual flow for Nam Mo 1 is 65.5m^3/s. Annual flow at various designed frequencies is presented below.

Table 6.15 Average annual flow, Nam Mo 1 HPP

Damsite	F (km^2)	N (year)	Qo (m^3/s)	Wo (10^6m^3)	Cv	Cs	Qp(m^3/s)		
							10%	50%	90%
Nam Mo 1	2492	43	65.5	2067	0.29	4Cv	91.0	62.0	44.9

Source: PECI, 2015, Feasibility Study
Note: **Qo (m^3/s)** - Annual mean discharge; **Wo (10^6m^3)** - Annual mean total runoff volume; **Cv** - Coefficient of variation; **Cs** - Coefficient of deviation and **Qp(m^3/s)** - Discharge corresponds to the designed frequencies.

6.6.2. Sedimentation

Due to the absence of a robust data set from a single gauging station, sediment flow at the damsite was estimated using a number of available data from various gauging stations (see Figure 6.6) proximal to the proposed damsite location and are presented below:

Table 6.16 Available data set used for sedimentation analysis

Parameters	Cua Rao gauging station	Thach Giam gauging station	Khe Bo gauging station
Water level	1959-1988	1984 -2011	1994-1997
Water discharge	1959-1976		1994-1997
Sediment load	1959-1976		1994-1997

From the empirical data sets taken in the above gauging stations, interpolation were carried out to construct new data points, by establishing the relationship between water discharge and sediment load among the gauging stations at various period. Note that analysis was only carried out until 2009 because a dam near Khe Bo gauging station (also called the Khe Bo dam) started to fill up in 2010, and therefore data sets beyond 2009 (e.g. water level, sediment load) has been altered by the impounding activities at that period, and considered not useful for this exercise.

From the mean daily discharge recorded at Cua Rao station from 1977-2009 (data sets reconstructed from interpolation), the daily sediment load from this periodis was estimated using the equation below:

$$\mathbf{Qs = 0.0224*Q^{2.1574}}$$

In which: Qs is sediment load (ton/day)
Q is water discharge (m^3/s)

Based from this exercise, the annual sediment load at Cua Rao station from 1961-2009 was estimated to be: R = 89.7 kg/s with turbidity at ρ=386.1 g/m^3.

The total sediment load at the reservoir every year is estimated using the equation:

$$\mathbf{W = W_{ll} + W_{dđ}}$$

In which:

- Volume of suspended sediment (W_{ll}) is estimated by equation

$$\mathbf{W_{ll} = Ro*T}$$

Where Ro is the mean annual suspended sediment discharge (kg/s).
T is period of time in 1 year, in seconds ($T = 31.54*10^6$).

- Volume of bed load ($W_{dđ}$) is estimated as 40% suspended load.

(β_{ll} is density of suspended load = 1.182 ton/m^3)
($\beta_{dđ}$is density of bed load = 1.554 ton/m^3).

Results of the sediment estimation are given in the following Table 6.17

Table 6.17 Estimated annual sediment load, Nam Mo 1 HPP

Dam	Qo (m^3/s)	ρ (g/m^3)	R (kg/s)	W_{ll}(10^3m^3/year)	W_{dd}(10^3m^3/year)	W (10^3m^3/year)
Nam Mo 1	65.5	386.1	25.3	675	205	881

Note: **Qo (m^3/s)** - Annual mean discharge; **W_{ll}(10^6m^3/year)** - Volume of suspended sediment; **W_{dd} (10^6m^3/year)** - Volume of bed load; **W (106m^3/year)** - Total sediment load volume at the reservoir every year.

Table 6.18 shows the sediment estimate over the years once the Project is operational. Based on the table, on the 50th year of operations, the reservoir is estimated to have been filled up by 9.48%.

Table 6.18 Sediment estimates in the Nam Mo 1 reservoir

No	Year	Volume of sediment in Nam Mo 1 reservoir (10^6m^3)			Percentage of filled volume in Nam Mo 1 reservoir (%)		
		Total volume	Dead volume	Active volume	Total volume	Dead volume	Active volume
1	1	0.517	0.456	0.060	0.19	0.38	0.04
2	10	5.20	3.82	1.375	1.91	3.16	0.91
3	20	10.4	7.34	3.04	3.81	6.08	2.01
4	30	15.5	10.7	4.86	5.71	8.85	3.21
5	40	20.7	14.2	6.46	7.60	11.77	4.27
6	50	25.8	17.6	8.18	9.48	14.57	5.41
7	60	30.9	21.1	9.70	11.34	17.50	6.42
8	70	35.9	24.1	11.8	13.20	19.96	7.79
9	80	40.9	27.0	13.9	15.04	22.34	9.21
10	90	45.9	29.9	16.0	16.87	24.79	10.54
11	100	50.8	32.9	17.9	18.69	27.26	11.83
Volume of the reservoir		**272.07**	**120.81**	**151.26**	**100.00**	**100.00**	**100.00**

6.7 Water quality

6.7.1. Surface water quality

To assess the water quality at Nam Mo river, three sampling regime was carried out in August 2015 in Vietnam, June 2016 in Laos territory and March 2017 both from the two countries.

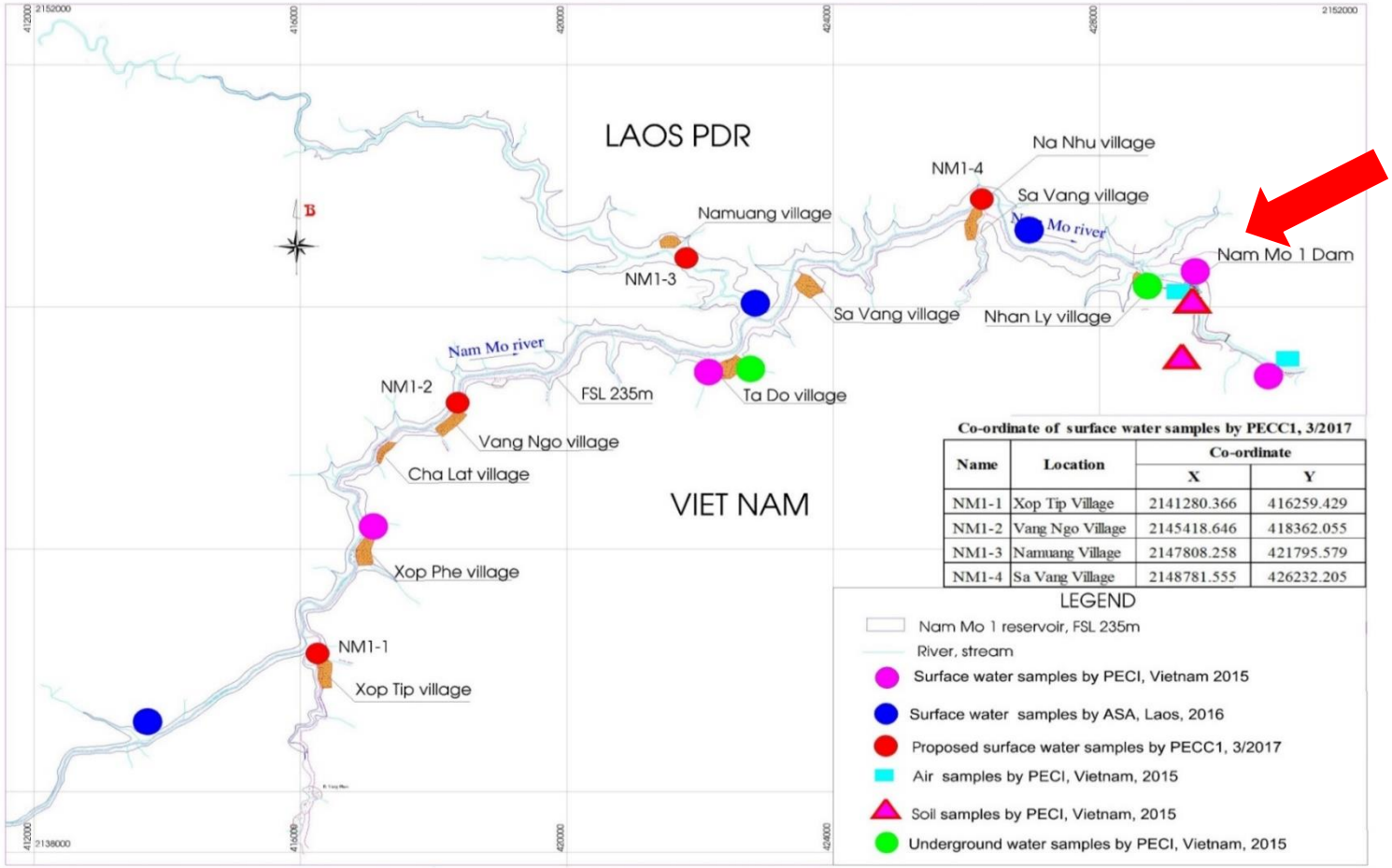


Figure 6.7 Location map of sampling stations

Table 6.19, Table 6.20 and Table 6.21 summarize the results of the water sampling. The water quality of Nam Mo river within the stretch of the Project area has no indication of industrial pollution, except for the tributaries coming from the Laos territory where Total Suspended Solids (TSS) is more than the allowable limit indicated in the national water standards (QCVN 08:2008)[54]. This elevated concentration is attributed to the gold mining activities upstream of the river. Albeit, physico-chemical properties and heavy metal concentrations conform to the national water standards, traces of coliform against the national water standard was also reported, although still within the allowable limits. This is expected when domestic sewage is haphazardly disposed off along the rivers and stream. In addition, raising of animals along the river banks are also common at the Project site

Table 6.19 Water quality, Nam Mo 1 HPP, August 2015

Parameters	Unit	Sampling locations				QCVN 08:2008	
		NM1	NM2	NM3	NM4		
		Tributary near Lao border guard station (Laos)	Near Ta Do border guard station (Vietnam	Nhan Ly village, Ta Ca Commune	Nhan Cu village, Ta Ca Commune	A2[5]	B1[5]
pH	-	7.36	7.4	7.6	7.6	6-8.5	5.5-9
DO	mg/l	6.2	6.3	6.5	6.7	>=5	>=4
TSS	mg/l	84.4	62.3	56.6	57	<30	50
COD	mg/l	5.4	3.6	5.4	6.3	<15	30
BOD_5	mg/l	3.6	3.27	3.65	4.11	<6	15
Ammonia	mg/l	0.03	0.038	0.032	0.038	0.2	0.5
Nitrite	mg/l	0.01	0.02	0.01	0.01	0.02	0.04
Nitrate	mg/l	3.25	4.45	4.22	0.05	5	10
Phosphate	mg/l	0.01	0.02	0.02	< 0.02	0.2	0.3
CN-	mg/l	KPH	KPH	KPH	KPH	0.01	0.02
Hg	mg/l	KPH	KPH	KPH	KPH	0.001	0.001
As	mg/l	KPH	KPH	KPH	KPH	0.02	0.05
Pb	mg/l	KPH	KPH		KPH	0.02	0.05
Zn	mg/l	KPH	KPH	KPH	KPH	1.0	1.5
E. Coli	MPN/ 100ml	34	60	66	24	50	100
Total coliform	MPN/ 100ml	420	625	527	316	5000	7500

[54] National Technical Standard on Surface Water QCVN 08:2008/BTNMT
A1 – Use for the purpose of supplying the running water and other purposes as:A2, B1 B2; A2 – Use for the purpose of supplying the running water after treating, preserving the aquatic life and other purposes as: B1 B2
B1 – Use for the purpose of irrigation and other purposes as: B2
B2 – Use for the purpose of river traffic and other purposes required the low quality water

Source: Center of Environmental Technology Development and Study- 8/2015

In addition to the four stations established in Vietnam side, another three stations were established at the proposed reservoir at Lao side in April/May 2016. Similar to water quality in Vietnam, water quality at the proposed reservoir conforms to Lao national water standards (PDR NO. 2734) except for turbidity and iron, again attributed to the active mining activities upstream of the river (Table 6.20).

Table 6.20 Water quality at the proposed reservoir, Nam Mo 1 HPP, June 2016

Parameters	WQNM1	WQNM2	WQNM3	PDR No 2734[55]
	About 1km from Vietnam – Laos border	Sopsan village, Lao PDR	About 2km from Phiang Hong village	
pH	8.36	8.11	8.18	6.5-8.5
Condustivity	284	291	125	<1200 µs/cm
Turbidity	**172**	**19**	**16**	<10 NTU
Color	Acceptable	Acceptable	Acceptable	<25 NCU
Iron (Fe)	0.53	1.15	0.39	<1 mg/l
Manganese (Mn)	0.125	0.084	0.223	<0.4 mg/l
Fluoride (F)	0.44	0.14	0.28	<1.5 mg/l
Nitrate (NO3)	1.5	1.1	1.1	<50 mg/l
Nitrite (NO2)	0.020	0.019	0.018	<3 mg/l
Arsenic (As)	<0.002	<0.002	<0.002	<0.05 mg/l
Total hardness	60	60	20	<300 mg/l
Total Coliform	62	47	36	<10 mg/l
Fecal Coliform	-	-	-	<10 mg/l
Chloride (Cl2)	-	-	-	<0.2

Source: Deparment of Hygiene and Health Promotion, National Centre for Environmental Health and Water Supply, Ministry of Health, Laos , June 2016

[55] PDR No.2734/PMO MONRE – Agreement on Environmental Quality Standards of Lao PDR, 2009, amended 2010

Table 6.21 Results of the water quality sampling in Nam Mo 1 HPP, March 2017

No	Parameters	Unit	Results and analysis				QCVN 08:2008/BTNMT Column A2
			NM1-1	NM1-2	NM1-3	NM1-4	
1	pH		6.44	6.64	6.56	6.50	6 to 8.5
2	BOD_5 (20°C)	mg/l	0.64	0.72	1.2	0.68	6
3	COD	mg/l	0.94	1.14	1.51	0.96	15
4	Dissolved oxygen	mg/l	6.5	6.6	6.2	6.4	≥ 5
5	Total suspended solid	mg/l	16	12	15	8	30
6	Ammonia	mg/l	0.14	0.05	0.12	0.02	0.3
7	Chloride	mg/l	1.62	1.62	1.62	1.45	350
8	Fluoride	mg/l	<0.05	<0.05	<0.05	<0.05	1.5
9	Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	0.05
10	Nitrate	mg/l	0.03	0.02	<0.01	0.03	5
11	Phosphate	mg/l	<0.01	<0.01	<0.01	<0.01	0.2
12	Cyanide	mg/l	<0.01	<0.01	<0.01	<0.01	0.05
13	Arsenic (As)	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	0.02
14	Zinc (Zn)	mg/l	0.012	0.010	0.005	0.005	1.0
15	Manganese (Mn)	mg/l	<0.01	<0.01	<0.01	<0.01	0.2
16	Mercury (Hg)	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	0.001
17	Iron (Fe)	mg/l	<0.01	<0.01	<0.01	<0.01	1
18	Oil & grease	mg/l	0.2	0.1	<0.1	<0.1	0.5
19	Total coliform	MPN/100 ml	680	310	250	210	5000
20	E.coli	MPN/100 ml	16	11	6	2	50

6.7.2. Groundwater quality

Drinking water is sourced from mountain spring because water wells are not common in the Project area. Samples for groundwater were therefore taken from three mountain springs

Table 6.22 summarize the water quality results from the three sampling stations.

Table 6.22 Groundwater Quality, Nam Mo 1 HPP, August 2015

Parameters	Unit	Sampling locations			QCVN 09:2008 /BTNMT[56]
		NN1	NN2	NN2	
		At dam site area, Nhan Ly village	At Ta Do border guard station, Ta Ca Commune	At Pha Danh quarry	
pH	-	7.6	7.3	7.6	5.5-8.5
Hardness	mg/l	124	112	125	500

[56] National Technical Regulation on Underground Water QCVN 09:2008/BTNMT

Parameters	Unit	Sampling locations			QCVN 09:2008 /BTNMT[56]
		NN1	NN2	NN2	
		At dam site area, Nhan Ly village	At Ta Do border guard station, Ta Ca Commune	At Pha Danh quarry	
TDS	mg/l	120	136	148	1500
COD	mg/l	0.08	0.05	0.16	4
F-	mg/l	KPH	KPH	KPH	1
CN-	mg/l	KPH	KPH	KPH	0.01
As	mg/l	KPH	KPH	KPH	0.05
Cd	mg/l	KPH	KPH	KPH	0.005
Fe	mg/l	KPH	KPH	KPH	5
E.Coli	MPN/100ml	3	3	2	KPH
Total coliform	MPN /100ml	23	26	12	3

Source: Center of Environmental Technology Development and Study, August 2015

The results showed that all physical and chemical parameters which were tested for drinking water quality at the Project site fall within the limits set by the GoV, GoL and WHO (see section on Aquatic Biology). COD index is low indicating that the groundwater is free from organic pollutants.

However, all the samples were contaminated with coliform bacteria which should be 'nil' to be considered suitable for drinking water. The presence of coliform in all samples indicated contamination from human excreta. These stations were located downstream of the settlements/villages suggesting that sanitation is lacking in the community.

6.8 Quality of soil environment

Soil within the Project area is characterized by three groups:

- Reddy brown soil formed and developed on fine grain purple shale, which is suitable for agriculture and forestry development, particularly planting specialty forestry.
- Yellow red soil with rich organic content on top-soil layer, while humus content is reduced by depth. This type of soil distributes widely on hill sides and is suitable for planting fruit tree, seed tree and grazing.
- Feralite soil is formed in valleys and stream valleys having high content of humus, suitable for secondary crops and paddy.

Such soil groups are suitable for agriculture and forestry. PEC1 in collaboration with the Center of Environmental Technology, took soil samples from three sampling station at the Project area in August 2015 (Figure 6.7). The soil samples were compared with QCVN 03:2008/BTNMT[57]. Results showed that soils samples are free from any heavy metal contamination (Table 6.23).

[57] QCVN 03:2008/BTNMT – National Technical Regulation on allowable limit of heavy metals in soil (Vietnam)

Table 6.23 Soil samples in Project area

Parameters	Unit	Sampling locations			QCVN 03:2008/BTNMT
		Đ1	Đ2	Đ3	
		At dam site area Nhan Ly village	Ta Ca commune	At Pha Danh quarry area	
pH	-	6.6	6.5	6.7	-
As	mg/kg	0.12	0.16	0.12	12
Cd	mg/kg	0.15	0.22	0.22	2
Cu	mg/kg	6.26	7.48	7.48	50
Zn	mg/kg	15.4	12.6	15.6	200

Source: Center of Environmental Technology Development and Study, August 2015, in PEC1 FS, 2015

6.9 Air quality

Observation at the different Project sites showed no serious sources of air quality deterioration such as factories, quarries, and stone crushing plants. However, movements of vehicles in the earthen road along the Project area are expected to cause dust pollution. Dust in the air in and around the settlements along the earthen road is observed to be major source of air quality deterioration. The thick dust layer observed on the tree leaves and vegetation in these areas signifies the dust pollution in the air. There is no mechanized stone crushing plant in the area but the local people along with their children are known to be crushing stones along the rivers and rivulets. Typical of rural areas, burning firewood for cooking meals has been the main source of air pollution at the household level. Exposure to indoor air pollution increases the risk of illnesses such as respiratory tract infections, pneumonia, chronic obstructive pulmonary disorder asthma and lung cancer.

6.9.1. Air Quality measurements

For ambient air quality, three stations were established to determine baseline concentrations. Table 6.24 summarize the results of the sampling.

The air quality measurements indicated low levels of air pollutant and ambient air quality levels are within the allowable limits of QCVN 05:2013[58] and WHO guidelines[59]. At the time of sampling, no operation was observed at the Pha Danh quarry site. Implementation of the project is associated with various construction activities such as drilling, blasting, quarrying, excavation works and movement of small and heavy vehicles for the transportation of construction materials, which could contribute in the deterioration of the quality of the air.

[58] QCVN 05: 2013/BTNMT- National Technical Specification on quality of ambient air

[59] World Health Organization (WHO).Air Quality Guidelines Global Update, 2005

Table 6.24 Ambient air quality, Nam Mo 1 HPP, August 2015

Parameters	Unit	Sampling locations			QCVN 05:2013/BTNMT	WHO Ambient Air Quality Guidelines
		KK1 At dam site, Nhan Ly village	KK2 At Nhan Cu village	KK3 At Pha Danh quarry		
TSP	mg/m^3	0.074	0.123	0.146	0.2	
CO	mg/m^3	1.323	1.871	1.623	-	100**
SO_2	mg/m^3	0.062	0.058	0.028	0.125	20*
NO_2	mg/m^3	0.015	0.024	0.026	0.100	40***
Pb	mg/m^3	KPH	KPH	KPH	0.0015	

Source: Center of Environmental Technology Development and Study, August 2015, in PEC1 2015
NOTE: KPH – undetected; *24hr averaging; **8hr daily maximum; ***one year averaging

6.10 Noise

Background noise in the Project area is low and inherent to a rural area where population density is low with limited economic activity (e.g., limited traffic noise, absence of industrial and/or commercial activities). Area where potential elevated noise may occur is the quarry site at Pha Danh where blasting and operation of excavator, loading and hauling activities are carried out during operations. However, at the time of measurement, the quarry was at a break so noise level was low at 52.5dBA and below allowable limits (QCVN 26:2010/BTNMT and IFC Guidelines) (Table 6.25).

Table 6.25 Noise levels (dBA), Nam Mo 1 HPP, August 2015

Location	Location description	Recorded levels (dBA)
KK1	At the dam site, Nhan Ly village, Ta Ca commune (X 03223620; Y 2148434)	55.6
KK2	At Nhan Cu village, Ta Ca commune (X 0325670 ;Y 2146866)	50.2
KK3	At Pha Danh quarry site (X 0326314 ;Y 2143065)	52.5
QCVN 26:2010/BTNMT[60]		70
IFC Daytime limit[61]		55 70
IFC Nightime limit[62]		45

Source: EIA Report. PECI. 2015, Field survey August 2015 by Center of Environmental Technology Development and Study

[60] QCVN26: 2010/BTNMT - National Technical Specification on Noise; 70 dBA (6a.m. to 21:00) in normal zone.

[61] IFC Noise level guidelines: Daytime (07:00 to 22:00) 55dBA for residential, institutional and educational while 70dBA for industrial and commercial receptors.

[62] IFC Noise level guidelines: Nighttime (22:00 to 07:00) 45dBA for residential, institutional and educational while 70dBA for industrial and commercial receptors.

CHAPTER 7 BIOLOGICAL CHARACTERISTICS

7.1 Natural Resources in Vietnam and Lao

7.1.1. Vietnam

Vegetation and land cover. Vietnam has experienced severe deforestation through the late 1980s; forest area shrank from 43.2% in 1943 to 28.8% in 1990 and then gradually recovered due to a change in forest policy and a drive for massive tree plantation[63]. As of December 2011, forest area in Vietnam was 13.515 Million ha, about 40.84 % of the total land area. Of which 10.243 5 Mha (75.8%) were natural forest, 3.090 Mha (22.9 %) plantation forest and 0.180 Mha (1.3%) were non-designated forest[64]. Forests in Vietnam are classified by use as *Production Forests* 6.677 Mha (49.4% of the total forested area), *Protection Forests* 4.645 M ha (34.4%), *Special-use Forests* 2.011 M a (14.9%) and *Non-designated Forest* 0.182 M ha (1.3%)[65].

Between 1990 and 2010, Vietnam gained 47.4% of its forest cover as a result of forest rehabilitation and plantation[66]. However, primary or natural forests continued to be under pressure. In late 1980s and 1990s, forest lands and upland farm management were reformed. Forestland and agricultural land allocation was carried out allocating rights to forest land for planting and upland farming.

Production forests are mainly for production and trading of timber and non-timber forest products (e.g., natural and planted production forests, seeding forests) while *protection forests*, are mainly to protect water sources and land, prevent erosion and desertification, restrict natural calamities and regulate climate (e.g., headwater protection forests; wind and sand shielding forests, and tide shielding and sea encroachment prevention forests), thus contributing to overall environmental protection. Managed exploitation activities are permitted in protection forests, where both extraction and management activities are allocated to local communities or groups of families who receive payments referred to as Environmental Payments.

On the other hand, *Special-use forests* are for conservation of nature, forest biological gene sources, for scientific research, protection of historical and cultural relics as well as landscapes. It is also aimed for recreation and tourism in combination of environmental protection. Examples are national parks, nature reserves and species-habitat conservation zones including forests of historical or cultural relics, scenic landscapes and experiment forests. No exploitative activity is not permitted in Special-use forests.

Biodiversity. Vietnam's vegetation is richly diverse, reflecting the country's great range of climate, topography, soils and the varying effects of human habitation. According to the Conservation International List Vietnam is identified as the fifth biodiversity hot spot in the world, on account of its exotic flora and fauna thriving in terrestrial ecosystems, freshwater ecosystems, and marine ecosystems. About 13,766 floral species have been recorded and/or described by 1999 in Vietnam, including 11,373 vascular species and 2,393 non-

[63] Stephen J. LEISZ (2009). Dynamics of Land Cover and Land Use Changes in the Upper Ca River Basin of Nghe An, Vietnam, Southeast Asian Studies: Vol 47 No 3, December 2009.

[64] To Xuan Phuc, Tran Huu Nghi and Roderick Zagt (2012), Forest Land Allocation in Viet Nam: Implementation Processes and Results, Tropbenos International Vietnam, Info Brief –May 2013.

[65] http://www.chainsawmilling.org/file.php/1284/fla%20info%20brief_web.pdf

[66] Vietnam Forest Information and Data, 2011http://rainforests.mongabay.com/deforestation/2000/Vietnam.htm. The Food and Agriculture Organization of the United Nations' Global Forest Resources Assessment (2005 & 2010).

vascular species of which about 10% are endemic. There are 160 species providing vegetable oils, 76 aromatic species, and 181 medicinal plant species[67].

Vietnam is also home to 310 species of mammals, 296 reptile species, 162 amphibian species, 889 species of birds, 310 species of land mollusks, 1,028 freshwater species of fish and 2,000 species of marine fish of which 100 birds and 78 mammals are endemic[68]. Recently, six mammals and one bird species have been discovered. Poaching and hunting wild animal for food and medicine have posed great threats in Vietnam - serving as food, aphrodisiac-medicinal, cultural, cultural use, collectors and export. The number of endangered plant and animal species are estimated to be 1,056, including 139 endangered plant species. By 2006, due to afforestation programs, some species that were threatened to extinction in the wild have had significantly regenerated, e.g., *Chukrasia tabularis* (Indian mahogany), *Aquilaria crassna* (agarwood or aloeswood), and *Panax vietnamensis* (Vietnamese ginseng).

Nghe An Province and Ky Son District

Nghe An province is situated in the North Central Coast Region of Vietnam. This province has 17 districts and Nam Mo 1 HPP is located in Ky Son district. In 2014, about 3.04 million people lived in this province having an area of 16,490 km2. Nghe An has a total forest area of 972,910 ha of which, Production Forest is 501,635ha, Protection Forest 302,069ha and Special-use Forest 169,207ha. Bamboos are a significant source of raw materials for forest exploitation and the development of forest-based industries.

Ky Son is a rural district in western Nghệ An Province and it covers an area of 2,095km2. The district had a population of 70,061 in 2015[69]. Kyson district is located in the upper Ca River basin, along the border with Laos and is the poorest district within the province. The topography of the district varies from flat valley plains to steep mountains. The Ca river is used extensively for transportation. Source of livelihood are mostly agriculture. The farming systems vary from subsistence long duration swidden-fallow cycle (fallow period up to 10 years or more) to medium duration (fallow period up to 5 years) in the mountainous areas near the Laos border while irrigated paddy and other crops and plantation forestry in the low land parts of the Ca river basin.

A study conducted in the upper Ca river basin including Ky Son district indicated that forest cover with mature trees significantly increased between 1993 and 2003 while overall natural forest cover with “herbaceous in transition to tree dominated forest” decreased. This was attributed to rampant land use change as a large area of “transitional forest” was converted to new agricultural land, residential and built-up areas[70].

[67] MONRE (2008). 4th country report Vietnam’s implementation of the biodiversity convention (draft), Report to the biodiversity convention secretariat, Ministry of Natural Resources and Environment, Environment administration, Han Noi 2008.

[68] MARD (2008) Report on the Review of Vietnam's Wildlife Trade Policy, the CITES Management Authority of Vietnam, Forest Protection Department, Ministry of Agriculture and Rural Development (MARD), Hanoi 2008.

[69] (Nghe An Portal (2017); Statistical Department of Ky Son District (Phòng thống kê huyện Kỳ Sơn), 2010; Statistical Documentation and Service Centre, 2015)

[70] Stephen J. LEISZ. 2009. Dynamics of Land Cover and Land Use Changes in the Upper Ca River Basin of Nghe An, Vietnam, Southeast Asian Studies: Vol 47 No 3 (December 2009)

7.1.1.1 Project Influence Communes

Implementation of Nam Mo 1 HPP will influence four communes in Ky Son district namely Ta Ca commune, Muong Tip commune, Muong Ai Commune and Nam Can commune; all these communes have upland areas with slopes of more than 25^0.

Ta Ca Commune

The forest area in Ta Ca commune covers 3,781ha (58.7% of the total land area) of which 1,885ha is classified as Protection Forest and 1,896ha as Production Forest (Table 7.1). On average, each household has 1.8ha of Production Forest. Production Forest area has been allocated by the commune[71] to households for planting trees. However, most of the Production Forest area has been converted and is farmed with rain-fed upland paddy rice, maize and cassava due to the lack of arable land in the area and therefore only small areas have been left for tree plantation.

Farmers have planted some fast-growing *Acacia* species, teakwood species, *Melia azedarach* and *Chukrasia tabularis* (Indian mahagany) in the upland crop areas. The Provincial Forest Protection Department has allocated part of the Protection Forest to groups of households as a community-based forest program. The village heads and the management boards are responsible for its protection and management. The forest, however, are of poor quality due to long-term illegal exploitation. Since there is limited arable land available in this commune, it is believed that a part of the Protection Forest is also now used as swidden agriculture.

The local households collect wild vegetables, bamboo shoots, mushrooms, and Jew's Ear (*Auricularia auricula-judae)* – an edible fungus for home consumption. Wild vegetables are collected everyday while bamboo shoots and Jew's Ear are collected only during the rainy season. The locals use herbal medicines, collected from the forests in treating diarrhea, fever and cough. Some few farmers also collect medicinal herbs for selling and these can fetch good prices.

They also hunt wild animals such as wild boars, birds, wild chickens, squirrels, barking deer (*Muntiacus muntjak)* and mice for food. Wild boars and barking deer are now very few. Mice are usually catch for consumption on a fairly regular basis (daily to several times a week).

Table 7.1 Forest area in project influenced communes in Ky Son district, Nam Mo 1 HPP

Forest land (ha)	Commune				
	Ta Ca	MuongTip	Muong Ai	Nam Can	Total
Total forest area	**3,781**	**6338**	**4,825**	na	**14,944**
Protection Forest	1,885	3,416	4,200	na	9,501
Production Forest	1,896	2,922	625	na	5,443
Special Land Use Forest	0	0	0	na	0
Total land area (ha)	**6,443**	**12,470**	**9,190**	-	**28,103**
Households	1,037	888	420	812	3,157
Population	4,779	4,349	2,442	4,270	15,840

Source: PEC1, 2016, Livelihoods Report for Nam Mo 1 HPP, ESIA

Ta Ca commune has about 7ha of water surface area, mostly fish ponds. Farmers only raise small fish in ponds and do not invest in fish ponds. Aquaculture is not developed and fishing is almost limited in Ca River and its tributaries. The common fish catch include Eel

[71] The commune makes a recommendation to the district which further coordinates with the province for forest designation to the village.

(Anguilliformes), *Gobiiformes*, common carp (*Cyprinus carpio),* rare Ray finned fish (*Garra fuliginosa)*, cat fish (*Hemibagrus guttatus)* and Sisorid cat fish *(Bagarius rutilus),* which is native to Vietnam and Laos. The catch is usually limited to domestic consumption only. Women also catch shrimp, crabs, snails and tadpoles along streams to supplement their fish catch. The catch ranges from 0.5-0.7 kg/day.

Muong Tip Commune

Muong Tip commune has 3,416ha Protection Forest and 2,922ha Production Forest. On average about 3.3ha of Production Forest is allocated to each household, and while this is supposed to be planted with trees, most of these forest allocations are converted into swidden land. Increase in population over time has put additional demand on farmland. There are very few trees planted, among those planted are *Melia azedarach, Acacia, Erythrophleum fordii,* and *Chukrasia tabularis*.

Protection Forest has been allocated to groups of households or to the village and is managed as community-based forest. Forest exploitation in terms of tree felling and slash-and-burn (swidden) agriculture has been high and forest quality has degraded. Protection Forests are mostly secondary forests with patches of broadleaf mixed bamboos. Villagers or groups of households managing the forest annually receive a remuneration of 180-200,000VND/ha.

Similar to Ta Ca commune, the locals in Muong Tip households collect wild plants and vegetables for food and medicine from these forests. They also hunt wild animals as a source of protein.

The households also catch fish and shrimp from Ca River and its tributaries. *Anguilliformes*, *Cyprinus carpio* (common carp) and other small fishes are frequently caught while *Hemibagrus guttatus*, *Bagarius bagarius* and tortoises are also caught but not as frequently. Some households also collect mosses along the river from October to April, as additional food source.

Muong Ai Commune

Muong Ai commune has 4,200ha Protection Forest and 625ha Production Forest, averaging 1.5ha of Production Forest allocated per household. Similar to other villages, Production Forest is allocated to households for planting trees but almost all of the allocations are converted into swidden farmland for growing upland crops such as rice, maize and cassava. In swidden farmland, villagers intercrop *Melia azedarach, Acacia, Chukrasia tabularis* and *Erythrophleum fordii*.

Protection forests on the other hand are mostly covered with bamboos, rattans and bushes. In general, the quality of vegetation is poor. Some areas have been over exploited for many years and some have also been converted into upland farming.

Similar to the two villages, the forest is source of food and medicine. The forest also provide wild animals as additional sources of protein food. This is supplemented with fishing from the river, which is only for household consumption. An average catch is in the range of 0.5-0.7 kg/day.

7.1.2. Lao PDR

In Lao PDR, forest area (defined as land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent[72]) is estimated at 15.8M ha in 2010, which was 67% of the total land area. Forest cover as well as forest quality is reported to have declined drastically in the last couple of decades, from 16.4M ha in 2002 to 15.8M

[72] FAO.2010. Global Forest Resources Assessment, 2010. Country Report, Lao PDR. FRA 2010/112 Rome.

ha in 2010[73]. Roughly 1.49M ha is classified as primary forest, the most bio-diverse form of forest.

Lao PDR is reported to have 8,286 higher plant species, 172 mammal species, 212 bird species and 165 species of amphibians and reptiles (IUCN, 2006). The illegal trade is thriving in Laos which has threatened survival of wildlife species.

Forest. Lao PDR with an area of 236,800 km^2 is a thinly populated country - it had a population of 6.492 million in 2015 at a density of 26.7 persons/km^2. Just over 80% of the land is composed of hills and mountains and the climate is typically tropical to subtropical influenced by monsoons. According to the last reconnaissance survey of forest cover in 2002, the total area of Lao PDR covered by natural forest (canopy density of higher than 20 % and height of above 5 metres) was 9.825 Million hectares (M ha). This made up roughly 41.5 % of the total land area, while the dry lands (lowland dry dipterocarp forest) covered approximately 1.317 M ha or 13.9 % of the total land area[74].

Forest cover declined continuously from 1982 to 2010 due to various land-use practices, such as shifting cultivation, commercial logging, commercial agriculture and tree plantation. The loss of forest cover was very high between 1992 and 2002; forest cover was 11.637 M ha in 1982, 11.168 M ha in 1992 and 9.825 M ha in 2002. In 2010, the Department of Forests estimated Lao PDR's forest cover at 9.5 million hectares or 40.3 % of total land area[75].

The national *Forest Strategy* aims at increasing forest cover to around 70% by 2020 through sustainable forest management and restoration. However, this goal may be unattainable based on the current rate of legal and illegal forest conversion. Up to 80% of the Lao population depends on forests and forest products, and 73% of rural citizens rely on small-scale agriculture and forestry for their livelihoods. In some rural communities, more than 50 % of a family's income is derived from non-timber forest products[76]. Forest conversion to other uses including farming has increased significantly; agriculture land increased from 0.936 M ha in 1998/1999 to 1.623 M ha in 2010/11 at the cost of forest cover[77].

The major forest types are mixed deciduous forests, dry evergreen forest, mixed coniferous forest and mixed bamboo forest. There is a huge potential for forest development in un-stocked forest areas which are over-harvested, mostly degraded and currently used for shifting cultivation[78].

Biodiversity. The forests and watersheds, and wetlands are important habitats for all species of wildlife and aquatic animals. These habitats are home to many rare and endangered species. There are 178 mammal species in Laos, of which four are critically

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[73] https://en.wikipedia.org/wiki/Xiangkhoung_Province

[74] Forest cover and land-use changes in Lao PDR according to the National Forest Reconnaissance Survey, Department of Land Planning and Development, National Land Management Authority, Lao PDR, FAO Study. http://www.fao.org/3/a-l1067e/l1067e01.pdf

[75] Forest Conversion in Lao PDR, Implications and Impacts of expanding land investments, Forest Trends Policy 2014.

[76] Ketphanh S., Foppes J., et al. 2012. Economic Valuation of Dry Dipterocarp Forest Ecosystem Services in Lao PDR: *Preliminary* lessons learned. Presentation to FIP scoping mission Vientiane, Department of Forestry.

[77] **Lao PDR.** Lao Census of Agriculture 2010/2011; Analysis of selected themes, Ministry of Agriculture and Forestry, Vientiane, October 2014, FAO.

[78] Forest cover and land-use changes in Lao PDR, FAO Study.

endangered, eight are endangered, 23 are vulnerable, and two are near-threatened[79]. The avifauna includes a total of 701 species, of which two have been introduced and eight are rare or accidental, and 25 species are globally threatened[80]. There are 189 species of reptiles and over 40 species of amphibians in Laos[81].

Fisheries are an integral part of the lives of rural people which account for more than 75% of the population. People traditionally live beside rivers and streams and they harvest fish and other aquatic foods which provide animal protein and micro-nutrient intakes as well as contribute to secondary income for their livelihoods. More than 481 fish species have been identified in Lao PDR, including 22 exotic species. Among other aquatic animals, about 37 amphibians, seven species of crabs and ten species of shrimps have been recorded[82].

7.1.2.1 Xiangkhoang Province, Nonghed District

Xiangkhoang Province located in the Xiangkhouang Plateau, north-east of the country covers an area of 15,880km^2 and has a mountainous topography[83]. The population of the province as of 2015 census is 244,684 with a density of 15 persons/ km^2. Nonghed is one of the seven districts in the province. The Nam Et-Phou Louey, a National Biodiversity Conservation Area (NBCA) is located in the province and covers a total area of 5,959 km^2. The NBCA is mountainous, with altitude ranging between 336 and 2,257 metres, has many rivers and has high level of biodiversity.

Forests are categorized as Protection Forest, Conservation forest and Production forest[84]. Protection Forests serve to function as protection for water resources, soil quality, river banks and road sides; prevent soil erosion, serve as strategic areas for national defense and protection from natural disasters while Conservation forests serve for the purposes of conserving nature, preserving plant and animal species, forest ecosystems and other valuable sites of natural, historical, cultural, tourism, environmental, educational and scientific research experiments. Production Forests can be natural or planted forests specifically for utilization and production of wood and other forest products to satisfy the requirements of national socio-economic development and people's living.

Because of the low population density in Laos, Protection and Conservation Forests are relatively intact. Villagers are not allowed to harvest forest products other than timber for house construction from these forests. Villagers harvest non-timber forest products like wild vegetables and other edible products from Production Forest while some areas are used for upland farming such as upland rice and maize.

7.1.3. Field surveys for vegetation, wildlife and fisheries

Nineteen sampling sites were established to collect data and close observations on the vegetation within the Project AI. Each sampling plot was a 20mx20m sized quadrat. Twelve sampling sites were located within the proposed reservoir, three sites at the proposed headworks and powerhouse locations and five sampling sites within the auxiliary areas

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[80] *Lepage, Denis (2007). "Checklist of birds of Laos". Bird Checklists of the World. Avibase.*

[81] Biodiversity Data Journal (2013) New country records of reptiles from Laos; 2013; (1): e1015.

[82] Phonvisay Singkham (2013) An introduction to the Fisheries of Lao PDR. Mekong Development Series No. 6, 62 pages. Mekong River Commission, Phnom Penh, Cambodia. ISSN 1680-4023.

[83] Provinces of Laos". *Statoids.com*.

[84] LAO Law of Forestry, 2007

(Figure 7.1). Several transect walks were taken to sample and observe birds and wildlife. All the sampling sites are located in Vietnam territory. Information on the occurrence of wildlife and bird species in the Project area of influence (AI) was gathered through interviews and focus group discussions with the local people in Muong Ai and Muong Tip communes.

Fish samples were collected at eight sampling sites in Nam Mo River including three sites in its tributaries: seven at the proposed reservoir area and one at the dam site and auxiliary areas (Figure 7.2). Various types of nets were used to collect fish samples.

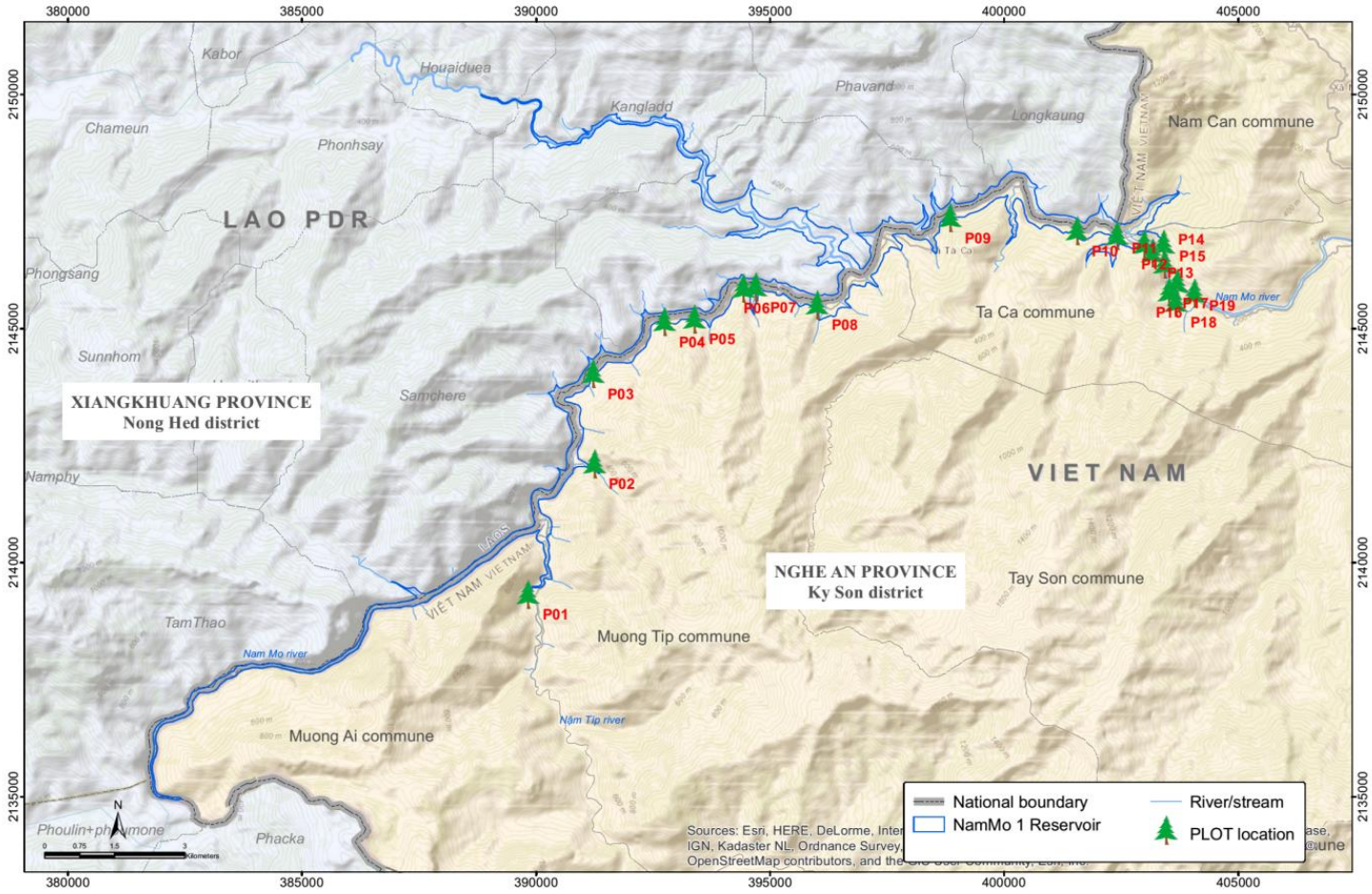


Figure 7.1 Location of vegetation sampling stations

Figure 7.2 Location of fish sampling stations

7.1.4. Forest resources

7.1.4.1 Forest vegetation systems[85] in the Project area

Forested areas close to the settlements and near the Project AI were heavily exploited and farmed without terraces using the traditional swidden agriculture system. Typical for swidden agriculture systems is that once soil fertility diminishes, the villagers abandon the farm and move to a new tract of land and the exploited once forest land is left to regenerate and restore naturally. Such areas gradually turn into grassland, scrubland and eventually secondary forests. The different forest vegetation systems within the Project AI and its adjacent areas are described below. The types of forest vegetation in the reservoir area, headworks, powerhouse, disposal area and auxiliary areas at village level are given in Appendix 7.1

The types of forest growth after exploitation are classified into four groups in this study, namely Semi-deciduous Forest, Secondary Mixed Evergreen Rain Forest, the Mixed and Bamboo Forest and the Predominantly Bamboo Forest. The main vegetation types in the reservoir area and dam site are Semi-deciduous forest while secondary Mixed Evergreen Forest, in auxiliary areas. Table 7.2 describes the two former types of forest growth while typical tropical grassland on uncultivated land is further described under progressive forest succession on uncultivated land. The mixed stages of forest growth, i.e., broadleaf-bamboo and bamboo forests are also common in many pockets within the Project AI (Table 7.2). This type of forest growth is further classified based on its succession in terms of being uncultivated for years/period. Plate 7.1 shows photos of the different types of vegetation existing in the Project IA.

The Mixed Evergreen Rain Forest and Semi-deciduous Forest have regenerated after exploitation. These types of vegetation are the result from human impact on natural forest causing exploitative succession and then progressive succession.

(a) Semi-deciduous Forest

The dominant layer includes semi-deciduous tree species that reaches up to 10-12m tall. *Burretiodendron hsienmu* is the most dominating species with high Important Index Value of 84% followed by *Ormosia pinnata* (41%), *Sterculia foetida* (39%), *Lagerstroemia tomentosa* (21%), and *Phyllanthus annamensis, Dimocarpus fumatus, Milletia sp., Celtis philippense, Streblus asper* and *Vitex tripinnata*.

(b) Mixed Evergreen Rain Forest

Mixed evergreen rain forest has broadleaf trees of timber species. The most dominant species are *Gironiera subaequalis*, *Aglaia* spp., *Aphanamixis polystachya*, *Engelhardtia roxburghiana* and *Endospermum chinense*. The composition of timber tree species is of high diversity, however, occurrence of Mixed Evergreen Rain Forests are very limited within the Project AI. The vegetation in the different layers of these two forest types is given in Table 7.2.

(c) The mixed broadleaf and bamboo forest

This type of forest has limited coverage within the Project DIA. This vegetation is the result of over exploitation and now is under recovery. Some broadleaf timber species, as high as 10-15m such as *Cinnamomum* spp., *Aglaia* spp., *Lithocarpus* spp. are growing with *Neohouzeaua dulloa* (Asian bamboo).

[85] The forest system classification is based on the Report on Biology Systems in Nam Mo 1 HPP, Ky Son District, Nghe An Province, Vietnam, by PEC1 and Institute of Ecology Biology Resources, Hanoi, April 2017 and the Environmental and Social Impact Assessment of Nam Mo 1 HPP in Lao PDR territory, August 2016.

(d) The Predominant bamboo forest

Bamboo Forest is usually formed after timber dominated forest has been overexploited, burned and left uncultivated after slash and burn activities.

Table 7.2 Types of vegetation growth after exploitation

1	**Semi-deciduous Forest**	
	Dominant layer	It includes semi-deciduous, 8-12m tall, timber tree species. The dominant species are *Burretiodendron hsienmu, Lagerstroemia tomentosa, Ormosia pinnata, Sterculia foetida, Phyllanthus annamensis, Dimocarpus fumatus*, *Celtis philippense and Streblus asper.*
	Scrub layer	It includes species of *Randia spinosa* (vạng trứng), *Vitex tripinnata* (bình linh) and *Dimocarpus fumatus* (nhãn rừng).
	Shrub layer	Mainly fern species
2	**The secondary Mixed Evergreen Rain Forest**	
	Dominant layer	Broadleaf tree species, about 15-20m tall including, *Aglaia* sp., *Aphanamixis polystachya*, *Castanopsis* spp., *Dimocarpus fumatus Engelhardtia roxburghiana*, *Endospermum chinense*, *Gironiera subaequalis, Horsfieldia* spp., *Knema conferta*, *Lithocarpus* spp., *Manglietia* spp., *Shorea chinensis, Syzygium* spp., *Madhuca* sp., and *Vatica odorata.* This type of forest is very few within the Project area of influence.
	Sub-dominant layer	Small trees, scattered, less than 15m tall such as *Baccaurea racemosa*, *Eurya* spp., *Syzygium* spp., *Garcinia* spp., *Litsea* spp., *Cinnamomum* spp., *Sterculia* sp., and *Canarium album*.
	Scrub layer	Regenerated premature trees and species in this layer include *Antidesmabunius*, *Tabernaemontana bovina*, *Melastoma septemnervium*, *Ardisia* spp., *Gomphandra mollis, Polygala tonkinensis, Pinnaga* spp., and *Licuala* spp.
	Shrub layer	Mainly fern and creeper species *such as Zingiberaceae*, *Poaceae* and *Cyperaceae*.
	Limb Layer	Species of fern, species of creeper - *Fabaceae*, *Convolvulaceae* and *Calamus* spp.
3	**Mixed Broadleaf and Bamboo Forest**	
		This forest type is a combination of some broadleaf timber species, as high as 10-15m and bamboos. The major species are *Cinnamomum* spp., *Aglaia* spp., *Lithocarpus* spp., *Garcinia* spp., *Canarium* sp., *Vatica* spp., *Mallotus* spp. and *Tremna* spp. Growing with *Neohouzeaua dulloa* (Asian bamboo)
4	**Predominant Bamboo Forest**	
		The predominant bamboo species recorded in the study area is *Chizostachyum dullooa*. The shrub layer comprises fern species and some other species of *Poaceae* and *Cyperacea* family.

The progressive forest succession on uncultivated land

This type of forest system is created when natural regeneration occurs on abandoned uncultivated land. There are two types under this forest system namely the Scrubland and Secondary Forest and Secondary Tropical Grassland. Table 7.3 describes this type of forest growth systems.

(a) Scrubland and Secondary Forest

The secondary scrub on uncultivated land for 5-10 years

Most of the vegetation communities within the Project AI exhibit the progressive succession on land uncultivated for 5-10 years, and presently in recovery process. Vegetative structure is relatively simple. There are timber tree species such as *Wightia pubescens*, *Macaranga denticulata*, *Ormosia pinnata,* as the first layer. The second layer, the scrub layer has tree and herbaceous species, and the third, the shrub layer are species in family Fabaceae, *Asteraceae*, *Poaceae*, *Cyperaceae,* followed by fern species and creepers (Table 7.3).

The Scrubland and Secondary Forest on uncultivated land for 10-15 years

The vegetation pattern includes vegetation communities of timber tree layer, scrub layer, shrub layer and limb layer. Trees are as high as 5-6m and dominant species include *Wightia pubescens*, *Macaranga denticulata*, *Ormosia pinnata and Tremna orrientalis*.

The scrub layer mainly includes species in family *Euphorbiaceae*, *Rubiaceae*, *Myrsinaceae*, *Apocynaceae*, *Melastomataceae* while the shrub layer has *Zingiberaceae*, *Poaceae*, *Cyperaceae*, *Fabaceae* and creepers in limb layer.

Young forest recovered on Scrubland area

The vegetation in this type of forest growth is characterized by tropical forest with evergreen rain forest. These are located in low hills. The upper layer is 15-20m tall timber species such as *Peltrophorum dasyrrhachis*, *Choerospondias axillaris*, *Vatica* spp. and foliage layer (second layer) has broadleaf timber trees, as high as 10-15m, such as *Lithocarpus* spp., *Cinnamomum* spp., *Litsea* spp., *Cryptocarya* spp., and *Aglaia* spp. The scrub layer is secondary tree species, low scrub bushes and usually species that are adapted to shadows. Shrub layer includes species of fern, *Poaceae* and *Cyperaceae* while the sub-layer includes creepers.

Table 7.3 Forest succession on uncultivated land

Forest succession period on uncultivated land		
1	**Scrubland and Secondary Forest**	
	This type of vegetation is found all throughout the Project AI. It is characterized based on the number of years not being disturbed.	
	5-10 years	**Secondary scrub -** Relatively simple vegetative structure; very few immature trees and saplings of species such as *Wightia pubescens*, *Macaranga denticulata*, *Ormosia pinnata, Trema angustifolia*, *Rhus chinensis*, *Apurosa dioca and Phyllanthus embrica.* Scrub layer consists of *Breynia fruticosa, Glycomis pentaphylla Randia spinosa, Ixora coccinea, Psychotria* spp.*, Micromelum hirsutum and Maesa* spp.; Shrub layer has Fabaceae, *Asteraceae*, *Poaceae and Cyperaceae* species; Fern species and creeper species are present in the limb layer.
	10-15 years	**Secondary Forest** - The first layer includes tree species, 5-6m tall, *Wightia pubescens*, *Macaranga denticulata*, *Ormosia pinnata, Tremna orrientalis*, *Rhus chinensis*, *Apurosa dioca*, *Phyllanthus embrica, Castanopsisannamensis*, *Pterospermumheterophyllum*, *Sterculia hymenocalys*, *Litsea* spp., *Ficus* spp., *Wendlandia paniculata*, *Gironiera subaequalis* and *Dillenia* spp;

Forest succession period on uncultivated land		
		The Scrub layer is dominated by *Euodia lepta*, *Psychotria* spp., *Tabernaemontana* spp., *Randia* spp., *Ixora* spp., *Kibatalia* sp. and *Wightia* sp. The Shrub layer has *Zingiberaceae*, *Poaceae*, *Cyperaceae*, *Fabaceae and fern species and* limb layer is creeper species from the family of *Convolvulaceae*.
	More than 15 years	**Young forest recovered on scrub land-** the upper layer contains 15-20m tall trees of species *Peltrophorum dasyrrhachis*, *Choerospondias axillaris* and, *Vatica* spp.. Foliage layer is species of broadleaf evergreen trees of 10-15m tall such as *Lithocarpus* spp., - *Cinnamomum* spp., *Litsea* spp., *Cryptocarya* spp., and *Aglaia* sp. The scrub layer is secondary tree and scrub species such as *Euodia lepta*, *Psychotria* spp., *Tabernaemontana* spp., *Randia* spp., *Ixora* spp., *Kibatalia* sp., and *Wightia* sp. The shrub layer consisting of fern and other species such as family of Poaceae, family of Cyperaceae, *Ammomum* spp., *Alpinia* spp., *Alocasia* sp., and *Homalomena oculta.* The sub-layer includes *Piper spp*., *Aschynanthus* spp., creepers in family *Convolvulaceae*, *Fabaceae*, *Menispermaceae,* creeping timber species or running species of family *Annonaceae* (*Desmos* spp., *Uvaria* spp., *Fissistigma* spp., *Tetrastigma* spp).The sub layer includes ferns and wild pepper species.
2	**Secondary Tropical Grassland**	
	At less degraded slopes, grass species such as *Imperata cylindrica, Phragmites karka*, *Saccharum spontaneum* and *Thysanolaena maxima* and *Miscanthus sinensis (*Chinese Silver grass) *dominate the grassland.* At degraded areas, major species are *Heteropogon conturtus, Paspalum conjugatum*, *Cymbopogon caesius, Arundinella nepalense* and *Themeda triandra.* At moderately good soils, grass species include *Chrysopogon aciculatus*, *Cynodon dactylon*, *Eulalia monostachya*, *Paspalum conjugatum* and some herb species like *Ageratum conyzoides* and *Eupatorium odoratum*. Seedlings of timber species and other species of creeper, bushes and ferns are also observed to regenerate.	

(b) The Secondary Tropical Grassland

The secondary tropical grasslands are formed on sloping land left uncultivated for 3-5 years and later on, scrubs emerge on some patches of these grasslands. Such grasslands occupy most of the area in the Project AI. Grass species such as *Imperata cylindrica, Phragmites karka*, *Saccharum spontaneum* and *Thysanolaena maxima* and *Miscanthus sinensis* (Chinese Silver grass) are found growing on less degraded slopes while *Heteropogon conturtus, Cymbopogon caesius, Arundinella nepalense* and *Themeda triandra* species dominate the grassland on more degraded areas. Recovery is very poor on these areas.

On lands which are subject to regular disturbace, grass species such as *Chrysopogon aciculatus*, *Cynodon dactylon*, *Eulalia monostachya* and *Paspalum conjugatum* grow while on good soils herb species such as *Ageratum conyzoides* and *Eupatorium odoratum* grow. Seedlings of timber species and other species of creeper, bushes and ferns have regenerated in secondary grasslands. With increasing soil fertility these non-grass species would later dominate the grassland.

<u>Vegetation on Rock along Streams</u>

River banks have exposed rock terrains with small sand lanes which created conditions for the different types of riverine vegetation to grow. The wetland species grown along river bed include *Acorus gramineus*, *Elaeocarpus hainanensis*, *Momonia riparia*, *Ficus subpyriformis, Aidia pilulifera* while on river banks, major species are *Pterocarya tonkinensis,* Ficus species and *Syzygium* spp. *Homalonema oculta*, *Tacca chantrieri*, *Ophiopogon* spp., and some species of *Cyperaceae* are found growing along streams.

In general, forest vegetation on the left bank of the Ca River in the Project AI of Sanche, Kenglet, Namuang, Phavanh and Longkoang villages, Nonghed district, Lao PDR is better than on the right bank. Most of of the Production Forests have woody vegetation on this side of the river. However, illegal logging takes place and households have encroached on Production Forests for upland cultivation.

	
Photo a. The mixed evergreen rain forest after exploitation in Ta Ca commune	*Photo b. The semi-deciduous forest after exploitation in Muong Tip commune*
	
Photo c. The secondary scrub on uncultivated land for 5-10 years in Ta Ca commune	*Photo d. Young forest recovered on scrub land area in Ta Ca commune*
	
Photo e. Grass land after cultivation in Ta Ca commune	Photo f. Secondary scrub land in Ta Ca commune

Plate 7.1 Some photos of the vegetation types found within the Project area, Nam Mo 1 HPP

7.1.5. Types of Vegetation in the Project Area of Influence

7.1.5.1 Vegetation map of Nam Mo 1 HPP

The vegetation map of Nam Mo 1 HPP is prepared using remote sensing and GIS methods. It describes five secondary forest vegetation namely Secondary Mixed Evergreen Rain Forest, Semi-deciduous Forest, Mixed Broadleaf and Bamboo Forest, Secondary Scrub on uncultivated land and Grass/shrub/bamboo/cultivated and uncultivated land, and other uses like other lands, and river/stream in the Project area of influence (

Figure 7.3).

7.1.5.2 Type of vegetation in the reservoir and construction areas

The type of forest vegetation found in the proposed reservoir area and construction areas is given in Table 7.4. The total area of the proposed reservoir is 962ha, of which about 39% is covered by a mixed of the three types of secondary forests, about 17% secondary scrub and about 24% of grassland/shrub/bamboos/cultivated/uncultivated.

The Project will acquire 1,042ha of land for the reservoir and various Project associated infrastructures and about 599ha for the buffer zone. Of the 1042ha, about 95% will be permanently used while only 5% will be for temporary use and will be rehabilitated as soon as construction and its usage is completed.

7.1.6. Biodiversity status and biomass

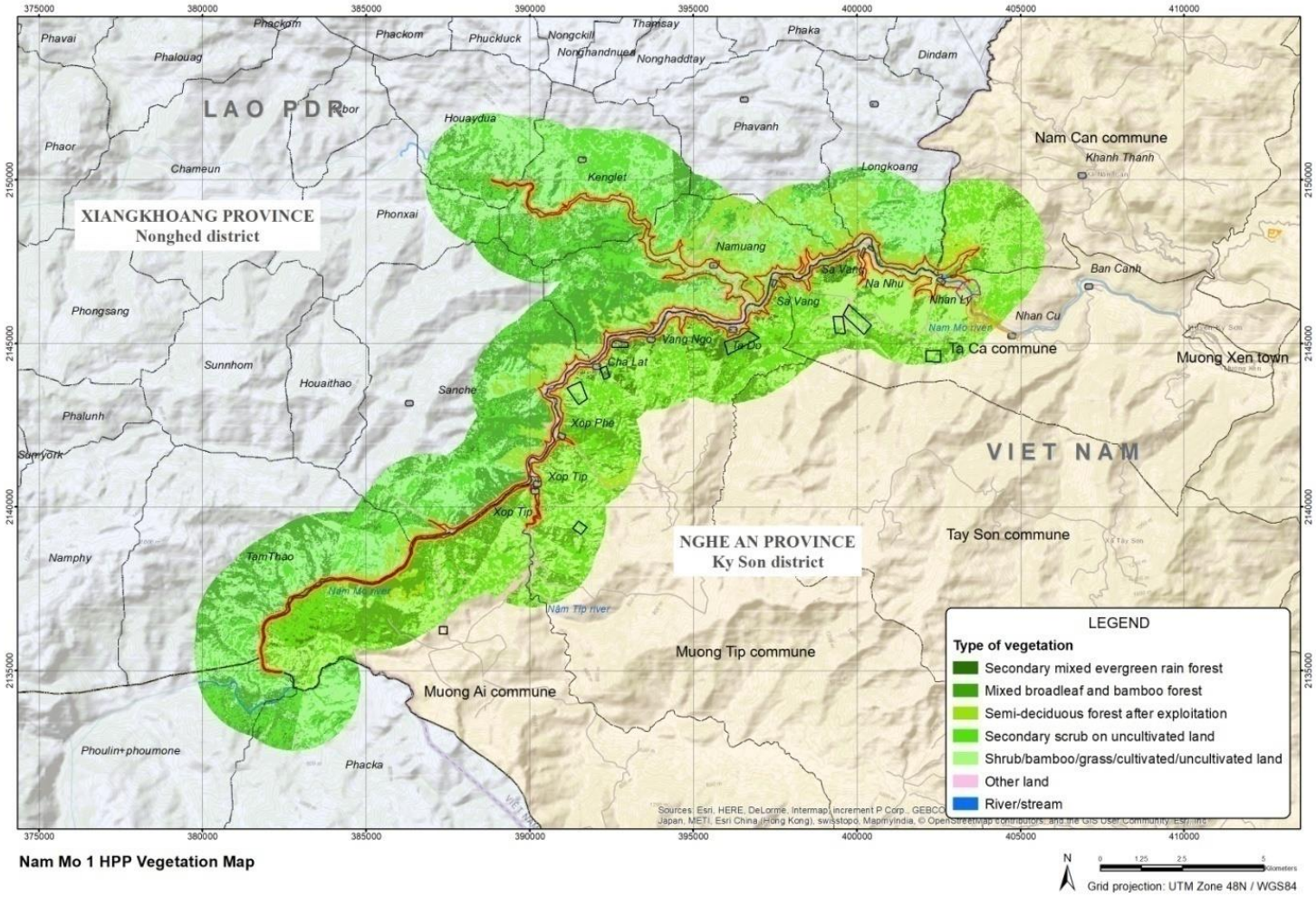
7.1.6.1 Biodiversity status

The present study shows that vegetation in the basin of Nam Mo 1 HPP comprises of at least 420 vascular plant species from 328 genera and 117 families. These include 408 flowering plant species (316 genera), 9 fern species (9 genera), 2 species from the Lycopodiophyta phylum – the oldest lineage of living vascular plants, and one conifer species. The forest types and the stage of forest growth regeneration at the reservoir area, headworks, powerhouse, disposal and auxiliary areas are given in Appendix 7.2.

The Semi-deciduous forests in the reservoir area have pole sized to mature trees. The tree species recorded include *Aglaia sp*., *Albizia corniculata, Albizia lucidior, Archidendron lucidum, Bauhinia viridescens, Burretiodendron hsienmu, Canthium sp., Canthium horridum, Capparis micrantha, Celtis philippense, Callicarpa arborea, Clerodendrum cyrtophyllum, Cratoxylum cochinchinensis, Dimocarpus fumatus, Litsea cubeba, Milletia sp, Ormosia pinnata, Phyllanthus annamensis, Streblus ilicifolius, Sterculia foetida, Milletia sp, Lagerstroemia tomentosa, Syzygium sp., Vitex tripinnata, Streblus asper* and*, Vitex tripinnata.* The plant densities ranged from 300 to 875 trees/ha. The shrub species include *Albizia corniculata, Bauhinia viridescens, Capparis micrantha* and *Fissistigma villossium*. The non-woody species comprise of *Eupatorium odoratum and Tinospora crispa* while fern and grass species cover the ground level strata. *Eupatorium odoratum* is a weedy species that usually grows when tree densities are low.

In the grassland area, there were some tree species growing as saplings to pole sized trees, e.g., *Albizia lucidior, Archidendron lucidum, Milletia sp.,* and *Ormosia pinnata.* Tree density was low at 50 to 200 trees/ha. *Cassia occidentalis* and *Eupatorium odoratum* are also spreading fast in this type of vegetation.

Biodiversity in the Project area is low to medium since most of the vegetation has been disturbed. The Secondary Evergreen Mixed Rain Forest has medium diversity while the secondary forest grown on uncultivated land, Mixed Broad Leaf Bamboo Forest and predominant Bamboo Forests are of low biodiversity value. The number of tree species in the reservoir area is higher (30 species) than in the headworks and powerhouse areas (7 species) and auxiliary area (18 species (Table 7.5). However, the density of tree species was similar at 183 trees/ha in both reservoir area and auxiliary area, with less in the headworks and powerhouse areas. Notably mature size trees are few due to selective logging.



Nam Mo 1 HPP Vegetation Map

Figure 7.3 Vegetation map of Nam Mo 1 HPP

Table 7.4 Vegetation types and other land uses within the Project area, Nam Mo 1 HPP

No	Vegetation type	Permanent Area (ha)		Temporary (ha) **	Total (ha)	Buffer Area (ha)
		Reservoir	Main works*			
I	Secondary Mixed Evergreen Rain forest	98.2	0	0.4	98.6	68.2
II	Mixed Broadleaf and Bamboo forest	128.5	4.8	10.6	143.9	126.7
III	Semi-deciduous Forest	152.0	2.7	0	154.7	100.5
IV	Secondary Scrub on Uncultivated land	159.5	1.1	17.9	178.5	108.4
V	Grass/shrub/bamboo/cultivated and uncultivated land	226.4	12.7	20.2	259.3	140.3
VI	Other lands	110.2	0.7	3.7	114.6	13.3
VII	River/stream	87.2	2.2	2.4	91.8	1.7
	Total	**962.0**	**24.2**	**55.2**	**1,041.4**	**559.1**

*Main works include dam and associated structures, powerhouse and permanent Project facilities such as permanent roads

**Temporary area includes disposal sites, auxiliary areas and construction roads

Table 7.5 Density of forest vegetation in reservoir and construction area

Forest vegetation	Reservoir area	Headworks, Powerhouse	Auxiliary 2
No. of species			
Tree	30	7	18
Density no./ha			
Trees	184	133	183

7.1.6.2 Regeneration, standing volume and total biomass

There is some regeneration of hardwood species in the Semi-deciduous forest. The species regenerating include *Dimocarpus fumatus*, *Streblus ilicifolius*, *Canthium sp.*, *Milletia sp.*, *Streblus ilicifoliu, Burretiodendron hsienmu*, *Lagerstroemia tomentosa*, *Celtis philippense*, and *Phyllanthus annamensis*. Plant density is moderate at 525 to 1,150 saplings/ha. In tropical grasslands and scrub areas, regeneration is poor which indicates heavy livestock pressure.

Feil! Fant ikke referansekilden. summarizes the estimated biomass for each type of forest within the reservoir and associated facilities areas. The total organic biomass in the reservoir area is estimated to be at 20,383mt, 14,920mt at the buffer zone area and 1,014mt in the construction areas.

Table 7.6 Estimated organic biomass above ground in the reservoir area

Type of Forests	Reservoir		Buffer zone		Construction sites	
	Area Ha	Biomass (mt)	Area Ha	Biomass (mt)	Area Ha	Biomass (mt)
Secondary mixed evergreen rain forest	98.2	5,892	68.2	4,092	0.4	24

Type of Forests	Reservoir		Buffer zone		Construction sites	
	Area Ha	Biomass (mt)	Area Ha	Biomass (mt)	Area Ha	Biomass (mt)
Mixed broadleaf and bamboo forest	128.5	3,849	126.7	3,801	15.4	462
Semi-deciduous forest	152.0	7,600	100.5	5,025	2.7	135
Secondary scrub on uncultivated land	159.5	1,910	108.4	1,301	19.0	228
Grass/shrub/bamboo/cultivated and uncultivated land	226.4	1,132	140.3	701	32.9	165
Total	**764.6**	**20,383**	**544.1**	**14,920**	**70.4**	**1,014**

*million tons

Species of conservation interest

There are two species of concern namely the Gu Sui Bu (*Drynaria fortunei),* a basket fern species native to Eastern Asia including eastern China and *Hopea mollissima* endemic to Vietnam and Yunan –China, naturally growing in the Evergreen Rain forest. The former is listed as endangered species in the Red Data Book of Vietnam, 2007[86] while the latter is recorded as regionally extinct in the IUCN[87], *Drynaria fortunei* is used in traditional Chinese medicine for bone healing. *Hopea mollissima* is a highly valued timber species. These species are disappearing because of deforestation and habitat degradation, and overexploitation.

7.1.7. Forest ecosystem services and ethno-botanical status

7.1.7.1 Ecosystem services

The terrestrial ecosystem, mainly forests and grasslands in the Project area, provides tangible products such as food, construction materials, medicinal plants and non- tangible items like tourism and recreation. The Millennium Ecosystem Assessment[88] defines *ecosystem services* as the benefits people obtain from the ecosystems. MIGA PS6 (see Chapter 4) identified four types of ecosystem services namely provisioning, regulating, cultural and supporting services. Two types, the provisional and cultural ecosystem services are evident within the Project area.

7.1.7.2 Ethno-botanical status

Out of the 420 total vascular plant species recorded in the Project area, 149 species have exhibited ethno-botanical importance either medicinal plant species, fuelwood and timber, edible plant, ornamental plant, rattan and bamboo species, or a combination of the uses (Appendix 7.3). In the Project AI, 61 species of medicinal & poisonous plants, 57 species of fuel-wood and timber trees, 18 species of edible plants, 16 species of ornamental plants, six species of rattan and bamboos, eight species of essential oil and resin plants, and eight species of plants for other uses were recorded (Table 7.7). There are several medicinal plants of high value. There are also poisonous plants naturally growing in the forest, like for example, *Crotontiglium spp.*, *Millettia pachyloba* and *Engelhardtia roxburghiana* which are also used locally.

[86] Red Book Vietnam

[87] IUCN – International Union for Conservation of Nature – IUCN Red list of Threatened Species

[88] Millennium Ecosystem Assessment (MA). 2005. Ecosystems and Human Well-Being: Synthesis [1]. Island Press, Washington. 155pp.

Table 7.7 Plant species with their uses

Use of plants	Species
Medicinal plants	There are 61 medicinal plant species in the Project area
Essential oils	*Acronychia pedunculata, Blumea balsamifera, Euodia lepta, Litsea cubeba, Litsea glutinosa, Vernicia Montana, and Zanthoxylum nitidum* (7 species).
Timber and fuel-wood plants	There are 58 species used for timber and fuel wood.
Edible plants	There are 18 edible plant species which produce fruits, roots and other edible parts. *Antidesma bunius, Artocarpus rigidus, Bischofia javanica, Callipteris esculenta, Crateva magna, Curcuma longa, Dioscorea persimilis, Garcinia cochinchinensis, Garcinia merguensis, Hodgsonia macrocarpa, Houttuynia cordata, Mosla dianthera, Oroxylum indicum, Pentaphragma sinense, Phyllanthus embrica, Piper lolot, Pouteria sapota* and *Spondias lakoensis,* (18 species)
Ornamentals	There are 16 species which have ornamental value
Rattan and bamboo	*Bambusa blumeana, Calamus faberi, Calamus rudentum, Calamus salicifolius, Pinanga dupperreana, Rhapis gracilis*, (six species). Local people use the fibers for cloths.
Other uses	There are eight species recorded in the Project area.

The local communities have always used the forest as a source of fuelwood, timber, fodder and forage, medicines, food and rituals. Some of the plant species have multiple purposes. Table 7.8 summarizes the plant species that has multiple uses.

Table 7.8 Multiple uses of plant species in Project area

No	Species	Use
1	*Acronychia pedunculata*	Essential oil and medicinal value
2	*Alstonia scholaris*	Fuel wood/timber and medicinal value
3	*Artocarpus rigidus*	Forage and edible fruits
4	*Blumea balsamifera*	Essential oil and medicinal value
5	*Canarium album*	Fuelwood/timber and medicinal value
6	*Costus speciosus*	Medicinal and ornamental plant
7	*Curcuma longa*	Medicinal and edible
8	*Dioscorea persimilis*	Medicinal and edible
9	*Euodia lepta*	Essential and medicinal value
10	*Garcinia cochinchinensis*	Fuelwood/timber and edible fruits
11	*Garcinia merguensis*	Fuelwood/timber and edible fruits
12	*Hopea mollissima*	Forage/timber and essential oil
13	*Hydnocarpus ilicifolia*	Forage/timber and medicinal value
14	*Litsea cubeba*	Essential oil and medicinal value
15	*Litsea glutinosa*	Essential oil and medicinal value
16	*Piper lolot*	Medicinal and edible
17	*Pterocarya stenoptera var. tonkinensis*	Forage/timber and medicinal value
18	*Spondias lakoensis*	Forage and edible fruits
19	*Symplocos cochinchinensis*	Fuelwood / timber and medicinal value
20	*Zanthoxylum nitidum*	Essential oil and medicinal value

7.1.8. Forest Protection and Management

Protection Forest

Management of Protection Forest is specified in the Protection Forest Regulation issued together with Decision No. 17/2015/QĐ-TTg dated 09/06/2015 of the Prime Minister. The provincial-level Forest Protection Department and Forest Protection Management Board are in-charge of the protection and management of Protection Forests and Special-use Forests. Forests are allocated to groups of households or village communities so that they manage and protect it under the supervision of the Forest Protection Force Station. The villagers are not allowed to collect wood and rare animals in accordance with the laws but are allowed to collect non-wood forest products. The households and the communities participating in forest protection receive protection remunerations in accordance with the State's regulations, which is 180,000-200,000VND per hectare of Protection forest. Part of this remuneration is used to protect the forests and the rest is shared with the households, the amounts vary across villages. It should be noted that this forest types is not a conservation forest which is classified as special-use forest – a type of forest which does not occur in the Project AI.

Production Forest

The protection and management of Productive Forest is provided in the Productive Forest Regulation issued together with Decision No. 49/2016/QĐ-TTg dated 01/11/2016 of the Prime Minister. The commune's Production Forests are allocated to households or groups of households for planting trees and protecting it. They get forest use certificates and are required to develop forest protection plans and organize forest protection by themselves. Local Forest Protection Offices and Commune People's Committees coordinate and support forest development, prevent and fight forest fires according to the National Law. Concerned households can utilize Non-Timber Forest Products (NTFPs) in allocated Production Forest area, develop NTFP, promote agriculture and fishery production program with less than 30% of the allocated area. However, due to the lack of arable area in the mountain areas, Production Forests have been converted into agriculture land for staple crops such as rice, maize and cassava.

In Laos, as observed in the field studies and satellite images, the Nam Mo 1 reservoir will affect portion of national boundary protection forests (5km buffer). These are mostly unstocked/ dry evergreen forests that have experienced encroaching and use. As per Laotian laws, boundary protection forest requires specific management (see Chapter 2). The proposed buffer zone aims to manage this resource and potentially increase the tree cover and diversity of species in this forest stretch.

7.2 Wildlife resources

7.2.1. Habitat

The dominant habitats in the Project AI are the secondary forests where growth is based on natural regeneration after the forest has been exploited or left abandoned after cultivation. They are predominantly the Mixed Evergreen Rain Forest, Semi-deciduous Forest, Scrub and Secondary forest developed on uncultivated land in the past 7-15 years. Mixed Broadleaf and Bamboo Forest and Secondary Tropical Grassland Forest areas close to the villages in the Project area has low tree cover and over exploited, providing a poor wildlife habitat. Although limited, swidden farming areas also provide good habitat and food for wildlife, particularly small mammals. There are some favorable habitats along Nam Mo River and its tributaries.

Mixed Evergreen Rain Forest

The major mammal species found in this type of habitat are: yellow monkey (*Macaca mulatta)*, wild pig (*Sus scrofa)*, muntjac (*Muntiacus muntjak)*, wild cat (*Felis bengalensis*) and big bamboo rat (*Bandicota indica)*. It is also habitat for bird species such as the drongo, crows, fly eating birds, honey eating birds, Chinese laughing-thrush, wild fowl and turtle bird. Reptile and amphibian species that thrive in this habitat include the lizard -chinese water dragon (*Physignathus cocincinus*), clouded monitor (*Varanus nebulosus)*, cobra (*Naja naja) and* green snakes (*Trimeresurus albalabris*) species of family *Emydidae,* tortoises, and the Tokay gecko (*Gecko gecko)*.

Secondary Forest and Scrubland

This forest type provides a good habitat for small mammals from the orders of *Rodentia (*rodents) and *Chiroptera (*bats). It forms a good feeding and resting habitat for a large number of bird species. The major reptiles and amphibians thriving here are lizards (e.g., *Physignathus cocincinus)*, snakes (*Ptyas mucosus*, *Bungarus fasciatus*, *Bungarus candidus)* and *cobra (Naja naja*).

Habitats along Nam Mo river, streams, swidden farming area and the village area

Areas along Nam Mo river and the adjacent streams, swidden farming areas, settlement areas and along road alignments provide habitat for mammals such as the black tail rat (*Crocidura attennata)*, mosquito eating bat (*Java Pipistrellus javanicus)*, mice (*Rattus flavipectus)*, rat (*R. norvegicus) and* bird species such as milky stork (*Egretta garzetta)*, fly stork (*Bubulcus ibis)*, Milky necked stork (*Amaurornis phoenicurus)*, big kingfisher (*Megaceryle lugubris)*, small kingfisher (*Ceryle rudis)*, wolly necked stork (*Halcyon chloris)* and *Alcedo atthis.* Typically for this habitat are species of gecko, water snakes, amphibians such as species of the families of Ranidae, Rhacophoridae (tree frogs), Microhylidae (small frogs) and species of butterfly. Many of the species are used as food on a regular basis.

Wildlife species

There are 31 mammal species, 22 reptile species, 19 amphibian species, 96 bird species and 171 insect species reported to occur in the Project AI based on the interviews conducted during the ecology survey in March 2017 (Table 7.9). This data was compared to the data collected in 2012. Table 7.9 summarizes the number of species recorded in 2012 and 2017 surveys. The families and species of mammals, reptiles, amphibians, and birds are given in Appendix 7.4.

Table 7.9 Wildlife species in Nam Mo 1 HPP, 2012 and 2017 surveys

Wildlife	No. of Family	No. of Species	
		2012*	2017**
Mammal	16	29	30
Reptile	11	22	22
Amphibian	6	19	19
Bird	43	96	96
Insect	14	171	171
Total	**90**	**337**	**338**

Source: *Environmental Impact Assessment report, Nam Mo 1 HPP, 2012, PECI.
**Ecology Survey, this ESIA, March 2017.

Mammals

Mammals in the Project AI include 13 rodent species (Rodentia), six bat species (Chiroptera), six carnivore species, one insectivore, and five other species. Large mammals are mainly distributed in areas where forest is in good condition, usually above 500 masl while small mammals, such as rodents and bats thrive well in secondary forests, swidden

farmland, upland farming and settlement areas. The dam site area has more rodents and bats than at the reservoir area.

The most commonly seen mammals are *Anourosorex squamipes* (Chinese mole shrew), *Suncus murinus* (Asian horse shrew), *Hipposideros armiger* (great roundleaf bat), *Hipposideros Pomona* (Pomona roundleaf bat), *Hipposideros larvatus* (intermediate roundleaf bat), *Rhinolophus pusillus* (least horseshoe bat), *Murina cyclotis* (round-eared tube-rosed bat), *Pipistrellus coromandra* ((Indian pipistrelle – bat), *Bandicota indica* (greater bandicoot rat), *Bandicota savilei* (savile's bandicoot rat), *Rattus flavipectus* (yellow breasted rat), and *Rattus norvegicus* (brown rat).

Reptiles

There are 22 species of scaled reptiles including 8 species of lizards (Iguanian lizard, geckos, wall lizards, water monitor, mabuya), 13 species of venomous and non-venomous snake, e.g., Banded krait (*Bungarus fasciatus*), Taiwanese Krait (*Bungarus multicinctus)* and cobras (Naja species), Brahminy blind snake (*Ramphotyphlops braminus*), sunbeam snake *Xenopeltis unicolor)*, Chinese rat snake (*Ptyas korros)* and one species of keeled box turtle. Reptile species are distributed mainly in areas of evergreen forests along the rivers and streams.

Amphibian

There are 19 amphibian species including six species of true frogs (*Ranidae),* four species of fork-tounged frogs (*Dicroglossidae)* and three species of narrow-mouth frogs (*Microhylidae)*. Amphibian species are distributed along streams and tributaries of the Nam Mo River.

Birds

A total of 96 bird species are reported to occur in the Project AI, among them are 73 perching birds (*Passeriformes)*. There are about 57 species identified through visual or their singing. Generally, diversity of birds in the AI is poor due to heavy exploitation.

Insects

There are 171 insect species and 170 species belonging to the order *Lepidoptera* – the butterflies and moths.

7.2.1.1 Fauna in the reservoir area

The reservoir area comprises mainly of secondary forest, mixed broadleaf bamboo forest, scrub land and grassland, and riverine areas. Human interference is high in this area and the habitat is disturbed. There were no large size animals/species or rare species instead small animals such as civets (*Viverridae)*, weasels (*Mustelidae)*, tree squirrels (*Sciuridae)*, rats (*Muridae)* and bamboo rats (*Rhizomyidae)* were reported to occur.

The bird species include wild fowl (*Gallus gallus)*, woodpeckers (*Piciformes)*, rollers (*Coraciidae)*, kingfisher (*Alcedinidae)*, drongo (small passerines) and *Muscicapidae.* Reptiles and amphibians reported to be present include the agama (*Agamidae)*, dragon *(Physignathus cocincinus)*, gecko *(Gekko gecko)*, poisonous and non-poisonous snake species, and some species of frogs.

7.2.1.2 Biodiversity

In the Project AI and up to a radius of 10 km, no special forests (i.e., classified as Special-Use Forest) such as National Parks or Natural reserves were reported to occur. Pu Mat, Pu Hoat and Pu Huong Natural Reserves are all located farther than 10km radius. The wildlife species found within the Nam Mo 1 HPP area and the proposed My Ly HPP, Ban Ve HPP and national parks /reserve are given in (Table 7.10). Species diversity of flora, wildlife and

fish are low in Nam Mo 1 HPP compared to My Ly HPP, Ban Ve HPP and the national parks.

The Nam Mo 1 HPP AI having riverine forest extending up to 33 km upstream from dam site, and forests in permanent and temporary construction sites provide good habitat-breeding, feeding, resting for small-sized mammals such as rodents, bats, shrew/shrew mouse, reptiles and amphibians, while large mammals occasionally visit the area for feeding. Wildlife habitats are under human pressure and disturbed and there is overexploitation of wildlife species for food and other purposes. In general, wildlife biodiversity could be considered low in the project's influence area; species diversity is low: 31 mammal species (10% total number of known species in Vietnam), 22 reptiles (7.4% total number of known species in Vietnam), 19 amphibian species (11.7% of total species) and 96 bird species (10.8% of total species). However, diversity is high in rodents Muridae family – common rats and Rhizomyidae family bamboo rats comprising of 11 species out of the total 31 mammals species. The genus *Rattas* – common rat has 9 species (Appendix 7.4). There are 6 species of bats belonging to 3 families.

Table 7.10 Number of species found at the Nam Mo 1 HPP, My Ly HPP area, Ban Ve HPP and adjacent national forest and parks

Location	Distance from Nam Mo 1 HPP (km)	No of species					
		Flora	Mammal	Bird	Reptile and amphibian	Insect	Fish
Nam Mo 1 HPP	0	347	30	96	41	171	80
My Ly HPP	38	447	45	111	43	203	76
Ban ve HPP	80	686	63	176	51	N/A	105
Pu Huong Natural reserve	50	665	291	265	N/A	N/A	N/A
Pu Hoat Natural reserve	40			142	N/A	N/A	N/A
Pu Mat national park	60	2,494	132	361	86	1084	119

Source: Biosphere Reserve of Western Nghe An (http://sinhquyennghean.vn/?n=11/da-dang-sinh-hoc); Environmental Impact Assessment for Ban Ve hydropower project on Ca river, Nghe An province, 2006.

7.2.2. Threatened wildlife in the Project Area of Influence

Wildlife species which are listed threatened either in the Vietnam Red Book or the IUCN or the government decree are given in Table 7.11. No amphibians or insect species are included in the list of threatened species.

7.2.2.1 Mammal

Among the 31 mammal species recorded in the Project AI and its surroundings, three species are listed at risk. The Bengal Slow Loris (*Nycticebus bengalensis)* is listed as vulnerable - collection and use for commercial purposes is therefore prohibited. The rhesus monkey (*Macaca mulatta*) is at low risk but restricted for exploitation while the leopard cat (*Felis bengalensis*) is prohibited for collection and use for commercial purpose. (Table 7.11).

Table 7.11 List of Species of Conservation interest

No	Scientific name	English Name	Vulnerability status[89]		
			Vietnam Redbook	IUCN	Decree 32/2006
1	Mammals				
	Nycticebus bengalensis	The Bengal Slow Loris	VU	VU	IB
	Macaca mulatta	Rhesus monkey	LR		IIB
	Felis bengalensis	Leopard cat			IB
2	Reptiles				
	Gekko gecko		VU		
	Physignatus coccincinus		VU		
	Varanus nebulosus		EN		IIB
	Varanus salvator		EN		IIB
	Ptyas korros		EN		IIB
	Ptyas mucosus		EN		IB
	Bungarus fasciatus		EN		IIB
	Naja naja		EN		IIB
3	Birds				
	Falco severus				**IIB**
	Psittacula alexandri				**IIB**
	Copsychus malabaricus				**IIB**

7.2.2.2 Bird

The three bird species *Falco severus*, *Psittacula alexandri* and *Copsychus malabaricus* are listed as species restricted from exploitation and use for commercial purposes in the Government Decree 32/2006.

7.2.2.3 Reptile

Among the 22 reptile species identified in the Project AI, eight species (36.4% of the total species) are listed as vulnerable and endangered in the Vietnam Red Data Book 2007. Six of them are restricted from exploitation and use for commercial purposes in the Government Decree 32/2006 (Table 7.11). Most of these species are listed as endangered and vulnerable are hunted for food by local communities as well as for commercial purposes.

7.2.3. Ecosystem services

The wildlife in the Project AI provides tangible products such as food and some organs of animals for medicinal purposes. Local residents normally exploit wildlife for various purposes. Poaching and hunting is a common practice – many households catch small mammals on a daily basis. Below are some of the local uses of wildlife.

7.2.3.1 For food

There are 38 species of wildlife used as food by villagers including ten mammal species (e.g. civet, squirrel, wild pig, rodents); 12 bird species such as doves (*Columbidae)*, red-whiskered bulbul (*Pycnonotus jocosus)* and sparrow (*Passeriformes*); 10 species of reptiles

[89] IUCN. 2016. The IUCN Red List of Threatened Species; VU = Vulnerable; VNRB. 2007. Vietnam Red Data Book; VU=Vulnerable; LR = Lower Risk; Decree 32/2006/ND-CP. Management of Endangered, Precious and Rare Species of Wild Plants and Animals; IB= Prohibiting collection and use for commercial purposes; IIB= Restricting exploitation and use for commercial purposes.

(e.g. Chinese water dragon (*Physignathus cocincinus)*, spotted gecko (*Varanus salvator*) and some species of snakes and six species of amphibians such as field frog (*Hoplobatrachus chinensis)*, big frog (*Sylvirana guentheri*, *Limnonectes kuhlii)*, stream frog (*Sylvirana nigrovittata)* and tree frog *Rhacophoridae*)[90]. Rodents and birds are the most common mammal trapped every day for food in the Project AI. Local communities trap snakes about once a week for food.

7.2.3.2 Medicinal value

There are 25 species used as traditional medicine including ten mammal species: loris (*Loricidae)*, monkey (*Cercopithecidae)*, and a species of cat (*Felidae*); four bird species such as boucal (*Centropus sinensis)*, dove (*Columbidae*); ten reptiles species such as gecko (*Gekko gecko)*, species of varan (*Varanidae)*, species of snakes (*Serpentes)*, species of tortoises (*Testudines*) and one amphibian species, the home toad (*Duttaphrynus melanostictus*)[91].

7.2.3.3 Commercial purposes

There are 45 species of animal exploited for commercial purposes including 20 animal species: species of loris *(Loricidae)*, species of monkeys *(Cercopithecidae)*, species of civets (*Viverridae)* and, species of squirrels (*Sciuridae*); 13 species of birds (blue dove, spotted dove, parrot (*Psittacidae)*, dollar bird, mynah (*Timaliidae)*, and Chinese laughing-thrush (*Sturnidae*); 12 species of reptile: gecko (*Gekko gecko)*, Chinese ground dragon *(Physignathus cocincinus)*, species of varan lizards (*Varanidae)*, species of snakes (*Serpentes)* and species of tortoises (*Testudines*). Those species are exploited, traded between regions all over the country or even exported abroad. Some species with food value are sold to restaurants as special dishes (also in the local towns) while some species are exploited for their fur either for clothing or household decorations.

7.3 Aquatic ecology and fisheries

7.3.1. Aquatic organisms

7.3.1.1 Phytoplankton

There are 44 species of phytoplankton with a density of 6.75 10^6cell/m^3 belonging to four algae phylum namely *Bacillariophyta, Cyanophyta, Chlorophyta* and *Euglenophyta*. Silica algae is the most dominant with 22 species accounting for 50 % of the total species followed by 14 species of green algae (31.8%), five species of blue algae (11.4%) and three species of eye algae, Table 7.12 summarizes the density of phytoplankton recorded for three sampling events.

The appearance of many species in the genus *Navicula*, *Nitzschia*, *Diatoma* (silica algae *Bacillariophyta*), *Oscillatoria* (blue algae *Cyanophyta*) and *Spirogyra* (green algae *Chlorophyta*) indicates unpolluted water where organic contamination is less. Low density of phytoplankton in 2012 and 2016 was primarily due to the timing of investigation/sampling, which was during the rainy season. During rainy season the water flows rapidly and has somehow limit growth of phytoplankton because of limited availability of nutrients.

[90] Policy brief: on controlling wildlife trade and consumption in Vietnam. The Asian Program actions against trafficking in endangered species. Biodiversity conservation Agency.

[91] Đặng Huy Huỳnh, Cao Văn Sung, Lê Xuân Cảnh, Phạm Trọng Ảnh, Nguyễn Xuân Đặng, Hoàng Minh Khiên, Nguyễn Minh Tâm, 2008. Fauna of Vietnam, volume 25. Science and Technique Publishing House, Ha Noi.

Table 7.12 Density of phytoplankton on Nam Mo River

Period	Density of phytoplankton (10^6cell /m^3)				
	Total	Bacillariophyta Silica algae	Cyanophyta Blue algae	Chlorophyta Green algae	Euglenophyta Eye algae
Sept 2012	4.69	2.43	1.02	1.24	0.01
July 2016	5.07	2.61	1.14	1.32	0.01
March 2017	6.75	3.58	1.59	1.54	0.03

Source: 2012: PECI (2012) Environmental Impact Assessment report, Nam Mo 1 HPP
2016: PECC1 (2016) EIA report, Nam Mo 1 HPP, 2016,. 2017: PECC1 (2017) Biology Report, this ESIA.

7.3.1.2 Zooplankton

The study identified 35 species of zooplankton which include 11 species of *Copepoda*, 17 species of *Cladocera,* six species of *Rotatoria* and one species of *Ostracoda.* There is also high population of small crustaceans. These are common species, widely distributed and typical for a flowing water environment where nutrient content is low. Common species in such types of water bodies include species *Diplois daviesiae* (Rotatoria)*, Macrothrix* spp.(Cladocera)*, Biapertura, Paracyclops, Paracyclops fimbriatus, Ectocyclops phaleratus* (Copepoda). The lower density of zooplankton during rainy season at 339 – 353 individual/m^3 compared to 429 individual/m^3 during the dry season reflects the characteristics of flowing water environment in mountain rivers where flow velocity can be high and generally lower in nutrients (Table 7.13**).**

Table 7.13 Density of zooplankton on Nam Mo River

Period	Density of zooplankton (individual/m^3)				
	Total	Copepoda	Cladocera	Rotatoria	Others
Sept 2012	339	171	120	17	31
July 2016	353	181	126	18	27
March 2017	429	248	142	11	27

Source: 2012: PECI (2012) Environmental Impact Assessment report, Nam Mo 1 HPP
2016: PECC1 (2016) EIA report, Nam Mo 1 HPP, 2016,. 2017: PECC1 (2017) Biology Report, this ESIA.

7.3.1.3 Zoobenthos

The study identified 26 species of benthos and includes six species of *Bivalvia,* 14 species of *Gastropoda,* four species of *Crustacea* and two species of *Insecta* larva. These species are widely distributed and reflective of the characteristics of mountainous river ecology. Density of zoobenthos was similar in dry season and rainy season, 49-50 individual/m^2 (Table 7.14). The most dominant species are insect larva (insect) followed by snails (Gastropods) which is normal in most mountainous water bodies. Snails are often found sticking on rocks or on aquatic vegetation. While the local residents assume to have a limited benefit from the zoobenthos community (e.g., only from collection of crabs and mussels), the benthic organisms play an important role in the overall nutrient cycling in the river system.

Table 7.14 Density of zoobenthos in Nam Mo River

Period	Density of zooplankton (individual/m^3)				
	Total	Bivalvia	Gastropoda	Crustacea	Insecta
Sept 2012	50	4	16	5	25
July 2016	49	5	15	4	24
March 2017	49	3	17	7	22

Source: 2012: PECI (2012) Environmental Impact Assessment report, Nam Mo 1 HPP
2016: PECC1 (2016) EIA report, Nam Mo 1 HPP, 2016,. 2017: PECC1 (2017) Biology Report, this ESIA.

7.3.2. Fish and fisheries

7.3.2.1 Fish species and diversity

The fish survey conducted in Nam Mo river and its tributaries identified 80 fish species from 18 families and six orders. There was a difference in species counts between Nam Mo river with 57 species compared to the streams joining it, which have 33 species. Out of the 33 species in streams, 23 species were found only in streams and 10 species were common to both water bodies (Appendix 7.5). The ten species that were common both in Nam Mo river and its tributaries are: *Acheilognathus lamensis, Garra poilanei, Puntius semifasciolatus, Misgurnus anguillicaudatus, Pseudobagrus virgatus, Pareuchiloglanis nebulifer*, *Monopterus albus, Anabas testudineus, Oreochromis mosambicus* and *Oreochromis niloticus*. Appendix 7.4 shows some of the species found in the Nam Mo river and its tributaries in the project AI. Fishes living in streams are normally small fish species, preferring rapid water and high oxygen content. Typical stream fish species are *Schistura*, *Rhinogobius, Oparichthys biden, Channa assiatica* particularly zebra tilapia (*Oreochromis niloticus)*. These species are adapted to streams. During the survey in March 2017, a school of young tilapia were observed in static waters. The mature tilapias that are large and elusive, and general hard to sight . Nets and electrofishing (although prohibited) are used for fishing.

The most common fish species recorded in Nam Mo river are given Table 7.15. Out of these 11 species, only three species were recorded in tributaries and streams. This difference is attributed to the differences in habitat between Nam Mo river and the tributaries, as well as fishing.

Table 7.15 Common fish species caught in Nam Mo River

SN	Fish species	English name	Nam Mo River	Stream / Tributary
1	*Cossoma brachypomum*	Red-bellied pacu	++*	
2	*Acheilognathus lamensis*	Cyprinid fish	++	+
3	*Garra poilanei*	Ray-finned fish	++	+
4	*Onychostoma lepturus*	Thintail shoveljaw carp	++	
5	*Puntius ocellatus*	Snakeskin barb	++	
6	*Culter erythropterus*	Redfin culter	++	
7	*Hemiculter leucisculus*	Sharpbelly carp	++	
8	*Silurus asotus*	Amur catfish	++	
9	*Cranoglanis henrici*	Armorhead catfish	++	
10	*Mastacembelus armatus*	Tire track eel	++	
11	*Oreochromis mosambicus*	Tilapine cichlid fish	++	+

*(+): less common; (++): common

Eight species have high economic value and most of them except *Onychostoma lepturus* and *Cranoglanis henrici* are less common in the river. Two species, *Anguilla marmorata* and *Bagarius rutilus* are classified as vulnerable, according to the Red Book of Vietnam (Table 7.16). None of these high valued fish species are found in streams

Table 7.16 Fish species of high economic value in Nam Mo River

SN	Scientific Name	Common Name	Common	Vulnerable[92]
1	*Anguilla marmorata*	Eel	+*	V
2	*Spinibarbus denticulatus*	Barbel	+	
3	*Cyprinus rubrofuscua*	Amur Carp	+	
4	*Onychostoma lepturus*	Thintail shoveljaw carp	++	
5	*Hemibagrus guttatus*	Catfish	+	
6	*Cranoglanis henrici*	Armoredhead catfish	++	
7	*Bagarius rutilus*	Catfish	+	V
8	*Channa striata*	Snakehead fish	+	

*Note: (+): less common; (++): common

7.3.2.2 Migratory fish species

The *Anguilla mamorata* is a long distance migratory fish species, migrating downstream to the sea for feeding. This species is considered to be of high economic value, is vulnerable and is less frequently seen in the river. The Nam Mo, Nam Cun and Ban Ang HPPs downstream of this proposed Project have already obstructed its movement to sea. Its habitat has been fragmented and a small population is now adapting to this new environment. *Hemibagrus guttatus* and *Bagarius rutilus* are migratory in nature and are therefore severely impacted by the dams. These species inhabit large rivers with currents and migrates to upper streams to spawn. These species are carnivorous, feeding on crustaceans, insects and other fishes.

7.3.2.3 Vulnerable species

There are five species namely *Anguilla marmorata, Acrossocheilus annamensis, Bagana lemassoni, Hemibagrus guttatus* (bagrid catfish), and *Bagarius rutilus* (devil catfish) listed as "Vulnerable" according to the IUCN Red Data Book 2007 (Table 7.17). Among them, the eel (*Anguilla mamorata)* and catfish *Hemibagrus guttatus* has already been impacted by dams constructed downstream; its migratory route has already been obstructed. As these fishes are large in size and of high economic value they are over-exploited and now are less commonly seen.

Table 7.17 List of vulnerable fish species

SN	Scientific name	Common name	Vietnamese name	Vulnerability status[93]	
				IUCN	Decree 32/2006
1	*Bagarius rutilus*	Cat fish	Cá Chiên	VU	DD
2	*Acrossocheilus annamensis*	Carp	Cá trốc	VU	
3	*Bangana lemassoni*	Trout	Cá Rầm xanh	VU	DD
4	*Hemibagrus guttatus*	Catfish	Cá Lăng	VU	DD
5	*Anguilla marmorata*	Eel	Cá lệch, cá Chình hoa	VU	LC

[92] Red Data Book of Vietnam, 2007

[93] IUCN. 2016. The IUCN Red List of Threatened Species; VU = Vulnerable; VNRB. 2007. Vietnam Red Data Book; VU=Vulnerable; LR = Lower Risk; Decree 32/2006/ND-CP. Management of Endangered, Precious and Rare Species of Wild Plants and Animals; IB= Prohibiting collection and use for commercial purposes; IIB= Restricting exploitation and use for commercial purposes

7.6.3 Fisheries in the Project area

Fishing is not a main occupation within the Project AI. However, most of the households do fishing for their household consumption. Men, women and children go for fishing. Men use boat and cast net, while women and children use baskets for fishing. Families take a day off to go to streams for fishing with basic fishnets and baskets. At times they divert or stop the flow of streams and de-water to fish. Some villagers also use poisonous leaves. Also, although it has been prohibited, the use of electro-fishing is still being practiced.

Even with the various fishing methods, fish catch is reported to be low, at about 0.5 – 2 kg/person/day, while on a good day a catch could increase to 5-10 kg/day. Local communities indicated lowering fish yields primarily due to over fishing. The species caught are: carp (*Cyprinus rubrofuscua)*, crucian *(Carassius auratus)*, hemicultur *(Hemiculter leucisculus)*, zebra tilapia *(Oreochromis niloticus)*, black tilapia (*Oreochromis mosambicus*rô), eel (*Monopterus albus)*, snake-head mullet, goby *(Spinibarbus denticulatus)*, *Glyptothorax quadriocellatus* and some other small fish species. Some people also catch crab, shrimp and mussels for household consumption. Sometime fishermen still catch some large sized fish of high sale value such as *Anguilla mamorata*, *Bagarius rutilus*, and *Hemibagrus guttatus*.

Aquaculture practice

Fish farming is not a common practice in the Project area although there are small ponds existing. Local residents living along river and streams have good access to fishing in the rivers and have little or no interest in pond farming. The lack of interest may be also due to limited capital and probably knowledge on pond fishing and access to markets.

CHAPTER 8 SOCIAL & LIVELIHOODS CHARACTERISTICS

8.1 Approach and methodology

Prior to the start of the baseline social assessment by the international ESIA team in December 2016, field surveys and consultations had been undertaken by national consultant groups in both Vietnam and Laos during 2012–2016. Summary of these is presented in Table 5.1 in Chapter 5 of this Volume and in Annex 4 in Volume IV. Reports prepared by the national consultants were not adequate for MIGA requirements, therefore, In January 2017 the IC with PECC1 and its sub-consultant team implemented baseline information collection in all the communes and villages to be affected by the planned HPP in Vietnam and in all the villages to be affected in Laos.

8.1.1. Baseline information collection

Following all the previous meetings and consultations that already had been undertaken in the affected villages, baseline information collection in January 2017 was undertaken through Focus Group Discussions (FGD) and Key Informant Interviews (KII) in the villages, and meetings with commune officials in the commune center. Commune-level data were collected and local considerations of the planned HPP were evaluated. The IC prepared a Guide Questionnaire for each type of FGD and KII that was used by the NC undertaking the field work (see Annex 3.2 in Volume III). Prior to the fieldwork, a one-day field methodology training workshop was also organized with the Vietnamese field teams.

The main methodology used for the comprehensive information collection was undertaking FGDs. The field teams undertook five types of thematic FGDs (agriculture, forestry, fishery, ethnic culture, gender) and four types of KII (village leader, village health worker, teacher, extension worker) in the villages both in Vietnam and across the river in the Lao territory. In Vietnam, the consultants also had meetings in every commune office for gathering basic population, socio-economic and land use data. They also interviewed commune health center and school staff, where available.

Five FGDs with different groups of people were arranged. Participants in each group were to be knowledgeable and experienced in the issues dealt with in the discussion. Each group was aimed to be gender and age balanced with both male and female participants, except for the group on gender issues (women only) and the group with ethnic elders/elder people (mostly men have the status of an elder/ethnic leader). The five thematic FGD groups were:

(1) Farmers – about land use and cultivation;
(2) Households doing forestry – about utilization of various forest resources;

(3) Fishing households – about fishing and other uses of the river and its resources;

(4) Ethnic elders/leaders – about the history, migration and the ethnic culture of the village;

(5) Gender –with only women, focusing on women's and children's lives and livelihoods, health and education.

In every FGD the participants were also asked about what information and how (through which information channel) they have received about the planned HPP, what they knew about the project, and what kind of information and through which information channel they would prefer in the future. The intention of this information was for the IC to find out what information the affected people had received, what they knew and comprehended about the Project, and what their concerns and expectations were.

In a brief meeting with villagers preceding the FGDs and KIIs in each village, the Project and its location was explained, the NC was introduced and the purpose of their visit was explained to the villagers. The NC also handed out a short leaflet (in Vietnamese) to the

villagers with basic information about the Project, the ongoing ESIA preparation and the purpose of the team's visit to the village (see Annex 3.3 in Annex III). The NC avoided conveying any further information about the expected Project impacts and potential mitigation measures, but instead heard with the villagers participating in the FGDs about the information they previously received and their considerations concerning the planned HPP.

8.1.2. Summary of the field work

The NC collected information in all the nine villages in Vietnam (Xop Tip in Muong Ai commune; Xop Tip, Xop Phe, Cha Lat, Vang Ngo and Ta Do in Muong Tip commune; Sa Vang, Na Nhu and Nhan Ly in Ta Ca commune) and in Namuang village in Laos that are expected to be inundated by the planned Nam Mo 1 HPP reservoir. The field team also collected baseline information in the downstream village of Nhan Cu, because during the fieldwork it was not yet clear how this village was expected to be affected by the Nam Mo 1 HPP.

Totally 473 people, 284 men and 189 women in the Vietnamese villages were consulted in FGDs and KIIs. In Namuang village in Laos only FGDs could be implemented with totally 44 persons (25 men and 19 women) participating. In sum, 517 persons, 309 men and 208 women in the villages to be affected by Nam Mo 1 HPP in the two countries were consulted concerning their socio-economic and cultural situation and their concerns about the planned HPP. In each commune center meetings were organized with commune staff, and added to them, key informant interviews were undertaken with commune health center and school staff wherever available. Totally 27 commune level staff, 16 men and 11 women were consulted in the four communes of Muong Ai, Muong Tip, Ta Ca and Nam Can. Summary of the people consulted in the villages and in the commune centers is enclosed in Annex 3.4 in Volume III.

8.1.3. Baseline reporting and analysis

For reporting the information and data collected in the Project area villages and communes, the IC prepared a reporting format for the NC. This format was used to summarize the information gathered through the FDGs, KIIs, informal discussions with villagers and field teams' observations in each village. The IC also provided a commune-level livelihoods reporting template covering general livelihoods conditions in each project-affected commune and the specific livelihoods situations in the villages to be affected by the Nam Mo 1 HPP. The different reporting templates are enclosed in Annex 3.5 in Volume III.

After the completed fieldwork, the NC under the responsibility of PECC1 prepared reports following the reporting templates instructions. The reports that were prepared in Vietnamese and then translated into English are enclosed in Annex 3.6 in Volume III. The village level baseline analysis undertaken by the IC is mainly based on this reporting, combined with the previous consultant reports and all other available information on the Project areas. Some of the village-level data and information was double-checked by the second group of NC team hired to implement the first phase of FPIC consultation process in the directly affected villages in June 2017 (as reported in Chapter 10 of this Volume and in Annex 5 in Volume IV). At that time the IC also visited the Project AI again and could likewise verify some situation information for the impact assessment.

8.2 Common socio-economic and cultural features of the villages to be affected

8.2.1. Population, ethnicity and movement

The administrative areas with villages and communes and the number of people to be affected in each area by the HPP are reported in the project description in Chapter 3.3. All the people in the direct impact area are Kho mu, Hmong and Thai ethnic minority people with their own identity, language and cultural features. In most villages one ethnic group is dominating and people have family ties with each other; wives and husbands regularly

moved in from other villages and sometimes they even originate from other ethnic minority groups. In some villages there are also a few households with another ethnicity than the majority one in the village.

The ethnic groups in the project area of impact in Vietnam and Laos are related to each other, some people have moved across the national border and settled down on the other side, and villagers have regular social and economic interaction with each other over the border river.

Most villages have existed in the area for decades, however, in Vietnam some villages have been relocated from high mountain areas to lower elevation following the GoV resettlement program. Due to scarce land availability in Vietnam, some villages have been split into two in order to have sufficient cultivation land at a closer distance. Men and women move in and out for marriage, even across the national border, and many families have during the years migrated from the Lao villages to Vientiane, and from the Vietnamese villages to other provinces in the country and also to Vientiane, which lies closer than the major cities in their own country. Regular seasonal and long-term labor migration of especially young people takes place to larger cities and to the South of Vietnam.

Virtually all the people in villages to be affected by the HPP are extremely poor, between 80 and 100% of the households are officially classified as poor, in four villages all the households are poor, and if added with the near-poor households, the household poverty status in all villages comes close to 100%.

8.2.2. Infrastructure and Services

The affected villages are located remotely and can be accessed along soil roads that become poorly vehicle accessible during the rainy season. Local people travel either by motorcycles or on foot, and people are used to walking long distances of many kilometers to their agricultural fields or to the commune center. In most villages only a few households if any own a boat that is used for transportation of goods and sometime of people along the Nam Mo River. However, due to road access and due to the existing Nam Mo HPP that has disrupted river transportation by cutting off the waterway, boat transportation is not commonly used.

Many of the private houses in the villages are constructed with local materials, wood and bamboo from the forest, built on stilts, but also constructed on the ground with a cement basement. The public buildings (village cultural house, kindergarten and school) in Vietnam are Vietnamese (Kinh) style houses built on bricks and cement on a ground concrete basement, in Laos the public structures are often wooden. There are large differences between the standard of the private houses, even in the same village. Space and land used for fruit trees and home gardens around the houses varies between different villages. Intra-village roads are mostly soil paths, but in a few villages concrete roads.

All the villages to be affected by Nam Mo 1 HPP in Muong Ai and Muong Tip communes are connected to the national electricity network, while the households in Ta Ca Commune lack grid electricity and each household has a micro-hydropower (so-called pico) generator in the Nam Mo River or in a tributary stream next to the village, providing petty electricity just enough for a few hours of lighting and TV. Namuang village in Laos has grid electricity.

Household water is led from tributaries and mountain streams to water tanks in villages that have been constructed through government or donor programs. These water tanks are built with bricks, covered with cement, have water taps and sometimes a washing room beside. Household water for cooking, drinking and washing is taken from these water tanks. Villagers in Vietnam lack skills to maintain the water systems, and in some villages pipes are blocked or taps broken. Additionally, villagers use the Nam Mo River and its tributaries for washing and bathing, as well as for watering animals.

8.2.3. Health and sanitation

Hygienic conditions in the remote villages are in general very poor. Household water has to be carried from village water tanks or from streams to houses. Villages in Ta Ca commune lack toilets, but in some of the villages in Muong Tip 20-25% of households have rudimentary toilets that are not well maintained. Pigs, poultry and dogs roam freely in the villages that lack any rubbish disposal system, and litter is thrown anywhere in and outside the village. The standard of knowledge about health, hygiene and nutrition is poor and based on tradition. Mothers lack knowledge about what kind of food and nutrition their children need in order to grow and stay healthy. Both ethnic minority men and many elder women are smoking, and men often get drunk by drinking home-brewed alcohol.

The most common reported health problems are headache, diarrhoea, cold, pneumonia and itchy eyes. Women report recurrent gynaecological problems with itching due to poor hygienic circumstances without clean water and privacy for body washing. Health care services are available in the commune health centers with road access, and the use of health services is highly dependent on the distance of each village to the commune center where the health center is located. The fuel cost for travel and price of medicines prescribed by the commune health center are experienced too high by many poor households. In the most remote villages, health problems are treated with medicinal plants collected in the forest. In some villages there are persons with special knowledge in herbal medicine

Most women give birth at home in the village, assisted by other women. Nowadays increasing number of younger women visit the health center at least once during pregnancy, deliver their babies at the clinic. There are few maternal or infant death cases reported during the recent years, but quite many miscarriages due to the hard physical labor women undertake even when pregnant. Commune health centers offer annual gynaecological health control for women, however, few women from the remote villages take the opportunity. Most children are vaccinated in the villages through monthly mobile vaccination services provided by the commune health center, or children from villages that have road access are taken to the CHC to be vaccinated.

8.2.4. Food and nutrition

Upland rice is the main cultivation crop and the staple food of all the affected people. Forest and river provide the resource base for other daily food. Women collect wild growing vegetables, roots, bamboo shoots and mushrooms in the forest several times every day for household food. Men are hunting rats, birds and bamboo rats for food on a daily basis. Another main protein source base is the river: Men are fishing with nets, women are fishing with baskets, and even children are collecting snails and shrimps in the shallow waters. Poultry with chicken and ducks is kept not only for selling but also for family food, but pigs are eaten more seldom at special occasions, during annual celebrations and family festivities such as weddings. The food base appears not to be sufficient; in the poorest villages in Ta Ca children appear to be underweight. In all villages households report rice insufficiency during a number of months before the annual harvest.

Family kitchen is in the poorest households located inside the house and food is prepared on open fire, filling the room with smoke and leading to itchy eyes, coughing and other respiratory problems, which are reported to be common by the commune health care staff and by villagers. In houses with more developed structure, kitchen may be attached or outside the house with fireplace of stone. Firewood is collected in the forests surrounding villages, both men and women collect firewood and carry it home in traditional baskets on their backs.

8.2.5. Education

According to the Vietnamese government standard, there is a kindergarten and a primary school in every village. Secondary boarding school is located in the commune center. GoV provides boarding support for ethnic minority children with home villages more than 7km from the school. Children stay in the school the entire week, go home on Saturday afternoon after school and return to school on Sunday evening. Government support covers only

tutoring and boarding, and parents have to send rice and other food with their children to the school. High school is located in the district town of Muong Xen, where parents have to pay their children's accommodation, which most of them cannot afford, so very few children from the poor remote villages continue their education at high school level. In Namuang village in Laos, the elder Kho mu people are illiterate, but most people can communicate in the Lao language and all children are reported to go to school.

In the villages the ethnic minority people use their own ethnic language in everyday communication. Women regularly have lower education level than men, because girls drop out of school early during the secondary school in order to help their families with household work. Most elder ethnic minority women are not able to communicate fluently in Vietnamese, and in some villages up to 90% of the elder women are illiterate. Road access and distance to school appear to be a decisive for children's school attendance or dropping out of school.

8.2.6. Livelihoods

8.2.6.1 Agriculture

All the inhabitants in the villages to be affected by the HPP are farmers living on low-productive rain-fed upland rotational swidden agriculture, combined with forest resources utilization, fishery and livestock farming. Many households do not have sufficient food year round, but lack rice a few months prior to the annual harvest. Apart from upland rice, farmers cultivate maize and cassava for animal fodder. Vegetables and fruit trees are grown on riverbanks, but in many areas the land along the Nam Mo River is too steep and rocky to allow cultivation activities.

In general, every household has received a land use certificate for its residential land but no land use certificates are issued for cultivation land, because the land used for agriculture is upland forest that is taken into rotational cultivation through clearing and burning down the forest. The fields cleared in the upland forest are located on steep slopes with high erosion and poor soil quality**.** Usually a field is used only for one or two years and then left fallow for 4-8 years. Even if the annually used field size of each family is generally only 1-1.5ha, the cultivation regime requires them to keep several parallel areas in rotation, consequently requiring larger areas that are cleared in the forests.

The main upland crops are rice, maize and cassava, the two latter ones grown for animal fodder and to be sold in order to generate cash income. According to both Ta Ca and Nam Can commune authorities, no spare land with production forest status is any more available, but if more land is required for compensating land that will be lost in the reservoir, protection forest areas need to be taken into use and accordingly those areas have to be re-classified as production forest.

Land use and agriculture production data of Ky Son District and in the affected communes is presented in Section 8.4.1 below. Section 8.5 provides information of agriculture at village level in the Project AI in Vietnam and Laos.

8.2.6.2 Livestock farming

Livestock farming is the most important livelihood after farming for people in the remote villages. All households have chicken and geese for family food, pigs are grown mostly to be sold but also to be eaten at special occasions as festivity food in the village. Animal diseases and deaths are not uncommon, especially among pigs and chicken that are roaming freely in the villages, and epidemics and cold weather kill even cattle. Animal deaths are reported to be more common in the villages in Vietnam than in Namuang village in Laos, where veterinary services are reported to be available in case animals get sick. In Vietnam, villagers appear to treat animals with traditional and home-made medicines before contacting the commune veterinary services. Most families have a few cows and some households even have buffaloes, which both are kept entirely for selling to generate cash. Together with goats kept by some farmers they are grazing in riverbank grasslands and

forests near the upland fields. Animals can roam freely because there are no wildlife predators in the nature.

Section 8.4.2 below provides data on livestock farming in the affected communes, and Section 8.5 details on livestock at village level in the Project AI in Vietnam and Laos.

8.2.6.3 Forest resources utilization

Forest resources are the crucial base for the daily food and provide approximately 50% or more of the livelihoods of the people in the riverside villages. Non-timber forest products are important for household food, medicine supply and economy. Women collect bamboo shoots and wild-growing vegetables and mushrooms every day for family food. Some NTFPs like mushrooms, bamboo shoots and medicinal herbal plants are sold to traders. Men collect firewood and do logging of timber that is both used for construction of houses and other structures in the village, and sold to traders. Hunting of birds, rats, bamboo rats, squirrels and snakes is done regularly for household food, mainly with crossbows and traps, and wild boars are hunted during the harvest season near the upland fields.

Forest areas in Ky Son District are designated as Production Forest and Protection Forest and their use and management system differ from each other.

Management of **Protection Forest** is specified in Protection Forest Regulation issued together with Decision No. 17/2015/QĐ-TTg dated 09/06/2015 of the Prime Minister. The provincial level Forest Protection Department and Forest Protection Management Board are in charge of protection forests and special-use forests. District forest management board allocate protection forest areas to each village to protect and manage. Forests are allocated to groups of households or village communities to manage and protect under the supervision of the forest protection force station. Villagers are not allowed to collect wood and rare animals in accordance with the laws but they are allowed to utilize NTFPs. Each village gets paid according to the area of the forest. Payment from the district is saved in the village forestry fund, and usually each household receives a fee from the fund depending on the area of protection forest it is managing. The households and the communities participating in forest protection receive protection remunerations in accordance with the State's regulations, which is 180-200,000VND per hectare per year. Part of it is used to protect forests, and the rest is shared to the households. This income appears significant for poor villagers, and the affected people expressed worry over lost income due to forest inundation in the reservoir.

Production Forest protection and management is regulated in Production Forest Regulation issued together with Decision No. 49/2016/QĐ-TTg dated 01/11/2016 of the Prime Minister. The commune's production forest areas are allocated to households or groups of households for planting trees and protecting the forest. Households get forest use certificates, they have to develop forest protection plans and organize protection of the allocated forest areas. Local Forest Protection Offices' and Commune People's Committees' task is to coordinate and support forest development, and to prevent and fight forest fires. Households are allowed to utilize NTFPs and to develop NTFP, agriculture and fishery production programs with less than 30% of the area allocated to them. However, there is a great lack of arable land, therefore areas in the highland production forests have been converted into cultivation land for staple crops, mainly rice, maize and cassava.

Forests in Laos have significantly better timber resources than forests in Vietnam where logging and swidden agriculture have deployed vast areas of any good quality timber. The Vietnamese are both working in forestry in Laos, and buying up and trading timber from forests in Laos. Illegal logging appears to be common, even if not openly reported. Income from timber and NTFPs is important for the local people

8.2.6.4 Utilization of the river

Many households in the villages along the Nam Mo River to be affected by the HPP are **fishing** in the river and its tributaries several days per week, and fish is significant as family food. Men are fishing with nets, women and children are using baskets, and also collecting

shrimps, snails and moss in the shallow river. Fish is an important protein source for the inhabitants along the Nam Mo River and its tributary rivers. A few households in two villages, Muong Tip in Muong Ai Commune and Cha Lat in Muong Tip have fishponds for raising fish from the river.

8.2.6.5 Market, business and employment

Market infrastructure is very deficient: the nearest market to the project-affected villages is in the district town of Muong Xen, which is too far away for the poor farmers to take their products for selling. Mobile traders enter the villages and buy rice, corn, timber, firewood, NTFs and animals hunted by villagers. Traders buy products in the villages under market prices, and at the same they bring household products and sell them to villagers over market prices. Traders also provide loans to farmers in cash or in rice especially before harvest time when many households have run out of rice from the year before; after the harvest households have to pay back the loan with high interest (e.g. loan payment of 10kg rice is 30kg rice after the harvest). Vietnamese traders are doing business also in Laos, and selling timber to the Vietnamese is an important source of income for Namuang villagers.

There are very few non-agricultural labor opportunities in the commune area. Seasonal labor migration of mostly young men and women takes place to the province capital Vinh City, to Ho Chi Minh City in the South, to Dalat and other places in Vietnam. Some people are recorded to have labor migrated abroad.

8.2.7. Cultural heritage

People in the villages to be affected by the Nam Mo 1 HPP along the Nam Mo River mainly belong to the ethnic minority groups of Kho mu and Hmong. Forest and river provide their needed resources and form the context for their way of living. Naturally forest and river also comprise the central spiritual elements in their culture. The local worldview contains gods/spirits related to heaven, including thunder and rain gods/spirits, to land including forest, upland field and village gods/spirits, to water resources including river and stream gods/spirits, and animal gods/spirits ruling over the wildlife. Added to all the gods in the nature, every family respects its household gods/spirits and ancestors' spirits. Gods/spirits have to be kept benevolent with offerings and prayers in all important occasions such as sowing/planting and after the harvest, building a house, hunting, fishing, etc.

Every village has a special protection forest area where the spirits of the dead are thought to abide. **The spirit forest** is regularly at some distance (about 1km or more) from the village. People are not allowed to utilize forest resources in the spirit forest, however, cattle can be grazing there. Death ceremonies are related to the river, with an animal sacrifice - usually a chicken - thrown into the river as an offering to the river god for bringing the spirit of the dead home to the realm of the dead. **Village graveyard** is often located near the river.

The villages to be affected by the HPP each have **a village worship place** that is importantly located by the biggest tree just outside the village, and in some villages has a small "temple" or spirit house on place, in some villages only a small wooden platform for offerings. Annual ceremonies are held there when different spirits are addressed to with offerings of agricultural products, fruit and animals. Regular ceremonies take place twice a year, the month of the year depending on the ethnic group residing in the village. Typically, the annual ceremonies are connected to the cultivation cycle in the upland fields.

8.2.8. Gender roles, opportunities and obstacles

In the villages to be affected by the HPP, women undertake hard physical work in agriculture side by side with men, and they collect daily NTFPs and firewood in the forest while hunting is the task of men only. Women are in general not fishing with nets, but they use baskets for catching fish and they collect snails, shrimps and moss in the shallow water. Women are traditionally responsible for cooking and taking care of children.

Women in the ethnic minority villages have in general lower education level than men, and especially elder women are illiterate and cannot fluently use and understand the Vietnamese language. Kho mu and Hmong girls drop out of school early in order to help their families with household work and livelihoods activities. It is common for these girls to get married early, even as young as 14-15 years only. Women are less mobile than men, and they rarely travel outside their village and livelihoods activity areas. Men are decision makers in village, and women are not used to speak up or express their opinions in meetings. Due to the low educational level and limited knowledge of ethnic minority women it is difficult for them to learn new skills for improving their livelihoods and living conditions.

8.2.9. Major reasons for prevailing poverty

There are very few available livelihoods opportunities apart from upland cultivation combined with livestock farming, fishing and forest resources utilization. The available production land is located in high areas with deep slopes, and in the Vietnamese territory where the available land is not sufficient for the farming population and pressure on land is therefore high, erosion and poor soil quality contribute to very low field yields. Cultivation methods are manual, seeds are local, farmers lack fertilizers and soil improvement methods, which lead to low productivity with hardly enough food for household annual consumption. Every year many households in the villages to be affected by the HPP lack rice during the months before the annual harvest.

Cultivation is rain fed and there are no irrigation systems. Agricultural and livestock services are very deficient in Vietnam, in Laos veterinary services appear to be better available and consequently animal mortality lower than in Vietnam. Support and advice from the commune is lacking, and farmers lack sufficient skills to take care of the animals that they receive through government development programs.

Villages are remote, far away from the district center both in Laos and in Vietnam, and poor road infrastructure affects people's mobility and market access. Market infrastructure is undeveloped with the only available markets in the district towns. Most villagers rarely visit the district center. Mobile traders buy agriculture and forest products from farmers in the villages for low prices and sell them household goods for high prices.

All the affected people belong to ethnic minorities who use their own language in everyday communication. Many elder people are illiterate and the general educational level is low, especially in the Vietnamese villages where many people are not fluent in Vietnamese and lack ability to take opportunities for health, hygiene, livelihoods or other living standards improvements. Still many children in the Vietnamese villages drop out of secondary school in order to contribute to the economy of their poor families, and grow up with deficient educational level which will further hamper their capacity to take new opportunities to escape poverty.

8.3 Baseline situation in the Project DIA villages

8.3.1. Villages to be relocated

Totally nine villages in Vietnam and one village in Laos are expected to be inundated by the Nam Mo 1 HPP reservoir and have to be relocated. In Muong Ai commune the village of Muong Tip with 16 households and 84 people need to be relocated. In Muong Tip commune Xop Tip village with 146 people in 29 households, in Xop Phe village with 360 people in 76 households, and in Ta Do village 556 people in 99 households need to be relocated. Two villages in Muong Tip commune consist each of two hamlets and one hamlet in each village will be inundated: Cha Lat village with 92 people in 16 households (of the total 166 people in 29 households) and Vang Ngo village with 130 people in 17 households (of the total 356 people in 47 households) need to be relocated. Moreover, Muong Tip commune center is located in Vang Ngo village next to the river, so the commune office and commune health center will be inundated as well.

In Ta Ca Commune three villages will be inundated and have to be relocated: Sa Vang village with 510 people in 97 households, Na Nhu village with 360 people in 67 households and Nhan Ly village with 275 people in 51 households.

In Nonghed District in Laos, the village of Namuang will be inundated. The village has 224 people in 34 households that have to be relocated.

All the affected villages are extremely poor with great majority of the people living under the national poverty line[94] and the rest of the village households being near-poor. Table 8.1 below presents an overview of the villages that will be inundated in the reservoir area of the Nam Mo 1 HPP.

Table 8.1 Villages in the expected reservoir inundation area of Nam Mo 1 HPP to be relocated[95]

NAM MO 1 HPP VILLAGES TO BE RELOCATED				
Village	**HH**	**Pop.**	**HH poverty %**	**Ethnicity**
Muong Ai Commune - Vietnam				
Xop Tip	16	84	88	Kho mu
Muong Tip Commune - Vietnam				
Xop Tip	29	146	86	Kho mu
Xop Phe	76	360	78	Kho mu
Cha Lat	16/29*	92/166	100	Hmong
Vang Ngo	17/47**	130/356	85	Hmong, Kho mu
Ta Do	99	556	97	Kho mu, Thai***
Subtotal Muong Tip Commune	237/280	1,284/1,584		
Ta Ca Commune - Vietnam				
Sa Vang	97	510	100	Kho mu, 6 HHs Thai
Na Nhu	67	360	100	Kho mu
Nhan Ly	51	275	100	Kho mu
Subtotal Ta Ca Commune	215	1,145		
Total Vietnam to be relocated	**468**	**2,513**		
Nonghed District - Laos				
Namuang	34	224	77	Kho mu
Total Laos to be relocated	**34**	**224**		
Total Nan Mo 1 HPP	**502**	**2,737**		

* Village consists of 2 hamlets, one by the river with 16 HHs, and the other higher up with 13 HHs.

** Village consists of 2 hamlets, commune center is in the lower hamlet and will be inundated.

94 The Laos official poverty line 2010–2015 issued through the Decree No.285/PO Poverty and development standard 2010-2015 is for country level 192,000 LAK/capita/month, for urban areas 240,000 LAK/capita/month and for rural areas 180,000 LAK/capita/month. 1USD≈8,300LAK (Sept 2017). The Vietnam official poverty line 2016–2020 issued through the GoV *Decision No. 59/2015/QD-TTg Promulgating multidimensional poverty levels applicable during 2016-2020* is for urban areas 900,000VND/capita/month and for rural areas 700,000VND/capita/month. 1USD=22,700VND (Sept 2017).

95 The population, poverty and ethnicity data is based on information collected during the baseline data collection in January 2017 from commune officials, village leaders and villagers participating in FGDs. Population data was reconfirmed during FPIC consultations in villages to be relocated in June 2017. The impact assessment is based on all the available information and observations made in the project areas.

***5 Thai HHs relocated in 2006 from Ban Ve HPP.

8.3.1.1 Muong Ai commune

Xop Tip village

Population: 16 HHs with 84 people

Ethnicity: Kho mu

Poverty: 88% of households under the poverty line, but food sufficiently, in average 4-5 meals/week with meat.

Location and movement: Village established in 2002 when relocated from higher elevation, Xop Tip at that time had only 3 HHs, has increased to the current 16 HHs that all are relatives. Village is one of the three hamlets of Xop Phong village where village cultural house is located.

Road infrastructure: Vehicle accessible road to village, it takes 30 min by motorbike to go to the Muong Ai commune center 8km away.

River transportation: Only one motorboat that is sometimes used for transportation. River transportation not needed because road access is good.

Electricity: National grid.

Water supply: Water is lead from mountain stream to 2 water tanks in village constructed by GoV Prgram 135, water sufficient all the year.

Educational standard: Daily communication language Kho mu, but people can speak Vietnamese, 80% of women can speak and read Vietnamese but 90% cannot write. Primary school in village, secondary school 2km away in Vang Pheo village, highschool in Muong Xen district town 30km away.

Health and Sanitation: Commune health clinic 8km away, takes 30 min by motorbike to go there, 1 hour when rain. Women usually deliver their babies in village but nowadays young women go to commune health center, latest maternal death case in 2005. Local drug store in village. 50% of HHs have toilet, but not all are in good hygienic condition.

Livelihoods: **Agriculture.** Upland fields area 3km from village, takes 30-50 min to reach by foot. Every HH has approx. 2-3ha of land and cultivate 1.5-2ha for 2 years, then leave land fallow for 4-6 years. Total cultivation area approx. 60ha. Upland area is limited and no new land is available.

Livestock farming. All HHs have animals, totally5 buffaloes and 65 cows in village. Each HH has 15-20 pigs and 50 chicken that are mainly for selling. Animals grazing area large, fenced area 2-3km from village, HH groups share grazing plots and together take care of animals and grazing land. Pigs and chicken often die of diseases, veterinary services available in commune, but villagers buy medicines and self-medicate animals when these get sick.

River use. There is fish in the Nam Mo River and in Nam Tit River but not in Long Nho stream. All HHs go fishing weekly using net, rod, basket, one-time catch 2-3kg, only for HH food. No river bank cultivation

Fishpond. One HH has a fish pond, raising carp.

Forest utilization. Protection forest 557ha allocated to village management, near village. Women collect daily NTPFs for food and collect firewood, men hunt every day rats, birds, bamboo rats for HH food, weekly squirrels, wild chicken, snakes. Deer and wild boar hunted seasonally.

Employment and trade. 3 rice milling machines in village, cost 1,000VND/kg rice. Some villagers moved to Ho Chi Minh City and Tay Nguyen province for employment.

Cultural heritage: **Graveyard** with 5 graves of villagers who died since 2002 located 1km from village.

8.3.1.2 Muong Tip commune

Xop Tip village

Population: 29 HHs with 146 people

Ethnicity: Kho mu

Poverty: 86% of households under the poverty line. Food sufficiently, HH daily meal sticky rice, fish, pork, green mustard, pumpkin, bamboo shoots.

Location and movement: Located in confluence of the Nam Mo River and Nam Tip stream, since 2002, no HH moved in or out the past 5 years except for individuals for marriage. Before that 6HHs moved to Xiangkhoang for working. Small residential area, 75-100m2/HH and houses stand close to each other.

Road infrastructure: Vehicle accessible road to village, village 100m from the road between district town and Muong Ai commune center. Villagers travel by foot or motorbike, it takes 30 min on motorbike and 1 hr on foot to Muong Tip commune center.

River transportation: No boats, river transportation not needed because road access is good.

Electricity: National grid.

Water supply: Water is lead from mountain stream to 3 water tanks in village, but one tank is broken. Villagers use mostly stream water for washing and bathing.

Educational standard: Kindergarten and primary school in village, secondary school in Vang Pheo village 20 minutes away by motorbike. Elder people not fluent in Vietnamese and 10 people illiterate.

Health and Sanitation: All health problems treated in the village, seldom attend commune health center, there are villagers with skills in traditional herbal medicine, and two traditional healers who are father and son. Women give birth in village and do not do any controls during pregnancy. Common health problems stomach and head ache. Hygienic standard poor, no toilets.

Livelihoods:

Agriculture. Upland fields area 3km from village, takes 30-50 min to reach by foot. Every HH has approx. 2-3ha of land and cultivate 1.5-2ha for 2 years, then leave land fallow for 4-6 years. Total cultivation area approx. 65ha. Upland area is limited and no new land is available.

Livestock farming. Totally 80 cows, only one HH has 3 buffaloes, over 100 pigs but suffer commonly from foot and mouth disease which villagers try to cure with diesel, lime and salt. Close to 200 chicken.

River use. Fishing only in the Tip stream, not in The Nam Mo River. Previously 3-4 years ago a lot of fish but after Nam Mo HPP construction fish reduced a lot. Fishing during summer months, all HH members fishing, men use net and hook to catch fish, women baskets. Fish enough only for HH daily food. No riverbank cultivation, and no collection of any wild-growing plants there either.

Forest utilization. Village has protection forest and production forest. Around village, easy to go to forest and resources abundant. Women collect firewood, wild-growing vegetables, bamboo shoots, mushrooms, herbs. Men collect timber and firewood, herbs. Men hunting every day rats, birds, bamboo rats for HH food, weekly squirrels, wild chicken, snakes, more seldom deer and wild boar.

Employment and trade, labor migration. Young female villagers working in other provinces, in Da Lat as agricultural workers or in garment factory in the South, no men labor migrating. Some women went abroad as workers but came back and still have debts. Previously 6 HHs moved to Xiankhoang, but no HH out-migration during the past 5 years. 2 HHs have small shops along the road.

40% of HHs have got bank loans since 2011 but livelihoods not much improved due to lack of knowledge.

Cultural heritage: Spirit forest area about 5ha. Graveyard located 2km from village.

Xop Phe village

Population: 76 HHs with 360 people

Ethnicity: Kho mu

Poverty: 78% of households under the poverty line. Food insufficiency with 70% of HHs 2-3 months/year, receive no rice support from GoV.

Location and movement: Village established in 2006, was previously located 500m downstream where area was flooded. Houses are located on both sides of the road from district to Muong Ai commune.

Road infrastructure: Village located along the road between the district town and Muong Ai commune center, about 2km to Muong Tip commune center and 35km to Muong Xen district town. Houses wooden built on stilts.

River transportation: Only one HH has a boat for transportation of goods, firewood, animal fodder; river transportation not needed because road access is good.

Electricity: National grid.

Water supply: Water is lead from mountain stream to 6 water tanks in village.

Educational standard: Daily communication language Kho mu, about 30% of women can speak Vietnamese. 90% of women cannot read. Primary school 1km from village, secondary boarding school 5km in Vang Pheo village. Children walk to school, many drop-outs after grade 8 and 9. High school in Muong Xen, students have to rent accommodation outside the school, 3 students in Muong Xen, one in ethnic boarding school in Vinh.

Health and Sanitation: There are people with skills in traditional herbal medicine in village. Village health worker who graduated from grade 9 and then attended 4months and 6 months of health training courses. Recording and reporting health conditions, no medical services. Summer rainy season health problems diarrhea and headache, cough in winter. Children have often respiratory problems and diarrhea. Infant death cases in 2014 and 2016. About 25% of HHs have toilet.

Livelihoods: **Agriculture.** Cultivation land totally 200ha, village manage and not allocated to HHs, nearest land 300-500m far and takes 15-20min to go there by foot, furthest land 3km away and gets 1.5-2hrs to get there on foot. Some HHs suffer land scarcity due to steepness and rocks, get permission from forest protection force to do slash and burn in protection forest. Main crops rice, maize, cassava, peanut, beans. For HH food, cassava for animals. Maize for animals, also sold when cash needed. No cultivation in village, only fruit trees around houses.

Livestock farming. 100 cows of local breed, 2-6 cows/HH for selling, all HHs raise pigs 2-5pigs/HH, pigs often die of diseases and HHs buy medicine for curing them. All HHs raise chicken, 15-20 chicken/HH, but

many died in 2016. No veterinary services available. Animals watered from the river, water not clean and animals get sick.

River use. Men fishing daily with nets in the Nam Mo River but only one HH use boat in fishing, fishing for HH food, only one HH selling fish. There is plenty of fish. Women fish with baskets, collect snails and moss for food. **River bank utilization**. Planted banana trees, and grass and cassava for animals, cattle grazing along the river.

Forest utilization. Production forest 3km away, 450ha, protection forest area 300ha. Women collect firewood, wild-growing vegetables, bamboo shoots, mushrooms, herbs. Men collect timber and firewood, herbs. Men hunting every day rats, birds, bamboo rats for HH food, weekly squirrels, wild chicken, snakes, more seldom deer and wild boar.

Employment and trade, labor migration. 7 girls working in HCMC, one girl in Laos, one in China, one in Thai Nguyen, all 25-30 years of age.

Cultural heritage: Spirit forest 1.4ha. Graveyard 1km away on both sides of the road in protection forest. Established in 1995 and was divided into 2 sections when the road was constructed. Three ravine areas that are sacred and should not be accessed, if somebody goes there he/she will get sick. No village worship place, however a big tree and its surroundings area considered sacred.

Cha Lat village

Population: Totally 29 HHs with 166 people in two hamlets, one in high location and the other by the Nam Mo River with 16 HHs and 92 people.

Ethnicity: Hmong

Poverty: 100% of households under the poverty line. Food insufficiency 3 months/year, all HHs receive government rice support. 50% of HHs do not have regularly meat to eat.

Location and movement: Village long time in high location, some HHs relocated in 2003 to lower elevation according to GoV program, now upper Cha Lat (13HHs) and lower Cha Lat (16HHs) 10km from each other.

Road infrastructure: Village access road to the road between the district town and Muong Ai commune steep, motorbike accessible but hardly during rains. Villagers travel by motorbike and walking. center, about 2km to Muong Tip commune center and 35km to Muong Xen district town.

River transportation: No boats or river transportation because road access.

Electricity: National grid.

Water supply: Water tanks with stream water.

Educational standard: Everyday communication in Hmong language, few people fluent in Vietnamese, only 3-4 women can speak Vietnamese. Girls usually stop

going to school after grade 5 in order to work in the family. 5 girls go to secondary boarding school 7km away in Vang Phao village, none in high school in district town.

Health and Sanitation: Commune health center only 2km from lower hamlet, and utilized by villagers from lower hamlet but far away from upper hamlet. Women give birth in village assisted by an elder woman. No infant deaths the past 5 years. Poor sanitation, no toilets.

Livelihoods:

Agriculture. Upland fields 20-30 min walk from village. Villagers do not know the area size. Each HH has 3-4 land plots in rotational cultivation, cultivate 1-2 years and leave fallow for 4-5 years. Cultivate rice, corn, cassava, sweet potato, mustard greens, pumpkins, peanut. For HH use only. No unused land available.

Livestock farming. 300 cows of local breed, 200 goats, 115 pigs, 400 chicken. In winter cows often die because there is no fodder for them. No agricultural services in upper village, sometimes in lower one.

River use. Fishing in the river with nets and cast nets, approx. every 3 days, fishing for HH food.

Fish ponds. 8 HHs are raising tilapia, mainly for HH food, can be sold when plenty of fish.

No riverbank cultivation.

Forest utilization. Totally 300ha forest. Receive protection forest management fee annually, 30MVND that is partially kept as village fund and the rest distributed to HHs, each HH 1MVND. NTF resources are abundant. Abundant with small animals (rats, squirrels, birds, snakes, bamboo rats) but no large animals.

Cultural heritage: Spirit forest 4ha. Graveyard about 3km away. No village worship place, however a big tree and its surroundings area considered sacred.

Causes of poverty as stated by villagers: weather conditions, steep land with high erosion.

Vang Ngo village

Population: Totally 47 HHs with 356 people in two hamlets, one in high location and the other by the Nam Mo River with 17 HHs and 130 people.

Ethnicity: Hmong, Kho mu

Poverty: 85% of households under the poverty line. 21 HHs with food insufficiency during 6 months annually, receive rice from Gov 15kg/person during hunger months.

Location and movement: Previously village located in higher altitude; in 2003, 17 HHs moved downhill with the Gov Relocation program, lower hamlet located in the

commune center, the 30 other HHs in Huoi Khoi hamlet some 7km from commune center, takes half a day to go there by foot from lower hamlet.

Road infrastructure: NR7B crosses the lower hamlet which is right in the commune center.

River transportation: No boats or river transportation because road access.

Electricity: National grid.

Water supply: Water is lead from mountain stream to 3 water tanks in lower hamlet that were constructed in 2005 by Program 135 and renovated in 2014. No water tanks in upper hamlet.

Educational standard: Village communication language Hmong. Majority of men can speak Vietnamese. About 100 villagers illiterate, of them 60 women. In the lower hamlet there are a few women who can speak Vietnamese.

Primary school in lower but not in upper hamlet where children go to school in the lower hamlet over the meek and go home in weekends, many children from upper hamlet drop out of school grade 5-6. Secondary boarding school 10km away in Vang Phao village.

Health and Sanitation: Commune health center in the commune center in the lower hamlet and easy to access, but far away for upper hamlet villagers who do not use the services. Hmong women do not go to annual female health check provided by the commune health center due to cultural reasons.

Livelihoods: **Agriculture.** Production land area 180hs. Upland fields 15km from village, takes 3-4 hrs to get there. Each HH cultivate 1-2ha for 1-2 years, then leave fallow. Rice, corn, cassava, mustard green, pumpkin cultivated for food. Cassava and corn grown for animal fodder.

Livestock farming. No specific grassland for livestock, ranging in forest and in cultivation areas after the harvest. Grass planted for buffalo and cow forage. Totally about 100-120 cows, a few buffaloes, 15-20 pigs/HH, 20-30 chicken/HH, 5-10 goats/HH. Cattle and poultry get regularly sick in Feb-May, commune veterinary services available when animals are sick, some HHs self-medicate animals. Animals watered from stream near the village. People eat chicken 1-2 times/month.

River use. Fishing in the river about 30% of HHs fishing once a week, others once a month, fishing with net, hook, basket. 2-3kg fish/catch during rainy season, some 2kg during the dry season. 5-6HHs collect wild growing vegetables along the river when they go fishing. Banana and grass planted along the river.

Forest utilization. Closest forest 1-2km, furthest 5-6km away. Protection forest GoV allocation to village annually 33MVND. NTFs important daily food.

Employment and trade. 2 HHs have small shops. Some villagers work as laborers collecting firewood for 100,000VND/day.

Cultural heritage: Old graveyard near the upper village. Village worship place with a big tree located in the upper village.

Causes of poverty as stated by villagers: weather conditions, steep land with high erosion.

Ta Do village

Population: 99 HHs with 556 people.

Ethnicity: Kho mu, Thai

Poverty: 97% of households under the poverty line. Food insufficiency with **2**0% of HHs 3-4 months annually.

Location and movement: Current location since 1988 through the GoV relocation program to move people to lower elevation, at that time all villagers were Kho mu, 1995 some Thai families moved into village, and 2006, 5 Thai HHs resettled from Ban Ve HPP. 4km from commune center along the road from Muong Xen district town to Muong Ai commune.

Road infrastructure: Village located along the road between the district town and Muong Ai commune center, 3-4km to Muong Tip commune center and 30km to Muong Xen district town.

River transportation: Only one small boat that used for transporting people only to cross the river and visit relatives in Namuang village in Laos for weddings, funerals and other festivities, no goods transportation

Electricity: National grid.

Water supply: 5 water tanks constructed 2004 by the Gov safe water program bringing water from streams to village. Some HHs have a piping system from water tank to their house.

Educational standard: 90% of women speak Vietnamese, most women over 40 years are illiterate. Kindergarten and primary school in village, secondary boarding school 16km away in Vang Phao village. One boy and one girl study in high school in MuonXen, one girl in college in Vinh city.

Health and Sanitation: All people use commune health center services. Child vaccination in village once a month. Younger women (<25 years give birth in commune health center, elder ones in village), there is a midwife who is now too old to work. Many people know how to use herbal medication, herbs are collected in the forest. Common health problems seasonal diarrhea, headache, flu, cold, children have fever, diarrhea, rubella, cough. Children are usually taken to CHC. Women have annual gyn. controls in CHC, mainly young women attend. About 20% HHs have toilet.

Livelihoods: **Agriculture.** 600ha upland fields, takes 1-2hrs on foot to get there. Cultivate rice, corn, peanut, taro, banana, ginger, chili, and cassava for livestock. 1 year cultivation, then 5 years of fallow.

One HH cultivating jack fruit, tamarind, apple, longan, litchi, mango trees for selling fruit. Some HHs planting fruit trees in home garden to grow fruit for selling.

Livestock farming. About 15 cows/HH, totally 12 buffaloes **in** village, 20-30 pigs/HH, Up tp 100 chicken/HH, 50 goats in village, every HH has dogs for food and selling to traders coming to the village. Animals mainly for selling. Pastureland near cultivation areas far from the village, no pasture land along the river.

River use. Fishing mainly in the Nam Mo River, many streams near the village where villagers catch shrimps, snails, collect moss. Most HHs do fishing, 1/3 of HHs 2-3 times/month, others more seldom. Fish reduced due to HPPs (Nam Mo 2013) and people from other villages (Canh village) killing fish with electricity. Fish only for HH food. Fishing more before HPP (Nam Mo), could catch 5-7kg at a time, nowadays 2-3kg. Cast net, rod, basket used for fishing.

Forest utilization. Protection forest about 2ha/HH, each HH gets annually 1MVD from Gov for forest protection. Abundant forest resource, NTFPs used daily, wild growing vegetables, bamboo shoots, mushrooms daily food. Wild animals like rats, birds, snakes, squirrels, bamboo rats, deer, wild chicken hunted year-round for food and for selling, but wild boars only during harvest time when they come to destroy the crops. Forest very close to village, 5 minutes' walk.

Some HHs collect herbs for selling to traders coming to village and placing order on certain herbs and linzhi mushrooms etc.

Employment and trade, labor migration. Young girls go to the South to work in garment factories or to Central Highlands to work as laborers.

Cultural heritage: Spirit forest about 15ha. Graveyard outside village. Village worship place under a big tree.

8.3.1.3 Ta Ca commune

Sa Vang village

Population: 97 HHs with 510 people.

Ethnicity: Kho mu, 6 Thai HHs

Poverty: 100% of households under the poverty line. Food insufficiency with **40**% of HHs 6-8 months annually.

Location and movement: Village consists of two hamlets 4km from each other, both along the Nam Mo River. Previously located near Huoi stream, moved 2003 to present location.

Road infrastructure: Village located along the road between the district town and Muong Ai commune center, Main hamlet 12km to Ta Ca commune center. Spacious village, each HH has 300-500m^2 residential land. Women usually go to commune center only once a year as they have to walk there which takes half a day. **Villagers** usually go to Muong Xen 1-2 times/year to buy clothes, tools and household items.

River transportation: Only two HHs have boats that used for fishing and transporting people (up to 10 persons) and goods.

Electricity: Micro hydro generators.

Water supply: 4 water tanks in main hamlet, no water supply in the 2nd hamlet

Educational standard: Communication language Kho mu, Thai, Hmong, most people can speak Vietnamese – many Kinh traders coming to village - but some people not fluent, some elder people are illiterate.

Men better educated than women, due to poverty

Few children finish grade 12, families have many children and cannot afford educating them. Past 2 years only 2 girls went to high school and one to college.

Kindergarten and primary school in village, secondary boarding school in commune center, children come home for weekend using bicycle or walking.

Health and Sanitation: Self-medication in village with herbs collected in forest, only with most serious cases of illness people go to CHC or district hospital. There are people with knowledge in herbal medicine providing services for free. No health services in village, only a male health officer who is responsible for information about Gov campaigns.

Women deliver babies in village or in the fields. Many miscarriages that are said to be caused by hard physical work women are continuing with during pregnancies. No pregnancy controls. CHC offer annual gynecological control for women but not all women go to CHC for that because of the distance, time and cost of travelling to the commune center.

Children are vaccinated in village by mobile vaccination services of commune and district health care.

Livelihoods: **Agriculture.** Total cultivation area approx. 300ha. Distribution of land uneven between HHs, only 3HHs have over 1ha cultivation land. Fallow cycle usually only 2 years, fields steep. Fields lie 3-5km from village.

30 HHs have totally about 16-17ha of paddy fields close to mountain streams, they produce 2 paddy crops annually but the areas are too small for producing sufficient food for their HHs.

Rice is grown for HH food, 2-3 HHs have enough to sell rice. Corn mostly sold after harvest, some HHs plant peanuts for selling. Sold to traders coming to village. Cassava, taro, beans.

Livestock farming. More than 200 cows, 43 buffaloes, every HH has 2-3 productive pigs plus piglets, all chicken had died (Jan 2017). 2009-2012 all HHs were supported by Program 135 and 30A, totally 120 cows and 50 pigs from the programs. In 2016 only one HH received a cow.

River use. According to villagers, the river contributes to 50% of HH food Fishing with cast nets, baskets. Fish reduced considerably since (Nam Mo) HPP construction, for 5 years ago plenty of big fish but no more. If fishing done every day there will be just enough for HH food. Catch shrimps, snails, crabs, collect moss during the dry season. Fishing during dry season every day, not during high waters of rainy season. **River bank cultivation**: Fruit trees, banana, papaya, sugar cane, chili, eggplant and other vegetables for family food.

Forest utilization. Forest close to village, just 5-10 minutes' walk away. Daily forest utilization. Women collect firewood, bamboo shoots, mushrooms, wild vegetables and herbs. Men go hunting, taking timber, taking care of livestock, collecting herbs. Abundant NTF resources as well as bamboo resources for construction and selling to traders.

Hunting: Rats, birds, bamboo rats are hunted for food every day; snakes several times/week, deer is rare and hunted a few times per year, wild boards during harvest times. Tools include trap, crossbow, net, catapult.

Employment and trade, labor migration. Four HHs have small shops (combined with Na Nhu village). Teenagers 14-15 years, sometimes as young as 12 years go to Saigon and to Dak Lak for working, more boys than girls. Doing agricultural work taking care of coffee and pepper trees, planting vegetables and picking up strawberries etc. People cross the river and work in Laos (forestry and agriculture), women over the day only get 120-150'VND, men in logging earn 250'VND/day and they stay over a longer time

Cultural heritage: Spirit forest about 15ha, graves 1km from the villages on a higher location then the village, but may still be affected by the reservoir. Village worship place by the biggest tree in the village.

Causes of poverty as stated by villagers: Small cultivation land area and poor soil quality, traditional cultivation methods, livestock diseases and high mortality of animals. Products are sold to traders coming to village at lower prices than market prices.

Villagers have to borrow money/rice when they do not have enough to eat, lenders come from Muong Xen, borrowers have to pay high interest, e.g. borrow 10kg rice and after harvest have to pay back 30kg. Some HHs take a loan from traders and after harvest have to pay in products – circle of poverty is continuing.

Na Nhu village

Population: 67 HHs with 360 people.

Ethnicity: Kho mu

Poverty: 100% of households under the poverty line. About 1/3 of HHs have not rice all the year, food insufficiency 3+ months when they will receive rice from the GoV, 15kg/person/month.

Location and movement: Established 1982, villagers came from Co My and Huoi Hien villages in Muong Tip commune and from Nhan Ly and Nhan Cu in ta Ca commune.

Today 2 hamlets, 12 HHs along the river and the road between Ta Ca and Muong Tip communes, the other hamlet with 50 HHs up in the forest. Riverbank high and steep.

Road infrastructure: Vehicle accessible year-round road, however, access during the rainy season gets difficult. 14km to commune center, villagers travel by motorbike or walk. Women seldom leave the village, go to commune center about once a year.

River transportation: Villagers do not own boats.

Electricity: Micro hydro generators.

Water supply: 5 water tanks with water led from a stream, some of them appear to be broken because they were constructed long time ago by the GoV.

Educational standard: Daily communication language Kho mu. About 10 illiterate elder people, most people able to communicate in Vietnamese. Women less educated than men, many dropped out of school after grade 5. Kindergarten and primary school in village, secondary boarding school in commune center, children come home for weekend using bicycle or walking.

Health and Sanitation: Backache, headache, fever, cold common. Children have seasonal itchy eyes and diarrhea, coughing, fever, respiratory infections.

Commune organize annual female controls and child vaccination, but few women utilize them due to distance of walking to commune center.

Women give birth in village, young women nowadays go to pregnancy controls to CHC. Previously maternal and infant death cases, nowadays not. Some malnourished children but less than previously. Miscarriages common.

There is a male health worker for information purpose only. One person knowledgeable in herbal medicine and provides advice free of charge.

No toilets, animals free ranging.

Livelihoods: **Agriculture.** Upland fields around the village at a distance from 2 to 5km away, takes 30min to 1 hour to go to the fields. Total upland area in rotation/HH 4-5ha, annually under cultivation 1-2ha/HH.

7ha of paddy land along the Huoi Nhu tributary river.

Village land fund is exhausted, and no new land can be allocated to new married couples.

Livestock farming. More than 100 cows, 20 buffaloes, in average every HH has 25-30 pigs of which 2-3 sows, 20-50 chicken per HHs but often die of diseases – meaning income loss when they cannot be sold. All animals are of local breed.

River use. No boats. Fishing in Huoi Nhu stream, but fish not abundant except for small fish, usually one time catch only up to 1kg. Along the stream collect bamboo shoots for people and pigs, and moss from the stream. No riverbank cultivation, river bank high and steep.

Forest utilization. Forest far away, 5-10km. Timber resources have been over-exploited so men have to go further away for logging, up to 50k away. They do that in groups of 7-10HHs who are related. Sometimes they go to Laos to take timber and sell it.

Women collect NTFs in the edges of the forest, men do hunting. Cattle and goats grazing in the forest.

Hunting: Rats, birds, bamboo rats are hunted for food every day; snakes several times/week, deer is rare and hunted a few times per year, wild boards during harvest times. Tools include trap, crossbow, net, catapult.

Employment and trade, labor migration. 4 HHs run small shops selling cookies, candies, cigarettes, soft drinks etc. (combined with Na Nhu village).

Cultural heritage: Spirit forest 10ha, outside the village. Graveyard outside village. Village worship place by the biggest tree in the village.

Causes of poverty as stated by villagers: Lack of production land, high slope land, poor soil quality, low educational level, low productivity, lack of trade. Most HHs are eligible for bank loan (State bank, loans for poor HHs for production development but they have no knowledge of how to apply and about

the procedures so very few HHs have taken any loan. Instead HHs borrow from traders who take high interest.

Nhan Ly village

Population:	51 HHs with 275 people.
Ethnicity:	Kho mu
Poverty:	100% of households under the poverty line. All HHs suffer lack of rice during the pre-harvest time, 20 HHs about 6 months annually and some 10 HHs all year round.
Location and movement:	Village in the same location since the 1950s.
Road infrastructure:	Vehicle accessible road, about 5km to commune center which is located in Ban Canh village by the Nam Mo HPP.
River transportation:	4HHs have boats, one HH use for fishing, the others for transportation of e.g. firewood and transporting people. They say they cannot travel to Muong Xen by boat any more due to Nam Mo HHP that is blocking the access.
Electricity:	Micro hydro generators.
Water supply:	4 water tanks constructed by the GoV, but the piping system in 3 of them is broken so villagers take their water from stream next to the village.
Educational standard:	Daily communication in Kho mu, but villagers can speak Thai with Thai people and Vietnamese with Kinh people. Only some elder people cannot understand and speak Vietnamese. Women have education highest level from grade 8 or 9. A few illiterate people. Kindergarten and primary school in village, secondary boarding school in commune center. Many children drop out of school. One student in high school in Muong Xen.
Health and Sanitation:	Child vaccination service from commune or district once/month. No other health services in village. No traditional healer. Young women nowadays often go to CHC for delivery, but still many women deliver in village, only a few go to any control to CHC during pregnancy. No toilets, animals free ranging.
Livelihoods:	**Agriculture.** About 30% of cultivation land located near the river. Each HH cultivating 3-4 plots annually, after one year the plots are left fallow for 3-4 years. Every HH cultivate approx. 1.5ha annually. Rice, corn, cassava, peanut the most important crops. **Livestock farming.** 40 cows, 15 buffaloes in village – 50% of HHs received cows from a livelihoods program but last year many cows died during the winter, now only some 15 HHs have cows left. No

pastureland but 5-6ha unused land used for livestock farming. Problem that fodder lacking during the winter so cattle gets sick and dies just before Tet.

50 pigs in village, many died from diseases.

No veterinary services, villagers try to cure sick animals by themselves.

River use. 4HHs have boats that are used for fishing. Villagers fish in the Nam Mo River, 2/3HHs during rainy season, less than ½ during dry season. Use cast nets, landing nets, baskets. Additional fishing in Huoi stream. Villagers complain that people from Canh village use electricity for fishing and kill the fish. If villagers cannot catch enough fish, they will buy sea fish from mobile traders coming from Muong Xen.

Riverbank cultivation. Each HH has land along the river about 1.5-1.8ha, no actual riverbank cultivation but fields along the river with vegetables and herbs, higher up mango, banana, and other fruit trees.

Forest utilization. Forest not allocated to HHs but managed by the village community. Women collect wild growing vegetables, mushrooms, bamboo shoots, herbs, firewood collected in the forest. Men hunting: Rats, birds, bamboo rats are hunted for food every day; snakes several times/week, deer is rare and hunted a few times per year, wild boards during harvest times. Tools include trap, crossbow, net, catapult.

Employment and trade, labor migration. Young people work for construction companies and road companies and can earn 100-150'VND/day. 2 HHs have small shops. Children usually drop out of school after grade 9 and go to the South and Central Highlands, more girls than boys, boys do logging in the nearby areas instead. for working. 3-4 people work abroad, earn 5-6MVND/ month and send home some 3MVND.

Cultural heritage: Spirit forest 5ha near the village. Graveyard outside village. Village worship place by the biggest tree in the village.

8.3.1.4 Nonghed District

Namuang village

Population: 34 HHs with 224 people.

Ethnicity: Kho mu

Poverty: 77% of households under the poverty line. 60% of HHs have annually rice insufficiency during 3-4 months.

Location and movement: Village established in the current location in 1994. 6 HHs s moved previously to Xiangkhoang, but the past 5 years no out-migration.

Road infrastructure: Vehicle accessible road, only by motorbike during the rainy season due to high slopes. 22km to Nonghed district center.

River transportation: Villagers do not own boats.

Electricity: Grid electricity.

Water supply: 3 village water taps with water led from a stream.

Educational standard: Daily communication language Kho mu, some men know Vietnamese, however, traders from Vietnam also communicate in Kho mu. Most villagers know the Lao language, but 20 elder people are illiterate.

All children in school age go to school, primary school in village. No kindergarten. Secondary students go to district boarding school. No school drop-outs.

Health and Sanitation: There are persons in village with skills in traditional herbal medicine. Poor access to public health services. Common health problems headache, cold, diarrhea, fever. Children vaccinated because mobile health workers come to village. Women give birth in village. There are no toilets.

Livelihoods: **Agriculture.** Upland fields are located along the tributary on a stretch of 3-5km, each HH cultivate approx. 2ha/year. There are no paddy fields. Land with high slopes, difficult to cultivate.

Land resources are abundant, so there are no land conflicts.

Livestock farming. In average 3-5 cows/HH, some HHs have more, totally approx. 300 cows and 15 buffaloes in village. 230 pigs both of local and hybrid breed, the latter raised in barns and fed with cassava and corn, while the local breed animals free ranging. Commune veterinary services available if animals get sick, so low animal death rate.

Chicken, fish or pork eaten 2-3 meals/week.

Animals grazing in forests, no grassland for animal pasture.

River use. Fishing without boats, men with cast nets, women use baskets. Fishing for HH daily need, catch usually sufficient for family food. No riverbank cultivation, only cattle is sometimes grazing there.

Forest utilization. Abundant forest resources. Women collect NTFs in the, men do hunting. Cattle grazing in the forest. Hunting: Rats, birds, bamboo rats are hunted for food every day; snakes several times/week, deer is rare and hunted a few times per year, wild boards during harvest times. Tools include trap, crossbow, net, catapult.

Employment and trade, labor migration. Selling timber to Vietnamese traders is important for HH income.

Cultural heritage: Graveyard outside village at a distance from the river. Village worship place in the village.

Causes of poverty as stated by villagers: Cultivation land is steep and crops productivity low, long lasting drought, losses of crops, no good access road and no market access.

During the months with rice insufficiency villagers borrow money from Vietnamese traders at an annual interest rate of 25-30%.

8.3.2. Villages with land to be inundated by the reservoir

Added to the villages that will be inundated, land areas in the area of two villages in Nam Can commune in Vietnam are within the reservoir area. In Laos, five villages with residential areas far from the river have land areas along the river. The villages that will lose land in the reservoir can be seen in Table 8.2.

Table 8.2 Villages Vietnam and Laos with land areas to be inundated by Nam Mo 1 HPP

Nam Mo 1 HPP Villages with land losses					
Village	**HH**	**Pop.**	**HH poverty %**	**Ethnicity**	**Impact**
Nam Can Commune - Vietnam					
Tien Tieu	170	420	61	Hmong	Production land and protection forest area by the river
Khanh Thanh	76	386	74	Kho mu	Land to be inundated 9ha protection forest and abt 25ha cultivation land, fishponds, fruit trees, grassland belonging mainly to CPC Vice chair, and to 3 other HHs.
Nonghed District - Laos					
Sanche			The residential areas of these villages are located far away from the Nam Mo River and separated from it by a steep mountainous terrain. However, according to the ASA ESIA Report (Aug 2016), land along the river is associated to these four villages (ownership or management). There is no information in the ASA report about the type of land and its utilization. The riverside in these areas is steep and probably not in an active use by the named villages. The affected areas, their status and utilization have to be confirmed during the detail design phase.		
Kenglet					
Phavanh					
Longkoang					
Tam Than			Reservoir tali end, same as above		

8.3.3. Downstream village to be potentially affected by the HPP

Nhan Cu village in Ta Ca Commune is located 2.1km downstream the planned Nam Mo 1 damsite and therefore will be potentially affected by reservoir water regulations and dry season low flow. However, Nhan Cu is located in the Nam Mo HPP reservoir area and affected by the HPP (see further Chapter 11.7 on the cumulative impacts).

Table 8.3 Downstream village of Nam Mo 1 HPP

NAM MO 1 HPP VILLAGE in the potential downstream impact area					
Village	**HHs**	**Pop.**	**HH poverty %**	**Ethnicity**	**Location**
Nhan Cu	35	158	100	Kho mu	2.1 km downstream the damsite, in the Nam Mo HPP reservoir area.

8.4 Agriculture and livestock farming in the affected communes

8.4.1. Agriculture

Ky Son is a rural district and majority of the inhabitants in its 21 communes are farmers living on upland agriculture and forestry. Cultivable land resources are limited and main part of agriculture takes place in upland areas.

Table 8.4 below provides an overview of land use in the three communes in Ky Son district, Vietnam to be affected by the Nam Mo 1 HPP.

Table 8.4 Land use in Muong Ai, Muong Tip and Ta Ca Communes

SN	Land Use	Commune		
		Muong Ai	Muong Tip	Ta Ca
1	Agriculture land (ha)			
	Wetland paddy	54	3	40
	Other annual crops	13	38	24
	Perennial Crops	0	0	34
	Total	67	41	98
2	Forest land			
	Protection Forest	4,200	3,416	1,885
	Production Forest	625	2,922	1,896
	Special use land	0	96	0
	Total	4,825	6,434	3,781
	Total land area	**9,190**	**12,470**	**6,443**
	Villages	9	9	11
	Households	420	517	1,037
	Population	2,442	2,998	4,779

Source: PECC1, Livelihoods Survey Report, Nam Mo 1 HPP ESIA (April 2017)
Land use data is based on commune level statistics (2015).

Farmland. The total land area in Muong Ai commune is 9,190ha of which 67ha farmland is under permanent agriculture growing wetland paddy and other annual crops (Table 8.4). Besides, there is 625ha of production forest allocated to households for planting trees and cultivating upland crops. Most of the production forest area has been converted into upland farming area where rain-fed crops such as upland rice, maize, and cassava are grown on rotation of 2-4 years.

The total land area of Muong Tip and Ta Ca communes is 12,470 and 6,443ha respectively. These communes have limited farmland under permanent agriculture, 41ha in Muong Tip Commune and 98ha in Ta Ca Commune. Due to lack of arable land, local communities have used most the production forest areas as swidden land growing rain-fed crops such as upland rice, maize, cassava, ginger and peanuts.

Farming Practices. Wetland paddy is cultivated along streams near to water source. Since there is a shortage of water during dry season, only one crop a year can be grown, and the land after harvest is usually left fallow for grazing land in winter-spring season. This is Composite Swidden Agriculture (CSA) system operating in the commune area which integrates several types of land use—including permanent wetland paddy fields and small patches of vegetables on valley floors, some perennial crops like banana and other fruit crops, and rotation of swidden plots for upland farming.

Swidden agriculture is widely practiced particularly in production forests. Ground vegetation is cleared and burnt and annual crops such as upland rice, maize, cassava and peanuts are planted as monoculture in wet season. Crops are grown continuously for two years and then left fallow for 2–3 years depending upon land availability and its productivity. Since cassava is a long duration crop, usually 2 years, a period of 3–4 years of fallow is practiced. However, those facing a shortage of land leave the land fallow for 1–2 year.

Typical swidden farming in Nam Mo 1 AI village. The slopes up to 50^0-60^0 are slashed and burnt just before rainy season for upland farming. Rain-fed annual crops e.g. rice, maize, cassava and other minor crops are grown. This is done in rotation of 3-6 years. With the rain most of the top soils are removed. This is an environmentally unstable system. This system in the catchment area of a reservoir would be disastrous.

Plate 8.1 Typical swidden agriculture land in the project impact area

Crop Cultivation. In Muong Ai Commune, farmers grow rain-fed crops such as upland rice (805ha), maize (289ha), cassava (110ha), forage crop – mostly local maize, and other crops such as Taro, pumpkin and ginger. Taro is usually intercropped either with maize or cassava. Farmers grow various rain-fed crops on 1,368ha of swidden land which averages 2.6ha per household (Table 8.5). Besides, this commune has about 54ha of permanent wetland rice fields.

In Muong Tip Commune farmers grow rain-fed crops such as upland rice (450ha), maize (341ha), and cassava (120ha) as the main crop, and other crops such as ginger, peanuts and vegetables. Currently, households grow various crops on at least 926ha of swidden land averaging 1.8ha per household (Table 8.5). Besides, this commune has about 41ha of permanent farmland. Farmers usually grow fruit crops such as longan, grapefruit, papaya and pine apple around houses and along the streams; vegetables are grown on swidden land and around houses.

Ta Ca is a large commune with 1,037 households, but the area covered by various cops e.g. upland rice (250ha) and maize (160ha) as reported by the commune office is far too low (Table 8.5). The FGD survey done in January 2017 estimated upland rice, maize and cassava cultivated on swidden land covering about 1,950ha, averaging 1.9ha per household. Besides, farmers grow peanuts, forage crops and vegetables on swidden land. Fruit and vegetables are planted around houses and along the river.

Table 8.5 Area and productivity of farm crops in communes

	Muong Ai Commune		Muong Tip Commune		Ta Ca Commune	
Crops	Area (ha)	(mt/ha)	Area (ha)	(mt/ha)	Areas	(mt/ha)
Wetland paddy	54	2.5 – 3.0	3	2.5-3.0	40	3.0 – 3.5
Vegetables	na	na	na	na	10	na
Upland farming						
Upland rice	805	1.1 – 3.0	450	1.3-3.0	250	1.3-3.0
Maize - hybrid	289	2.5 – 3.0	341	3.0-4.0	160	2.5-4.0
Cassava	110	18 - 20	120	18-20	150	17-20
Pumpkin	57	na	x		x	x
Ginger	10	1.5	7	x	x	x

	Muong Ai Commune		Muong Tip Commune		Ta Ca Commune	
Tarro	96	na	x	x	x	x
Peanuts	x	x	8	0.13-0.15		0.12-0.16
Forage crop	11	na			x	x

Source: Areas according to the commune's statistics; area measured by the CPC.

na = not available

8.4.1.1 Main crops on swidden land

Upland rice is the main crop, grown rain-fed during the wet season. Local seeds that can tolerate poor soil fertility and minimal crop management are used, and yields are only about 1.1-3.0mt/ha (Table 8.5). The applied cultivation techniques are traditional, and crop growth is dependent on rainfall patterns. Sometimes the yield is even lower than 1mt/ha due to unfavorable weather conditions, traditional cultivation methods, crop diseases and pests, shortened fallow periods, and low quality seeds (which are not selected from good crops).

Besides low soil fertility, change in precipitation and temperature regime affects rice production. Improved agronomic practices and improved seed materials could increase rice yields. Rice is staple food and the locally preferred crop.

Table 8.6 Average household upland farming area size (ha)

Crops	Muong Ai Commune		Muong Tip Commune		Ta Ca Commune	
	Average	Maximum *	Average	Maximum*	Average	Maximum *
Upland rice	1.5–2.0	3.0–3.5	0.8–1.2	1.5-3.0	0.8–1.0	1.5–2.0
Maize	0.5–1.0	2:0–2.5	0.5–0.8	1.0–1.5	0.6–0.8	1.0–1.5
Cassava	300–500 roots/HH	Up to 1,000 roots /HH	100–200 roots/HH	Up to 1,000 roots /HH	300-500 roots /HH	Up to 3,000 roots/HH
Peanuts			200–500 m^2		200-500 m^2	

Source: Data collected through FGDs in Jan 2016.

* A few households having access to land and labor cultivate larger area.

Maize is grown during wet season; planting is done in June and harvest in November. Although farmers use some fertilizer, there has been no improvement in traditional agronomic practices. The grain yields 2.5 to 4.0mt/ha are considered low for hybrid maize, with a potential yield production of 6-7mt/ha. The yield of local seed is 1.0-1.5mt/ha. Low yield is primarily due to unfavorable weather conditions such as long lasting droughts and declining soil fertility level. About 60-80% of the harvests are sold and the rest are fed to livestock.

Cassava is a perennial starchy root crop and has to be grown two years before harvesting. On an average, each household plants 300-500 roots/year at the beginning of the wet season; some households plant up to 3,000 roots in large areas. Yield can be as high as 18-20mt/ha depending on the duration of the crop. Farmers start harvesting after one and a half years after planting, depending on the household needs. Harvested roots are usually fed to livestock as well as used for wine making.

Peanuts are grown in small patches as rain-fed crop. Usually it is intercropped with maize or cassava or even grown alone in small patches of 200–500m^2 using 3-5kg of seeds. Local seeds are used and the yields are poor, 130-150kg/ha. Harvest is about 10–30kg per household and most of the production is sold to traders.

Wetland rice is grown along streams and river where irrigation water is available. The total area under wetland rice is about 54ha in Muong Ai Commune, and 3ha and 40ha in Muong Tip and Ta Ca communes respectively. Only one crop during wet season is grown; there is

not enough moisture retained in the soil after the first crop harvest and no irrigation facility developed. Land after harvest is left fallow for grazing livestock. The average reported yield of 2.5–3.5 mt/ha is low.

Vegetable and fruit cultivation. Vegetables are usually planted along the river or in the homestead gardens covering a small area of 50–100m^2. Pumpkins and other creeping vegetable crops are grown intercropped with maize and cassava on swidden land. The common vegetables planted are *Brassicaceae* (crucifers, mustards and cabbage family), *Lactuca sativa* (lettuce), and *Allium* (onion, garlic, leeks and chives). The crops are cultivated for family food. Most of the vegetables are planted in Thai villages. The Kho Mu generally do not plant vegetables but instead collect wild growing vegetables in the forest.

Fruit trees are planted around houses or along the river and sometimes on swidden farms. The common categories are longan (*Dimocarpus longan)*, pomelo (*Citrus maxima*), mango, papaya (*Carica papaya)* and pine apple (*Ananas comosus)*. The yields are often low and the fruit is therefore for family use only.

8.4.2. Livestock farming

Livestock is an integral part of farming system in the project AI communes. Cattle, buffalo, pigs, goats and poultry including ducks and geese are the main livestock reared. On an average, in Muong Ai Commune each household has 2.9 cattle, 0.8 buffalo, 0.9 goats, 2.9 pigs and 7.4 poultry (Table 8.7). An average household in Muong Tip Commune has less number of cattle and buffaloes, but more goats, pigs and poultry than in Muong Ai Commune. In Ta Ca Commune, the average number of cattle and buffaloes is less compared to other communes, there are more pigs,

Free-range grazing is the common practice, however a few households near the commune center or near the road stall-feed particularly pig and poultry with commercial livestock feed. Most of the livestock raised are of local breed adapted to low level of feeding and management. Cattle, buffalo and goats are reared for sale, while pigs and poultry are reared both for sale and for home consumption. Small ruminants, poultry and pigs provide protein to household diet as well as contribute to household income. The major constraints in livestock improvement are disease prevalence, and the lack of effective animal health services, winter forage and market. Local farmers sell live animals to traders visiting villages regularly.

Table 8.7 Livestock reared in the project DIA communes

Livestock	Muong Ai commune		Muong Tip commune		Ta Ca commune	
	No.	No/HH	No.	No/HH	No.	No/HH
Cattle	1,224	2.9	1,390	3.3	2,150	2.1
Buffaloes	327	0.8			102	0.1
Goats	394	0.9	635	1.2	265	0.3
Pigs	1,222	2.9	1,543	3.0	4,200	4.1
Poultry (chicken, ducks, geese)	3,092	7.4	6,149	11.9	3,066	3.0

Source: Estimated based on FDGs in Jan 2016.

Ruminant livestock. 1,224 cattle, 327 buffaloes and 394 goats are reared in Muong Ai Commune, 1,390 cattle/buffaloes and 635 goats in Muong Tip Commune, and 2,252 cattle/buffaloes and 265 goats in Ta Ca Commune. Each household has 2–3 cattle and buffaloes; some households rear up to 10–20 of them. A few farmers rear 15–20 goats each.

During the planting season all ruminants are grazing in forests, while in the dry season they are grazing on both forest and fallow land. Availability of forage appears to be a major

problem for ruminant livestock. Grazing areas in forest and fallow lands have decreased due to increasing demand for arable land, and in recent years the fallow period has become shorter. Forage shortage is serious during the winter. Some farmers grow local maize as forage crop, but there is severe shortage of forage during winter. Another major constraint in livestock improvement is disease outbreaks, worm infestations, and lack of effective and affordable animal health services and medicines/vaccines. Low level of nutrition and poor health services lead to many livestock deaths.

Pigs. Each household rears 1-3 pigs that are left free-ranging. Pigs are fed with maize and cassava. Pig rearing plays a crucial role in households' income. Each household sells 2-4 pigs per year. Pigs are the major source of household income. Disease occurrence is high in March to June and farmers lose many piglets; mortality is very high. There is no available animal health service and medicines in villages.

Poultry. Each household rears 4-6 chicken and/or ducks and geese. Some farmers rear a large flock of 20-40 birds. There are more poultry birds in Muong Tip commune than the other two communes. The poultry breed is adapted to free-ranging system. There is no breed improvement in poultry. Disease incidences are quite high and there is no effective animal health service in villages. Poultry is raised for home consumption and sale.

8.5 Agriculture and livestock farming in the affected villages

8.5.1. Villages in Vietnam

There are totally 468 households in the Project DIA villages in Vietnam. The upland area under annual cultivation totals 942ha and wetland paddy area 23ha. Additionally, there is about 1,200ha of upland fallow land. The villages have totally 586ha of upland rice, 247ha of maize, 54ha of cassava and 55ha of other crops including taro, pumpkin and peanut (Table 8.8). Only Sa Vang and Nha Nhu villages in Ta Ca commune cultivate wetland paddy that covers about 23ha.

The estimated livestock reared in these nine villages totals 1,084 cattle, 64 buffaloes, 552 goats, 1,994 pigs, and 4,070 poultry birds. Most of the buffaloes are reared in Ta Ca commune, and all goats are reared in two villages Cha Lat and Vang Ngo of Muong Tip commune. Pigs and poultry are reared in all the villages (Table 8.8).

Table 8.8 Estimated area under crop cultivation and livestock reared in Project AI villages in Vietnam

Villages	HH	Swidden land (ha)	Wetland Paddy (ha)	Livestock				
				Cattle	Buffalo	Goat	Pig	Poultry
Muong Ai Commune								
Xop Tip	16	32	0	80	3	0	104	194
Muong Tip Commune								
Xop Tip	29	56	0	80	3	0	110	120
Xop Phe	76	152	0	300	0	0	270	635
Cha Lat	29	60	0	100	0	200	115	285
Vang Ngo	47	92	0	120	3	352	188	464
Ta Do	99	195	0	224	0	0	250	396
Total	**280**	**587**		**824**	**9**	**552**	**933**	**1900**
Ta Ca commune								
Sa Vang	97	168	17	100	23	0	440	180

Villages	HH	Swidden land (ha)	Wetland Paddy (ha)	Livestock				
Na Nhu	67	122	6	100	17	0	526	1,405
Nhan Ly	51	65	0	60	15	0	95	585
Total	**215**	**355**	**23**	**260**	**55**	**0**	**1,061**	**2,170**
Total	**468**	**942***	**23**	**1,084**	**64**	**552**	**1,994**	**4,070**

Source: PECC1, Commune Livelihoods Reports and Village Baseline Reports for Nam Mo 1 HPP ESIA, January 2017.

*Of the total 942ha upland cropped area in the nine villages, 586ha was under rice cultivation, 247ha maize, 54ha cassava and 55ha under various crops e.g. taro, pumpkin, ginger, peanut.

8.5.1.1 Xop Tip Village, Muong Ai Commune

Crop farming. Normally each household has 1.5-3ha swidden land and annually cultivates 1.5 to 2ha for 2 years and then leave the land fallow for 4-6 years. The total swidden land is estimated to be 32ha. There is no river bank cultivation and no wetland paddy land. Farming operation has been very traditional and subsistence oriented.

There is no record for area farmed for each crop. On an average each household plants 60kg rice seed and harvests about 80 bags grain equivalent to 3.84mt which indicate that each household cultivates about 1.4-1.5ha land. Maize is the second crop grown on upland area; each household plants 3-4kg maize seeds (0.25ha) and harvests about 500–700kg grain. On an average, farmers plant about 300–500 cassava roots (1 root/2m^2), some up to 1,000 roots, and harvest 2–3kg/plant, which is used for feeding livestock and for wine making. Peanuts and ginger are intercropped with cassava on small area. The other crops grown are banana, taro, pumpkin, blueberry, sticky corn, red bean, black bean, pepper, tomato, and sugarcane.

Livestock. 80 cattle, 3 buffaloes, 104 pigs and 194 poultry including ducks are being reared in this village. All villagers rear livestock. Cattle and buffaloes graze freely in forests and fallow land. Pigs and poultry are usually raised in pens, however, some households let them free around the village. Pigs and cattle usually suffer from foot-and-mouth disease and farmers treat them using traditional methods. No veterinary service is available in this village.

Constraints for crops cultivation include unfavorable weather, traditional cultivation methods and low land productivity. Main constraints for livestock are annual disease outbreaks in pigs, poultry and cattle and lack of animal health services.

8.5.1.2 Xop Tip Village, Muong Tip Commune

Crops. Farmers do not know the acreage of crops cultivated. The total swidden land farmed each year is estimated to be 56ha, averaging 1.9ha per household. On an average, each household annually cultivates 1–3ha of crops on a rotation of 3–5 year, which indicates that each household has access to 3–6 ha of swidden land. Upland rice is cultivated on about 1.5–2ha area that produces about 80 bags of grain equivalent to 3.84mt. Each household plants 3–4 kg maize seed (0.2 ha) and harvests about 500–700kg grain and plants 300–1,000 roots covering about 0.03–0.1ha. Maize and cassava are fed to livestock and some maize is sold. Due to shortage of land farmers tend to cultivate the land again after only 2 years of fallow period.

Livestock. About 80 cattle, 3 buffaloes, 110 pigs and 120 poultry are reared in the village. Each household raises at least 1–2 pigs and 5–10 poultry. All the livestock are reared on free-ranging system and their production is low. Due to various diseases many livestock died in 2015 and villagers had very low income from livestock sale. No veterinary service is available in this village.

Constraints for crops cultivation include unfavorable weather, traditional cultivation methods low land productivity and shortage of land. Main constraints for livestock are annual disease outbreaks in pigs, poultry and cattle, lack of animal health services and lack of fodder.

8.5.1.3 Xop Phe Village

Crops. The total upland area of the village under annual cultivation is 152ha, which makes about 2ha per household. Each household grows 1.0–1.5 ha of upland rice and the yield is 1.5–2.5mt/h. Total production is just enough for household consumption. Maize cultivation area is approx. 500m^2 per household. Some 30 households plant about 100 to 1,000 cassava roots each. Peanut, vegetables and Taro are intercropped with maize or cassava, and each household plants about 2–10 kg of peanut.

Livestock. About 300 cattle, 270 pigs and 635 poultry are reared in the village. Farmers do not raise buffaloes or goats. Each household has 3–5 cattle (2–3 to about 15 cattle), 2-3 pigs (up to 10) and 6–10 poultry. All the livestock are reared on free-ranging system and their production is low. Many chickens died in 2016 due to various diseases. No veterinary service is available in this village.

Constraints for crops cultivation include unfavorable weather, traditional cultivation methods low land and crops productivity and shortage of land. Main constraints for livestock are annual disease outbreaks in pigs, poultry and cattle, lack of animal health services, lack of good fodder and inadequate fodder supply in the winter season.

8.5.1.4 Cha Lat Village

Crops. About 60ha of upland farming area is annually under cultivation in this village, averaging 2.1ha per household. Each household grows 1–1.2ha of upland rice, and the yield is 2.5–3mt/h depending upon the weather. The total production is just enough for household consumption. An average a farming family sows 10–20 kg maize seeds (0.6–1.2ha) in May and harvest it in September. Some 9–10 households plant about 200 to 300 cassava roots each.

Livestock. About 100 cattle, 200 goats, 115 pigs and 285 poultry are raised in Cha Lat village. Cattle numbers have significantly decreased in the last two years due to disease outbreaks. Goats graze in forest and nearby areas and they are kept in goat-sheds during nights. All the livestock are reared on a free-ranging system and their production is low.

Constraints. Main constraint for crops cultivation is unfavorable weather. The constraints for livestock farming include disease outbreaks in cattle, unavailability of animal health service, shortage of fodder and inadequate fodder supply particularly in winter.

8.5.1.5 Vang Ngo Village

Crops. The swidden land under annual cultivation in this village is 92ha, which is just about 2ha per household. Each household grows 1–1.2ha of upland rice and the yield is 2.0–3.0mt/h depending on the land condition; sloping land is very degenerated and the yields are low, on average 1.5–2.0mt/ha. Farmers sow about 12–15 kg of hybrid seeds on 1ha. Maize yield is about 3mt/ha. Each household plants 300 to 1,000 cassava roots. The productivity of all crops is low. Other crops grown are banana, pumpkin, kale, green mustard, etc. Banana and grass are planted along rivers and streams.

Livestock. About 120 cattle, a few buffaloes, 352 goats (5–10 goats/hh), 180 pigs including piglets (10–12 piglets/hh) and 464 poultry (10–20 chickens/hh) are reared in Vang Ngo village. Very few farmers rear buffaloes because of the high cost to buy one. Usually one pair of adult pigs is raised for breeding and piglets are raised for meat or for sale. Goats graze in forests and nearby areas, and they are kept in goat-shed during night time. All the livestock are reared on a free-ranging system and their production is low. Mortality of pigs and chicken is high, because disease outbreaks cannot be controlled. Farmers plant local maize breed for forage.

Constraints. Main constraints for crops cultivation are low productivity on sloping land and unfavorable weather conditions. The constraints for livestock farming include lack of grazing land, shortage of forage for ruminants and uncontrollable disease outbreaks.

8.5.1.6 Ta Do Village

Crops. This village has about 195ha of swidden land where various rain-fed crops are grown. Each household has access to 3–4 ha of upland fields and cultivates annually about 2.0ha of the area for 2–3 years, after which the land is left fallow for 3-4 years. Each household grows about 1.5–2.0 ha of upland rice, and the yield is 1.5–2.0mt/h, depending on the land condition. Maize is grown on a small area; each household plants about 0.15–0.2 ha (2–3kg seeds) with an average yield of 2.5mt/ha. The small quantity of maize produced is for livestock feeding. Crop yields are low.

Peanut, banana, taro, ginger, etc. are also planted on swidden land. Each household sows about 2–3kg of peanut that is intercropped with maize, and 200–300 roots of taro. An average household harvests some 10–15 bunches of banana, 50–100 kg of taro, 5–20 kg ginger, and 5–7 kg chili. In addition, some households plant winter melon and kale. Some products can be sold when the harvest is large enough. Some households also produce sugar cane, which is sold to traders.

Livestock. About 224 cattle, 250 pigs and 396 poultry are reared in this village. All the livestock breeds are local and managed under free-ranging system. A few farmers received improved cattle through Program 135, but the animals could not thrive under the free-ranging management system. Piglets are raised until they attain a weight of 20kg and they are sold for meat. Dogs are reared for meat and sale. Mortality in chicken is high. All the live animals are sold to traders who visit the village frequently.

Constraints. Main constraints for crops cultivation are low productivity on sloping land and unfavorable weather conditions. The constraints for livestock farming include lack of forage for ruminants and uncontrollable disease outbreaks in poultry.

8.5.1.7 Sa Vang Village

Crops. This village has about 168ha of swidden land, most of which is located on steep slopes, leading to the fallow cycle for restoration of only 2 years. All households have huts in the farming area, and they stay there during the cultivation period. On an average, each household plants 30-40kg of upland rice seeds on about 1.0–1.2ha, 5–7kg of maize seeds (0.3–0.5 ha), a few cassava roots, a small area of peanut intercropped with cassava, bean, some vegetables and taro.

Riverbank cultivation: 30 households cultivate 17ha of wetland paddy near streams. Both local and improved paddy varieties are used. Farmers plant fruit trees and vegetables for household consumption. Pumpkin, kale and other vegetables are grown around houses.

Livestock. About 100 cattle, 23 buffaloes, 440 pigs including piglets (2–3/hh) and 180 poultry are reared in Vang Ngo village. Many of the poultry die due to various diseases. Because the dead animals are eaten, the local people do not take much care of the sick animals.

Constraints. Main constraints for crops cultivation are low productivity on sloping land and unfavorable weather conditions, for the livestock uncontrollable diseases.

8.5.1.8 Nha Nhu Village

Crops. The swidden areas of the village are located on a high slope where cultivation is difficult. The swidden land cropped annually is 122ha, averaging 1.8ha per household. Each household has access to about 3.5–4.0ha, but due unfavorable land conditions, only about 1.5-2.0ha is under annually cultivation. The fallow period of land is 3–5 years. Traditional, manual cultivation methods are used on these sloped fields.

Main crops are rice, maize, cassava, peanut added to other crops like taro, kale and winter melon, which are intercropped on swidden land. Each household sows 15–20kg of rice seeds (0.8–1.0ha), 7–9 kg of maize seeds (0.5–0.6ha), and plants 400–1,000 cassava roots. Some households intercrop taro, peanut and kale.

Riverbank Cultivation. 7 ha of wetland paddy fields are located along the Huoi Nhu stream which provides a sufficient water source for growing 2 crops a year. Fruit trees are planted on land along the stream, and also some vegetables like kale is grown for home consumption.

Livestock. About 100 cattle, 17 buffaloes. 526 pigs and 1,405 poultry are raised in this village. There are no goats. Each household rears 5–10 pigs including 2–3 gilts for breeding and 10-15 poultry. Many chicken died from diseases in 2016 and farmers could not sale much. The local community is ignorant about treating diseased animal with modern medicine. They eat the dead animals and they are afraid that animals injected with medicines are not suitable for consumption rather they use traditional medicine like minced garlic when chickens are sick.

Constraints. Main constraints for crops cultivation are unfavorable terrain and low productivity on sloping land. The major constraint for livestock farming is lack of knowledge in disease treatment methods among the local people.

8.5.1.9 Nhan Ly Village

Crops. Swidden land lies around the village: about 70% of the swidden land is located up from the Nam Mo River while the rest is along the riverbank slopes. The total area of swidden land that is annually cropped is 65ha, which is about 1.3 ha per household This village has no wetland paddy farming area.

On the swidden land, people cultivate upland rice, maize, peanut and cassava, and they intercrop peanut and vegetables like squash with maize or rice. Each household cultivates less than 1ha of upland rice, producing 2.0–2.5mt, sows 15–20kg of maize seeds, producing 2.5–3.0mt/ha, plants 300–500 cassava roots, and grows some peanuts.

Riverbank cultivation. Land on riverbank is used for growing fruit trees and vegetables for home consumption.

Livestock. Farmers rear cattle, pigs and poultry. There are about 40 cattle, 15 buffaloes, 95 pigs and 585 poultry in this village. Each family rears 2 breeding pigs and 8–12 poultry including ducks. Approximately 50% of the households in the village received cows from a development project few years back but in Jan 2017 only 14–15 households had any left: Many cattle and pigs died in diseases and due to lack of forage during a cold period in 2016. No animal health service is available in the village, and people usually go to local pharmacy to buy medicine that is chosen based on the observed symptoms in animals.

Constraints. Main constraints for crops cultivation is insufficient upland farming area and low productivity on sloping land. The major constraint for livestock is disease outbreaks in pigs and poultry.

8.5.2. Village in Laos

8.5.2.1 Namuang Village

The 34 households in Namuang village annually cultivate 68ha of upland area and raise about 300 cattle, 15 buffaloes, 230 pigs and 680 poultry.

Crops. Upland farming areas are located on the left bank of the Nam Mo River and stretched about 3–5 km along its tributary stream. The total swidden land of the village is 68ha, mainly located on high slopes. Farmers usually grow one annual crop, then leave the land fallow for 5–6 years. Riverbank along the Nam Mo River is not used for cultivation.

Main crops are upland rice, maize, cassava and peanut. Villagers also grow bean, winter melon and vegetables. Traditional, manual cultivation methods are used on the sloped fields.

Upland rice is the main crop and only one crop is harvested annually. Each household plants 20–30kg rice seeds covering about 1.0–1.5ha. The average yield is 2.5–3.0mt/ha, but when the weather is unfavorable, the harvest is only about 1mt/ha. Each household sows at least 6–8kg of maize seeds i.e. 0.4–0.6ha, and the average yield of hybrid maize is 5.0–5.5mt/ha. Villagers collect wild-growing vegetables and bamboo shoots in the forest during the rainy season.

Livestock. Farmers rear local breeds of cattle, buffalo, pig and poultry. Altogether there are about 300 cattle and 15 buffaloes. On an average, each household rears 8–10 cattle and buffaloes, some households up to 15–20 animals. Each household sells 1–2 cattle and buffalo per year. The village is surrounded by forests, only about 500m away, which provide sufficient grazing land for ruminants. Farmers have easy access to district veterinary services and they have good awareness of animal disease prevention and treatment.

The village has 230 pigs; each household has 4–5 pigs, including breeding pigs, they rear piglets and sell 1–3 pigs/year, some households sell annually up to 5–7 pigs. Some 5–7 households are raising 4–5 hybrid pigs each. The village has about 680 poultry. Each household rears 10 to 20 chicken.

Constraints. Unfavorable weather is a constraint for crops cultivation, but villagers see no constraints for livestock farming.

8.6 Current intervention in Ky Son District

Provincial government has supported cattle improvement and crop development program through Ky Son District Agriculture Extension Office. Commune level animal health worker (veterinarian) provides animal health services such as vaccination and disease treatment to villages. However, the assigned technical staff cannot cover all the villages in a commune and he/she usually has no adequate skills, techniques and medicines for treating different kinds of livestock and various diseases. Government intervention level is generally low in the remote mountainous areas where the commercial agriculture production is virtually non-existent.

Program 30a, a poverty reduction program, has supported a few farmers in increasing their household income through provision of seedlings and small livestock as well as basic skills training in livestock improvement. However, due to poor animal health services, these farmers had lost all the livestock. No crop improvement or soil fertility enhancement program is available for the farmers in the Project AI.

8.7 Major constraints in agriculture and livestock farming

Major constraints in agriculture and livestock farming observed by local communities to be affected by Nam Mo 1 HPP are summarized in Table 8.9.

Table 8.9 Major constraints in agriculture and livestock farming

Village/Commune	Major constraints	
	Crops cultivation	Livestock farming
Muong Ai Commune		
Xop Tip	Unfavorable weather; traditional agronomic practices; low land productivity	Annual disease outbreak in pigs, poultry and cattle; lack of animal health services
Muong Tip Commune		

Village/Commune	Major constraints	
	Crops cultivation	Livestock farming
Xop Tip	Unfavorable weather; traditional agronomic practices; low land productivity; shortage of land	Annual disease outbreak in pigs, poultry and cattle; lack of animal health services; shortage of fodder
Xop Phe	Unfavorable weather; traditional agronomic practices; low land productivity; shortage of land; low productivity of crops	Annual disease outbreak in pigs, poultry and cattle; lack of animal health services; shortage of fodder; inadequate fodder supply
Cha Lat	Unfavorable weather	Annual disease outbreak in pigs, poultry and cattle; lack of animal health services; shortage of fodder; inadequate fodder supply especially in winter
Vang Ngo	Low productivity on sloping land; unfavorable weather	Lack of grazing land; shortage of forage for ruminants; uncontrollable disease outbreaks
Ta Do	Low productivity on sloping land; unfavorable weather	Lack of forage for ruminants; uncontrollable diseases in poultry
Ta Ca Commune		
Sa Vang	Low productivity on sloping land; unfavorable weather	Uncontrollable disease outbreaks
Na Nhu	Scarcity of arable land; low productivity on sloping land	Lack of awareness on treatment of animal diseases
Nhan Ly	Insufficient upland farming area; low productivity on sloping land	Disease outbreaks in pigs and poultry
Nonghed District		
Namuang	Unfavorable weather	None

8.7.1. Farming system

The Project AI has a mountainous terrain and the people living there are ethnic minority people who rely on subsistence farming for their livelihoods. The area of arable land for permanent crop production such as wetland paddy is very limited along the Nam Mo river and its tributary streams. Farmers grow rain-fed crops on swidden land on slopes located mostly in production forests. They harvest one crop per year and leave the land fallow for 3 to 6 years. On sloping land without terraces, animals or machines cannot be used for ploughing land, therefore all farming is done manually. Farmers use local seed materials except maize, and farming technology has not improved over the years. Many farmers do not grow vegetables, because they collect wild-growing vegetables for home consumption in the forests. Crops are grown as monoculture, but peanuts, ginger and other crops grown in small areas are also intercropped with cassava and maize.

8.7.2. Soil fertility

There is no intervention observed in improving swidden cultivation in the Project AI. This agriculture practice is not sustainable: The period of keeping land fallow after cultivation to rejuvenate soil fertility is very short (not sufficient for the soil to recover) due to demand for farming the land again. Fertilizers are not used, except occasionally in maize cultivation, and there is no system of compost making. Legumes are not grown as main crop or as an inter-crop which could gradually build up soil fertility. In upland agriculture, annual cropping without reasonable improvement measures rapidly degrades soil. Farmers indicated poor crop yields due to low soil fertility.

8.7.3. Climate change

Crop yields are highly varying, and farmers reported reduced yields due to unfavorable weather conditions and long periods of droughts. Yield of the hybrid maize is only 40-50% of its potential. Failures of harvest were reported during the FGDs conducted in the villages in January 2017. Climate change effects will be more profound for crops growing on swidden land because these crops grow under natural conditions and wholly depend on rainfall and temperature regimes, which are gradually changing.

8.7.4. Livestock feeds and fodder

All the livestock reared are of undescribed local breeds, adapted to free-ranging system and low level of nutrition and management. Farmers reported ruminant fodder shortage during winter months; in some villages an acute shortage was noticed. Some farmers rearing hybrid pigs buy commercial livestock feeds. Nutrition level needs to be improved for livestock development and better yields.

8.7.5. Animal health service

Livestock health status is in general poor and high mortality in pigs and poultry was reported. Animal health service is not easily available; it is costly and of poor standard. Farmers are not trained and lack knowledge in disease treatment. In some villages, farmers are aware of prevention methods such as vaccination, but the lack of veterinary services makes it very difficult for them to improve their livestock farming.

CHAPTER 9 CROSS-CUTTING ISSUES

9.1 Gender

Gender roles in the communities to be affected by Nam Mo 1 HPP are defined by both ethnicity and livelihoods production system. The affected people in both Vietnam and Laos originate from Kho mu ethnic minority. In Vietnam, two villages are inhabited by Hmong people, and in in two villages some households are Thai. The Kho mu apply temporary matrilineal residence, so that a newly married Kho mu couple stays with the bride's family and may only later choose its permanent location. Women's domain is the family and they may take decisions within the household, however, in the village society, decision-making and leadership is left for men, and very few women, if any, hold any leadership position. Hmong ethnic minority people have traditionally been living isolated in the highest mountain areas. Hmong women have few contacts outside their own village and ethnic group, woman's place is culturally at home in the village, and girls' education and activities outside the village are discouraged.

Both men and women work hard in the agricultural fields, in the forests and connected to the river, but with partly different tasks. Men undertake the hardest work in agriculture, such as clearing a field in the forest, in the forest environment they are hunting and logging timber while women collect NTFPs for family food and firewood for cooking Plate 9.1. While men are fishing with nets, women catch fish with baskets, and they also collect shrimps, snails and moss in the shallow waters near the river shore. Cooking and childcare are female tasks.

Women's educational level is generally lower than that of men, more women than men are illiterate and are not fluent in communication in the Vietnamese language. Girls drop out of school in order to help in the household work, and Kho mu and Hmong girls generally get married when 15-17 years old, and even at the age of 13-14 years.

Women are less mobile than men, in both Hmong and Kho mu culture girls and women are even discouraged by tradition to travel outside the village, and then only with male company. While men go to commune or district centre by motorbike, many women do not even know how to drive a motorbike, and seldom move outside their village and production areas; women may visit other villages for socializing with relatives and for festivities like weddings and funerals, but women in the project-affected villages visit the commune or district centre only in order to visit the health centre or for administrative issues with the government offices. Women have poor access to information, and their lack of knowledge about health, nutrition and hygiene contributes to child malnourishment.

Women have less contact with the world outside their village and the nearby environment than men, and their knowledge and skills are accordingly limited to the daily living and livelihoods environment of their own group. Women's capacity to learn new methods and skills in livelihoods activities such as cultivation methods or animal breeding is hampered by tradition, low educational level and isolated traditional lifestyle. In this environment, women are shy and dare not speak up to tell their opinion or ask questions in order to understand issues that are dealt with in a meeting in village. It is therefore important to design HPP impact mitigation programs for relocation and livelihoods restoration in a way that is culturally sensitive and appropriate and considering separately the roles and capacities of ethnic minority men and women.

All consultations and training programs should be arranged in a language that is understandable and culturally appropriate for ethnic minority men and women, and separately for men and women in order to ensure that women's opinions are heard,

documented and taken into consideration, and that women will be able to understand and develop the skills needed for restoration of their and their families' lives and livelihoods affected by the HPP. It is likewise crucial to consider the vulnerability of ethnic minority girls and women with little regular contact with the outside world in a situation when thousands of workers and camp followers from a totally different culture with available money and different habits will be present in their remote home area. Mitigation program for adverse social impacts from the HPP construction has to be based on the vulnerability, cultural situation and knowledge level of the local ethnic minority people, especially of girls and women.

Women working in village

Woman working in upland maize field

Women carrying home firewood

Elder Kho mu women in village

Plate 9.1 Women and livelihoods in the project area of influence.

9.2 Livelihoods depend on forest, upland agriculture and water/river resources

Currently, livelihoods of the local communities in Laos and Vietnam in the Project AOI depend upon forest, water and land resources, the later in the form of swidden (shifting agriculture) agriculture. Forest dependence is high, with protein resources, edible and medicinal plants: providing vegetables, materials for household energy, construction and

other use, and animal protein through small mammals, birds, rodents, lizards and amphibians. Water resources provide free protein through fishes and aquatic insects. Apart from daily food, both these resources are helpful in generating some occasional cash through sale of small mammals and rodents. Livestock is another source providing animal some protein (mainly poultry) and cash through the sale of live animals, but disease outbreaks cause immense loss: there is little animal health available. Agriculture in the form of swidden system is less productive and provides carbohydrate needs in the form of rice as the staple food while maize and cassava for livestock. Rice production is, however, is not sufficient for yearly consumption needs for the poor families whose numbers are comparatively high, thus food insufficiency is common. Thus, food security is a serious aspect influencing PAP lives and wellbeing. This livelihoods scenario among the ethnic minorities/groups will continue resulting in deterioration in forest and other land in use until changes are brought to the practices used and sustainable processes are put in place. The Nam Mo 1 HHP project affecting the above resources will have detrimental effects on livelihoods of ethnic minorities living in the Project DIA. In the context of livelihoods, forest resources are significantly more important than fisheries, livestock and crop farming as these provide a reliable and available source of food and other products.

Under the social programs of the ESMP, various plans are recommended to provide alternative livelihoods for the community such as Agriculture, Livestock and Fisheries Support Programs. Since the forest resource has been the primary source of the communities livelihoods, a biodiversity enhancement and buffer zone management plans are also recommended (See Chapter 13 for the elaboration of these plans).

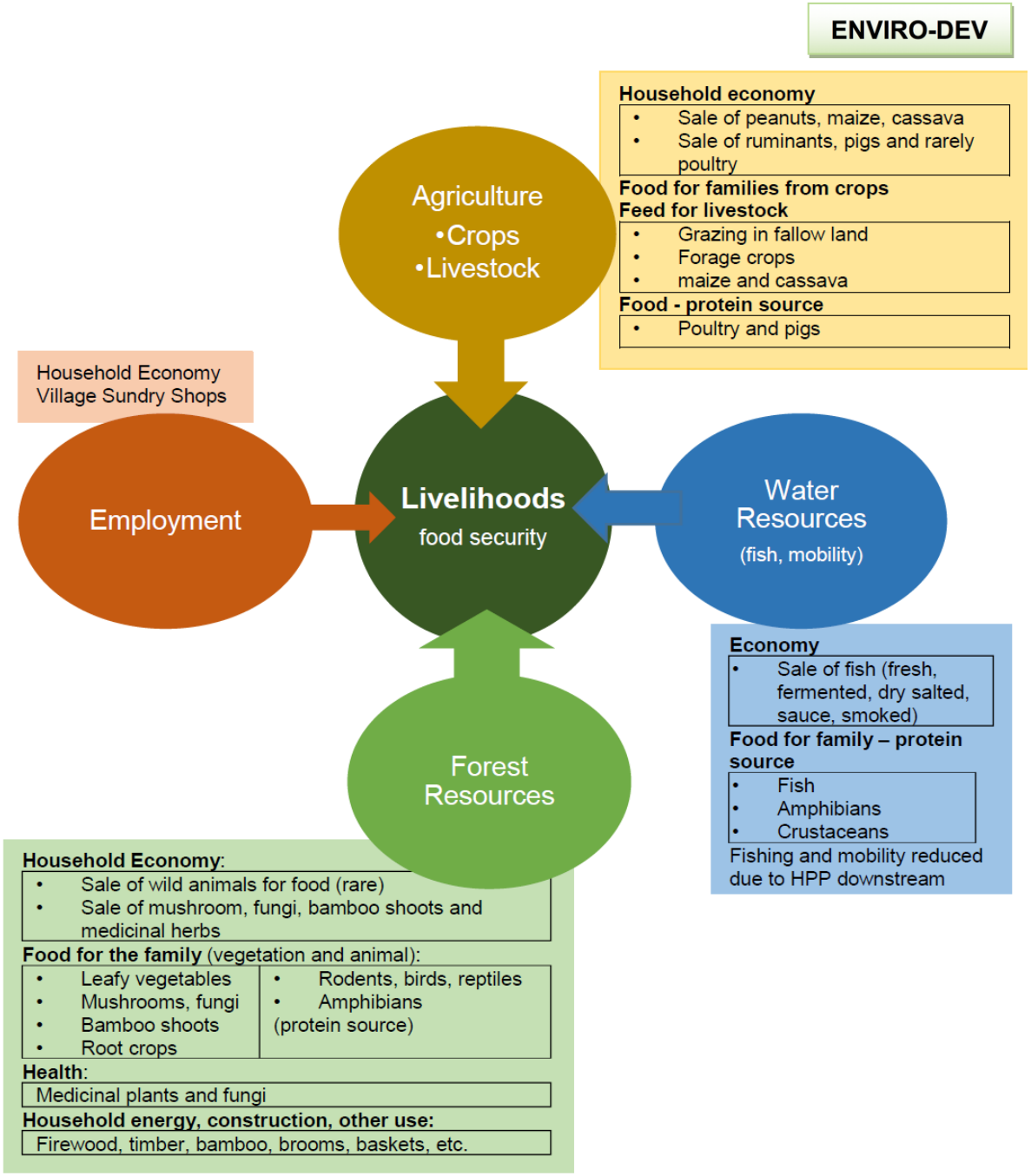


Figure 9.1 Livelihoods of Project affected households depend primarily on forest resources followed by upland agriculture and the water resources of the river.

9.3 Biodiversity

The terrestrial ecosystem, mainly forests and grasslands and aquatic ecosystems and their quality in the form water resources in rivers, as a function of river's catchment, provide a good habitat for wildlife and aquatic life including fish. Biodiversity of forest vegetation and wildlife are inter-related, and serve to provide products for humans, enriched soil (after a few year or regeneration) for agriculture and work to reduce siltation through providing a more stable land cover than, for example, grasslands do. In the Nam Mo 1 HPP area, biodiversity of forest vegetation, a growing secondary forest vegetation after exploitation or developing through a progressive forest succession on uncultivated fallow land is comparatively low but growing, while because of the riverine location of habitats biodiversity of wildlife is limited to smaller size mammals, e.g., rodents and bats, and reptiles and amphibians. A past long period of exploitation of mature forests has depleted larger wildlife and timber resources. Short- to long-distance migratory fish species and resident species

make-up the existing fish biodiversity, however a dam (Nam Mo HPP) operating downstream from the proposed Nam Mo 1 HPP has already impacted upward movement of migratory species, particularly for spawning.

Both the terrestrial and aquatic ecosystems in the project area provide tangible food products and some cash flow for the ethnic minority communities. The communities in the project area depend more on forest resources including wildlife and aquatic resources, fish and other aquatic life, for their livelihoods than on crop farming which is restricted to mainly rice. The food resources from the forests are vital, for daily needs and during lean periods when food is insufficient. In general, a hydropower project disturbs the ecosystem, and as in Nam Mo 1 HPP could imbalance products available from forests and rivers to the local people. The mitigation suggested is meant to minimize impacts due to the land-take of the Project through proposing forest conservation and maintenance linked to community involvement.

9.4 Ecosystem services

Ecosystem Services are the benefits that people derive from the ecosystems and includes four types: provisioning, regulating, cultural and supporting services. In the case of Nam Mo 1 HPP the most relevant types are those provisioning services commonly referred to as natural resources, e.g., water, food and fuel contributing to the human well-being, being central to livelihoods in the DIA and IIA. In order of decreasing relative contribution to livelihoods and importance the ecosystem services including provisioning, cultural, recreation are from:

- Forest and forest-bamboo (food sources mainly rodents, snakes); medicinal plants; firewood, wood for construction).
- Land (agriculture for rice production, cash crop (peanuts) and feed (maize and cassava) for livestock, some grazing of livestock; vegetation cover that provides for soil and slope stability in DIA and IIA);
- Water (fish; transport; cultural importance linked to rituals related to burials and spirits; bathing) – it is noted that the river has gradually not been used for transport due to the Nam Mo HPP downstream and fishing has reduced due to the reduction of fish in the river which may in part related to gradual disappearance of migratory fish.

The dependence on the forest and forest-bamboo ecosystems is high and its contribution is directly contributing to by provision of food sources, especially protein in the form of rodents and snakes. Many HH make daily collections for food sources from forest ecosystems. The areas that will be inundated will result in a loss of core nutrition and protein sources. The water resources of the river are sources of fish (free protein) for many villages located in the planned inundation area (DIA, reservoir). This ecosystem service will change in composition and will need to be managed if the reservoir is to be used as a source of fish. Burial ritual related sacrifice (chickens) is performed with the river serving as a pathway for spirits.

There are intimate livelihoods links with forests and upland lands which all provide ecosystem services to the local communities. Ecosystem services and their dependence is high and the loss is significant. The conservation and sound management of forest ecosystems and sustainable use of agricultural and grazing land is required in the relocation areas, so that the ecosystem services are available. The river will be a reservoir and fish production may increase if fishing in the form of aquaculture is instilled.

CHAPTER 10 COMMUNICATION, PARTICIPATION, & DISCLOSURE

10.1 Introduction

A Public Consultation and Disclosure Plan (PCDP) is prepared for the Nam Mo 1 HPP as proposed by My Ly – Nam Mo Hydropower JSC. The Project Proponent[96] is required to develop and implement a PCDP for a project identified as a "Category A" project based on criteria of MIGA. The *Policy on Environmental and Social Sustainability* (MIGA 2013), *Performance Standards* (MIGA 2013)[97] and *Guidance Notes* (IFC, 2012) have guided the public consultation and disclosure procedures.

The PCDP aims to:

- Identify key local stakeholders and ensure there are adequate mechanisms for stakeholder feedback and information sharing;
- Carry out *meaningful consultation*[98], encapsulated by the practice of Disclosure of Information, Consultation and Informed Communication and Participation (ICP) of the MIGA PS (Box 1) in a mutually acceptable process between the client and affected communities of ethnic minorities (MIGA PS7).
- Provide a framework for consultation at the local, national and international levels.
- Ensure that issues raised by key stakeholders are addressed in the ESIA report as well as in the project decision-making and detailed design phase;
- Provide mechanisms that ensure the formulation of the RAP based on the framework RPF (entitlements) prepared as part of the Nam Mo 1 HPP ESIA;
- Identify the level of resources required to implement the plan and procedures to monitor implementation;
- Outline principles for grievance mechanism for local stakeholders;
- Ensure project benefits for the affected people through gender-balanced participation of different stakeholder groups.

Box 1. From the Performance Standard 1 of the MIGA, 2013 (*adapted for terminology)*

Indigenous Peoples (Ethnic Minorities)

32. For projects with adverse impacts to Indigenous Peoples, the client is required to engage them in a process of ICP and in certain circumstances the client is required to obtain their Free, Prior, and Informed Consent (FPIC). The requirements related to Indigenous Peoples (Ethnic Minorities) and the definition of the special circumstances requiring FPIC are described in Performance Standard 7.

[96] The terms "Proponent" or "Client" are used in this plan as per practice by some International Finance Institutions (IFI) including MIGA (PS 2013). It refers to the term "Sponsor" as is often the term used in IFC documents.

[97] MIGA (2013) and IFC (2012) Performance Standards are identical and MIGA applies Guidance Notes of IFC (2012).

[98] Meaningful Consultation. A process that (i) begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle; (ii) provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people; (iii) is undertaken in an atmosphere free of intimidation or coercion; (iv) is gender inclusive and responsive, and tailored to the needs of disadvantaged and vulnerable groups; and (v) enables the incorporation of all relevant views of affected people and other stakeholders into decision making, such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues (ADB. Safeguard Policy Statement, 2009).

Disclosure of Information

29. Disclosure of relevant project information helps Affected Communities and other stakeholders understand the risks, impacts and opportunities of the project. The client will provide Affected Communities with access to relevant information on: (i) the purpose, nature, and scale of the project; (ii) the duration of proposed project activities; (iii) any risks to and potential impacts on such communities and relevant mitigation measures; (iv) the envisaged stakeholder engagement process; and (v) the grievance mechanism.

Consultation

30. When Affected Communities are subject to identified risks and adverse impacts from a project, the client will undertake a process of consultation in a manner that provides the Affected Communities with opportunities to express their views on project risks, impacts and mitigation measures, and allows the client to consider and respond to them. The extent and degree of engagement required by the consultation process should be commensurate with the project's risks and adverse impacts and with the concerns raised by the Affected Communities. Effective consultation is a two-way process that should: (i) begin early in the process of identification of environmental and social risks and impacts and continue on an ongoing basis as risks and impacts arise; (ii) be based on the prior disclosure and dissemination of relevant, transparent, objective, meaningful and easily accessible information which is in a culturally appropriate local language(s) and format and is understandable to Affected Communities; (iii) focus inclusive engagement on those directly affected as opposed to those not directly affected; (iv) be free of external manipulation, interference, coercion, or intimidation; (v) enable meaningful participation, where applicable; and (vi) be documented. The client will tailor its consultation process to the language preferences of the Affected Communities, their decision-making process, and the needs of disadvantaged or vulnerable groups. If clients have already engaged in such a process, they will provide adequate documented evidence of such engagement.

Informed Consultation and Participation

31. For projects with potentially significant adverse impacts on Affected Communities, the client will conduct an Informed Consultation and Participation (ICP) process that will build upon the steps outlined above in Consultation and will result in the Affected Communities' informed participation. ICP involves a more in-depth exchange of views and information, and an organized and iterative consultation, leading to the client's incorporating into their decision-making process the views of the Affected Communities on matters that affect them directly, such as the proposed mitigation measures, the sharing of development benefits and opportunities, and implementation issues. The consultation process should (i) capture both men's and women's views, if necessary through separate forums or engagements, and (ii) reflect men's and women's different concerns and priorities about impacts, mitigation mechanisms, and benefits, where appropriate. The client will document the process, in particular the measures taken to avoid or minimize risks to and adverse impacts on the affected people.

This PCDP presents stakeholder consultation and engagement activities that were undertaken during the preparation of the ESIA for the Nam Mo 1 HPP. This PCDP also provides an outline of planned stakeholder consultation and engagement activities that are to be undertaken leading up to and during the construction of the HPP. The planned activities are to be done in association with various plans proposed in the ESIA, including the Resettlement and Ethnic Minority Livelihoods Restoration Plan (REMLRP) and the Environmental and Social Management Plan (ESMP).

An EIA to meet national requirements will be prepared for the associated transmission line project[99] by a different consultant. Thus the PCDP prepared does not include processes for the transmission line.

In line with MIGA policies, as noted above, the PCDP is intended to enhance community benefits and related environmental issues by minimizing negative effects through engaging the community. The purpose of community engagement is to build and maintain over time a constructive relationship with communities. The nature and frequency of community engagement will reflect the project's risks to and adverse impacts on the affected

[99] The consultant for the GoV transmission line EIA is identified as PECC1 of EVN, Vietnam.

communities. Through functioning as a means to fully integrate with all phases of the project - planning, design and implementation - the PCDP goes beyond only describing what has already been undertaken and is thus proactive in nature. It more saliently sets outs a roadmap for achieving the aims of the community plans, and guides the overall long term social and environmental management systems of the project.

The PCDP builds upon public consultation and disclosure procedures carried out since January 2017 during the ESIA period. It is also based on project area information that had been collected in 2015-16 and then verified through information gathering and through consultations conducted in January and June 2017. A wide range of stakeholders were consulted particularly at the local community and commune/district levels. To be consistent with MIGA policies, if communities may be affected by risks or adverse impacts from the project, the proponent is expected to provide communities with access to information on the purpose, nature and scale of the project, the duration of proposed project activities, and any risks to and potential impacts on such communities. The Proponent has obtained public views on the Nam Mo 1 hydropower project and concerns of potential impacts, and ways to mitigate such impacts. Based on this input, the Proponent has assessed alternative ways of mitigation and considered raised concerns in its decision-making process and will continue to do so. Public consultation and disclosure procedures have been (1st half of 2017) and will continue to be carried out in an ongoing, transparent, consistent, up-to-date and equitable manner. Relevant project information has been and will be made accessible in a timely manner and in a language understandable to the groups being consulted. *Broad community support* through a FPIC process has been confirmed for this project and follow up of this process is required. The Proponent will explore a range of modes of communication during the future project period. Information included as part of this process has been considered in the preparation of the ESIA Report and associated plans and safeguard documents (e.g., the ESMP and REMLRP).

A common communication strategy and program will be developed in line with the proposed PCDP.

10.2 Previous Public Consultation and Disclosure

A range of communication activities have taken place since 2012 through January 2017. The activities were combined for two HPPs which the Proponent is expecting to develop. These are listed below (Box 2).

Box 2: Communication taken place with project stakeholders during 2012–2016

The Project Owner (Proponent) hired Vietnamese consultants have undertaken meetings and investigations in the planned project areas in 2012, 2015 and 2016. The Proponent representatives accompanied the different consultant teams and presented the proposed projects in the meetings with commune and village representatives. In 2017, the international consultant collected baseline data. The communication meetings are listed below.

In 2012 PECI (Power Engineering Consulting and Investment JSC) undertook an assessment in the project areas for preparing an EIA.

In August 2015 PECI worked in the project area for an updated EIA[100].

In July-August 2015 Nghe An Consultant worked in the project areas for preparing a resettlement plan according to the GoV requirements, during which meetings with commune, village and mass organizations leaders are recorded to have taken place.

[100] The EIAs for both hydropower projects were approved by MONRE, Nov. 20, 2015. (MONRE-Ministry of Natural Resources and Environment, GoV).

In July 2016 PECC1 (Power Engineering Consulting Company 1) undertook an updated assessment in the communities in the two HPP project areas covering all the villages identified to be directly affected in both.

In the Lao territory, 2016, ASA Consultant prepared Environmental and Social Impact Assessments[101] on the areas identified to be affected by the two HPPs.

10.2.1. Details on the communication meetings

In 2012 PECI (Power Engineering Consulting and Investment JSC) undertook an assessment in the project areas for preparing an EIA for each hydropower project, during which meetings with a few commune and party officials and mass organization representatives are recorded to have taken place in the communes to be affected by the planned HPPs.

In August 2015 PECI worked in the project area for updated EIAs. The Proponent provided a document (209/ML-TD of 14 Aug 2015 by ML & NM1 JSC) presenting the Project in the meetings with commune officials and a few village leaders to inform them about the Project.

The following content of the meetings was reported by PECI:

- Proponent summarized the EIA results;
- Positive and negative impacts on the environment and health of communities in the project area;
- Mitigation measures of negative impacts on the environment during construction and operation;
- Opinions of the participants;
- Conclusions from the meeting:
- Agreement on the project;
- Proponent will ensure mitigation of negative environmental impacts;
- Agreement about the environmental mitigation measures that Proponent proposed;
- Proponent will confirm that the construction site will be restored to be clean and beautiful after the project.

In July-August 2015 Nghe An Consultant worked in the project areas for preparing a resettlement plan according to the GoV requirements, during which meetings with commune, village and mass organizations leaders are recorded to have taken place. The issues dealt with in these meetings were the expected Project impacts, land losses, compensation, resettlement and agreement of suitable areas for relocation of each affected village. The consultant team also undertook a survey among the households that were identified to be relocated by the Project, covering the household living standards, size and standard of their houses and other structures, land areas and crops cultivated.

The General Resettlement Plans (RP) for Nam Mo 1 HPP (Nghe An Forestry planning Division 2015) that were prepared based on the assessment in the project areas include the villages in the Vietnamese territory that are expected to be relocated by the respective project, but not those affected by land loss only. The RP contains no information about communication with local stakeholders, except for reporting as the survey and interview methods “quick interviews with families, hearing comments from community and authorities at various levels about their expectations on compensation and resettlement”, and as “method of study with community co-operation: the proposed resettlement options have been made available to authorities, unions of villages and commune so as they can jointly discuss and exchange wishes, comments on resettlement options”. There is no further reporting over how the local authorities and the affected households were consulted or what information about the Project they received. The RP contains no information of the

[101] The ESIAs are not approved yet.

expectations, wishes and comments of the local people. To date, the prepared RPs are awaiting approval by Nghe An Province authorities.

In July 2016 PECC1 (Power Engineering Consulting Company 1) undertook an updated assessment in the communities in the HPP project area covering all the villages identified to be directly affected. PECC1 distributed a summary EIA to commune representatives and Village leaders. Copies of this document were handed out to each commune and each village leader. PECC1 and Proponent representatives had meetings in each commune and in each affected village, where this information was conveyed to participating commune and mass organization leaders and household representatives. In these meetings the Proponent and PECC1 consultants presented the same issues as in the Summary EIA document. PECC1 consultants also conducted key informant interviews with commune chairmen, village leaders, commune health center staff, village Women's Union chairpersons as well as focus group meetings with fishing households in a few villages, for collecting information on land use and livelihoods, and health and poverty situations. PECC1 also undertook a comprehensive household socio-economic sample survey on approx. 25% of the households to be directly affected by the HPP (as identified in the RP).

In the Lao territory, 2016, ASA Consultant prepared an Environmental and Social Impact Assessment on the areas identified to be affected by the Nam Mo 1 HPP. The ESIA report that the consultant undertook household surveys and focus group discussions with people in the villages to be affected by the HPPs. It is reported that any issues that were raised during household interviews were brought to a panel of village representatives for further discussion. It is further reported that most people learned about the project from the consultant team and from the local authorities, and they were worried over the inundation of their villages, and in that case preferred to move up to higher location. The consultant provided data and detailed cost estimates over the losses of houses, land, crops and other assets as well as a cost estimates for relocation and livelihoods restoration, but no information on what kind of information was conveyed and how to the local stakeholders, what kind of communication that took place during the preparation of the ESIAs.

10.2.2. Conclusions from the consultation meetings

The information that has been provided to local leaders and communities has been mostly technical, added to presenting in general terms the expected positive and potential negative impacts from the project on people and the environment, and the GoV general policy requirements concerning mitigation of negative environmental impacts, land acquisition and resettlement. Commune and village leaders have been told about the positive impacts the HPP will bring to the communities such as roads, electricity, and economic development, and they have been informed about the reservoir impacts on villages that need to be relocated. Local leaders and villagers are recorded to have agreed to the project implementation and the mitigation to be provided by the Proponent. However, the discussions with village level stakeholders in January 2017 revealed that majority of them knew about the project only through hearsay; they had heard that there will be a HPP and that some households or maybe all the village will be relocated, but they had no knowledge about when the project will start, if and where they will be relocated, and what other impacts the project will cause them. Lack of information had led to worry and insecurity among the people in the affected villages.

Neither the prepared ESIAs for the Nam Mo 1 HPP in the Lao territory nor the RP for the affected villages in the Vietnamese territory contain any documentation of the stakeholder communication that is referred to as methodology used for preparing these documents. There is no documentation of what information the affected communities have received and how they have been consulted.

These meetings in villages appear not to have been arranged in a way that would have made it possible for the affected people to properly understand the project impacts and mitigation measures and provide them with opportunities to ask questions, express their views and concerns and receive response to their worry.

10.3 Baseline information collection since January 2017 as part of this ESIA

In January 2017, the International ESIA consultant with PECC1 and its sub-consultant team implemented complementary baseline information collection in all the villages to be affected by the HPP. They undertook five types of thematic focus group discussions (agriculture, forestry, fishery, ethnic leaders, gender) and key informant interviews (village leader, village health worker, teacher, extension worker) in the villages both in Vietnam and across the river in the Lao territory. In Vietnam, the Consultant also had meetings in every commune office for gathering basic population, socio-economic and land use data. They also interviewed commune health center and school staff where available. In a brief meeting with villagers preceding the focus group discussions and key informant interviews in each village, the project and its location was explained, the consultant team was introduced and the purpose of its visit was explained to the villagers. The consultant also handed out a short leaflet (in Vietnamese) to the villagers with basic information about the project, the ongoing ESIA preparation and the purpose of the team's visit to the village. The consultant avoided conveying any information about the expected project impacts and potential mitigation measures, but instead asked the villagers what information and how (through which information channel) they so far received about the planned HPP, what they knew about the project, and what kind of information and through which information channel they would prefer in the future.

10.3.1. FPIC process, June 5 – 16, 2017

Consultation process based on MIGA requirements on Free, Prior and Informed Consent (FPIC) were initiated in June 2017 with an independent Vietnamese communication team hired by the Proponent according to advice from and designed by the IC to undertake informed consultations in all the villages to be affected by the HPP. These consultations were aimed to be the first step in the FPIC process to be continued throughout the Project planning and design, implementation, monitoring and evaluation.

Villagers were provided clear and understandable information about the HPP planning, expected schedule, impacts and proposed mitigation measures. All households in each village to be affected by the reservoir inundation and dam construction received an information leaflet which explained the Project and its specific expected impacts on their village, the proposed relocation site for the village and the proposed mitigation measures. Every household also received a project impact area map showing the dam site, the reservoir and all the villages and communes to be affected. This information was presented and explained by the consultant in a public meeting in each village, and all the information was also provided in large format flip charts hanged up along the walls in the meeting room.

For those villages that will lose riverside land but not be relocated, the consultant had similar consultations with the Village leaders and affected land owners.

All commune offices and all the Village leaders in the villages to be affected by relocation or by land loss also received and Information leaflet presenting the Project, its reach, inundated villages and other impacts and proposed mitigation measures. Importantly, both information leaflets contained information of the Project developer and the expected planning and implementation schedule.

Having received the information, the PAP had an opportunity to discuss the Project, its impacts and proposed mitigation measures. Their views and opinions, questions, worries, concerns and proposals were discussed and recorded by the consultant team. All the issues that had come up in the consultation meeting were written down in a village consent document that was signed by the Village leader representing the villagers.

Results from the consultations and main concerns from the affected people

There was a broad community consent and support to the Project: In all villages except one the PAP agreed to the Project and to be relocated – on the condition that all the proposed mitigation and compensation measures will be realized in a proper way. Villagers expressed many issues of concern and requirements on the available resources in the relocation site and on the procedures for a feasible resettlement that they can agree to. The PAP were also in full understanding that they will receive information, be consulted and participate in all phases of the planning and implementation of the relocation. Their preferred future communication methods are printed information, village and group meetings and information through the Village leader.

The most important issues of concern expressed were on the proposed relocation site, its location, geography and available resources for daily living and livelihoods. Villagers want to participate in choosing the relocation site and in its design, and monitor its construction. They request to receive sufficient compensation covering all the losses, damage and relocation costs that is paid in full and in only one or two payments before relocation directly from the Proponent to each affected household without any intermediaries. Compensation payment procedures and timing of the relocation are a great worry for all villagers. The other key issues concern the construction and type of village as well as private infrastructure including houses, roads, electricity and water supply systems. Villagers emphasize that land use certificates have to be issued to all households on the new location. They also request a monitoring and grievance system and involvement of villagers in monitoring of the resettlement and compensation process.

Cultivation land and forest resources are a critical concern for livelihoods of the PAP. They request that land is compensated with similar land, and land is also needed for livestock. Access to forest resources should not be disrupted during relocation, and the important income from forest protection and management has to be ensured and not be reduced due to the Project. Loss of river fishery is a great worry due to the importance of fish resources for both household food and income.

Culturally proper procedures for dealing with the cultural heritage to be inundated are also of vital concern for the PAP who want to choose the location for a new graveyard and for a village spirit house in the new location.

10.4 Public Consultation and Disclosure Program

10.4.1. Key principles for the Public Consultation and Disclosure Program

This section outlines the key principles applied in the development of the PCDP, and those guiding the consultation and disclosure activities of the proponent. These principles are in conformity with GoV, GoL and MIGA guidelines suitably modified to align with the cultural specificities of the impact area.

The principles are:

- Stakeholders must be consulted and be involved in a two-way communication with the project Proponent. Men and women must be included in the communication.
- The consultation should be preceded by providing all the relevant and accurate information.
- Consultations should be a continuous process to allow the participants to know whether their concerns are being addressed by the project proponent, particularly in the final project design and the construction periods.
- Supply of information and consultation with different stakeholders should be through a language and medium they are comfortable with.

- The formulation of the final RAP is based on the meaningful consultation and the framework RRP, ideally done after all consultations and disclosure on the entitlement framework is complete and agreed upon.
- In certain cases, for example, the land acquisition process, where the information provided by the government is not easily understood by the people, the proponent should take responsibility for simplifying and ensuring that the whole process is understood by the project affected persons. In the case of Nam Mo 1 HPP the proponent will facilitate communication with the affected people so that a common understanding of the resettlement and compensation process is achieved.
- There ought to be a specific and transparent mechanism for recording of grievances and a feedback mechanism to inform the action taken by the project proponent.
- Clear enunciation of responsibility and accountability procedures, qualified and trained personnel and resource availability for effective implementation of PCDP.

Modes of communication and information provision

The choice of specific medium for specific stakeholders is determined by their facility with a particular medium and the need for that information. The project will utilize a range of modes of communication to provide information to various stakeholders. Project Information and a non-tech summary sheet/booklet of the ESIA Report will be made available in written once approved. The brochures planned and project information will be made available in the local languages. Regular communication will be maintained with key stakeholders via a communication plan which will be elaborated based on this PCDP and the different project phases and activities.

Record of consultations

All records of public consultation sessions will be maintained and made available for public access at the district office, village school and/ or proponent's office in the project area.

Response

A response will be provided to all queries and grievances at the next meeting else reasons will be explained for delays with the provision of a possible time frame for redressal.

Periodicity of public consultation

- For the directly affected people, those who are losing land and income, a regular and continuous process of consultation will be held throughout the land acquisition and relocation process.
- For the public in general, the frequency of the consultations and their focus will vary with the changing project phases.
- The consultations before the construction stage should be held at regular fortnightly or monthly, where appropriate, intervals to apprise the people regarding the land acquisition process, the compensation amount, other entitlements, alternate employment/agricultural-training opportunities, training programs, mitigation plans & land purchase assistance.
- In the beginning of the project, discussions will be held with villagers for restoration and rehabilitation of cultural sites, if any of concern, as will rehabilitation/ restoration/ relocation and conservation of erosion risk areas, protection forests, and planned safeguard, mitigation and safety plans.
- Temporary workers' impacts will have to be addressed.
- At a later stage, when the residential colony (permanent housing) is occupied by project staff and free movement of outside public starts due to new road, consultations will be held with the (settlements) residents to mitigate impacts on social and cultural environment. For instance, safety and security of women and

children, in settlements, who are left alone when men may in the field due to temporary migration of men may be a concern.
- After the plant is commissioned, issues of waste disposal from plant operations and to a limited extent from residential colony will be discussed with villagers.
- The project proponents should maintain a regular process of dialogue and information sharing at least every quarter with other stakeholders such as the government officials and district administration.

10.6.2 Tasks and timeline for an effective PCDP

A task list is provided in the PCDP for the period when the environmental and social management plans, relocation and livelihood restoration will be implemented. The pre-construction and construction periods are critical periods for consultations as the key management and safeguard plans are put in action. It should be developed beyond the construction based on an analysis of engagement needs during operation.

10.4.2. Resources and responsibilities

The project proponent will establish dedicated units for environment and social issues within the ESMP and RAP institutional structure to address all social and environmental impacts of the project, as well as ensure proper implementation of the public consultation and disclosure programs, REMLRP (eventual RAP) and ESIA programs and plans included in the ESMP.

10.6.3 Responsibility and organization for Communication and Disclosure

Apart from the institutional support to be provided by the Proponent's staff, an implementing agency (one or two effective consulting environmental and social organization/ institution/ company and/or an NGO) should be appointed for the implementation of the safeguard documents (ESMP, REMLRP, FPIC process, etc.) and for consultation and participation with the local communities. It is vital that an international consultant team should be used to closely guide the implementation of the above plans in line with MIGA practice. Note that based on experience from several projects in Vietnam and Laos, the team used for communication/ public consultations should be separate from the ESMP unit, as the ICP requires specialized expertise and ability to take a neutral stand.

At the corporate level, the Proponent will set up a section for Resettlement, Mitigation and Enhancement which will be headed by a General Manager (GM) or the Chief Executive Officer (CEO). The GM will be responsible for a Division called Social and Environment Management Division (SEMD).

This corporate unit will have the following key functions:

- Setting up appropriate institutional arrangements at the project site to oversee implementation of social and environment mitigation action plans.
- Appointing an independent Monitoring and Evaluation agency.
- Establishing village development funds from the project in each of the villages where the REMLRP and all other relevant plans will be planned and implemented.
- Monitoring the RAP (as part of the REMLRP) and ESMP activities.
- Address grievances not addressed by the Project office.
- Ensure that the RAP is implemented in accordance to the guiding policies of the Proponent and IFC/MIGA, and coordinated with the Proponent's CSR program, when prepared.
- Arrange training programs for officers to be involved in the RAP, and follow-up.
- Explore and develop corporate linkages with financial institutions and banks to facilitate financing of income generating schemes for the PAFs.

The project office should have a number of key staff, e.g., a Community Liaison Officer (CLO), a Resettlement/Social Specialist (RS), a Community Development Officer (CDO).

10.6.4 Grievance Redress Mechanism

In compliance with MIGA guidelines the Proponent is to respond to communities' concerns related to the project. If the Proponent anticipates ongoing risks to or adverse impacts on affected communities, the Proponent is required to establish a grievance redress mechanism to receive and facilitate resolution of the affected communities' concerns and grievances about the Proponent's environmental and social performance. The grievance redress mechanism should be scaled to the risks and adverse impacts of the project. It should address concerns promptly, using an understandable and transparent process that is culturally appropriate and readily accessible to all segments of the affected communities, and at no cost and without retribution. The mechanism should not impede access to judicial or administrative remedies. The Proponent will inform the affected communities about the mechanism in the course of its community engagement process. The PCDP proposes core steps for the Proponent's grievance redress handling procedure.

CHAPTER 11 IMPACT ASSESSMENT AND MITIGATION

11.1 Overview

This chapter presents primary impacts from the Project that will likely affect the physical, biological and social environments. It also provides recommendations for mitigation measures to minimize if not totally avoid these impacts. Impacts were assessed based on their extent, duration, significance and vulnerability of receptors (See Chapter 5 Approach). A summary of the impacts are then presented in Table 11.3.

11.2 Pre-construction / Construction phase - Physical impacts

11.2.1. Change in topography, landscape and visual impacts

Issue. Construction of headworks and auxiliary facilities will change local topography and landscape of the Project area

Baseline. The Project area is located in a remote rural mountainous setting. The proposed construction area is distributed at an elevation range of 200-500masl and slopes can reach up to 40^0 to 50^0.	

Impact and rational. The construction of the headworks (dam, penstock, spillway etc), the power station, and the auxiliary facilities will require earth moving activities such as stripping of top soil, shallow to deep excavation and levelling of the slopes/land and eventually change the topography and ultimately the rural landscape setting of the area. The earthmoving activities will also induce soil erosion, sedimentation, slope instability and landslides.

The dam will also give way to a 962ha reservoir (at FSL) with a length of 33km and a conspicuous 96m dam wall.

Location. The main components (e.g., dam, powerhouse, spillway, intake) and auxiliary areas are located in Muong Tip, Muong Ai, Ta Ca and Nam Can commune, Ky Son district, Nghe An province, Vietnam. The reservoir tail will reach up to Laos.

Assessment. The change in topography and landscapes are **site specific** but its duration is **permanent**. Inducement of impacts such as soil erosion are **temporary** and limited during construction only. Sensitivity of the resource is **moderate** having no sensitive physical resource in the Project DIA and overall the impact has a **major significance**.

Proposed mitigation. Advanced engineering measures are now available to arrest slope stability and erosion issues. Available best engineering practices/technology will be considered in the design stage to ensure slope protection and sedimentation ponds will be available. This will be supported with revegetation measures. The 50m safeguard buffer zone along the perimeter of the reservoir will enhance soil protection and watershed management efforts.

Reservoir Catchment Management Plan (CRMP) will be developed to ensure adequate and proper implementation of the indicated measures.

11.2.2. Generation of waste and hazardous materials

Issue. Construction works will generate large volume of solid waste and some hazardous wastes materials.

Baseline. The Project is in rural setting where commercial activities are limited and industrial operations are non-existent and therefore waste are mostly from domestic activities. Waste therefore are kept either within backyard or burned. No community waste disposal area is established more so a landfill.

Impact and rational. The various construction activities will generate the following waste:

- Large volume of soil spoil from the excavation;
- Construction wastes such as left-over building materials (e.g., cement and steel, insulation, electrical wirings, tree stumps/branches, rubble and plastics, nails, shingle and roofing material, lubricants and paints etc.). Construction wastes may contain lead, asbestos or other hazardous substances.
- Domestic waste from 1750 workers and employees during the peak of construction. These workers will produce solid and liquid wastes and will require treatment and safe disposal.
- Hazardous wastes such as used oil and lubricants from the use of petrochemical products from delivery trucks and heavy construction machineries (e.g., bulldozers, booms, brakes, cranes forklifts, and back hoes). In addition, old tyres from trucks and company vehicles.
- Waste from the use of explosives to level off the soil at the construction area or at quarry site.

Improper disposal and handling of the above waste can contaminate soil and water and cause a health hazards to the workers and the community.

Location. Waste will be generated across the Project construction areas and if properly managed, the area of impact will be within the confines of the Project DIA. For hazardous substances that requires special disposal treatment, these will be disposed off-site or stored properly.

Assessment. Extent of impact is **site specific** and has a **short term** duration (construction phase only). With the sheer volume of wastes to be potentially generated, magnitude is potentially **large** with **medium** sensitivity. The impact is of **major** significance

Proposed mitigation. . Waste generation will be managed by developing the Solid Waste Management Plan which will address solid wastes including construction spoils. A Material Use and Site Waste Management Plan will also be developed to address hazardous wastes. A bespoke Construction Environmental Management Plan (Construction EMP) which include water and sediment management shall be developed for the Project. This Construction EMP shall be part of the agreement between the Proponent and the Contractor.

A spoil disposal area of about 14ha has been identified for the Project (see Chapter 3. Project Description). The Plans will provide guidance and procedures on proper disposal and treatment using a waste management hierarchy, reduce, re-use and re-cycle.

11.2.3. Quarry operations

Issue. Quarry operations can cause dust and noise pollution. The quarry area is at some distance from the Project DIA and transport of aggregates will pose road safety problems along its route.

Baseline. The Pah Danh quarry will be the source of rock aggregates. It is estimated that the Project will need 1Mm^3 of aggregates and 0.45Mm^3 of crushed sand. The quarry site is about 6.5ha and located approximately 14km downstream of the dam site. Villages are present along the stretch of this road.

Impact and rational. The operation of the quarry will have the following impacts:

- Potential loss of assets due to widening and upgrading of roads to cater heavy trucks;
- Noise pollution from blasting activities; and
- Dust pollution at quarry area, nearby villages and along the route of delivery trucks.

Location. The Pah Danh quarry is located approximately 14km downstream of the dam site, in Pha Khao and Pha Danh village, Ky Son district Nghe An province.

Assessment. The extent of impacts is **local** and duration is **short term** during construction phase only. The degree of impact is **moderate** and sensitivity is **high** due to the presence of sensitive receptors along the route of delivery. The impact is of **major** significance.

Proposed mitigation. The quarry footprint and the extent of the road to be rehabilitated need to be surveyed and delineated to identify potential loss of assets and determine if compensation is necessary. Land loss is not anticipated because a right of way (ROW) has been established, although some temporary assets may have occupied the ROW.

If blasting is used, there is a need to determine the boundaries of the quarry area and determine its proximity to the nearest sensitive receptors. It is also important to establish baseline of fauna within the quarry area to identify sensitive wildlife that maybe affected by the elevated noise during blasting. A blasting clearance needs to be secured and blasting plan will need to be developed.

11.2.4. Deterioration of water quality

Issue. Damming rivers can reduce water quality due to lower oxygenation and dilution of pollutants. Earthmoving for construction of facilities can further induce pollutants to the river.

Baseline. Drinking water at the Project site is sourced from mountain springs. Few can afford treated water/filtered mineral water. Water for domestic uses is from the river. The river is also used for fishing and recreation such as swimming and navigation. Baseline water quality monitoring indicated a clean water free from industrial pollutive substances although some presence of higher levels coliform were detected.

Impact and rational. The impoundment of rivers can reduce water quality due to lower oxygenation. The relatively stagnant water at reservoirs compared to fast flowing rivers allow dilution of pollutants. Also the flooding of biomass especially forests creates underwater decay and reservoir stratification. Water quality can decline because deeper lake waters lack oxygen. The Project will inundate 962ha and the FSL of the reservoir is 235m.

The earthmoving activities to construct the headworks and auxiliary facilities induce sedimentation and soil erosion. Both impacts will consequently have impact on the water quality of the river. Stripping of vegetation and earthmoving might also alter the spring/s or reduce volume of water used by the community.

Generation of waste (see discussion on waste generations), if not properly managed can potentially contaminate water quality both groundwater and surface water. The diversion of river water to create the dam will increase sediment load and therefore affect water quality.

Location. Change in the quality of the river water can be seen in the reservoir, immediate downstream of the proposed dam and along the river stretch adjacent to the auxiliary

facilities. Depending on the degree of disturbance, load of pollutants and time of the year, where rain water might reduce the concentration of pollutants.

Assessment. Change in water quality is **site specific** but can also extend beyond the Direct Impact Area (see above). Although the trigger is **short term** (construction activities), depending on the degree of effect, it can extend to **medium term** (e.g., slow release of sediments). For this impact, magnitude is **large** and sensitivity of the resource is **high**. The impact is of **major** significance.

Proposed mitigation. Water quality can be maintained or potential impacts reduced by:

- Delineate boundaries of the work areas to limit unnecessary clearing;
- Schedule activities areas to be cleared/ stripped to exposure at one given time;
- Stabilisation of slopes;
- Development of the Construction EMP that shall contain management of water quality, sedimentation, construction and domestic waste including toxic wastes.
- Sanitation improvement and waste management programs in the villages and camps would be required.

11.2.5. Flood risks

Issue. Flood risks during river water diversion and reservoir filling/inundation

Baseline. There are 11 villages in Vietnam and 5 villages in Laos that are either located within the proposed dam site or construction areas and will be inundated or lose land during the filling of the reservoir. The PAF will however be relocated prior to any construction activities (see Social section). A total of 962ha will be submerged, along with physical assets and vegetation.

Impact and rational. Although relocation will be done prior, the river diversion may pose flood risks to some extent, e.g., stray animals, assets very near the reservoir edge. The diversion may also create a local tremor (reservoir triggered seismicity) from the strong current of the diverted water. Increased suspended solid is also anticipated as the water current scour the bottom sediments.

Location. Within the estimated reservoir area of 962ha.

Assessment. Extent of the inundation covers Laos territory and Vietnam territory which makes it **regional**. Duration however is **short term** within the construction phase while magnitude of impact is **large**. With no declared national parks or any highly sensitive resource to be submerged except for two plant species, an epiphytic herb species (*Drynaria fortunei*) and *Hopea mollissima* (see Biology and Social sections), resource vulnerability is **medium**. The impact is of **major** significance.

Proposed mitigation. Relocation of conservation plants will be carried out prior to construction. A resettlement policy framework that covers the required elements for a relocation plan including compensation is discussed in Social section. An Emergency Preparedness and Response Plan (EPRP) that contain a warning notification system shall be developed to ensure that once water diversion has started, the safety of both the workers and community is paramount.

11.2.6. Riparian release and environmental flows

Issue. Maintenance of riparian release and environmental flow during inundation of the dam (and moving into the operation phase).

Baseline. The proposed dam site overlaps with the reservoir of Nam Mo HPP downstream (See Cumluative Impact). At present, there is sufficient water since its MOL has to be maintained.

Impact and rational. During reservoir impoundment, upstream of the dam has to be collected to meet water storage requirement before the operation of the hydropower. However, there is still a need to release and maintain minimum flow downstream to mitigate and maintain the MOL of Nam Mo HPP downstream. A reduction in water flow downstream is likely to happen.

Location. The river stretch downstream of the proposed dam site of Nam Mo 1 HPP reservoir.

Assessment Potential affected area will be local and will only be felt during filling of the reservoir and therefore **short term**. The degree of impact is **major** and because of the presence of the villagers downstream who use the river, vulnerability is **high**. The impact is of **major** significance.

Proposed mitigation. Reduction of flow is inevitable during the water impoundment. At this stage, it has not been determined how much reduction is anticipated. The detailed design phase shall include modelling of water releases. The dam reservoir of Nam Mo HPP downstream stretching into the reservoir of Nam Mo 1 HPP is of prime consideration.

11.2.7. Air and noise pollution

Issue. Construction activities pose air and noise pollution

Baseline. The Project AI has no indication of air pollution while noise level is also inherent of rural setting and therefore has low levels. There are no significant sources of man-made air pollution and noise in the area except for road traffic (usually motorbikes or small trucks) which are irregular and in-frequent. Baseline noise and ambient air monitoring are all within the national standards.

Most of the community however, prepares food using solid fuel (eg wood, charcoal or crop wastes) in open fire. Such inefficient cooking fuels produce high levels of indoor pollution with health damaging pollutants including small soot particles that penetrate deep into the lungs. Respiratory ailments are very common in the community.

Impact and rational. Major construction activities will pose air pollution and can be a health hazard to workers and to the residents. Example of construction activities that create dust suspension and release emissions are:

- Road works for access roads;
- Rock blasting and breaking out of hard grounds;
- Foundation excavation;
- Filing;
- Concrete placing;
- Grouting works;
- Plying of delivery trucks and company vehicles across Project AI;
- On-site operation of both fixed and mobile construction plant and equipment; and
- Quarry related activities (e.g., blasting, excavation – detailed impacts are further discussed in quarry section);

Noise generating activities includes the above construction activities including diversion of water and filling out of the reservoir.

Location. Construction areas and along access roads

Assessment. Extent of impacts will be **local** and limited to the construction areas and along the access roads. Duration is **short term** within the construction phase and degree of

impacts is **moderate** at the construction area while **large** along the access roads. There are no sensitive receptors at the construction areas because PAPs should have been relocated prior to construction. Along the access road, there is the presence of sensitive receptors such as settlements, children crossing, school, community activities and traffic, and therefore with a potential **large** magnitude impact. Vulnerability is therefore **medium to high**. The impact is of **major** significance.

Proposed mitigation. Noise reduction options that shall be considered during construction include:

- Relocation of sensitive receptors (see Social section);
- Positioning of temporary site compounds as far as reasonably practical from sensitive receptors and use of terrain, material stockpiles and natural vegetation as screen to maximise distance between work activities and receptors.
- Selecting equipment with lower power levels;
- Installation of suitable mufflers on engine exhausts and compressor components;
- Installation of acoustic enclosures and noise barriers;
- Limiting the hours of operation especially for noisy equipment;
- Scheduling of workers movement and use of vehicle as practicable to avoid peak of traffic volume/ community activities;
- Ensuring compliance with MIGA standards;
- Undertake construction activities in accordance with best practices; and
- Develop a Grievance Redress Mechanism, both for the workers and the community to record complaints and be able to adequately and properly address concerns.

Poor air quality due to release of contaminants can result in possible respiratory irritation. If the above best construction practices are practiced, this also eliminate sources of air pollution. In addition, awareness and education related to sanitation and general health program is part of the social programs for the community.

11.2.8. Traffic impact

Issue. The increase of road traffic poses road safety and health hazards

Baseline. Traffic is low and the mode of transportation is mostly motorbikes and motorboats. About 30-50% of the households own a motorbike while most of them have motorboatsand many local people go on foot. There are a few trucks that are used to transport limited farm produce such as rice and maize. Motorbikes are also used for mobile trade (e.g. products such as mattresses are being sold house to house using motorbikes).

Impact and rational. The transport of heavy equipment, delivery of construction materials, movements of workers and employees (e.g., estimated at 1,756 during construction) will create a significant disturbance in a currently slow traffic. The significant increase in traffic will also pose road safety hazards to the community.

Location. Construction area and along access roads.

Assessment. The extent of impacts will be **local** and limited to the construction areas and along the access roads. Duration is **short term** within the construction period. The degree of impacts is **large** because the community has not been exposed to high volume traffic and some roads are not ready to accommodate the significant increase in vehicular traffic including heavy trucks. Vulnerability is **high** because of the presence of sensitive receptors (community) and limited resource (existing road conditions). The impact is of **major** significance.

Proposed mitigation. Roads shall be upgraded both to cater the increased volume and type of vehicular traffic (e.g., heavy trucks). Road safety measures will be implemented and will include the following:

- Road safety signs shall be installed in strategic locations
- Vehicles will be properly maintained; and
- Drivers will be trained in safe driving.
- Influx Management Plan and safety plans

11.2.9. Sedimentation (operation)

Issue. The impact of siltation and sedimentation in the reservoir

Baseline. Estimated annual sediment load is $675x10^3m^3/yr$ was reported for NamMo1 HPP. A sediment modelling has yet to be prepared to determine potential sediment yield at the reservoir within the Projects operation period.

Impact and rational. Overtime, sedimentation reduces live storage and at some degree the power generation capacity, and ultimately economic viability of the HPP.

Location. Reservoir

Assessment. Extent of the impact is **site specific** to the reservoir and impact is **long term**. The magnitude is **major** and sensitivity is **high** and therefore significance is **major**.

Proposed mitigation. Watershed management can minimize sedimentation and extend the reservoir's useful physical life. Measures shall include:

- Control of road construction and other land uses in the upper catchment area;
- Establish forest conservation (planting and maintaining) areas upstream of catchment to reduce sediment flows in to the reservoir. The 50m buffer can serve for this purpose;
- Maintain slope stability through using new and efficient slope engineering techniques; and
- Install upstream sediment check structures, protect dam outlets.

The operational regime should also consider regular flushing reservoir, otherwise removal of sediment mechanically will be needed, which is costly.

11.3 Pre-construction/ Construction phase - Biological impacts

11.3.1. Impact on forest and wildlife biodiversity

Issue. Inundation of forests can cause loss of forest and wildlife biodiversity and wildlife habitat, and construction activities can disturb wildlife habitat.

Baseline. Secondary forests, e.g., mixed evergreen rain forest, semi-deciduous forest and mixed broadleaf bamboo forest have regenerated after exploitation, and some progressive forest succession has taken place on abandoned uncultivated land for the last 3-15 years. The biodiversity value of forest vegetation in the direct impact area of the Project is low to medium since these growing forests are still disturbed due to grazing and occasional conversion to upland farming. Out of the total 420 vascular plant species, 149 of them are medicinal plant and edible plant species, fuelwood and timber species, and ornamental and rattan /bamboos species. There are two threatened species *Drynaria fortune* an epiphytic herb and *Hopea mollissima*, however these species are widely distributed in adjoining forests.

The secondary forest, mixed broadleaf bamboo forest, and riverine area provide essential habitat for small mammals from the orders of rodents and bats, and bird species, reptiles and amphibians. There are no large mammals in the Project DIA. There are 30 mammal, 22 reptile species, 19 amphibian species, 96 bird species reported to occur in the Project DIA. Three mammal species and 2 reptile species are listed in IUCN Red List as species of

conservation concern. The wildlife in the Project DIA serves as tangible ecosystem products to the local communities (e.g., such as food and some organs of animals for medicinal purposes). There are 38 species of wildlife used as food by the villagers including ten mammals, ten reptiles and six species of amphibian.

Impact and rational. There will be loss of forest biodiversity and habitat of small mammals, bats, lizards and amphibians due to inundation of about 1764ha forests along the Ca River to a stretch of 33 km, and submerge plants of the two threatened plant species *Drynaria fortune* and *Hopea mollissima.* Small size wildlife, bird, reptile will move out of submergence area or spreading far from Project site for new habitat. The two vulnerable plant species, are well distributed in adjoining secondary forests.

There will be disturbance to wildlife habitat at the construction sites and some smaller species e.g. frogs, lizards and rodent species may be killed. Large size mammals e.g. monkey, wild boar, mumtjac will move to further calm forest in higher areas. Wildlife dispersed from the site during construction disturbances will come back when noises caused by construction activities are reduced under project operation.

Location. All along the 33 km long reservoir and construction areas.

Assessment. The extent of the Project impact is **site specific** in reservoir and construction areas. Impacts will be **long term** duration due to loss of forest biodiversity and wildlife habitat in submergence area, while wildlife habitat disturbance in construction area will **short term** duration. Magnitude of the impact is **large** in reservoir area and **small** at construction sites. Sensitivity is high in reservoir area and **low** in construction sites**.** The overall significance of the impact is **moderate**.

Proposed mitigation. . Reservoir Catchment Management Plan (RCMP), Safeguard Buffer Zone, Biodiversity Enhancement and Environmental Services Restoration Plan (BEESRP), and Endangered Species Restoration shall be developed and implemented for restoring and improving biodiversity numbers status and wildlife habitat in the Project DIA. The conservation plant species will be relocated from the inundation area. The safeguard buffer zone will create suitable environment for small mammals, bats, lizards and amphibians.

11.3.2. Impact on aquatic life and fisheries

Issue. Barrier to movement of migratory fish species, change in aquatic habitat in reservoir and habitat disturbances at the dam site during construction are the major issues.

Baseline. There are 80 fish species in Nam River and its tributaries; streams have normally small fish species, preferring rapid water and high oxygen content. Among the 80 species five species, *Anguilla mamorata*, *Acrossocheilus annamensis*, *Hemibagrus guttatus*, *Bagarius rutilus, Bangana lemassoni*, are listed as “Vulnerable” in IUCN Red List. The *Hemibagrus guttatus, Anguilla mamorata* and *Bagarius rutilus* are medium to long distance migratory fish species and they are overexploited for their high sale value. The Nam Mo dam constructed downstream of this proposed project has already obstructed their movement and their habitat has been fragmented and a small population is now adapting to this new environment.

Impact and rational. (a) Habitat of aquatic life and fish species will alter at the dam construction site due to water course change, increase in turbidity and water pollution from lubricants, cement slurry and other chemicals. Reduced visibility will normally reduce primary production (algae and peripyton) affecting the invertebrates and fish, thus eventually fishery activities. Species of fish preferring clean water habitat and oxygen rich habitat will be reduced and could disappear. Biodiversity will be less, fish species of migration habit along river and oxygen and clean habitat adapted fish species will be gradually replaced by small size fish species which can bear and deal with polluted environment.

(b) Aquatic species structure and composition will change both in quantity and quality, reflecting typical characteristics of aquatic communities in reservoir. High sediment load, increased organic and nutrients from decomposed vegetation will favour mud eating fish species adapted with stand still water environment and fish species adapted with flowing water environment will reduce both in number of species and quantity. Fish biodiversity will change.

(c) Migratory species in upstream of the dam will be stopped to get to downstream areas for reproduction while fingerlings are stopped in downstream of the dam, unable to get to the upstream to live and grow. Habitat will be fragmented. Low flow in the downstream area during dry season will impact aquatic life and fishery.

Location. Dam site, reservoir, and downstream area

Assessment. The extent of the Project impact is **site specific** in reservoir and construction area and downstream area. Biodiversity impact in reservoir will be **long term** duration. Magnitude of the impact is **medium.** Sensitivity is **moderate** and the overall significance of the impact is **minor** as dam downstream has already obstructed upward movement of migratory species.

Proposed mitigation. Compensatory environment flow will be regulated which could minimize downstream impacts. Periodic removal of blue algae and weeds in the reservoir, and implementation of Fisheries Support Plan are proposed. A fish adaptation study is also proposed to monitor fish species diversity and populations in the Nam Mo 1 reservoir and downstream stretches (See Chapter 12).

11.4 Social

11.4.1. Impact on physical assets

Issue. The reservoir will inundate the villages along the river and the tributaries that will be part of the reservoir. All private residential land, houses and assets, and all public infrastructure and structures will be inundated.

Baseline. Private houses in the villages are constructed mainly with local materials, wood and bamboo from the forest, most houses are built on stilts, but there are also private houses located on the ground with a cement basement. The public buildings (village cultural house, kindergarten and school) in Vietnam are Vietnamese (Kinh) style houses built on bricks and cement on a concrete basement on the ground. Space and land used for fruit trees and home gardens around houses varies between different villages. Villages in Muong Ai and Muong Tip communes as well as Namuang village in Laos have grid electricity, in other villages a micro-hydropower generator in the river provides each household with electricity. Intra-village roads are mostly soil paths, and the village access roads are not year-round vehicle accessible ones.

Impact and Rational. The reservoir will inundate the entire villages including:

(1) Private family houses and all the related household assets

(2) Residential land around the family houses with garden and fruit trees

(3) Family electricity supply with micro hydro generators in the river and related power lines

(4) Public infrastructure: (i) Public water tanks with related water pipes for household water supply; (ii) electricity supply; (iii) intra-village roads; (iv) village cultural house; (v) kindergarten, (vi) school

Location. Nine villages in Vietnam: Xop Tip in Muong Ai commune, Xop Tip, Xop Phe, Cha Lat, Vang Ngo and Ta Do in Muong Tip commune, and Sa Vang, Na Nhu and Nhan Ly in Ta Ca commune, as well as in Laos Namuang village in Kouan District are located in the reservoir inundation area and will be permanently lost in the reservoir inundation.

Assessment. The extent of the project impact on the villages is **site specific** in the reservoir area and will be **permanent** in duration. Magnitude of the impact on village inundation is **large**. Sensitivity is **high**, due to extreme poverty and vulnerability of the affected ethnic minority people. The impact is of **major** significance.

Proposed Mitigation. The affected villages have to be relocated and full compensation provided for all land and assets lost due to the HPP. The impact is assessed and required mitigation measures proposed in the Resettlement Policy Framework (RPF) of the REMLRP. The RPF is based on the baseline assessment, assessment of the expected impacts, and on the opinions and concerns from the affected people during the first phase consultations of the ICP process that were undertaken during the ESIA preparation.

A Resettlement Action Plan will be required for each affected village following MIGA standards and has to be prepared in the next phase of detail design of the HPP, when all the detail losses will be confirmed.

11.4.2. Impact on physical assets of the government

A. Commune centre

Issue. Muong Tip commune center is located in the inundation area and has to be relocated.

Baseline. Local government offices and commune health centre are located in the commune centre. These provide services for the commune inhabitants. The commune office building is a wooden one and the health clinic is a Kinh-style stone building.

Impact and Rational. The reservoir will inundate the Muong Tip commune centre with government offices and health clinic, impacting the commune administration and related services as well as health services provided for the population in the entire commune. The houses and other constructions and infrastructure will be lost in the reservoir.

Location. Muong Tip commune centre is located in Vang Ngo village.

Assessment. The extent of the project impact is **site specific** in the reservoir area and dam construction area and will be **permanent** in duration. Magnitude of the inundation impact is **medium**. Sensitivity is **medium**, and the significance is **moderate**.

Proposed Mitigation. Proposed mitigation is provided in ESMP, and decision of the compensation made in consultations with the local government.

B. Border military and District Forest Management Board

Issue. Two border guard stations and a field office of Ky Son District Forest Management Board are located in the area to be inundated. These have to be relocated.

Baseline. The project area is located in the national border area between Vietnam and Laos, and there are border military stations along the river. Protection forests in the area are allocated to management by local villages by the District Forest Management Board.

Impact and Rational. The reservoir will inundate two border guard stations and a Ky Son District forest management board field office. These have to be relocated.

Location. One border guard station is located between Sa Vang and Ta Do villages by the road along the river, the other one is located along the Nam Tip tributary river upstream Xop Tip village. The forest management board office is located in Ta Do village. They all are located in Muong Tip commune area.

Assessment. The extent of the project impact is **site specific** in the reservoir area and dam construction area and will be **permanent** in duration. Magnitude of the inundation impact is **small**. Sensitivity is **low**, and the significance is **minor**.

Proposed Mitigation. Proposed mitigation is provided in ESMP, and decision of the compensation made in consultations with the GoV.

11.4.3. Impact on cultural heritage

Issue. Land areas and assets that are of crucial cultural and spiritual importance for the affected ethnic minority people will be inundated.

Baseline. All the affected villages have: (1) A spirit forest area which is comprehended as the residence of the dead; (2) Graveyard located outside the village, often near the river; (3) Village worship site, sometimes with a very simple wooden spirit house or wooden platform for offerings only, usually located in the outskirts of the village. These cultural sites and assets are central in the worldview of the affected people and therefore have to be taken into consideration in a culturally sensitive and appropriate way.

Impact and Rational. The reservoir will inundate village worship sites in the affected villages, and land areas with spirit forests and graveyards.

Location. The culturally important lands and assets of each affected village are located in the inundation area near the village or at a short distance from it. Some of the graveyard and spirits forest areas may not be inundated but be located near the reservoir border, but remain at a distance from the village resettlement site. The exact location of the area of each village and the reservoir impact will be assessed in detail in the planning and design phase of the HPP during the relocation and compensation planning.

Assessment. The extent of the project impact is **site specific** in the reservoir area and will be **permanent** in duration. Magnitude of the inundation impact is **large**. Sensitivity is **high**, due to the central role of the spirits of the dead and the gods/spirits of different natural elements and places in the worldview of the affected ethnic minority people. The impact is of **major** significance.

Proposed Mitigation. Proposed mitigation is provided in the RPF of the REMLDP. According to the traditions of most of the affected ethnic minority groups, graves need not be relocated if inundated. However, some families have expressed worry over the submerged spirits and want to relocate the graves. New graveyard, new spirit forest and new village worship site have to be founded in the resettlement site in a culturally sensitive and appropriate way. The project is required to provide compensation to the affected people for arranging culturally required spirit relocation ceremonies, some of which according to the ethnic tradition have to take place one year before the relocation of people.

11.4.4. Impact on the downstream low flow area

Issue. Downstream the dam water flow will potentially be reduced during the dry season.

Baseline. In the operation one village in the downstream is potentially affected by reduced water flow during the dry season and water fluctuations depending on the dam operation regime, however, this village is located in the existing Nam Mo Nam Mo HPP reservoir area.

Impact and Rational. Dam downstream area may potentially be affected by reduced water flow during the dry season and water fluctuations depending on the dam operation. This may have impact on fishery, riverbank cultivation, river transportation and household water availability.

Location. Downstream the dam. The area is within the Nam Mo HPP reservoir.

Assessment. The extent of the project impact is **site specific** in the downstream area and will be **long term** in duration. Magnitude of the downstream impact is **small**, due to the area being within a HPP reservoir. Sensitivity is **minor**, and the significance is **minor**.

Proposed Mitigation. Proposed mitigation is provided in ESMP through monitoring of water use and water levels.

11.4.5. Impacts due to construction activities and influx of workers and camp followers

Issue. An estimated 1750 workers will be present in the workers' camp during the peak of construction works, and additional camp followers is expected. Influx of people will have a social, cultural and health impact on the local communities near the construction areas and along the transportation roads.

Baseline. Resettlement villages and downstream villages will be located at a short distance from the construction area and workers' camps. Villages are very poor and the populations consist of ethnic minority people with a traditional and isolated lifestyle. However, due to the previous construction of the Nam Mo HPP, local residents have already been exposed to a construction situation with migrant workers; additionally, many younger men and women from the villages have been working periodically in other parts of Vietnam and Laos.

Impact and rational. Villages in the nearby area to the HPP will be impacted by the influx of high numbers of people coming from outside the local setting. There will be not only new opportunities for trade and business with the construction staff, but these will also potentially increase the pressure on natural resources in forests, lands and water if not properly managed. Local people will be affected by the presence of construction workers and camp followers, transportations, noise, dust and other disturbance from the construction (See physical section). Local people are vulnerable to losing their social norms, ethnic culture and way of life, as well as be at risk for prostitution, sexually transmitted diseases, drugs, drinking, human trafficking, gambling, etc. through an influx of the expected 1750 mainly male workers plus camp followers from other parts of the country with different culture and lifestyle and more available money. There is a high risk for negative social as well as both physical and mental health impacts from the presence of the HPP construction, especially on women and children.

Location. Workers' camps will be located at a distance of a few kms from the nearest villages and there will be road access between the construction area and the local communities.

Assessment. The extent of the project impact on the local communities is **site specific** in the local area and will be **short term** in duration. Magnitude of the impact is **medium**. Sensitivity is **high**, due to the extreme vulnerability of the affected ethnic minority people. The impact is of **major** significance.

Proposed mitigation. A community awareness program on risk behavior, HIV/AIDS and other sexually transmitted diseases (STDs) and human trafficking prevention is proposed as part of the REMLRP. The program will cover all the villages in the vicinity of the construction areas and along the transportation roads to the construction area.

ESMP will include the awareness raising and agreements required to reduce the potential risk on the local environment by the construction workers through hunting, fishing, wood removal from the forest, etc.

Construction contractors will also be required to implement an awareness program for all the construction workers on risk behavior, HIV/AIDS and other sexually transmitted diseases (STDs) and human trafficking prevention. The program will be included in all the construction contracts. An Influx Management Plan following MIGA standards has to be prepared in the next phase of the planning and detail design of the HPP.

11.5 Pre-construction / Construction phase Impact on livelihoods

11.5.1. Reduced access to wildlife harvests for food

Issue. Loss of wildlife used as food by the local community.

Baseline. The forests and the riverine area serve as provisioning food products to local communities. Wildlife species such as rats, bamboo rats, civet, tree squirrels, wild chicken

and birds, wild dragon, gecko, some species of snakes and frogs are sources of protein. Some organs of wildlife species are also used for medicinal purposes.

Impact and rational. Loss of about 1042ha forest land to inundation and restrictions imposed on wildlife collection/harvest in safeguard buffer area covering about 559ha all along the reservoir stretch will reduce wild life hunting opportunities for local communities. This will impact upon nutrient rich food availability and will put more pressure on the remaining forests for hunting.

Location. Forests and riverine areas along the reservoir in all Project affected villages.

Assessment. The extent of the Project impact is **site specific** in the reservoir and safeguard buffer areas. Impacts will be **long term** in duration. Magnitude of the impact is **medium**. Sensitivity is **high** because of reduced availability of food from forests and the overall significance of the impact is **major**.

Proposed mitigation. The BEESRP will be developed. Conservation and managed harvests of wildlife in DIA forests and riverine areas will be adopted. The approach will be sustainable harvests of wildlife used for food by local community. This program will be implemented in the remaining production forest areas and in some parts of protection forests at community level. It will be planned and implemented as a "compensatory program" to enhance the livelihoods of ethnic minority population (see Biology section).

11.5.2. Impacts on livelihoods related to Nam Mo River

Issue. Loss of fish and other river resources (e.g., shrimp, crabs, shells) used as food by the local community.

Baseline. Generally, all households fish for consumption. Both rivers and streams are used. Fishes, shrimp, crabs, frogs and snakes among others contribute to protein requirements of local communities, as well as provide cash for livelihoods. Locals people indicated that reduced fish yields are primarily due to over fishing. Many families have boats used for fishing, and access is not an issue. Aquaculture practice is not common although a few households have maintained a small pond each and rear fish species collected from the river.

Impact and rational. Alteration in aquatic habitat and water pollution in river and riverine areas in the construction sites, e.g., Nhan Ly, and over harvesting for meeting the demand from the workforce during construction would reduce fish catch in Nhanly and downstream villages. Barriers to fish migration during operation phase will further reduce fish catch in reservoir area. Displaced people from the direct impact area will be resettled higher up from the river and they will have less access to the reservoir for fishing. Again, controlled water release from the dam will affect the river ecosystem downstream the dam and fishing will be much reduced particularly during the low flow period.

Location. Within the reservoir and downstream villages such as Nhan Ly and downstream villages.

Assessment. The extent of the Project impact is **site specific** in the reservoir area and immediate downstream from the dam. Impacts will be **long term** in duration. Magnitude of the impact is **medium**. Sensitivity is **high** because of reduced availability of fish and other river resources during construction and thus the overall significance of the impact is **major.**

Proposed mitigation. Implementation of the Fisheries Support Plan (see section ESMP) which will have program components such as cage fish program, community fish farming in relevant villages and provision of community managed boats. The environmental flow shall also be decided in the detailed design regulated and monitored to main aquatic ecosystems just below the dam.

11.5.3. Loss of livelihoods related to livestock

Issue. Loss of fallow land and forests will reduce grazing area and forage availability for ruminant livestock like cattle, buffaloes and goats.

Baseline. The villagers rear cattle, buffaloes, goats, pigs and poultry including ducks. Pig and poultry population is volatile and decreases drastically with frequent disease outbreaks. All animals are reared under free-ranging management system. Disease outbreaks in poultry, pigs and cattle are uncontrolled due to lack of animal health services, and frequent animals deaths mean a great economic loss for the poor farmers.

Impact and rational. Farmers will lose grazing area of about 900ha forest on riverbanks that will be inundated, about 560ha forests in safeguard buffer area, and about 85ha of fallow land after crop harvest. Loss of land will reduce forage availability and affect livestock production; pressure on adjoining forest areas for animal grazing will potentially increase as well.

Location. Fallow land and forest area along Nam Mo river in all the DIA villages

Assessment. The extent of the Project impact is **site specific** in the reservoir and safeguard buffer areas. Impacts will be **long term** in duration. Magnitude of the impact is **medium**. Sensitivity is **low** because of less productive ruminants and the overall significance of the impact is **minor**.

Proposed mitigation. Development of a Biodiversity Enhancement and Environmental Services Restoration Plan (BEESRP, see ESMP section). This will involve propagating / planting, conserving and managing plant materials that could provide food and medicines for local community and forage for ruminant livestock. This program will be implemented in the remaining production forest area and in some parts of protection forests at community level. It will be planned and implemented as “compensatory program” to enhance livelihoods of ethnic minority population.

11.5.4. Inundation of land areas used for livelihoods activities

Issue. Loss of agricultural land and crop production which are the basis of livelihoods for local communities.

Baseline. Nine villages in Muong Ai, Muong Tip and Ta Ca communes, in Vietnam and one village Namuang, in Nonghed district, Laos, cultivate rain-fed crops on about 1,147ha of swidden land. Under the rotational farming system, they have access to about 2,294ha additional swidden land for crop cultivation. Villagers grow wetland paddy along streams in about 26ha and they plant vegetables and fruit crops on riverbank and homesteads. They grow rain-fed paddy maize and cassava as main crops on swidden land and some minor crops like peanut and pumpkin.

Impact and rational. Farmers will permanently lose about 55ha of swidden land in the reservoir, 10-12ha in Safeguard Buffer Area and about one hectare at the auxiliary construction site and some farming land on river bank and homestead. There will be an annual loss of up to 61mt rice, 23mt maize, 51mt cassava, about 1 mt of peanuts and minor crops as well as loss of fruits and vegetables grown on riverbank in reservoir area.

Assessment. The extent of the Project impact is **site specific** in the reservoir area will be **long term** in duration. Magnitude of the impact is **small** as just about 10% of their cultivated swidden land is lost. Sensitivity is **high** due to high poverty status while the overall significance of the impact is **major.**

Proposed mitigation

a) The swidden land lost in production forest area has low productivity. Moreover this land area will be reasonably compensated and provided a resettlement site so as to ensure livelihood and living standard of PAPs will be better than before (see RPF).
b) Development of an Upland Farming Diversification Plan (see ESMP). This will include component on crop diversification and multiple cropping with perennial plants – fruits and fodder and medicinal plants.
c) Development of the Soil Fertility Enhancement Plan (see ESMP). Simple compost making practices such as using biomass collected from nearby forests, crop residues and cattle dung will be adopted and implemented as pilot project in the swidden land as well as in wetland paddy area and home gardens. Legumes such as soybean, beans or other similar plants will be intercropped with maize and cassava which will provide some edible and also enhance soil fertility.

11.5.5. Impact on river transportation

Issue. Impact of the dam and reservoir on river transportation between up- and downstream areas.

Baseline. Due to road access in all the affected villages and the shallow and rocky structure of the river in many areas, the Nam Mo River is used only moderately as a transportation way by the villages to be affected by the reservoir inundation. Nam Mo HPP downstream the planned Nam Mo 1 dam has already affected accessibility so that villagers can no more travel by boat to the district town as they used to do before the Nam Mo dam construction. River transportation of agricultural products, timber and NTFPs currently takes place in a limited scale in the planned reservoir and downstream area. People also cross the river for visiting relatives and for working in Laos.

Impact and Rational. River transportation will be disturbed by the reservoir inundation and the dam will cut off transportation between up- and downstream areas. Lost transportation of goods and people will affect communications and transportation of agricultural and forest products from production areas to villages.

Location. Reservoir area and downstream the dam. Both the villages along the river to be inundated in the reservoir area and the villages downstream the dam will be affected.

Assessment. The extent of the project impact is **site specific** in the reservoir and downstream area and will be **permanent** in duration. Magnitude of the impact is **moderate and** the sensitivity is **moderate** because Nam Mo dam has already cut off the transportation route and impacted on people's lives and livelihoods. The impact is of **moderate** significance.

Proposed Mitigation. All the affected villages will have a vehicle accessible year-round road. To compensate for lost river transportation other type of transportation means have to be considered in the detail design phase. The impact is assessed and required mitigation measures proposed in the REMLRP.

11.6 Operation phase

11.6.1. Impacts on the downstream low flow area during operation

Issue. Downstream the dam water flow will potentially be reduced during the dry season.

Baseline. Fishing and river transportation is important for the villagers, animals are grazing on the riverbank and drinking the river water, and people wash clothes and bath in the river. The Nam Mo HPP downstream reaches or beyond the planned dam of Nam Mo 1 HPP

Impact and rational. Villages in the downstream may potentially be affected by reduced water flow during the dry season and water fluctuations depending on the dam operation.

This may have impact on fishery, riverbank cultivation, river transportation and household water availability.

Location. Downstream of the NamMo1 HPP damsite.

Assessment. The extent of the project impact is **site specific** in the downstream area and will be **long term** in duration. Magnitude of the downstream impact is **medium**, expected to occur only part of the year. Sensitivity is **medium**, and the significance is **moderate**.

Proposed mitigation. Proposed mitigation is provided in ESMP through monitoring of water use and water levels. The Project's operational regime, when finalized during the detailed design shall consider the environmental flow and the existing NamMo operational regime as well.

11.6.2. Implementation of the environmental safeguards

Issue. Implementation of the environmental safeguards (the ESMP) will enhance the physical features and biodiversity of the Project AI thus having a positive effects.

Baseline. The Project DIA has been assessed to have low to medium biodiversity as human pressure to the available natural resource is high. Forest serves as the primary source of food for the villagers, and the river provides source of protein. Some areas declared as Protection Forests are converted into swidden farming. The pressure for exploitation for forest products for food and use of natural resource is expected to increase as the population increases in the area. Without sustainable management of these resources, biodiversity is further put at risk. Swidden farming also leaves soil less productive, can result to landslides, increase soil erosion and ultimately affect water quality and fishery resources.

Impact and rational. The development of the Environmental and Social Management Plan (see ESMP), if implemented properly and adequately will ensure that the impacts identified will be mitigated and addressed. The above current conditions of natural resources will be improved and enhanced. The REMLRP also aims to improve the living conditions of the PAF/PAP. The Project is also expected to generate employment for the community which will decrease their dependence on natural resources alone.

Location. The Project area and especially the DIA.

Assessment. The extent of the Project impact is **site specific** and duration is long term. Magnitude of the impact is **large** and sensitivity is high therefore the overall significance of the impact is **moderate**.

Proposed mitigation. See ESMP and REMLRP

11.7 Cumulative impacts

The cumulative impacts has been assessed based on the principle outlined in the IFC Guidance Notes (2012). Cumulative impacts are those that result from the incremental impact of the Project when added to existing, planned and reasonably predictable future projects and developments.

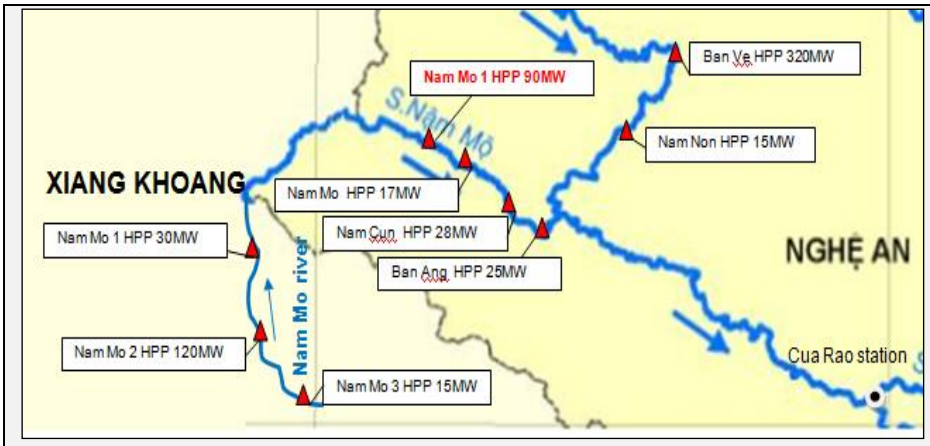
The purpose therefore of this assessment is to better understand the impacts of the existing HPP and planned HPPs within the Ca river cascade system, together with this Project. There is currently limited quantitative data available to make an informed cumulative impact assessment. As more information on the planned operation and information from proposed monitoring (river and use) will only be available at the detailed design, the assessment below has been limited to semi-qualitative. The assessment however has looked at different aspects such as biodiversity, critical habitats, sensitive receptors, livelihood and ecosystem services. Two of the large rivers that flow downstream into Vietnam from Lao PDR are the Ca (Nam Non in Lao) and Nam Mo (a tributary of the Ca) rivers. These join in confluence and flow into the Gulf of Tonkin at Vinh City. Nam Mo 1 HPP is planned on the Nam Mo river where there are existing, under-construction and planned dams in both the Vietnam

and Lao PDR territories. The list and figure below provide an indication of HPPs upstream and downstream of the Nam Mo 1 HPP (Table 11.1, Figure 11.1). The Nam Mo 1 HPP is located between an existing HPP (Nam Mo) downstream and a planned one upstream in Laos (Nam Mo 1, having the same name).

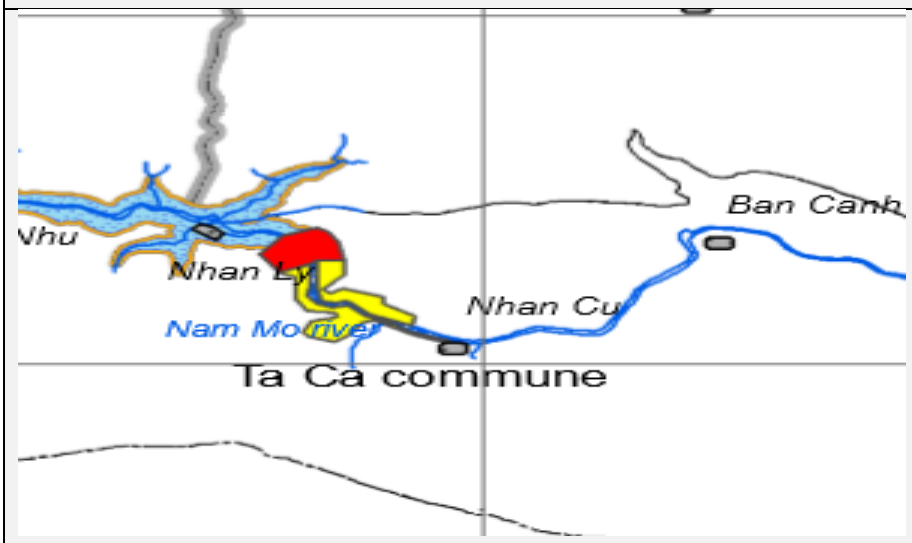
Table 11.1 Existing and planned hydropower projects on the Nam Mo river

Hydropower projects on the Nam Mo river	Installed capacity (MW) Current or planned	Status	Country	Project documents available	Project owner / Proponent
Nam Mo 3	15	Operation	Lao DPR		
Nam Mo 2	120	Under Construction	Lao DPR		
Nam Mo 1* (in Laos, dam site located 18 km from the Vietnam-Laos border; preferred alternative has FSL=430m; MOL=427.5m; dam height = 17 m)	55	FS (April 2011) and EIA completed (by PECC3 and EVN1 (Vietnam)	Lao DPR	Technical Design Hydrological report EIA, SIA report	Hanoi Construction Investment, Trading and Technology JSC, 2016
↑ Upstream					
Nam Mo 1 (this Project)	90	FS	Vietnam-Lao DPR	GoV Technical FS, EIA and RP, GoL EIA	My Ly and Nam Mo 1 Hydropower JSC
↓ Downstream					
Tail race outlet of Nam Can 2 HPP (diversion, power station upstream (left bank, Vietnam) of existing Nam Mo HPP)	20	In Operation	Vietnam		
Nam Mo (FSL = 157.7 m; MOL = 156; 5.1 km from planned Nam Mo 1 HPP. Has its reservoir overlapping with that of Nam Mo 1 HPP)	18 (was 17, 16.6)	In Operation (since 2013)	Vietnam		Nam Mo Hydroelectric JSC, 2016, 16/121 Thai Ha St., Trung Liet Ward, Dong Da Dist.,**Ha Noi**
Nam Cun	28	Under construction	Vietnam		
Ban Ang	25	Operation	Vietnam		
FS = feasibility study					

*Note that this planned HPP is located in Laos and has the same name as this planned Project.



A. Location of the planned Nam Mo 1 HPP (90 MW) in Vietnam (Nghe An Province) in relation to existing and planned hydropower project projects. Ivory colored area is Laos (XiangKhouang Province).



B. The existing Nam Mo HPP downstream (show in picture below) of the planned Nam Mo 1 HPP is located at Ban Canh village approximately 5 km from the planned Nam Mo 1 HPP dam site.

(note: red area in line map is the Nam Mo 1 HPP dam site and yellow the permanent and auxiliary project works area)

C. Ban Can 2 HPP is a diversion project with the power station and tailrace located on the left bank of the Nam River, about 1.2 km upstream from the existing Nam Mo HPP dam site.

D. The existing in-operation Nam Mo HPP downstream (5 km) of the planned Nam Mo 1 HPP

Figure 11.1 Hydropower projects in Nam Mo river (A, C,D) and downstream villages (B).

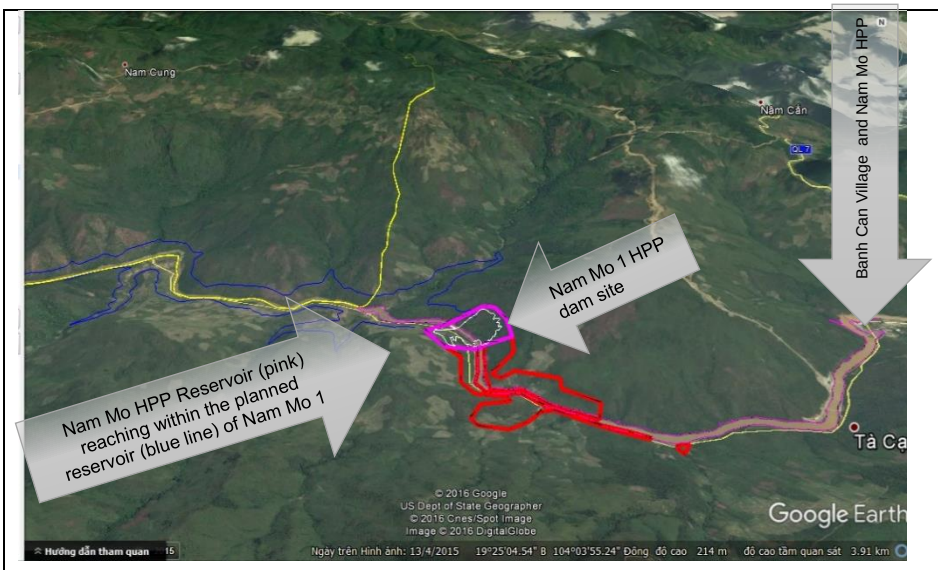
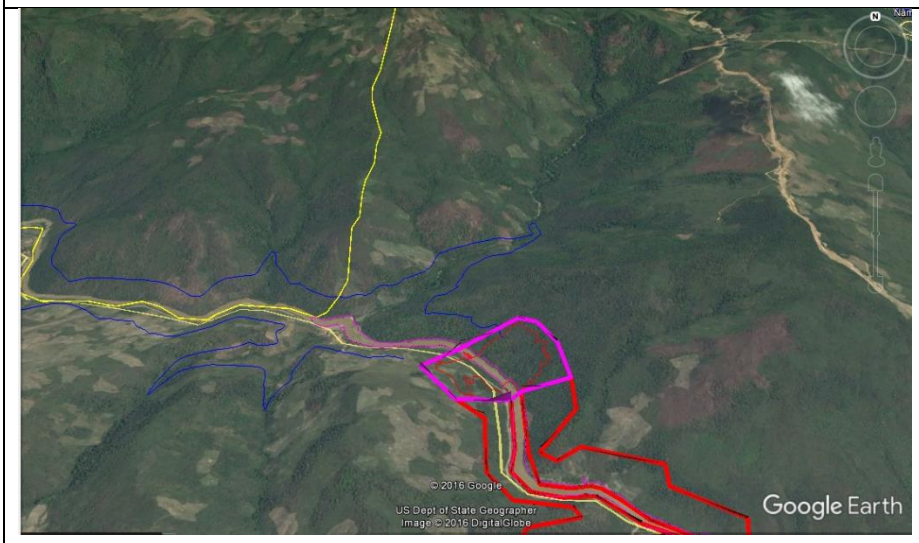
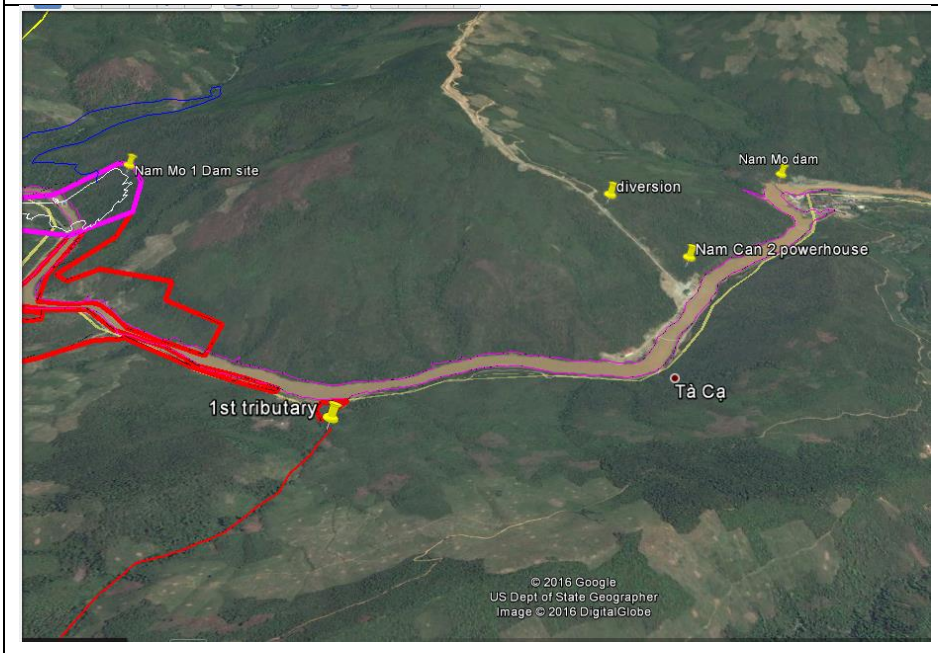
The potential impacts of the planned Nam Mo 1 HPP and impacts of the other planned existing and planned hydropower projects immediately downstream and upstream of the Nam Mo 1 HPP are presented in Table 11.2. The reservoir reach of the existing Nam Mo HPP downstream of the planned Nam Mo 1 HPP is illustrated in Table 11.2. The reservoir of Nam Mo HP extends beyond the planned dam site of Nam Mo 1 HPP. During the FSL level of the Nam Mo HPP (157.7 m) the end of the reservoir extends by 1.5km into the planned Nam Mo 1. At MOL the reservoir of the existing Nam Mo HPP extends at 0.2 km into the planned reservoir of the Nam Mo 1 HPP. The release from the tail race of Nam Can HPP is 0.52 m^3/s (Q_{dbtm} 85%) during the low flow and otherwise the discharge release is Q_o1.61 m^3/s. The operation of the cascade of hydropower projects in the Nam Mo river will need to be coordinated by the authorities, MOIT, and with the various Project owners including EVN.

Table 11.2 Characteristics, receptors and potential impacts of other hydropower projects

Issue / Theme	Technical details / Current status	**Cumulative Impacts:** due to the presence of Nam Mo HPP (downstream of dam site, in operation) and planned projects (Nam Mo 1 (in Laos) upstream of reservoir of planned Nam Mo 1 HPP, in Vietnam
Downstream		
Dam Height of Nam Mo HPP (RCC – roller compacted concrete dam	96 meters	Nam Mo HPP dam wall has blocked migratory fish.
FSL of Nam Mo reservoir	157.7masl End of reservoir reaching about 1.2km upstream from planned Nam Mo 1 HPP dam site.	Given that the reservoir of Nam Mo HPP reaches beyond the planned Nam Mo 1 HPP there will be no additive impacts.
MOL of Nam Mo HPP reservoir (dry season)	156masl End of reservoir reaching 0.2 km upstream from Nam Mo 1 Dam site. See FSL above.	More details and the exact reservoir level is being worked out at present.
Operation	Storage project / Peaking	Reservoir fluctuation may affect level of water downstream the planned Nam Mo 1 HPP dam site. Precise operation will be decided during the detail design phase as required by MOIT.
River stretch between planned Nam Mo 1 HPP and existing Nam Mo HPP at FSL	The existing Nam Mo HPP is located approximately 5km downstream (at Ban Canh village) of the planned Nam Mo 1 HPP. Note the slope of the river is rather gradual so variation is little noticed in the water level during fluctuation periods.	Given that the reservoir of Nam Mo HPP reaches beyond the planned Nam Mo 1 HPP there will be no additive impacts on fish and aquatic life, and river bank activities already affected by the existing Nam Mo HPP.
River stretch between planned Nam Mo 1 HPP Dam site and Nam	At MOL the reservoir of the existing Nam Mo HPP extends by 0.2km into the planned reservoir of the Nam Mo 1 HPP	Impacts during the dry season depend on the backwater (tail-end) of the reservoir of Nam Mo HPP. Note that during the field trip in Jan

Issue / Theme	Technical details / Current status	**Cumulative Impacts:** due to the presence of Nam Mo HPP (downstream of dam site, in operation) and planned projects (Nam Mo 1 (in Laos) upstream of reservoir of planned Nam Mo 1 HPP, in Vietnam
Mo HPP reservoir back water at MOL dry period.		2017, the reservoir was visible fairly close to the dam site of the planned Nam Mo 1 HPP, but due to the gradual slope of the river stretch the exact reservoir end is hard to determine visually.
Fish species diversity and migration, and fisheries	Fisheries comprising aquaculture is practiced and fishing is done (including using boats) in the Nam Mo reservoir.	The migratory fish have been blocked due to the dam wall of the existing Nam Mo HPP. The reservoir of Nam Mo HPP (approximate length of 6.5km) has likely allowed for short- and medium -range migrants to survive, in addition to addition of fishes (for fisheries). The planned Nam Mo 1 will not affect long distance migrants and not likely other fish, and would function likely the Nam Mo HPP in having habitat for fish and fisheries.
Vegetation diversity, critical habitats and status of river slopes	Impacts have taken place due to the reservoir of the existing Nam Mo HPP.	River side vegetation has been affected by the existing Nam Mo HPP reservoir. Thus impacts are already present since operation of Nam Mo HPP. Additive impacts of the planned Nam Mo 1 HPP are seen as minimum.
Settlements along reservoir of the existing Nam Mo HPP are Nhan Cu and Banh Can.	Settlements are not affected at FSL and during lower reservoir levels of the existing Nam Mo HPP reservoir. There is water for fishing and other activities, including mobility by boat and domestic use (also observed in Jan 2017, dry period).	The lowering of the existing Nam Mo reservoir water level during the dry season does not appear to affect the villages. There will be no additional impacts due to the planned Nam Mo 1 HPP.
Livelihoods	See above Agriculture water use is obtained from tributaries and mountain water springs. River is used for domestic activities, fishing and mobility (to other villages, across the river and fishing).	Fisheries and mobility will not be affected due to the existing reservoir of Nam Mo HPP downstream. Assuming the water level will remain as it is at present due to the operation of the existing Nam Mo HPP, river use is not expected to change. The reservoir of the planned Nam Mo 1 would certainly be possible to use for fisheries, including cage, boats and nets as is done successfully in other reservoirs.
Ecosystem Services that will be affected	At present there is river water present and available all year round. The situation is not expected to change during the construction and operation of the Nam Mo 1 HPP, however water diversion may occur and this will need to be assessed	There will be no additional changes due to Nam Mo HPP (e.g., expected impacts are on fisheries, mobility and domestic uses in the construction area).

Issue / Theme	Technical details / Current status	**Cumulative Impacts:** due to the presence of Nam Mo HPP (downstream of dam site, in operation) and planned projects (Nam Mo 1 (in Laos) upstream of reservoir of planned Nam Mo 1 HPP, in Vietnam
	further after the detail design is done.	
Upstream		
Dam height (planned Nam Mo 1 HPP, in Laos)	17masl	The dam is 18km from the Vietnam-Laos Border.
FSL	430masl	
MOL	427.5masl	
Stretch of river between tail-end of reservoir of the planned Nam Mo 1 HPP in Vietnam (this study) and Nam Mo 1 HPP in Laos.	18km	At present the Nam Mo HPP has blocked migratory fish and the planned Nam Mo 1 in Laos will potentially blocked fish upstream so there appears to be no significant additive impacts of the Project.
Villages upstream	There are no villages by the river. The terrain is rough and valley narrow and any land in village boundary is likely to be too steep and/or inaccessible for use.	Only small land take by the river. This will be assessed further after the detail design and reservoir reach is finalized. Impact seen as minimum.
Ecosystem Services	No visible landslides, although the Vietnamese site has experience deforestation and this would require assessment for vulnerable slopes and be subject to re-vegetation to reduce erosion which would impact sediment loads in the river.	No significant impact expected other than landslides and erosion which would cause water quality, aquatic life and sediment load changes.

	Maps showing the reach of the reservoir of the existing Nam Mo HPP.
	Closer view (see above)
	Nam Ca 2 power house on the left bank of the Nam Mo river

Planned Nam Mo I HPP in Laos is about 18km upstream from the Vietnam-Laos border

Figure 11.2 Map showing the location of existing Nam Mo HPP and its reservoir reach, Nam Can 2 (power station on left bank) and upstream Nam Mo 1 HPP in Laos.

11.7.1. Key cumulative impacts

Due to the reservoir reach of the Nam Mo HPP located downstream of the planned Nam Mo 1 HPP dam site, the additive impacts are expected to be minimum. The current fishing activities are not expected to alter due to Nam Mo 1. It would be necessary to monitor the river water levels and river use during the dry season as the regulation of both the planned Nam Mo 1 HPP with respect to Nam Mo HPP will be done at the detailed design phase.

The length of the planned Nam Mo 1 HPP reservoir is expected to sustain a range of fish species and serve for fishing needs. This is the case in other reservoirs in the region and elsewhere in Vietnam.

11.8 Riparian release and environmental flow

Issue. There is a need to maintain riparian release and preserve environmental flow for the river ecology to thrive.

Baseline. For use in the hydrological analysis, both for technical and environmental purposes, river discharge were modelled using a limited empirical data. At Nam Mo 1 dam site, the annual discharge is 65.5m^3/s. This discharge currently meets the operational requirements of Nam Mo HPP downstream of the Project (see Cumulative section). The practice in Vietnam is that the environmental flow is decided during the detailed design phase when the mode of operation is finalized. An economically sound environmental flow is recommended which maintains minimum ecosystem services and aquatic diversity.

Impact and rationale. It is anticipated that there will be a reduction of river flow when the Nam Mo 1 dam site is operational.

Assessment. The extent of the impact is **site specific** but duration is **long term**. However no sufficient conclusion can be made at this stage therefore assessment is not complete.

Proposed mitigation. There is a need to monitor the river flow of Nam Mo river at strategic locations and this primary data collection shall be an input to a more robust hydrological assessment and be able to make a fully informed assessment.

11.9 Transboundary impacts

Issue. The Ca river system (where Nam Mo river is one of the tributaries) originates from Laos and extend to Vietnam, covering two countries and may potentially trigger transboundary impacts.

Baseline. The Nam Mo 1 HPP is located in the boundary area of Vietnam - Lao PDR on the Ca River. The main components (e.g., dam, powerhouse, spillway, intake) and auxiliary areas are located about 1km from the Vietnam - Lao PDR border in Ta Ca commune, Ky Son district, Nghe An province, in Vietnam. The catchment area down to the proposed dam site is approximately 2492km^2 and more than 99% of which is in Laos territory.

There is an agreement between the two governments to develop Nam Mo 1 HPP in Vietnam addressing the impacts in Laos and complying with Laos EIA requirements (see Chapter 1).

Location. Project influence area.

Impact and rational. Based on MIGA's definition of transboundary impacts, the Project triggers an assessment of potential transboundary effects because of the use of river water from Laos while the HPP is in Vietnam. In addition, the agreement approved the use of the river. The agreement spelled out conditions on responsibility and benefit sharing for each of the participating countries.

Potential positive impacts will include benefit sharing and economic opportunities which will be a subject for the two countries and Proponent. At this period, the precise scope of the benefit sharing is not known. Most of the physical and biological impacts are concentrated in Vietnam, being the host for both the main construction works and auxiliary facilities. A total of five villages will be affected in Laos, one of which will be relocated (see Social section).

There is an existing HPP downstream the planned Nam Mo 1 HPP, which has blocked long distant migrant fishes, and the impact on this at this stage is small. There are also planned projects upstream in the Laos territory for which feasibility studies have been completed (see Cumulative Impacts, this chapter). It is not anticipated that any further environmental impacts will affect the Laos side.

Assessment. The extent of the impact of the development of the Project is **regional** given that the benefits will go to the two countries and duration is **long term**. However, overall assessment of transboundary impacts on physical and biological environments is **low.** Since the Project in Vietnam results in impacts on villages in Laos, the social impact is **high** due to the relocation needed. The relocation process if done according to IFC/MIGA requirements will work to reduce expected impacts.

Proposed mitigation. Overall mitigation is in REMLRP and ESMP. Monitoring of reservoir buffer zone, water quality and all measures proposed in the plans.

11.10 The reservoir and global impacts

Issue: Climate change and reservoir

Impact and rational: The Nam Mo 1 HPP area of influence is regarded as warm sub-tropical in climate and the vegetation composition and crops grown in the area attest to its clear tropical affinity. For this evaluation the dam is assessed as a warm sub-tropical reservoir. Studies point to emissions being much higher in the humid wet tropics than in other regions (St Louis et al. 2000; Duchemin et al. 2002; Barros et al. 2011; Demarty and

Bastien 2011) and the region where Nam Mo 1 HPP is planned. Emissions are large in the first years after forming a reservoir (e.g., Galy-Lacaux et al.1999; Abril et al. 2005) and when large biomass material is present submerged in the reservoir, unlike the large poorly vegetation covered Ca river valley (grassland and secondary vegetation abounds in the DIA) in the Nghe An Province.

In reservoirs water quality (e.g. turbidity and oxygen concentration amongst others) decreases accordingly to depth. Water quality can however also have pronounced horizontal quality gradients, especially in long and relatively narrow reservoirs as the Ca, where the water quality can vary considerably between the riverine, transitional and lacustrine zone and within the season. Water depth and hydraulic retention time are the most important characteristics determining water quality. The water depth, geomorphologic and climatic conditions (wind exposition) determine the stratification pattern (mixing regime). The hydraulic retention time is important for the exploitation of nutrients, trophic tolerance, self-purification processes and secondary pollution effects.

In the deeper strata of the reservoir the oxygen content will be reduced compared to the surface layers due to decomposition of organic matter accumulated at the bottom of the reservoir. The decomposition consumes oxygen, increase carbon dioxide and increase the content of nutrients. This will probably be most profound the first years because of release of organic matter from the inundated areas in the reservoir. If O_2 is not present in the lower strata of the water, due to decomposition of organic matter, it might lead to toxic values of manganese, iron and H_2S. A possible effect will also be increased emission of carbon dioxide (CO_2), methane (CH_4) and N_2O, although CO_2 is not regarded as a serious issue in dam/reservoirs based on recent research (Abril et. al. 2013). The vegetation in the planned reservoir inundation area will be removed as required by the GoV. In deep-water especially of warm humid tropical reservoirs high concentrations of methane are often formed (up to 10 mg/l and more). When water level in the reservoir is lowered during the dry season, methane starts to bubble off through the reservoir surface. But more important is the release over the turbines and the spillways. The sudden fall in pressure when the water comes out results in quick release of methane and carbon dioxide. This will not be the case in this reservoir, due to its length and the release pressure is not expected to be very high.

However, since the reservoir will be flushed as deemed required (details to be determined during the design phase and expected to nearly every year) it is not anticipated that there will be a build-up of organic matter over time and dramatically reducing the chances of gas accumulation and release (Duchemin et al. 2002; Barros et al. 2011). According to the water quality samples, Ca river at this stretch is an oligothrophic river system with a medium content of organic matter which again adds to keep gas levels on the lower side. These facts contribute to reduce the chances of a high release of greenhouse gasses. However, depending on the temperature and the turnover time in the reservoir decomposition will likely release some CH_4 accordingly to seasonal and reservoir characteristics at a given time. The release of gasses is however not seen as serious for this dam.

Due to the long reservoir turnover time in approximate December to June/July the oxygen content probably will be not very different in the deeper strata from the upper strata during this time of the year. The months with the longest reservoir turnover time are during the cold period of November to Feb/March. This is the coldest time of the year which will slow down the decomposition and production of CH_4, to some degree overall contributing to low levels of greenhouse gas release. The situation should be monitored carefully especially the first years and if the reservoir is not flushed. It is noted that it is planned that the reservoir will be flushed on a 1-2 year basis.

There is no clear-cut model developed on how to estimate the emission from a reservoir prior to its construction. A very rough approximation can, however, be achieved by using average emission numbers from other reservoirs. A Canadian group looking into this question found that average emissions from tropical reservoirs range from 200 to 3000 grams of CO_2 per kilowatt-hour (kWh), and temperate reservoirs have low emissions. Since relevant estimates for reservoirs in the region as the Nam Mo 1 HPP reservoir are not available and since the waters temperatures can be warm with cool season period we

believe that the emission level will be on the lower end of the scale above (Duchemin *et al*. 2002).

Impact assessment: Any emission is a **direct** result of Project reservoir impounding. The impacts are **short-term**, if measures are taken to assure that carbon material entering the reservoir is minimized. The levels (magnitude) are as mentioned and according to the current understanding are of **small** impact globally and the significance is **low**.

Mitigation: Monitoring of reservoir and downstream water. Actions to be taken to minimize carbon material (vegetation, wood) resident in the reservoir for long periods and catchment conservation (Abril et al., 2013).

Table 11.3 Environmental and Social Impact Matrix, Nam Mo 1 HPP.

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
CONSTRUCTION PHASE									
Physical environment									
1	Change in topography, landscape and visual impacts	DIA, The main components (headworks) and auxiliary areas are located Muong Tip, Muong Ai, Ta Ca and Nam Can commune, Ky Son district, Nghe An province, Vietnam. The reservoir tail will reach up to Laos	Earth moving activities due to construction of both main works and auxiliary facilities will result to, change in topography, and further induce soil erosion and sedimentation, landslides and slope instability.	SS	ST to P	L	M	Major	Sound engineering practices/technology consideration; Construction EMP RCMP
2	Generation of wastes and hazardous materials	DIA, Across Project construction area	Various construction activities will generate wastes such as large volume of spoils, construction wastes, domestic wastes from 1750 workers during the peak construction works; used oil, lubricant and used tires from truck, company vehicles and heavy machineries; Use of explosives.	SS	ST	L	M	Major	13.57 ha designated disposal area Solid Waste Management Plan, RCMP EHSP Construction EMP EPRP Influx Management Plan Material Use and Site Waste Management Plan

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
3	Quarry operations	DIA, IIA Pha Khao and Pha Danh villages communes	Potential loss of assets; Noise and dust pollution;	L	ST	M	H	Major	Construction EMP; Blasting clearance; Delineation of the quarry area and extent of road rehabilitation
4	Water quality	DIA, IIA Reservoir and downstream of the dam	Degradation of water quality	L	ST to MT	M	H	Major	Construction EMP that covers Water and Sediment Management Plan Solid Waste Management Plan and Materials and Handling Management Plan
5	Flood risks	DIA, IIA Reservoir area	Impoundment of the reservoir may pose flood risks	R	ST	L	M	Major	Resettlement Plan, Emergency procedure and Response Plan
6	Riparian release and Environmental flows during river diversion	DIA River stretch downstream of the dam site	Impoundment of the reservoir will cause reduction of river flow	L	ST	L	M	Major	Monitoring of water level Legal obligation to the operation regime the dam downstream
7	Air Quality and noise	DIA, IIA Construction area and access roads	Air quality and noise pollution	L	ST	M to L	M to H	Major	ESMP

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
8	Traffic impact	DIA, IIA Along access roads	Road safety due to increase of vehicular traffic	L	ST	L	H		ESMP
Biological Environment									
9	Clear felling of trees/shrubs and other vegetation in permanent construction sites	DIA At Ta Ca	Loss of forest vegetation	SS	ST	L	L	Negligible	Good practices in felling trees; plantation after construction work
10	Clear felling of trees/shrubs and other vegetation in auxiliary construction sites	DIA	Loss of forest land and upland farms	SS	ST	S	L	Negligible	Good practices in felling trees; plantation after construction work
11	Pressure on forest resources for fuel wood and timber	DIA, IIA	Pressure on forest from about 1750 workforce and others on fuel demand of about 600m^3/1000 persons/yr	SS	ST	L	H	Moderate	Supply of alternate source of cooking energy; regulated harvest; wood harvested from forests to be inundated

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
12	Land acquisition for reservoir	DIA Inundation area	Total loss of 962 ha forest land; loss of trees, shrubs and other vegetation including threatened species	SS	LT	L	H	Major	Safeguard buffer zone CRMP BEESRP
			Submergence of approximately 20,383Mt of organic biomass	SS	LT	L	M	Moderate	Organic biomass will be cleared and removed from the inundated area.
13	Acquisition of secondary forest, scrub for proposed safeguard buffer area establishment at elevation between 300m-350m all around the reservoir	DIA	Degraded and over used fallow land, upland farm, scrubs and secondary forests are managed and improved	SS	LT	S	L	Negligible	Safeguard buffer area ecosystem management plan

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
14	Clearing, excavation, grading and filling activities	DIA Construction site	Loss of wildlife habitat due to removal of vegetation Less mobile, smaller species such as frogs, lizards and small mammals (rats) will be killed,	SS	ST	S	L	Negligible	Implementation of Good Practices for Construction work
15	Construction disturbances e.g. blasting, drilling, vehicle,construction work at night	DIA Construction site	Interrupt normal wildlife movement, feeding and other activities of mammals and birds Some wildlife species might temporarily migrate to other forest area	SS	ST	S	S	Minor	Implementation of Good practices for construction work; Restrict heavy construction work during night time
16	Increased workforce population	DIA Construction site	Potential for illegal hunting, trapping, poaching for food and trading	SS	ST	L	L	Major	Implementation of Good practices for Construction work
17	Coffer dam construction and related activities, Changing water course and drainage system	DIA, IIA Dam site	Stream bed disturbances; increase in turbidity; alter habitat of fish, amphibians and other species	SS	ST	S	L	Moderate	Implementation of Good practices for Construction work

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
18	Petrochemicals, cement slurry and other toxic materials discharge into river	DIA Dam site	Water pollution in dam site and downstream area; mortality in fish and aquatic species in dam site and downstream area	SS	ST	M	M	Minor	Implementation of Good Practices for Construction work
19	Influx of construction workforce up to 1750 at peak stage	DIA, IIA Dam site	Increased demand for fish, lizards and amphibians for food and trade; over harvesting	SS	ST	L	H	Major	Awareness and training to construction supervisors and community; enforcement of government regulations
20	Restricted use of buffer area	DIA Safeguard Buffer Area	Less opportunity to local community for harvesting forest products	SS	LT	S	L	Minor	Biodiversity conservation & environment resources development plan
21	Pressure on forest resources for fuelwood	DIA, IIA Fuelwood need of permanent staff at dam/powerhouse site	Illegal felling in nearby forest; 100 persons need 60m^3 wood per year	SS	LT	S	L	Negligible	Regulated felling of dead woods
22	Operation of diversion weir	DIA, IIA downstream area,	Obstruction to fish passage of migratory species such as Eel species; Nam Mo 1 dam in the downstream area has already obstructed movement of migratory species	R	LT	M	M	Minor	Reservoir fisheries development plan; community fish farming plan

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
23	Regulated water diversion to powerhouse in dry season	DIA Dam site and downstream area	Creation of low flow zone from immediate downstream area; impacts on aquatic habitat and growth	SS	LT	L	H	Moderate	15% of average minimum monthly flow will be released as environmental flow
24	Flushing of de-sander basin in low flow season	DIA, IIA Downstream area	Increase turbidity in downstream area affecting fish habitat	SS	ST	M	L	Minor	Avoid flushing during dry period
Social Environment									
25	Reservoir filling/ inundation	DIA Inundation area	Impact on Physical Assets Inundation of villages in Vietnam and in Laos with private residential land, houses and assets, and public structures (intra-village roads, water supply, kindergarten, school, village cultural house). Villages to be relocated.	SS	LT	L	H	Major	Relocation and compensation. as required by MGA. See RPF in REMLRP. Participatory consultations and Agreements required, see PCDP.

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
26	Reservoir filling/inundation	DIA Inundation area and IIA	Inundation of land areas used for livelihoods activities, both riverbank lands, upland fields and forest areas providing timber and NTFPs, and areas used for animal grazing.	SS	LT	L	H	Major	REMLRP
			Graveyards inundated or at a longer distance. Graveyards inundated or to be left at a long distance from resettled villages.						
27	Reservoir inundating the river and the dam construction	DIA and IIA Inundation area and downstream	(i) Fishing and collection of other edible river resources will be lost, affecting livelihoods and food supply of local people. (ii) River transportation will be cut off by the dam and consequently lost between upstream and downstream areas.	SS	LT	L	H	Major	REMLRP

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
28	Reservoir filling/ inundation	DIA Inundation area and IIA	Inundation of one border guard station and another one located in the dam construction area; these have to be relocated.	SS	LT	S	S	Minor	ESMP, a decision to be made in consultations with the GoV
29	Land acquisition for dam, powerhouse, temporary & permanent work and living facilities at auxiliary area	DIA Dam site	Loss of forest vegetation; arable land and other land at auxiliary areas	SS	ST	S	L	Negligible	REMLRP
30	Land acquisition for reservoir	DIA	Loss of swidden – upland farming area	SS	ST	S	L	Negligible	All DIA villages will be relocated and households will be compensated & resettled with land to land;
			b).Loss of grazing land in secondary forest /scrub vegetation c) Loss of forest land; loss of opportunity for harvesting wildlife for home use.	SS	MT	H	M	Minor	BEESRP

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
OPERATION									
31	Dam operation	DIA, IIA Low flow area	Villages in the downstream area potentially affected by reduced water flow during the dry season and water fluctuations depending on the dam operation, impacting fishery, riverbank cultivation, river transportation and household water availability.	SS	LT	M	M	Moderate	ESMP
32	Low flow and Cumulative impact	DIA, IIA Downstream of the dam	Downstream Villages may potentially be affected by reduced water flow and water fluctuations from dam operation. Impact on fishery, riverbank cultivation, river transportation and household water availability.	SS	LT	M	M	Moderate	ESMP Legal obligation to the downstream HPPs operation regime

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
33	Implementation of environmental and social safeguards	The Project Area of Influence	The development of ESMP if implemented properly and adequately will ensure that the impacts identified will be mitigated and addressed. The above current conditions of natural resources and villagers will be improved and enhanced. The Project is also expected to generate employment for the community.	SS	LT	L	H	Moderate (+) impactt	
34	Trans-boundary Impacts	Project Area of Influence	Most of the physical and biological impacts are concentrated in Vietnam, being the host for both the main construction works and auxiliary facilities.	R	LT	L	H	Low (Physical and biological)	
			Potential positive impacts will include benefit sharing and economic opportunities which will be a subject for the two countries and Proponent.	R	LT	L	H	Major Social	

No	Project activities	Location	Impact and rationale	Impact qualifier				Significance	Mitigation
				Extent	Duration	Magnitude	Sensitivity		
35	Global change and reservoir	DIA Reservoir	The reservoir may potentially generate emissions and affect water quality and impact on climate change.	SS	ST	S	S	Low	ESMP, Monitoring of reservoir and downstream water
36	Dam construction	Construction and influx of workers and camp followers	Impacts due to workers and camp followers, and construction activities.	SS	ST	M	H	Major	REMLRP: Influx management Plan
	DIA – Direct Impact Area IIA – Indirect Impact Area								

Notes: Description of Impact Qualifier:

Extent: SS= Site Specific in the Project area/Local, R= Regional, N = National; **Duration:** ST= Short term, MT= Medium term, LT= Long term

Magnitude: S= Small, M= Medium, L= Large; and **Sensitivity**: S=Low, M=Medium, H=High.

CHAPTER 12 SUMMARY OF MITIGATION, ENHANCEMENT AND SAFEGUARD MEASURES

12.1 General overview

This chapter provides the summary of the mitigation and enhancement measures proposed in the preceding section (Chapter 11, various potential Project impacts). In addition to these safeguard measures, note that part of the impact mitigation process has already taken place during the Project design and optimization phase. As part of the Project optimization process, a number of measures have been taken to minimize the social and ecological footprint of the proposed HPP. For instance, among the alternative locations for the different Project components (dam site, powerhouse location etc.), the technical team has selected optimal locations taking into account multiple criteria (e.g. social, environmental, economic, and bio-physical, etc., See Chapter 4 - Analysis of alternatives).

This chapter provides the details of the mitigation and enhancement measures proposed during the ESIA process. A summary of the measures are provided in Figure 12.1. The measures listed combine and integrate measures across different themes presented below. There are three umbrella programs which encompass the thematic plans.

- Physical Environment Program;
- Biological Environment Program; and
- Social Program

The plans within each programs are listed in the respective sections in this chapter. There is however four plans placed under the Physical Environment Program which span across all programs but may have different degrees of requirement or may not need all the components and these are:

(a) Reservoir Catchment Management Plan (RCMP)
(b) Environment, Health and Safety Plan (EHSP)
(c) Awareness and Capacity Building Plan (ACBP)
(d) Emergency Preparedness and Response Plan (EPRP)

There is also mitigation measures which are specific and stand-alone actions proposed and these are listed in the sections of concern.

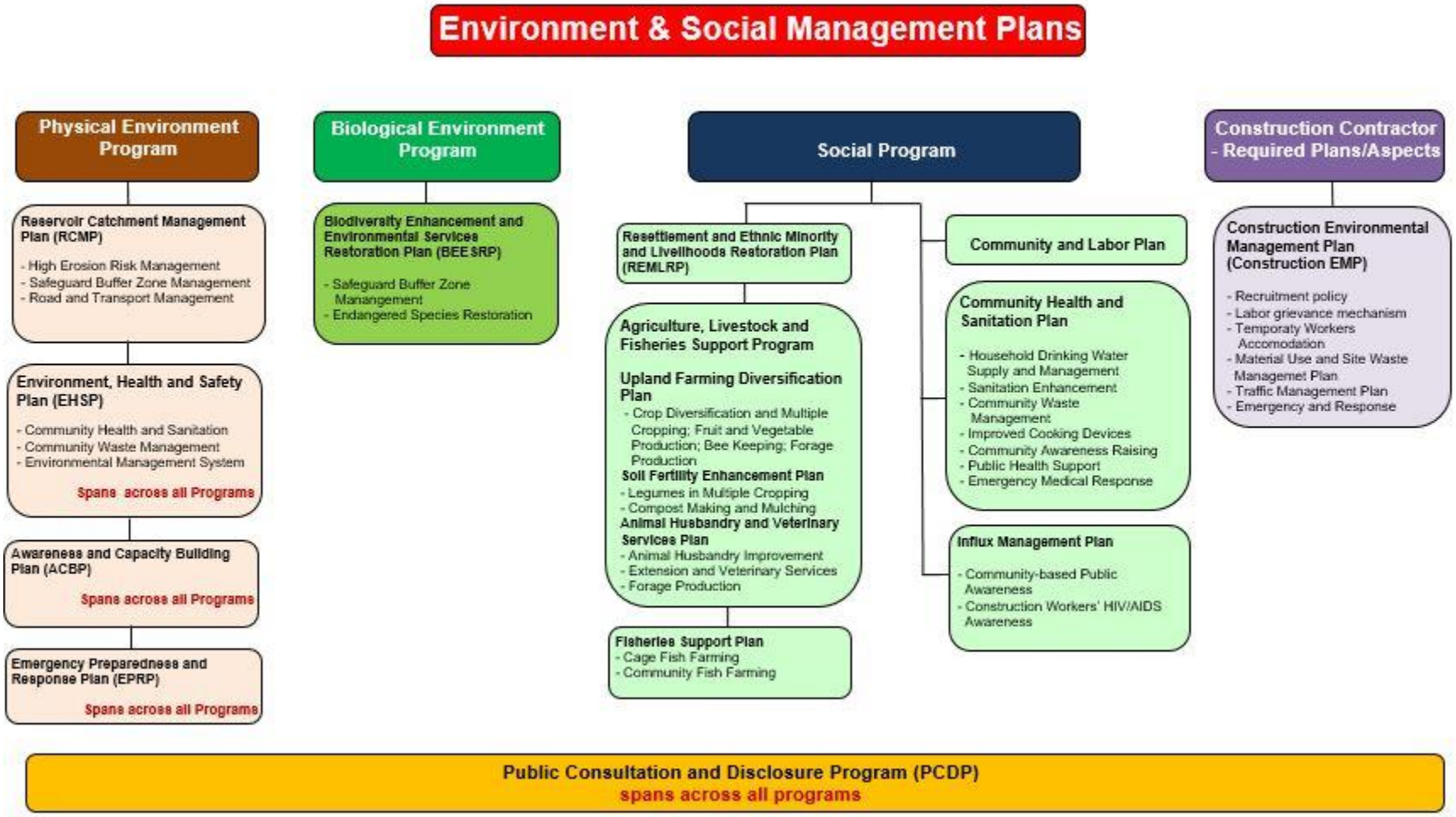


Figure 12.1. Environmental and Social Management Plans

12.2 Physical environment

12.2.1. Land use

Slope stability and risk assessment techniques for the high risk slopes in the reservoir area are recommended and include modification of slope geometry, drainage, retaining structures and internal slope reinforcement. The mitigation measures are as follows:

(i) Toe embankments and/or toe buttressing and/or slope angle reduction;
(ii) Drainage galleries/tunnels and/or sub-horizontal drains to lower groundwater level;
(iii) Removal of potential slides either by excavation or by triggering them under controlled conditions (e.g. during reservoir filling);
(iv) Erosion protection measures in the water fluctuation zone (rip rap) and upslope (drainage trenches and vegetation planting); and
(v) Soil nailing / ground anchors.

The final mitigation techniques chosen will be part of the detailed design phase (pre-construction phase). The above mitigating measures can all be included in a plan. The development and formulation of the Reservoir Catchment Management Plan (RCMP) is highly recommended .

Reservoir Catchment and Management Plan
The maintenance of the stability and integrity of slopes of the reservoir, and the immediate catchment is essential for human safety, upland land-in-use stability, and reducing potential erosions and mass movement. The life of the Nam Mo 1 HPP Project is dependent on securing slopes, reducing erosion, and halting to the degree possible, landslides. All mitigation extended to secure slopes and Project construction and other used areas (e.g., auxiliary, roads, labor and construction camps) will directly and indirectly increase security and enhancement to natural resources and arable lands in the immediate vicinity of the Project.

This would foster also wellbeing of local people. All reservoir catchment management will contribute to watershed stability and maintain ecosystem functioning. A sub-plan for roads is also proposed under this plan, the framework of which is provided below. The cost of the slope stability mitigation is included in the Project costs in the feasibility study.

The slopes that need revegetation above the reservoir level are dealt with in the vegetation and forest resources section of this report. In addition, strict regulation of the reservoir level fluctuations and local communities using the land resources have to be taken into account.

The CRMP has key sub-plans and salient features are given below:

High Erosion Risk Management Sub-plan
The RCMP will be securing the Safeguard Buffer Zone (SBZ) and all areas identified as 'erosion risk area'. In addition, it will include measures to increase landscape stability. Forest management, protection and planting should follow established practices based on the experiences of similar conditions. Compensatory planting is also included as part of this plan. The Project proposes the reservoir catchment area to be mapped and identified for its vulnerability during detailed design phase.

Safeguard Buffer Zone Management Subplan
The concept of a safeguard buffer is to make the area completely vegetated (covered with forest) maintaining vegetation at different strata so that it will function to reduce erosion, and infiltrate sediments before water is discharged into the reservoir. The proposed SBZ has secondary mixed evergreen and deciduous forest, secondary scrub, mixed broadleaf and bamboo, grassland, cultivated and uncultivated fallow land, rocky areas and streams. Currently, it is over exploited for grazing, collecting food materials and hunting for rodents, birds, lizards and amphibians for home consumption.

'Greening' the safeguard buffer zone and safeguarding high risk erosion areas.

The safeguard buffer covering an additional 50m elevation and contouring above 235 - 285masl full supply level of the reservoir has been mapped for land cover but not for soil erosions and vulnerability status. In order to ensure safety from the reservoir to local people and to protect the reservoir shoreline (catchment stability) through planting forests (afforestation and reforestation including fodder and fruit trees and other vegetation used by local community. The Project has proposed to maintain a buffer area between settlements and the upper contour of SBZ (285m). This strip is recommended to be 50m with the understanding that it will be jagged as it can be significantly narrower in rocky areas (where no protection is needed) and in stable forest areas but can include the adjoining high risk soil erosion area. The latter may increase the width of the buffer strip to secure slopes to decrease sediments in the reservoir and enhance safety.

To reduce the erosion risks and sediment flow to the river, upland cultivation on slopes inside SBZ will not be allowed, however, riverbank cultivation on more favorable slopes could be practiced with clearance and allowance from the commune authorities. Grazing will have to be stopped but the non-timber forest products and small size wildlife like rodents, birds, lizards, frogs and similar species could be harvested in a sustainable manner for home consumption since this is related to livelihoods of the ethnic minorities. Similar to Protection Forest, the SBZ could be managed by a group of local community.

The SBZ is therefore proposed as a 'green' belt of the Project/reservoir to enhance catchment stability (reduce erosion and landslides) and thus function to provide ecosystem services (e.g., forest products, soil stability, nutrient retention, carbon storage).

Road and Transport Management Subplan

One of the potential impact of the Project is road traffic and safety especially those associated with heavy vehicle movements along the transport corridors. The Project will require widening of roads, strengthening of bridges, special slope stabilization and erosion measures, special warning systems, land acquisition, and fulfillment of national requirements, and acceptance by and interaction with the national road authorities, some of which has already been considered in the FS, and details will be worked up in the detailed design. In addition and importantly, the issue of the loss of connectivity and its mitigation has to be included. It is recommended that a bespoke transport plan be commissioned for the Project at the detailed design phase looking at logistics and engineering requirements of the Project, and assessing environmental and social impacts, as appropriate.

Vehicle movement during the construction phase in connection to spoil disposal activities, machinery movement within the Project Direct Impact Area (DIA) can be harmful to local populations and domestic/wild animals. Potential impacts of such traffic have been addressed in this ESIA in the respective sections. Precise impacts and detailed mitigation measures, however, are not possible to delineate at this time due to the fact that the final planning and alignment of roads is not complete. However a framework for a road plan is suggested below.

A sub-plan for the planned roads within the RCMP should be formulated after the road alignments are finalized. A framework for the development of such a sub-plan is provided here. The plan should include guidelines for integrating environmental considerations into constructing and maintaining roads supported by the Project as good engineering practice. The guidelines will be included in all contractor's bidding documents and operating contracts. The guidelines will cover all aspects of road construction, such as (i) clearing and grubbing; (ii) roadway excavation; (iii) channel excavation; (iv) excavation and backfill of structures; (v) embankment; (vi) sub-base and base; (vii) pavements; (viii) drainage, pipes, and outlets; (ix) grassed areas; (x) slope protection; and (xi) mortared stonework. In addition the guidelines describe the maintenance and environmental management required in relation to roads, including monitoring needs.

Excavation of roads in steep sides with soft soil leaves large areas of denuded soil open for rain and water erosion. This problem applies to the inner side of the roads with the drain ditch, the road itself and the outward facing of the road. Even for temporary roads, this will

create wounds in the terrain that will slide and erode during the construction period if no stabilization is done. The construction of roads, and permanent and temporary housings and camps should begin at the onset of the dry season with the excavating and bulldozing. Before the wet season starts, the road sides should be sowed with grass.

The road ditch should be lined in erosion prone areas. The water in the road ditch should be released into existing brooks/streams. The road ditch should be released as often as possible, i.e. wherever there is a natural brook/flood brook. Road ditch outlets should not be allowed to be discharged into places where there has been no waterway before. If this is necessary in some places, relevant enforcements should be made to prevent erosion.

All road construction (access roads and broadening of roads) will require similar procedures adjusted to the specific sites. The permanent roads and sites should be paved as soon as possible after the construction. The team responsible for this should work out a strategy for structured procedures for bio-engineering and revegetation allowing for adjustment based on site specifics. Parking lots, camp areas and construction sites should be subjected to the same mitigation measures as recommended for roads.

12.2.2. Hydrology, sediments and reservoir

Mitigations presented here are for the Operation phase:

12.2.2.1 Reduction of sediment inflow

At present it seems the most realistic place candidate for check dams etc. is the tributaries of Nam Mo River. Check dams here, if properly constructed may trap some of the heavy bed load in the streams. Yet it has to be verified that the cost is reasonable when measured against the benefits / sediment volume that is trapped. The local sediment load from its tributaries has not been assessed at this stage.

12.2.2.2 Flushing

It is suggested to remove sediments annually with flushing through bottom gates which are as close as possible to the river bed level to prevent build-up of sediments. Flushing may be performed at beginning of the monsoon season, when reservoir is drawn down and when pre-monsoon floods with initially high sediment loads can be used to flush sediments.

A large majority of the incoming sediments can be flushed within approximately one week during a normal year, provided there are low level flushing gates with sufficient capacity. Also in years with substantially higher sediment load it will be possible to remove nearly all incoming sediment. Most of the time, water will be used to flush the last few percent of sediment which are coarse gravel and stones and which require high discharge / high energy gradient to be mobilized. The time required for flushing will therefore depend how much of the reservoir volume one will maintain.

12.2.3. Air, water and noise

See section on Community Health and Sanitation (Section 2.4.2.1) where mitigation includes these components.

12.2.4. Seismic hazards

As part of further studies, possible mitigation measures should be considered. Measures that should be in place must include procedures for evacuation as part of the Project's Environmental Health and Safety Plan (EHSP), which must be finalized before the construction period.

Environmental, Health and Safety Plan (EHSP)

This plan spans across all programs and sectors of the Project. Health and safety is a key issue seen from both an occupational and local public perspective. The EHSP should be made in compliance with MIGA Performance Standards and national requirements. This plan should be formulated during the pre-construction stage.

The plan must include, among others: (i) setting the EHS policies and requirements for the Project covering all components of the Project (including project activity areas and workers, vehicle usage, dam and road safety, waste, visitors and local people in the Project DIA, etc); (ii) training local persons; (iii) ensuring subcontractors complete work to international standards; (iv) develop processes and mechanisms for increasing environmental, health and safety awareness working across the Project's programs and plans; (v) assisting the corporate office with any other environmental, social, health or safety problems and coordinate across other plans of the Project (e.g. Community Health and Sanitation Plan, Community Waste Management Sub-plan, etc); (vi) include or coordinate with the risk/hazard and warning plans, and evacuation planning groups of the Project; (vii) cover all safety measures for the Project and (ix) have regular drills (four times a year) and provision of information to workers and the public.

The Project is expected to adopt an Environment and Social Management System (ESMS) as part of the EHSP in line with international practice which will include, but not limited to, the following key components,: (1). increase the environmental awareness of all employees (see also the Awareness and Capacity Building Plan (ACBP) below); (2). train employees, especially the environmental manager and the section heads; (3). establish procedures within the company for recording, monitoring and reducing pollutants emitted in the atmosphere and water, as well as for improving the handling of toxic waste and hazardous materials; (4). elaborate emergency plans and issue relevant instructions.

The EHSP should ensure that the contractors and sub-contractors carry out their work in accordance with the environmental, labor and safety policies and commitments of the company, and comply with applicable Vietnam and international requirements. Thus the plan should also build on awareness campaigns and modes established in the ACBP.

Community Waste Management Subplan

The Community Waste Management Plan (WMP) will identify key sources and types of wastes and the expected management of Project wastes streams, which can be a subplan under EHSP. The construction and subsequent operation of the Project has the potential to create several impacts resulting from the management of wastes (e.g., water quality, sanitation),

The principal materials for construction include excavated materials, cement and steel. The exact quantities of materials will need to be calculated during the detailed design. There would also so be number of other materials such as paint, lubricants plastics and timber, among others. The 1750 estimated construction employees will also generate solid and liquid wastes and need to be managed.

The WMP will identify predicted waste stream streams, appropriate handling, reuse and recycle opportunities and as a last resort, disposal. The WMP will be prepared in accordance with Vietnam's regulations and international best practices.

Awareness and Capacity Building Plan (ACBP)

The Awareness and Capacity Building Plan (ACBP) is a Plan that can span across the different environmental programs. Capacity can be defined as the ability of individuals and organizations to perform functions effectively, efficiently and sustainably. Capacity building, or rather capacity development, should be a dynamic process building upon an existing capacity base. Human resources and the way in which they are utilized are central to capacity development, as is the overall context within which organizations undertake their functions. All plans proposed in this ESIA will require the advice of experts, authorities and the training of the stakeholders, especially those directly involved in a particular mitigation or enhancement measures. The degree to which this will be required will need an assessment when each plan is drawn out. All stakeholders, including those not directly involved in mitigation measures, must be kept aware of measures implemented in the Project. More importantly awareness on programs and plans in the ESIA has to be done as proposed in the PCDP. Awareness will also include all protocols and guidelines outlined in the EHSP and awareness campaigns will have to be carried out throughout the life of the Project, with higher frequency during the construction phase. Such campaigns will include among others, for example: road safety; pollution and sanitation; forest and wildlife

enhancement; warning systems and drills; etc. Local communities are vulnerable and need to be prioritized in the campaigns through the use of modes of communication that can be easily understood and those that are practical. Where relevant this plan is elaborated upon in the thematic sections.

12.3 Biological environment

12.3.1. Vegetation and forest resources

The impacts during Project construction and operation phases have been assessed in the preceding chapter and came up with the following appropriate mitigation measures. The timing for implementation of the proposed measures is categorically specified as far as it is practicable. Project impacts, mitigation measures, organization responsible for implementation in the environmental and social management matrix. Mitigation actions/measures presented below are elaborated in the environmental mitigation matrix and ESMP as well.

The mitigation and enhancement for forest and wildlife placed in a Biological Environmental Program will include the following plans:

- Reservoir Catchment Management Plan(RCMP)
- Biodiversity Enhancement and Environmental Services Restoration Plan (BCESRP)
- Awareness and Capacity Building Plan (ACBP)

12.3.1.1 Pre-construction Phase

Control damage to standing trees and ground vegetation
Forest surveys and inventory work carried out in forests require alignments to be cleared to maintain good sight and visibility between the pegging points and this implies removal of obstructing tree branches and clearing of shrubs. Chances are the forest survey teams may chop down saplings and branches of trees for the making of pegs and trees. Trees are marked by chopping the bark to denote locations and counted numbers. This practice should avoid unnecessary damage to saplings, shrubs and trees.

12.3.1.2 Construction Phase

The following mitigation measures are to be considered and developed as part of the RCMP (See RCMP). Relevant aspects are also included under the next section on wildlife and birds.

(a) Re-consideration of Project sites to reduce loss of forest areas
The primary impact of the Project is the loss of 24.2ha of lands permanently due to construction of dam, powerhouse and permanent housing and structures. Another 55ha will be lost temporarily due to forest areas used for camp sites and establishment of other facilities in auxiliary area. The reservoir will occupy about 962ha. These are secondary forests, scrubs and grasslands, and thus the biodiversity loss would be minimal. The Project does not see any alternatives for land areas for the construction of reservoir, dam and other structures and activities in the planned areas. The impact is largely consolidated along one stretch of the river.

(b) Discourage clear felling
The quality of land in auxiliary areas will depreciate after the construction work and regeneration will take time. Particularly, the forest lands temporarily used will result in permanent loss of vegetation cover and plants. It is recommended that where possible pole size to matured trees are left. A conscious choice to leave trees where possible would also add to the general greening atmosphere of workers camps, permanent and temporary work areas.

(c) Management of felled trees and areas used for temporary and permanent areas

The total biomass estimated in the main work area (dam, powerhouse, permanent constructions) and auxiliary area is 21,397MT. As the area has disturbed secondary forest, wood standing biomass and yield is low, and is approximately 50-60% of the total biomass. Project laborers and contractors residing in and around the forest areas may cut trees for various reasons – including cooking and heating in winter. The Project workforce is estimated to be about 1,750 persons during the peak period and approximately 750 workers will be residing all year round and these would require almost 450MT of fuel wood per year for cooking daily. Alternative sources must be used for cooking and heating in the project areas – no wood must be used.

(d) Safeguard Buffer Zone Management
See RCMP

(e) Implementing forest management practices
Managing forests can function as a preventive as well as remedial measure to the Project's impact on the existing forests. Management of forests is required to not only protect the forest resources but also to supply forest products in a sustainable manner to the users. The Project shall contribute to improvement and management of this forest area. A forest management plan should be made with the GoV institutions so that pressure of existing forests in the project Area of Influence (AI) are not further deteriorated. It is proposed that this forest management plan will focus on enhancement of biodiversity and restore environmental services.

Biodiversity Enhancement and Environmental Services Restoration Plan (BEESRP)
The main objective of Biodiversity Enhancement and Environmental Services Restoration Plan Plan (BEESRP) is to protect forests and conserve biodiversity in an effective manner, with the active participation of local communities and enhance the contribution of environmental services from forests. This plan is elaborated in key subplans:

Forest Management Subplan
The Project has proposed plantation (revegetation) in the permanently acquired area in dam site /powerhouse and other facility areas and maintaining the area with vegetation on using a landscape approach.

The Proponent will prioritize the greening of the safeguard buffer and adjoining areas through carrying out afforestation or reforestation and enrichment plantation. The buffer area covers 559ha out of which 248ha is scrub and grasslands with few shrubs and other non-woody plants and this degraded area could be available for plantation. Besides, vegetation enrichment could be done in buffer area between settlement and buffer zone. In the DIA villages, local communities largely depend on forests for leafy vegetables, mushroom/fungi, bamboo shoots, roots, etc., for their daily consumption. In the plantation area emphasis should be given to include species which can be used by the local people as food. This would encourage local community to participate in forest protection and management.

(b) Forest protection
During construction of the Project, forests in the adjoining area of campsites would be overused by workforce for fuelwood and other uses such as temporary construction. It is difficult to check as project staff and camp followers themselves, may be involved in such activities. The Project shall seek ways to ensure that forests are not overexploited. The Forest Management subplan must include awareness on avoidance of deforestation, wood collection for fuel use and forest area designations (e.g., protection forests which the local communities are assigned to manage by the commune/province).

(c) Management of forest fire hazards
Incidences of forest fires may occur due to workforce or local communities. The Project shall implement code of conduct and organize orientation programs to its workforce and supervisors on regular basis. This should be included in the Forest Management Subplan.

Endangered Species Restoration Subplan
(a) Relocation of Protected Plant species
Drynaria fortunei, (Gu Sui Bu) an epiphytic medicinal herb species listed as endangered species and *Hopea mollissima*, endemic to Vietnam and Yunan – China, naturally growing in the Evergreen Rainforest are listed in the IUCN and Vietnam red list. Both are heavily exploited for their uses. Impacts on these plant species shall be mitigated by relocating them in the SBZ before felling activities begin in the reservoir. There are continuous belts of forested areas extending from the proposed inundation area to the SBZ which can also be areas where the above species may be relocated. Saplings of the hardwood species are likely to survive replanting as the trees are not possible or costly to replant. These species in the non-affected areas should be protected and awareness of their conservation status be made known to communities, contractors and Project workers. A species plan for relocation of protection plant species and their monitoring should be made and implemented.

Awareness and Capacity Building Plan (ACBP)
See also the main description of ACBP. In the Project DIA, like most parts of upland landscape in Vietnam and Laos, forests serve as the key pillar for the provision and maintenance of ecosystem services. Forest resources are the major source of food for the family (vegetation and small size wild animals e.g. rodents, birds, reptiles and amphibians), medicinal plants and fungi, household energy, construction and other uses, forage for their ruminants, and household economy to sell small size wild animals. Forest catchment area serves as the main source of water used for hydroelectricity power generation and domestic consumption. Despite these benefits, forest resources are exploited and subject to human - caused fires, illegal felling and extract valuable plants for trading.

The reservoir catchment is important nationally in terms of electricity generation and locally as an important source of providing materials for their livelihoods. Therefore its protection, management and sustainable use is primary.

The ACBP will serve to increase awareness of forest protection and management policies, and benefits of reforestation, develop materials for publicity on forest, land and biodiversity enhancement and land (soil) protection in the Project affected areas and in the reservoir catchment in general. The Project will provide funds for producing posters and pamphlets.

12.3.1.3 Operation Phase

Forest protection and management
With the completion of Project construction works, most of the workforce will leave for their respective places and there remain small numbers of skilled man power. They will stay mainly for the maintenance and operation of the Project. Obviously, less pressure on the forest environment is expected during Project operation phase. The Project will continue forest re-vegetation and greening in critical areas in SBZ and high risk erosion areas. This will be a regular work continued at least five years of the operation phase.

12.3.2. Wildlife and birds

12.3.2.1 Construction phase

RCMP, SBZ Management Subplan and BEERSP
The same measures proposed under the section above on forest vegetation are relevant to the mitigation measures for wildlife and birds. To minimize the habitat loss, trees which are not felled need to be protected from logging especially in the SBZ. Native tree species should be prioritized in reforestation regimes. There are no large wild mammals in the

Project AI and surrounding forests, however, the reservoir catchment area serves as a good habitat for small mammals like rodent species, bat species and reptiles. The above programs would improve the quality of wildlife habitat and will include the following features:

(a) Establishment of wildlife habitat
Protection of safeguard buffer zone and adjoining areas in the reservoir catchment will improve habitat quality. The approximately 33km (x2) long SBZ and the adjoining riverine area would provide a habitat for small mammals, bat species, reptiles, amphibians and bird species.

(b) Enforcement of laws
Local communities and workers are to be made aware about the regulations for endangered and vulnerable species and conservations needs. Related information about rules and regulations about wildlife killing/hunting must be displayed in several areas. Where possible, disturbance to wild animals and birds must be avoided.

ACBP
During construction phase, blasting, drilling, heavy vehicle movement and high sound would interrupt normal movement, feeding and other activities of mammals and birds leading to their temporary displacement, and there is high potential for illegal hunting, trapping, poaching for food and trading.

The following aspects are proposed for inclusion into the ACBP. See also the main description of the ACBP.

(a) Production of awareness posters and pamphlets.
General awareness posters and pamphlets enhancement of wildlife species will be published and distributed to the construction workers and to the local community. People support unknowingly in illegal hunting practices due to lack of knowledge of the legal provisions. Such illegal hunting practices need to be informed to local people, workers, contractors and the Project staff. Awareness poster will provide educational information for minimizing negative impacts on wild animals during the Project construction.

(b) Training to local contractors, supervisors and labor force.
Local contractors, supervisors and even followers can influence on local labor force. Training manuals need to be developed for local contractors, supervisors and labor force about existing rules and regulations, importance of biodiversity enhancement, threats to wild fauna and vegetation (trees), responsibility of project implementing agencies, institutes and individuals.

(c) Local people's participation in enhancement
Without active participation of local people, wildlife enhancement is not possible. Formation of biodiversity enhancement groups from different Project impact families and dissemination of information about value of biodiversity and related ecosystem services will help in further participatory management in the area.

12.3.2.2 Operation phase

RCMP and SBZ Management, BEERSP and Endangered Species Restoration Sub-plan
The same measures proposed under the section above on forest vegetation and construction phase are relevant to the mitigation measures for wildlife and birds during the operation phase. Additional specific actions are listed below:

(a) Awareness and environmental protection
The programs set-up by the ESMU during the construction should be continued although the awareness campaigns can be reduced in number, and training would consist mainly of renewing knowledge bases and reviewing experiences to include in on-going programs.

(*b) Regular monitoring on migratory birds*
The formation of dams may serve as a favorable habitat for waterfowls and migratory wetland birds. Regular monitoring and seasonal counting of birds would be an essential contribution on the census information on migratory birds of global significance.

12.3.3. Aquatic ecology and fisheries

12.3.3.1 Construction phase

RCMP
Most of the impacts in this Project affecting the aquatic environment, impact the whole freshwater ecosystem. For example, increased erosion will affect water quality, increasing turbidity and reducing visibility. The increased amounts of sediments can change the habitat quality, impacting both macro invertebrates and fish. Reduced visibility will normally reduce primary production (algae and planktons) affecting the invertebrates and fish, thus eventually fishery activities. Water quality issues are also dealt with under the EHSP, and the section on the Social and Cultural Environment Program.

See sections under the Physical Environment Program, the RCMP covering erosion, ACBP and the EHSP. The RCMP will manage the following:

(a) Erosion in the reservoir – vegetation removal
To avoid erosion in the reservoir area, clearance of woody vegetation from the inundation zone prior to flooding (nutrient removal) should be carried out as well as weed control measures should be taken. In similar lines, sedimentation in the reservoir and subsequent loss of storage capacity may be minimized by control of land use in the watershed (especially prevention of conversion of forests to agriculture). These require reforestation and/or soil enhancement activities in watersheds coupled with the hydraulic removal of sediments (flushing, sluicing, release of density currents) and the operation of reservoir to minimize sedimentation (which can entail loss of power benefits).

(b) Runoff from tunnel blasting and tunnel drilling and sediment deposits
The water from the tunnel excavation performed either by blasting or full profile drilling, should pass a sedimentation pond prior to be discharged into the river, if the pressure is expected to be very high.

In the low flow period, the sedimentation pond should be monitored with respect to ammonium, free ammonia and pH. If necessary, pH should be adjusted to neutrality before any discharge into the river. In the wet season, the ammonia discharge will not harm the river biota.

In the first period after a major tunnel and hydropower construction work, the spoil rock deposit is normally used for construction purposes, filling material for road construction, quarries, etc. After some years they are abandoned, and should be closed in a proper way. To prevent impact on water environment, the location, water handling and the final rehabilitation are necessary. The sites for the soil and spoil deposits should be strategically positioned to avoid runoff directly in the river, and provide lining, if necessary.

Location and water handling. The deposits should not be placed in steep terrain. The best location would be in natural depression with infiltration outlet. Such depressions are, however, not always easy to find in the terrain near the construction area. The second best would be to place the spoil rock deposit in a flat area with little runoff (i.e. upstream catchment) and with good infiltration capacities (sandy soils). If the deposits are placed in a valley-like depression, incoming water shall be drained through by a pipeline of necessary capacity to safely by-pass storm runoff. Downstream of the deposits, a sedimentation pond to settle out as much as possible of the eroded particles should be constructed. The drainage from areas upstream of the deposit shall by-pass the sedimentation basin. If possible the runoff from the spoil rock deposit should be infiltrated in the terrain.

Runoff from blasted tunnel material shall be controlled with respect to the content of nitrogen and particularly ammonia and pH. Water with high concentration of ammonia and high pH

can cause fish kills in low flow periods. In such cases, the pH in the sedimentation pond shall be adjusted to neutrality before released from the pond.

Final rehabilitation of the spoil rock deposit. When there is no more use of the spoil rock, the deposit should be leveled and formed into nature-looking terrain and covered by vegetation. Deposits with material from full profile drilling can often be sowed and planted directly, while material from blasted tunnels must be covered by fertile top soil.

The top soil, gravel and soil from the tunnel ideally need to be separately deposited. Upon spoil deposition, top soil needs to spread unto the spoil material, and a multilayered technique ought to be used. This will allow roots of trees to reach and proliferate into rich soil zones within the spoil, thus increasing anchorage and overall stability of the spoil. Most of the top soil must be placed on top. Planting of tree species needs to be done immediately at edges and grass lines on contours. Open flat areas of the spoil deposits where top soil is deposited, should be immediately made available to the local people for agricultural practices of agro-forestry. It is vital that the rehabilitated areas is not open for grazing until all vegetation is established, six years minimum, as this will result in spoil slope weakening.

EHSP
See also the main description of this plan in the section on Physical Environment Program The following measures must be included in the EHSP.

(a) Sanitary effluents from the construction workers camp
During the construction phase there will be much activity at the different construction sites. There will partly be residential camps for construction workers, administration buildings, workshops, machine parks etc., as mentioned above. At these sites there have to be built sanitary systems with no direct discharge to the river. If possible, the camps shal be placed in areas with good infiltration capacity. In such areas standard pit latrines may prevent hygienic pollution to enter the river.

(b) Oil and chemical spill
During construction there will be a large park of machineries such as trucks, tractors, excavators, bulldozers, drilling machines, cars, etc. These will need diesel and gasoline, motor oil, hydraulic oil, battery acids, etc. Storage places for such chemicals must be established in secure areas where such compounds cannot enter the Ca river. The storage and fuel filling shall take place on paved area, which is water-tightly drained to a collecting tank in case of accident spills. Workshop floors shall be drained to a collecting tank from where the content can be removed and correctly treated. Parking areas shall consist of loose material with infiltration capacity which can absorb small spills. Such area shall be constructed of stones, gravel, sand and silt.

(c) Accidental water releases and dry-ups – testing and warning systems
The functioning of the spillway gates shall be tested out properly with respect to both opening and closing before filling the reservoir. A flood warning system to people living downstream the dam and the outlet of the power plant construction site shall be established. The initial filling of the reservoir is suggested to be done only in the wet season with bypass of at least of the proposed environmental flow. It is important that the river is not dry.

12.3.3.2 Operation phase

(a)Proper design of spillway or addition of structures to favor degassing
One of the problems of taking water from deep in the reservoir might be the super saturation of gasses in the deeper levels. If these gasses are not released before the water is in contact aquatic life – gas sickness will result. The design of the spillway, therefore, should be constructed to avoid these problems. The same problem might arise if water for the minimum flow is taken from the bottom of the reservoir. Taking the water from this level will also involve a risk for toxic water and low water temperature. The final design and operation should take into account the above issues.

(ii) Compensatory environmental flow

Releasing of water flow for environmental requirements and downstream users is a new concept in Vietnam. There is no regulatory requirement for environmental release, however most of the large dams had a provision for releasing 10 % of the average minimum flow for ecosystem and social needs.

A minimum average monthly flow increasing down the river course of the dam would be required. This discharge from an ecological perspective must consider that it is sufficient for the maintenance of adequate wetness conditions to support the ecosystems that may exist in the boulder bed river, riparian vegetation, water resources, and fisheries. Provision shall thus be made to release such quantum of water which is able to sustain fish and local use of the river.

The fish and river use activities as such should be monitored and if the findings reveal that the recommended release is not adequate, the operator should be willing to adjust the minimum environmental flow. Thus an adaptive approach should be taken in the long run. Any adjustment to the environmental flow after 3-5 years of monitoring should reflect the building blocks (low flows, channel flushing, habitat maintenance and spawning/migration freshest).

(iii) Evaluating the building of a bypass system for fish at the dam
There are three species, *Anguilla mamorata* and *Bagarius rutilus* listed as "Vulnerable" according to the Vietnam Red Data Book (2007). They are medium to long -range migratory species and they have already been impacted by Nam Mo, Nam Cun and Ban Ang dams constructed downstream; their migratory route has already been obstructed. Most other species found are residents and these resident species are known to undertake short distant migration within stretches of the river. In the case of Nam Mo 1 HPP the likelihood that a bypass system like a fish ladder will work are remote. Consideration of a screen as discussed below should be considered.

(iv) Consideration of a screen in front of the intake in the dam
One of the main risks of fish mortality occurs during the downstream migration phase of migratory fish species since all or a large part of the river flow is diverted through the turbines. Also fish that live in the reservoir meet the risk of being lost in the intake. Various techniques exist to prevent this, like fine meshed screens across the turbine inlets. This technique is however most effective if the fishes are diverted back to the river, e.g. if not all the water is diverted through the turbines. Furthermore, these screens impose a heavy maintenance burden that can reduce electric production. Thus there are alternatives to traditional fish screens like acoustic, louvre, bubble or electric screens that are considered in various places. Even if the dam design cannot allow for the fish to migrate downstream with the help of the screen system, it can be of considerable help to avoid the fish populations living in the reservoir to be caught in the intake. This has to be looked into during the design phase.

(v) Fish Adaptation Study
The two species, *Anguilla mamorata* and *Bagarius rutilus,* listed as "Vulnerable" according to the Vietnam Red Data Book (2007) are medium to long -range migratory species and they have already been impacted by Nam Mo, Nam Cun and Ban Ang dams constructed downstream; i.e., their migratory route has already been obstructed. These fish were reported from the river during the sampling reported in this ESIA pointing to their continued presence and likely adaptation. 80 fish species appear to inhabit the river system. Thus, there are several other fish which may be adapted to the reservoir environment. Similarly the Nam Mo 1 HPP may be expected to allow for adaptation of many of the fish species. It has to be noted that long-distant migrants are likely to disappear eventually due to the lack of stage of sea-water life-stage, if highly dependent on having this stage. A study is proposed to monitor fish species diversity and populations in the Nam Mo 1 reservoir and downstream stretches.

(vi) Mitigation against peaking
The daily peaking activity will degrade aquatic life, fish and fishery and be a risk to people, especially children downstream the outlet of the power plant.

(vii)Starting the peaking for the first time
Experiences from other peaking operations, shows that the first peaking operations should be gentler both in volume and have a long up and down peaking time. This gives especially the fish a possibility to adapt the rapid and high changes coming.

EHSP
The EHSP should include full guidelines for the set-up of a system for early warning of floods, spillway releases from the outlet and downstream the dam as well as rapid changes in water quality which can affect people and animals. The warning system should be based on direct warning from the operation staff at the Nam Mo 1 HPP station to the people living along the Nam Mo river. This system could be based on battery/solar cell-operated sirens with wireless transmission.

(viii) Fish stocking programs
A common course is to promote aquaculture as mitigation. In many cases aquaculture actually exacerbates biodiversity losses, for example by introduction of exotic species which affect indigenous species negatively. Proper controls are advised through monitoring. A fisheries support programs and is part of the overall livelihoods restoration initiative is recommended and is detailed below:

Fisheries Support Plan (FSP)
This plan has two subplans to elaborate a more detailed approach.

Cage Fish Farming Sub-plan
Introducing fish cages in the reservoir face some of the same problems regarding exotic species as in dam projects. However by using fish cages the risk of escaping and introducing new species and possibly fish sicknesses in the river ecosystem is even higher than in fish dams. We therefore strongly recommend using local fish species because in many cases aquaculture actually exacerbates biodiversity losses, by affecting indigenous species negatively.

Big size fish species, with rapid growth and feed on planktons are used in cage fish culture. In Vietnam, cage fish culture in dams is common. During the construction phase which is assumed to take five years, a more close investigation should be done to evaluate the risk of using exotic species, and to evaluate new equipment that in a higher degree than what seems to be available today, can give a higher guarantee against escapes. Because of the high daily and yearly fluctuations of the water level and the flushing of the reservoir once a year the effect of this mitigation is somewhat uncertain. The recommendation is to start carefully with not more than 10 fishermen, each using five cages.

Community Fish Farming Sub-Plan
In all sections of the Project AI there is expected loss in fish production which will negatively affect the outcome for the fishermen. In some DIA villages, households have built fish ponds and are raising carp and other native species stocked from the river. This seems to work well. The experiences gained in by these farmers will be used as mitigation in the Nam Mo 1 HPP.

From an ecological point of view, we strongly recommend using local fish species because in many cases aquaculture actually exacerbates biodiversity losses, for example by introduction of exotic species which affect indigenous species negatively and are virtually impossible to eradicate once established. Fingerlings are available outside the DIA area. Feeding fish pellets would provide a *reasonable growth.*

ACBP
Given that the water flow will be reduced substantially in the low flow season, the risk of over fishing and use of illegal fishing methods may increase. Similarly, during construction phase over fishing is expected. This may be managed through establishing controls and increasing awareness. An awareness programs dealing with over fishing and use of illegal fishing methods as well as other threats to the environment should be worked out. Workers, permanent and non-permanent technical project staff, project administrators, local people, children, district and local level Government personnel should be well informed.

12.4 Social and cultural environment

12.4.1. Agriculture improvement

The loss of land and properties, and the displacement of population from their settlement areas are probably among the major social and cultural impacts of the Nam Mo 1 HPP. Livelihoods of the local communities comprising mostly of ethnic minority population depend upon forest and water resources, and land resources in the form of upland farming. Forests provide the much needed food items like vegetables, materials for household energy, construction and other use, and animal protein through small mammals, lizards and amphibians for home consumption. River resources provide animal protein. Both these resources are helpful in generating some cash to maintain households through sale of small mammals and rodents. Livestock is another source providing animal protein and cash through the sale of live animals, but disease outbreaks cause immense loss. Agriculture in the form of swidden systems is influenced by weather patterns and poor soil quality, provides rice as a staple food, and maize and cassava for livestock feeding and some sale, however, rice production is not sufficient all year round for the many poor families. Farming practices are traditional and subsistence oriented, and all livestock are free-ranged; uncontrolled disease outbreaks cause immense loss to livestock. The ethnic minorities have little to no access to agricultural extension services of district or commune agencies, and moreover the local extension technical staff have poor technical capacity to manage livestock diseases.

In the context of Nam Mo 1 HPP, the local community though resettled in new location, will not loss all their upland farming area; However, the loss of 765ha forests in reservoir could significantly reduce grazing areas for their domestic animals.

All mitigation and enhancement measures are organized in integral plans. These plans are integral in the sense that they integrate both compensatory and enhancement measures in specific fields aiming to improve living conditions of the population in the DIA. In order to present the contents of each of these plans and avoid repetitions, a general introduction to the plans is made below and elaborations done in the sections that follow.

The compensatory and enhancement measures, in the context of agriculture and livestock are organized into three main areas of intervention under Agriculture and Livestock Support Program:

Agriculture, Livestock and Fisheries Support Program

- Upland Farming Diversification Plan (UFDP)
- Soil Fertility Enhancement Plan (SFEP)
- Animal Husbandry and Veterinary Services Plan (AHVSP)

These are also integrated across programs plans, namely the RCMP, BEESRP, SBZ Management Plan, and the ACBP.

12.4.1.1 Upland farming diversification plan

This programs includes measures and plans aiming to compensate the production losses, enhance productivity, diversify production and improve marketing in agriculture. These measures are organized into different sub-plans, including:

- Crop diversification and Multiple Cropping Sub-plan
- Fruit and Vegetable Production Sub-plan
- Bee Keeping Sub-plan
- Forage Production Sub-plan

The Project will implement these plans in the Project DIA in collaboration with the extension services at commune and district levels. The plans below are to be formulated during the design phase of the Project and implemented during the Project construction phase.

Crop Diversification and Multiple Cropping Sub-plan

The Crop diversification and Multiple Cropping Sub-plan will be executed as compensatory and enhancement measures in 20 households in each Project affected village as a pilot project during the first 2-3 years and then extended to other households. This will include growing crops such as ginger, peanuts, beans, pumpkins and other vegetables and similar other crops intercropped with traditionally grown maize and cassava. This will also include planting fodder trees.

The plan will include improved farming practices, improved drought tolerant seeds, fertilizers, and other necessary inputs such as capacity building of farmers. The Project will facilitate the farmers in order to effectively implement the proposed mitigation plan. The project will collaborate with state extension services for seeds and improved agronomic practices.

Capacity building of farmers (part of the ACBP)

A series of training programs will be organized, in collaboration with extension services at commune and district level. The training is expected to enhance the skills and capacity of farmers to efficiently utilize land resources adopting improved farming practices and change in cropping patterns. Training will also include the components of crops, vegetables, horticulture, beekeeping, soil fertility enhancement, compost making and related fields.

Implementation approach

Crop diversification on uplands will be a new initiative among the ethnic minorities as few households cultivate more than upland rice, maize and cassava. The Project will prepare a plan and introduce the local community to new farming approach, growing more types of crops alone or intercropped on uplands. Adoption of appropriate farming techniques and agronomic practices will be necessary.

The Project will select 5-6 households in each village, discuss with them about this new initiative, make a household group, provide training and involve them in the programs. A good technical support will be required. The Project will collaborate with state extension agencies at the commune and district levels for technology and materials as well as draw from other experiences in Vietnam and Laos. The Project will financially support extension services with manpower and technology.

Fruit tree and vegetable production sub-plan

The Project will implement the Fruit Tree and Vegetable Production Sub-plan on homestead areas and on river bank. The Project will collaborate with concerned communes to allocate suitable area with gentle topography in the SBZ on the riverbank or near streams in other areas for cultivation. Initially, five households will be involved in fruit tree production in riverbank cultivation and all other households in homestead area. Most households have a small plot for farming. The Project in collaboration with state extension agencies will provide improved seeds and fertilizers to participating farmers. If water source is available, provision will be made for drip irrigation.

Bee keeping Sub-plan

This will be a new farming initiation in the ethnic minority. Honey production using forest vegetation is a common activity in upland areas. Initially, two willing households will be selected in each village, trained and provided with beehives and bees. (See capacity building explained earlier). If successful, this will gradually involve more households. The Project will prepare and implement a Bee Keeping Plan.

Forage Production Farming Sub-plan

Forage scarcity was reported in most Project affected villages and very few farmers grow local maize seeds for fodder production. It has not been a common practice among ethnic minorities to grow forage crops. Since a large forest area covering 765ha will be inundated which would reduce grazing area, the Project will prepare and implement forage production

programs in all the Project affected villages. In Laos, households have more access to grazing area than in Vietnam side. Forage crops will be grown on upland farms as a single crop or intercropped with cassava. Locally available fodder tree species will be planted on uplands.

12.4.1.2 Soil Fertility Enhancement Plan (SFEP)

This programs includes activities aiming to improve soil fertility, enhance crop productivity, and eventually increase crop production. Soils are very poor and less productive. Slash and burn just before rainy season and planting seeds at early rainy season aggravates soil erosion. Yields of hybrid maize in such areas are less than one third of its potential grain production. These measures are organized into different sub-plans, including:

- Growing Legumes and Similar crops in Multiple Cropping Sub-plan
- Compost Making and Mulching Sub-plan

Growing Legumes and Similar Crops in Multiple Cropping Sub-plan
Farmers are growing beans in home gardens and occasionally on uplands. Legumes such as soya beans, beans and similar crops could be grown inter cropped with maize and other plants. These legumes can provide pulses and their roots will add nitrogen to the soil. Capacity building will be provided to local farmers (See Crop Diversification).

Compost Making and Mulching Sub-plan
The Project will prepare and implement a compost making plan. Simple compost making process will be adopted using biomass collected from nearby forests (only if needed), crop residue and cattle dung. Farmers usually have a temporary house in upland farming areas and live there during crop maturity and harvest. Cattle while grazing on fallow land can be put in paddocks at night and dung collected for compost. A simple technique is to have a ditch/pit for biomass and dung decomposing. The decomposing process will take some time, but it is an easy and viable cost-free option. Compost can be used during crop planting. Compost making is to be introduced and practiced at homesteads where all the organic waste can be dumped into a ditch (or compost bins) and then harvested after 3-4 months. This compost can be used in home gardens and field vegetable plots.

Farmers at present leave all crop residues after harvesting grain and they just get blown off with to wind. Crop residues could instead be collected, put aside and used during cropping as mulch or dumped into compost pits.

12.4.1.3 Animal Husbandry and Veterinary Services Plan

Farmers rear a range of domestic livestock e.g. cattle, goats, buffaloes, pigs and poultry. All animals are free-ranged although a few farmers rear hybrid pigs in confinement. During the HH survey, a few households expressed intension to keep their pigs and poultry confined (sheds and sties [pigpens]). Disease outbreaks are common and many animals die. Forage scarcity particularly during winter has been a major problem in the Nam Mo1 HPP Project affected areas, more so in Vietnam than in Laos.

This programs includes plans aiming to improve animal husbandry practices, management of livestock, improved feeding, reducing incidence of diseases and improving animal health services. Farming pigs and poultry in confinement could be considered as environmental programs reducing litter and waste in the village area. Proposed measures are organized into three different sub-plans:

- Animal Husbandry Improvement Sub-plan
- Extension and Veterinary Services Sub-plan
- Forage Production Sub-plan

Animal Husbandry Improvement Sub-plan
This will include feeding, breeding and management of all kinds of livestock in the Project DIA villages (resettled in most cases) and will involve a large number of households. Special

attention will be paid to pig farming and poultry rearing in terms of feeding, management and breed improvement. The Project will prepare and implement an Animal Husbandry Improvement Plan giving emphasis to improve feeding, breeding, and management of livestock, particularly of pigs and poultry.

The Project will financially support the construction of a pigsty (pigpens) for 5-6 pigs and a small poultry shed for 15-20 poultry birds for every household in the DIA villages, agreed with each household. Farmers will be encouraged to rear hybrid pigs in pigsties and additionally use commercial livestock feed for better growth. Poultry can be managed at a semi free-range system. Some of the households will also be persuaded to rear improved poultry.

Extension and Veterinary Services Sub-plan
The Project will prepare and implement a comprehensive Extension and Veterinary Services program which will include (i) support to extension service centers at commune and district level both in terms of manpower and technology, including medicines and vaccines; (ii) awareness and training to at least one person from each DIA household on animal hygiene and primary treatment, (iii) equipment and appliances needed for improved husbandry and treatment.

This will be an important program in the Project DIA and its adoption rate by farmers is expected to be very high.

Forage Production Sub-plan
See section 2.4.1.1, above on Forage Production Sub-plan

12.4.2. Social improvement

12.4.2.1 Community Health and Sanitation Plan

A Community Health and Sanitation Plan will be developed prior to Project construction with the aim of improving health status of communities in the Project DIA. The plan will be developed for both construction and post construction phases of the Project. The plan will incorporate the following specific programs that will be implemented in the Project villages:

(a) Household Water Supply and Management
Household water supply will be provided in all the relocated villages with the same type of system as in the existing villages, and with a proper filtering system to allow safer drinking water. The Project will also support villages losing land and in the DIA to develop drinking water systems. Such support will be in the form of remediating and augmenting existing drinking water systems. The Project will collaborate with villages to support the access to safe piped drinking water to relocated households. Similarly, the Project will support drinking water quality analysis in villages. The aim is that the Project will contribute to the establishment of treatment practices for safe drinking water to Project-affected households and bring the quality of drinking water up to the standard prescribed by the National Drinking Water Quality Standards.

(b) Sanitation Enhancement Sub-plan
Approximately more than 80% of the households in the Project DIA do not have toilet facilities. They use nearby forest areas, river/stream banks and open lands for open defecation. This low hygienic standard contributes to high prevalence of diarrhea and related health problems. In the relocation villages, every household will be provided with a toilet. The Project will also provide support for construction of the toilets with septic systems and flushing mechanisms in other affected villages in the DIA.

(c) Community Waste Management
Villages at present lack waste management practices and people dispose waste haphazardly in and outside the village. There is no awareness of the health risks from litter around the houses, which the free roaming animals are partly eating. The Project will support developing simple waste management systems in relocated villages that are

sustainable, based on the local culture and designed together with the villagers in order to be managed by the community. Such a waste management system may include e.g., construction of an open but fenced area for waste disposal outside the village, composting development for organic waste, and organization of community rubbish collection team.

(d) Improved Cooking Devices

Smoke from traditional cooking oven open fire is a serious health hazard, especially for women, who are cooking inside the house and children staying with their mothers. The Project will provide support for Improved Cooking Stoves (ICS) in the relocated households that should be included in the house kitchen design. ICS has a range of benefits compared to traditional fuel wood stoves; ranging from reduced emission of smoke and noxious gases in the atmosphere consequently aiding in reduced incidence of respiratory diseases. ICS requires less fuel wood and accordingly also contributes to less firewood needed from the forest areas surrounding villages. Consequently, reduced firewood collection will contribute to lessen women's work load both physically and timewise.

(e) Awareness and Capacity Building Plan (ACBP)

The Project will launch health and sanitation awareness programs in different locations in the Project DIA. Such awareness programs will be conducted in villages. The awareness will focus on water use and treatment practices, pollution of water sources, personal hygiene and households as well as community sanitation. The Project will collaborate with state agencies at district/commune level to effectively implement such awareness and education programs.

(f) Public Health Support

Availability of health services is very poor in the Project DIA. Villages lack any health services, and the distance and travel to the available services in commune and district health centers is long, difficult and in many cases too costly for the poor people. There are trained health workers in many Vietnamese villages, but these are trained only in delivery of government health information and without medical training. It is proposed that the Proponent will: (i) develop health services availability for the local PAPs connected to the construction workers' health facilities, (ii) support training of health workers in villages, and (iii) develop mobile health services to the villages in cooperation with the commune/district health providers. Health services that are built up in the construction area will be in operation during the construction period, but could remain after the construction and run by a local administration.

(vii) Emergency Medical Response

An Emergency Medical Response Unit (EMRU) will be established in each construction site for first aid and emergency assistance. One medical doctor will be employed in the ESMU of the Project during construction.

12.4.2.2 Community Labor and Employment Plan

Most of the people in the Project DIA are farmers and there are hardly any labor opportunities apart from agriculture and forestry. Seasonal and permanent labor out-migration of especially young people, both men and women, from the affected villages to other provinces and major cities is high. There will be many labor opportunities for unskilled workers in the HPP construction and it is required that local workers from the affected communities will be prioritized whenever possible. Requirements for local employment among the unskilled labor force and measures to ensure are required to be included in all the procurement documents and construction contracts and sub-contracts. It is required that:

- Contractor has to prioritize employment of local unskilled labor force (through subcontracting) so that at least 30% of the unskilled labor force over the Project construction time are workers from the Project DIA communities.

- A total of 30% of the local unskilled labor force has to be women. Contractor has to implement measures to enhance employment of women, including awareness raising to prevent sexual harassment of women.
- Male and female unskilled workers will receive equal pay for equal work.
- Contractor is not allowed to use any child labor (workers under 16 years of age).
- Contractor has to provide basic facilities (such as water and latrines) separately for men and women in the construction sites. The quality of these facilities has to meet the locally acceptable standard.
- Contractor is required to provide adequate working conditions and facilities for their workers, as well as ensure health and safety measures in the workplace. Contractor is required to coordinate with local health centers in order to ensure that necessary arrangements will be made for prevention of accidents and epidemics, and that first aid facilities and access to basic health care and emergency care are available at all times for all employees at the construction site and at workers' camps.

12.4.2.3 Influx Management Plan

The HPP construction will contribute to an influx of people to the Project DIA who may far outnumber the local people. There will be large numbers of workers, mostly male, camp followers (entrepreneurs) and other people taking the appearing economic opportunities (small business, commercial sex-workers) in the Project DIA, especially around the construction area and in the existing local population centers[102]. New people with culture and habits different from the local ones will greatly increase the risk of sexually transmitted diseases such as HIV/AIDS and the risk of human trafficking especially women and children. There is also an apparent risk of increasing drug trafficking and drug use added to the already existing problem of drug addiction in some Project-affected villages. Influx of people also can have a significant impact on local natural resources and can create conflicts with local communities that rely on the limited resources on a daily basis. Awareness of potential risk and social problems should be enhanced among vulnerable local people, especially women and girls. See also forest related plans on awareness raising.

(a) Increased number of people in project affected area: work force, camp followers etc.
A peak workforce presence over 1750 individuals will trigger related influx of entrepreneurs, commercial sex-workers, increase in entertainment centers (e.g., karaoke bars), food shops with local wild meats and forest medicinal herbs, etc. There is usually pressure on local resources, including wood, land and hunting. Both monitoring and a worker and community based awareness program have to be implemented (described below and in the Physical Program). Particularly vulnerable are the young girls and women from villages in the vicinity of camps and populated areas.

(b) Community-based Public Awareness Program in Project DIA communities
Experience shows that the risk of HIV/AIDS and other sexually transmitted diseases (STDs) as well as of human trafficking will increase during big infrastructure construction projects. With usually provided better connectivity leading to increased mobility, these risks remain even after the construction period.

In order to mitigate these potential negative consequences of the HPP, a community-based Public Awareness Program with two components will be implemented in the Project DIA:

1) HIV/AIDS and other sexually transmitted diseases prevention; and

[102] MIGA, 2009. Projects and People. A handbook for addressing project-induced in-migration. http://www.MIGA.org/wps/wcm/connect/topics_ext_content/MIGA_external_corporate_site/sustainability-at-MIGA/publications/publications_handbook_inmigration__wci__1319576839994

2) Human trafficking prevention.

The intention of the Public Awareness Program is to increase the risk awareness of the local people through information dissemination in the Project-affected villages and communes. Better knowledge of the sexually transmitted infections and of protection against them is expected to obstruct the increase in HIV/AIDS and STD cases. Likewise understanding of the ways and methods of human trafficking will hinder individuals falling easy victim for it. The awareness programs will be designed to be appropriate for the local culture, using local language and appropriate communication methods for ensuring that the information is understandable and accessible for the local ethnic minority communities with low educational level; pictorial information is prioritized. The Project will provide funds for information materials and for engaging Women's Union at province, district and commune level for implementation of the Program.

(c) Construction Workers' HIV/AIDS Awareness Program

All Project contractors are required to implement an HIV/AIDS Awareness Program among construction workers and to undertake measures to reduce the risk of the transfer of the HIV virus and other sexually transmitted infections between and among the construction personnel and the local communities. Contractor is requested to subcontract an approved service provider, such as the Province HIV/AIDS Prevention Centre to:

- Carry out regular awareness raising among the employees throughout the construction time through information, education and communication activities that address HIV/AIDS and other STDs, transmission risks and promote preventive measures. The awareness programs shall cover all the contractor's employees, all subcontractors and any other employees, as well as all truck drivers and crew making deliveries to the construction site.

- Promote early diagnosis of HIV: Ensure workers have access to and know how to access voluntary counselling, screening and diagnosis for HIV/AIDS, so that all workers can find out their HIV status.

- Provide free condoms at the workers' camps.

The contractor will include the HIV/AIDS awareness program as a sub-clause in the execution of the works, budget it as a lump sum covering all the costs related to the program and clearly indicate when, how and at what cost the program with all the required measures will be implemented. Contractor shall detail the resources to be utilized and the proposed sub-contracting arrangements and provide a cost estimate with supporting documentation. Payment to contractor for preparation and implementation of this program shall not exceed the budgeted sum for the purpose.

The Project Owner will assure that the HIV/AIDS awareness program is included in the construction bidding documents and accordingly included in the construction contracts and implemented by eligible contractors.

12.5 Resettlement Policy Framework (RPF)

The Proponent is responsible for preparing and implementing a Resettlement Action Plan (RAP) for each of the villages that have to be relocated due to the HPP, based on the Resettlement Policy Framework (RPF) and the Entitlement Matrix for lost land and assets, provided in the ESIA. Details are provided in Volume VI. In the ESIA, Chapter 8 provides a baseline assessment of the people to be physically and economically displaced, and the impacts assessment is included in Chapter 11. The RAP will be prepared through an informed consultation process with the affected communities and with each affected household according to the mechanism given in the PCDP enclosed in Volume V. The RAP will be prepared based on the applicable resettlement policy of the government and of MIGA

on the outcome from the consultations with the PAP and following the Entitlements Matrix for resettlement and compensation.

12.5.1. Legal basis and standards

The Project Policy and Entitlement Matrix is based on the following legal documents and standards:

- Agreement Between the Government of the Lao Peoples Democratic Front and the Government of the Socialist Republic of Vietnam of 11 March 2016;
- Decree on Compensation and Resettlement of People Affected by Development Projects (Decree No. 84/GOL, 2016);
- Land Law 2013 which is effective from Jul. 1st, 2014 of the GoV and Decree No. 01/2017 / ND-CP amending the decree guiding the Land Law;
- Decree No.38/2013/NĐ-CP on management and utilization of official development assistance (ODA) and concessional loans from donors;
- Decree No.44/2014 of the Government regulating land prices, Decree No. 104/2014/ND-CP on land prices, and Circular detailing a number of articles of the Government's decree no. 43/2014/NĐ-CP and decree no. 44/2014/NĐ-CP dated May 15, 2014 (GoV);
- Decree No.47/2014/NĐ-CP of the Government of May 5th, 2014 on compensation, support and resettlement upon land expropriation by the State, which is effective from Jul. 1st, 2014 (GoV);
- Circular No. 37/2014/TT-BTNMT of June 30th, 2014 on detailed regulations on compensation, support, and resettlement upon land expropriation by the State (GoV);
- International Finance Corporation (MIGA, 2012) guidelines and Performance Standards (PS), PS 1, PS 5 and PS 7.

12.5.2. Proposed Nam Mo 1 Hydropower Project Policy for PAPs in Vietnam and Laos

- Project impacts shall be avoided or minimized wherever possible by exploring viable alternatives in design and location.
- Full assessments shall be conducted to ensure all impacts are identified and mitigated.
- PAPs shall be compensated and resettled in order to improve their standard of living, including access to community services and resources.
- Land acquisition and resettlement shall be planned and implemented to cause least possible amount of social, cultural and economic disruption.
- All measures shall be implemented without detriment to the environment.
- Special measures shall be incorporated to protect socially and economically vulnerable groups, and groups that cannot for various reasons participate in restoration programs.
- All persons residing within the areas directly impacted by the Project shall be considered as PAPs and will be entitled to compensation and resettlement if the impact influences their residences and livelihoods negatively. Those without legal titles or required documentation shall be assisted in acquiring the necessary documents that will give entitlement to compensation or replacement.
- The previous level of community services and resources shall be improved after compensation and resettlement.
- The Project development costs take into account the costs of resettlement. The resettlement programs shall be planned and implemented with the consent and agreement of the affected people through a participatory involvement process.
- All households will have access to effective mechanisms for hearing and resolving grievances during the implementation of compensation and resettlement programs.

- Proponent will carry out monitoring of PAPs until compensation is completed and livelihoods are fully restored, and until development targets are achieved.

12.6 Public Consultation and Disclosure Plan (PCDP)

To guide future consultation and engagement activities a Public Consultation and Disclosure Plan (PCDP, see Volume V) according to MIGA (World Bank Group) guidelines has been prepared. The PCDP provides details on consultations that have been conducted, stakeholder concerns, policy and regulations, key principles for planned consultations, tasks for an effective PCDP, management organization, and a grievance redress mechanism.

The PCDP aims to:

- Identify key stakeholders and ensure there are adequate mechanisms for stakeholder feedback and information sharing;
- Carry out *meaningful consultation* in accordance with PS1, PS5 and PS7, where PS7 calls for FPIC process where *broad community support* is confirmed;
- Provide a framework for consultation at the local, national and international levels;
- Ensure issues raised by key stakeholders are addressed in the ESIA report as well as in the project decision-making and detailed design phase;
- Provide mechanisms that ensure the formulation of the RAP based on the framework prepared as part of the Nam Mo 1 HPP ESIA;
- Identify the level of resources required to implement the plan and procedures to monitor implementation; and
- Outline a grievance mechanism for local stakeholders.

In line with MIGA policies, as noted above, the PCDP is intended to enhance community benefits and related environmental issues by minimizing negative effects through engaging the community. The purpose of community engagement is to build and maintain over time a constructive relationship with communities. The nature and frequency of community engagement will reflect the Project's risks to and adverse impacts on the affected communities. Through functioning as a means to fully integrate with all phases of the project - planning, design and implementation - the PCDP goes beyond only describing what has already been undertaken and is thus proactive in nature. It more saliently sets outs a roadmap for achieving the aims of the community plans, and guides the overall long term social and environmental management systems of the Project.

The PCDP has built on public consultation and disclosure procedures carried out during the ESIA period, and built on Project AI information in 2017 and experiences in the region.

12.6.1. Contractor's responsibility

The Contractor shall develop its own Environment Management Plan (Contractor's EMP). The Contractor shall ensure that the contractors and its sub-contractors carry out their work in accordance with the environmental, labor and safety policies and commitments of the company, and comply with applicable Vietnam and International requirements. It shall develop its own Environmental Health and Safety Procedures (EHSP) patterned according to the EHS policy of the PO. This shall be included in the contractual obligations of the Contractor.

An Emergency Preparedness and Response Plan (EPRP) will also be developed by the Contractor. Key hazards to the Project and to workers which present potential emergency situations will be considered in developing the EPRP and it shall have the following components:

- Landslides and rockfalls;
- Earthquakes;

- Coffer dam failure;
- Road traffic accidents;
- Flooding of tunnels during construction;
- Working in confined spaces;
- Flood discharges and impacts on major structures (especially those higher than the return period design flood level);
- Operational phase flushing (of sediment traps, if used based on final design) and significant increases in downstream levels / discharge rates
- Power cuts / outages;
- Storage, handling and use of explosives;
- Fuel and chemical storage, handling and use;
- Fire hazard;
- Weather and climatic events;
- Site security; and
- Border conflicts or civil unrest.

CHAPTER 13 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

13.1 Introduction

An integrated Environmental and Social Management Plan (ESMP) has been prepared for the Nam Mo 1 HPP to set out environmental management requirements[103]. Besides, it also proposes procedural frameworks to ensure that all mitigation measures and monitoring requirements specified in the Environmental and Social Impact Assessment (ESIA) report will actually be carried out in subsequent stages of Project construction and operation.

13.2 Environmental program

The ESMP as written now is to function as a framework for the formulation of in-depth plans, programs and specific mitigation measures during construction phase. When its contents are fully formulated it is envisaged to serve as an environmental operation manual for the Nam Mo 1 HPP management group and staff employed by the management. In addition, it will be an advisory document to the regulatory authorities such as Ministry of Industry and Trade (MOIT), Ministry of Natural Resources and Environment (MONRE, both Vietnam and Laos) and The Ministry of Agriculture and Rural Development (MARD).

The ESMP will require a revision during the detailed design and tender stage and the development of specific contract clauses concerning the required environmental and social mitigation; the revision will also address any required changes to the current design of Nam Mo 1 HPP.

The basic objectives of the ESMP are to:

- formulate environmental management requirements to ensure that all mitigation measures and monitoring requirements specified in the ESIA report is actually be carried out in different stages of Nam Mo 1 HPP implementation;
- define environmental management principles and guidelines for the pre-construction, construction, post construction and operation phase of Nam Mo 1 HPP;
- establish environmental resource needs;
- recommend a plan of action and a means of testing this plan to meet existing and projected environmental problems;
- establish the roles and responsibilities of all parties involved in project environmental management;
- describe mitigation measures that shall be implemented to avoid or mitigate adverse environmental impacts by maximizing the positive ones;
- establish a supervision, monitoring, auditing and reporting framework;
- ensure implementation of recommended corrective actions aimed for environmental management and its enhancement; and

[103] MIGA and MIGA. Performance Standards (MIGA, 2013) and Guidance Notes (MIGA, 2012). https://www.miga.org/projects/environmental-and-social-sustainability/performance-standards

- ensure that the environment of Nam Mo 1 HPP construction sites and the region of influence is protected and developed to meet the needs of the local people, the stakeholders and safeguard the national interest.

13.3 Implementation approach and mechanism

The Proponent will be the overall responsible for the implementation of the ESMP. It will hire the experts and staff necessary to formulate the proposed plans in the ESMP through consultative processes with relevant stakeholders. Each plan/programs/measure will be disclosed to the stakeholders and agreements made with them to ensure implementation viability. The ESMP is meant to be adaptable to changes that may occur in the Project area, policy and regulatory mechanisms, and stakeholder concerns and views. An Environmental and Social Management Plan Unit (ESMP Unit) of the Social and Environmental Management Division (SEMD) of the Proponent will actively liaison with the state agencies to assure that implementation is smooth. The Public Communication and Disclosure Plan (PCDP) will provide a frame for consultative and disclosure during the ESMP formulation and implementation.

Different parties to be involved directly and indirectly for environmental management of the proposed Nam Mo 1 HPP components include among others:

- Ministry of Industry and Trade (MOIT), Vietnam
- Ministry of Natural Resources and Environment (MONRE), Vietnam
- The Ministry of Agriculture and Rural Development (MARD), Vietnam
- Committee on Ethnic Minority Affairs, Vietnam
- Ministry of Energy and Mine, Laos
- Ministry of Natural Resources and Environment (MONRE), Laos
- Ministry of Agriculture and Forestry, Laos
- Ministry of Labor and Social Welfare, Laos
- Environment and Social Management Plan Unit of Proponent
- Supervising Engineers for Nam Mo 1 HPP implementation;
- Construction Contractor; and
- Provincial, District and Commune level state institutions, etc.

The effective implementation of ESMP will require a continuous monitoring of its environmental performance, and where necessary initiate appropriate planning and implement corrective actions to rectify any shortfalls in performance that may occur. The standard is based on the methodology known as Plan-Do-Check-Act principle, which can be briefly described as follows:

- Plan: establish the objectives and processes necessary to deliver results in accordance with the organization's environmental policy.
- Do: implement the processes.
- Check: monitor and measure processes against environmental policy, objectives, targets, legal and other requirements, and report the results.
- Act: take actions to continually improve performance of the environmental management system.

To complete this cycle, Nam Mo 1 HPP will adopt the following approaches in the implementation of the ESMP:

Partnership approach: The partnership principle implies close cooperation between the Nam Mo 1 HPP and the state agencies at commune, district, provincial and national stakeholders, village level committee at local level at different stages of the implementation cycle of the Project. Although, Nam Mo 1 ESMP Unit will lead the environmental project under the SEMD, it will accommodate all the concerned people and institutions that have roles and responsibilities in the planning, implementation and monitoring of environmental mitigations. Similarly, a monitoring committee will be developed in the district to perform joint monitoring of the impact mitigation measures carried out by different service providers. Basically the service providers will be commune agencies and contractors and their roles should be defined in the elaborated mitigation plan based on agreements.

Community based: Community organizations, e.g., village level committees are non-profit based made civil-group representatives that operate within a single local community. The recent studies and understanding of roles of community organizations has strengthened the view that these bottom-up organizations are more effective addressing local needs than larger charitable organizations. Local involvement from villages in all decision making is essential and the Proponent can foster local community groups/committee to be formed to be part of, e.g., final definition of mitigation decisions, decision on relocation areas, resettlement and mitigation monitoring, grievance redress and equitable resource use.

Capacity building: Capacity building is a key strategy within all Nam Mo 1 HPP programs with focus on both individual and institutional development, understanding that both must be addressed together in order to achieve meaningful changes. The Nam Mo 1 HPP will design and run training programs by coordinating with the district and commune line agencies and experts working in similar fields elsewhere. The main aim is to help in achieving the Project's objectives. The local Government, communities and village level committees are the main clients of Nam Mo 1 HPP, but the private sector also needs support.

Information sharing: Throughout the project period, Nam Mo 1 HPP ESMP Unit will play coordinating roles with aforementioned line agencies and stakeholders in the commune and district. Information sharing is another important aspect to building cooperation between the stakeholders and the Project.

13.4 Institutional arrangement

13.4.1. Institutional arrangement and responsibility

My Ly -Nam Mo Hydropower JSC headed by a General Manager (GM) will implement the proposed Project. There will be a provision for Nam Mo 1 HPP Board which will guide the implementation of the Project during construction and operation phase. Under the GM, among with other divisions, the SEMD will be established and later will have Resettlement and Livelihoods Restoration Unit (RLRU), Grievances Redressal Unit (GRU), Monitoring and Evaluation Unit and Environmental and Social Management Project Unit (ESMP Unit). The organizational setup for environmental management is shown in Figure 13.1.

13.4.1.1 Nam Mo 1 HPP General Manager Office

The Nam Mo 1 HPP General Manager Office will establish Nam Mo 1 HPP SEMD as implementing agency for environmental programs. The GM will coordinate and make final decisions on the implementation of environment mitigation and monitoring plan, however, the GM may delegate some authority to Nam Mo 1 HPP SEMD. Most of the mitigation measures will be implemented during the construction phase as part of tender document clauses and by the Project with technical assistance or in partnership with line agencies,

and Village Level Committees. The GM will approve the Contractors ESMP and other relevant environmental programs prepared by the Contractors as recommended by Nam Mo 1 HPP SEMD. The Nam Mo 1 HPP Board may authorize the Project Director Office to stop work or penalize Contractors for breaching environmental tender clauses, non-compliance or non-performance. The GM Office will ensure timely and quality implementation of mitigation and enhancement measures as well as monitoring. The GM will sign agreements with public and private agencies to implement approved environmental and social programs as recommended by Nam Mo 1 HPP SEMD.

13.4.1.2 Nam Mo 1 HPP Social and Environment Management Division

The Nam Mo 1 HPP SEMD headed by the Social and Environmental Manager will be established in the GM Office at the very beginning of the Project implementation. SEMD will report directly to the GM Office. As shown in Figure 13.1, SEMD will have four sections namely Resettlement and Livelihoods Restoration Unit (RLRU), Grievances Redressal Unit (GRU), Monitoring and Evaluation Unit and Environmental and Social Management Project Unit (ESMPU). Since the ESMP implementation will also need to cover Laos there is a need to assure that units are represented by individuals from both nations having both language and cultural knowhow to implement and conduct themselves. In this regard the Proponent will compose two terms where required, i.e., covering Laos and Vietnam.

The ESMP Unit will be responsible for implementing physical and biological mitigation and enhancement programs while the RLRU will work on land acquisition and compensation, resettlement and rehabilitation, community development, livelihood programs, health related programs and other social activities. The Monitoring and Evaluation Unit will be responsible for monitoring of environmental and social programs implemented by the Project and the contractors as per contractual agreement, and will report on compliance. (See Volume V-PCDP and Volume VI - REMLRP for related details of organization).

During the Project construction phase, SEMD will be a full-fledged office but it will be reduced in size as SEMU during the operation phase. Functions and responsibility of SEMU will be influenced by the findings of an environmental audit conducted by the Project through outsourced agency within three months of the completion of the construction work, which will assess the environmental compliance during construction phase, identify the emerging problems, assess the environmental and social works to be done, and recommend mitigation and enhancement measures to be implemented during the operation phase. After the environmental audit, regular works of SEMD may be considerably reduced or cease. My Ly-Nam Mo Hydropower JSC can opt to have certain aspects on monitoring to be managed by the SEMD (or if reduced, SEMU). These aspects have to be formulated during the pre-construction stage.

The Nam Mo 1 HPP SEMD will review the Contractor's EMP and other social plans prepared by the contractors and assist the GM Office for their timely approval. The SEMD will prepare annual ESMP for implementation, coordinate with Nam Mo 1 HPP Divisions and other commune, district, provincial or national level, private agencies for program implementation, and prepare monthly, quarterly and annual reports (as required). Liaison with local communities, agencies, and other major stakeholders will be the major task of SEMD Environment Manager. The Nam Mo 1 HPP SEMD will manage the Project Information Centre established in Hanoi, project districts, and project sites.

13.4.1.3 Staff positions and responsibility

The staff positions and their qualification, staff responsibilities, duration of staff, reporting types and frequencies, and other related matters will be developed during the design phase of the Project.

13.4.1.4 Construction contractors

Environmental and social responsibility of construction contractors, contractual agreements, mitigation measures to be implemented by contractors as per contractual agreement, and contractual notification procedures will be developed during the design phase.

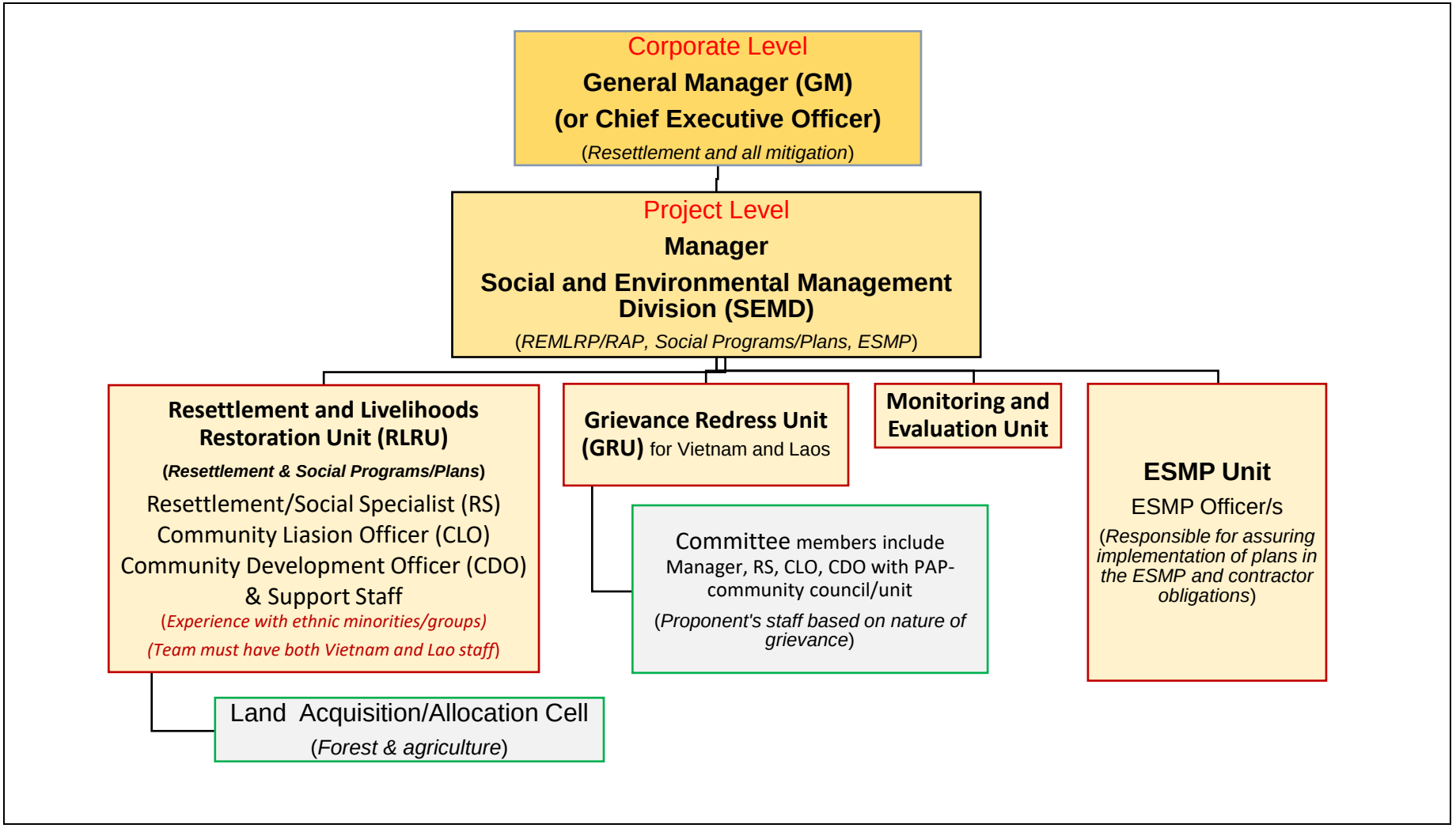


Figure 13.1 Organizational Set-up for Social and Environmental Management

13.4.2. Regulatory mechanism and environmental permits and approval

Implementation of environmental and social mitigation measures will be regulated by the Government of Vietnam (GoV) and Government of Laos (GoL) policies and legal framework (see Chapter 2 on policy, ESIA) which have made provisions for the compliance of ESIA Report, monitoring and evaluation, environmental audit, and restrict discharge of radio-active emission and other waste materials in convention to the criteria fixed by the Government. There are many other Acts, Rules and policies which directly or indirectly regulate the socio-economic and environmental activities to be implemented by the Project. The detail will need to be reviewed in detail during design phase.

The Nam Mo 1 HPP GM will acquire permits for clear felling or cutting trees in the national forests in the Project area from the Forest Protection Department, Vietnam and Department of Forestry, Laos. In the Project construction sites, contractors will make request to the GM through Nam Mo 1 HPP SEMD for the approval for clear felling or felling few trees, and with the recommendation of SEMD, the GM would make official request to District/Commune Forest Office for tree felling approval.

13.4.3. Environmental standards

Benchmarks for limits must be established based on GoV, GoL, and MIGA.

13.4.4. Construction contractor

Construction contractor will prepare specific plans based on the Project ESMP, labor, health, safety plans, among others. The contractor will ensure (i) properly and timely implementation of all mitigation measures as mentioned in ESMP; (ii) timely inform emerging environmental and social problems during construction works to ESMP Unit; and (iii) implement corrective actions to safeguard environment in response to requests made by the Project.

The Contractor will be responsible for the implementation of spoil disposal, waste management, occupational safety, structural bioengineering measures, air, noise and water quality protection measures, etc. The Contractor will provide Quarterly and Annual Reports regarding their performance on these issues to SEMD.

13.4.5. Public communication and disclosure

The ESMP implementation reports prepared by ESMP Unit will be disclosed to local community, commune and district agencies. They will regularly prepare disclosure documents (flyers, bulletin, etc.) also in the local language that will cover Project activities including environmental and social mitigation measures and monitoring works. In addition, a regular meeting will be conducted with district-level line agencies, Commune Office and Village level Committees at the Project site to brief them about the status of the Project, ongoing environmental and social activities and problems that have arisen during implementation. The PCDP of Nam Mo 1 HPP will guide the stakeholder consultation and disclosure process.

13.5 Reporting

Nam Mo 1 HPP ESMP Unit will prepare monthly, quarterly and annual progress reports (based on the agreed requirements), and send them to district line agencies. The Nam Mo 1 HPP ESMP Unit will organize regular meetings, which can also be called as project coordination meeting. Frequency of progress reporting of the project activities can be reviewed and openly discussed. The Project will organize the annual meeting either in Hanoi or in Project's district headquarters, Ky Son district in Vietnam and Kouan district in Laos (and in Nonghed district in Laos if required) to review yearly progress of the Project activities. It will be targeted to concerned line ministries and departments and other principal stakeholders in the districts. The reporting may be altered to fit MIGA requirements.

13.6 Environmental monitoring

13.6.1. Rational for environmental monitoring

As per the regulatory requirements in Vietnam and Laos the proponent shall comply with the matters mentioned in the approved ESIA report while the concerned agency has to monitor the impact on environment, resulting from the implementation of the Project.

The effective monitoring of the mitigation measures requires a constant feedback between those charged with administering the compensation schedule and the intended beneficiaries. The monitoring should include, among other environmental and social aspects:

- Disbursement of compensation should take place promptly and according to procedures;
- Communities in the affected areas share some benefits from the implementation of the Project;
- Local population is engaged/hired whenever possible;
- Access to health care facilities is provided and clinics are staffed and stocked;
- Assure proper safety material, training and information meeting international standards (MIGA, World Bank Group);
- Rates of disease infection are monitored, with special attention to STDs; and
- Resettlement arrangements are effective and minimize the level of conflict between re-settlers and host populations.

13.6.2. Objectives of monitoring

Environmental monitoring is needed to ensure compliance of the implementation measures and to assess the actual effects of these measures as well as the emerging impacts during project construction and operation phases. Environmental monitoring for this Project will be undertaken to meet the following objectives:

- To fully comprehend the physical, social and environmental conditions in the Project area such as inundation area, safeguard buffer area and Project structure and activity area prior to the implementation of the Project;
- To understand the compliance status of the implementation of mitigation measures and other regulatory standards;
- To ensure effectiveness of mitigation measures implemented by contractors as per contractual clauses and obligations;
- To check the effectiveness of mitigation and enhancement measures, implemented by the Project; and,
- To verify the accuracy of ESIA predictions and assess the emerging and cumulative environmental problems, which could provide timely warning of potential environmental damage.

A more detailed monitoring plan in the form of a fully formulated ESMP based on formulated plans/programs/mitigation will be prepared at design phase. The SEMD will develop detailed monitoring for each programs in the ESMP as each plan is fully formulated, and will require that contractors adhere to the regime set-up and the recommended international standards.

13.6.3. Site inspections

The SEMD will carry out site inspections prior to construction, during construction and at the end of construction in coordination with the contractors. In general, the ‘Initial

Inspections' conducted in the pre-construction phase will brief the contractors of environmental and social sensitivities in the Project area and document pre-project conditions. The 'Progress Inspections' of project sites during construction would refer to the compliance monitoring. The 'Final Inspection" will be carried out at the end of construction phase which documents that the contractors have met their contractual obligations with regard to environmental contract clauses.

13.6.3.1 Initial inspections

Nam Mo 1 HPP ESMD will conduct the initial inspections:

- Nam Mo 1 HPP SEMD will monitor the environmental and social condition of various Project sites prior to contractor's mobilization on the Project site. It will confirm the location of Project sites for temporary and permanent use;
- Under the guidance of the GM, it will establish standards for construction and required environmental controls. Sites will be surveyed jointly by Nam Mo 1 HPP SEMD and Contractor's representative. Photographic record of the sites will be prepared; and,
- It will prepare the project site document.

13.6.3.2 Progress inspections

Nam Mo 1 HPP ESMD will conduct the progress inspections:

- It will prepare environmental and social checklists and reporting procedures once construction works commence;
- Site inspections will put emphasis on early identification of any environmental and social problems and suitable remedial action;
- It will make a regular and frequent monitoring of Project sites without prior notification of the contractors. Daily, weekly and monthly site inspections of all works such as vegetation clearance, excavation and spoil disposal activities, blasting, tunneling, chemical storage, drainage and erosion hazards, and campsites will be carried out. The contractors will be notified to take necessary measures to minimize the level of impacts; and,
- It will give the inspection reports to the construction contractors for action. Any deficiency or inadequacy that is noted during inspection will be immediately drawn to the contractor's attention and reported to the Project Director. The Contractors will prepare a monthly site inspection report and submit to Nam Mo 1 HPP SEMD.

13.6.3.3 Final inspection

Nam Mo 1 HPP ESMD will conduct the final inspection:

- It will conduct final inspection of the Project sites at the end of Project construction which will determine whether assigned works are completed and necessary mitigation measures are implemented.
- Contractor's obligations and requirements as per the contractual agreement will be verified and deficiencies will be identified. In case of non-compliance, the contractors will be enforced to implement the remaining works.
- It will recommend the compliance of contractor's works to the Project Director, and it will prepare a 'Final Inspection Report" documenting site conditions and compliance with contractual obligations.

13.6.4. Monitoring types

Monitoring will be done throughout the Project life. Apart from external expert monitoring, internal monitoring by the Project, as well as participatory monitoring involving Government agencies or other stakeholders will be carried out. Below are the main types of monitoring that will be conducted.

13.6.4.1 Pre-construction monitoring

The Nam Mo 1 HPP will have the principal responsibility for environmental and social monitoring during the pre-construction phase.

(a) Baseline monitoring

Data and information will be collected on key physical, biological and social aspects in the direct impacted project area such as inundation area, project structure and activity area, safeguard buffer area and other environmentally sensitive area, and the data provided by ESIA report will be updated. The Nam Mo 1 HPP SEMD will be responsible for baseline monitoring during the pre-construction phase. Physical, biological and social aspects are highlighted here.

The primary concern during this phase will be to collect field data needed to enhance the knowledge of baseline conditions. Focus will be on gathering key physical, biological and sociological information needed to verify and update the data provided by the ESIA process such as river flow, river water quality, air quality in project sites, number of trees to be felled, number of project affected families and their assets etc. Some of the monitoring activities are given below:

Physical aspects

- Monitor river flow/discharge to establish environmental flow that can sustain the riverine life and river uses;
- Monitor river water quality and drinking water quality in settlements close to Project camps and sites for physical, chemical and biological parameters;
- Monitor air quality at the proposed dam and powerhouse sites, crushing plant, batching plant, haul and service road, quarry site and spoil disposal area; and
- Monitor geological/soil erosion hazards.

Biological aspects

- Pegging of forest sites to be used by contractors;
- Counting and marking the trees to be felled from the temporary and permanent sites; Concerned state agency at commune and district levels will jointly count and mark the trees to be felled.
- Approval from the concerned state agency at commune and district levels for felling the trees from forests;
- Wildlife habitat, and wildlife species and their abundance;
- Edible plants and wildlife;
- Medicinal plants;
- Population status of threatened species just before clearing forests in inundation area and project construction and activity areas; and,
- Monitoring spawning ground and fisheries activity.

Social aspects

- Monitor/update detailed information on land, buildings and other housing structures, and biological assets on land to be temporarily or permanently acquired by the Project. The Project Affected People (PAP) and village; level committee will participate while carrying out such activity; and,

- The Resettlement and Ethnic Minority Livelihood Restoration Plan (REMLRP) will be discussed and agreed with the project affected families, village level committee and other stakeholders.

13.6.4.2 Construction monitoring

Environmental and social monitoring during project construction will include two major groups of activities:

- Review of the contractor's plans such as Material use and Site Waste Management Plan, Traffic Management Plan and Emergency and Response Preparedness Plan and other environmental plans, as the need arises. Monitor implementation arrangements, compliance and impacts.

- Systematic observation to check that contract arrangements by contractors, and other requirements of agencies of the GoV and GoL, and concerns (where relevant) of NGOs, community based organizations/committees or user groups are in fact complied with, and that emerging impacts are properly mitigated and concerns are addressed.

Both compliance monitoring and impact monitoring will be carried out.

(a) Compliance monitoring

During construction phase, compliance monitoring will be important and will play bigger role in checking whether recommended mitigation measures and environment management plans have been properly and timely implemented or not. It will determine the overall environmental and social performance of the Project. Compliance monitoring will mainly focus on:

- Compliance with tender clauses;
- Compliance with mitigation measures;
- Timely and adequate implementation of the ESMP; and
- The overall environmental and social performance of the Project.

(b) Impact monitoring

The impact monitoring will examine the effectiveness of the mitigation measures, identify the emerging impacts due to Project activities or natural process and develop remedial actions. Impact monitoring will focus on key indicators to assess whether the impacts have been accurately predicted, and whether the mitigation measures are sufficient and effective. The actual impacts caused by the project implementation and the emerging impacts will be closely monitored during the construction period.

A single summary table with the main aspects to be included in the Monitoring Plan of the ESMP will be developed. Salient features of monitoring physical, biological and socio-economic activities during construction phase are presented in tables, and need to be detailed according to location. The annual environmental monitoring report will be incorporated in the Annual Environment Report which would include the current status of environment in the Project area, emerging and cumulative impacts, and remedial tasks implemented.

13.6.4.3 Operational monitoring

Both compliance and impact monitoring will be carried out during the Project operation phase. The compliance monitoring will focus on determining that the prescribed mitigation and enhancement measures in the operation phase are being fully and properly carried out

by the Project. Impacts of activities implemented during construction phase and operation phase will be monitored at regular intervals. However, the monitoring intensity will be much lower compared to the construction phase. Some of the monitoring tasks will be as follows:

- Discharge below the dam; the minimum flow which is agreed and approved by MOIT (in Vietnam);
- Reservoir shore erosion due to peaking operation;
- Physical stability in and around dam site, powerhouse site and other vulnerable areas;
- Siren warning system in low flow area and downstream of tailrace outlet;
- Vegetation cover in safeguard buffer area;
- Fish population and biodiversity in reservoir, low flow area and downstream of tailrace outlet;
- Agriculture and livestock improvement programs such as crop diversification, fertility enhancement, raising pigs and poultry under confinement and animal disease control; and,
- Socio-economic status of displaced people resettled in another place.

13.6.5. Environmental monitoring programs

All plans will have monitoring tailored to the final formulated ESMP.

13.6.5.1 Physical Environment Program

For the Physical Environment Program, the monitoring will implicitly be part of the biological, socio-economic and cultural environments. It is likely that upon full formulation that there will be a number of over lapping parameters which will allow more rational monitoring. The construction section will be involved in slope stabilization mitigation and monitoring should be worked out as appropriate based on the techniques used (see also relevant forest monitoring). In addition, the Environmental Health and Safety Plan (EHS) will address the monitoring of water, air and noise apart from all safety aspects.

13.6.5.2 Biological Environment Program

(i)Vegetation and forestry

Monitoring plan in vegetation and forestry includes both compliance and impact monitoring during construction and operation phase.

(ii) Wildlife and birds

Baseline monitoring will include population status of threatened and rare species and clearing forest area while impact monitoring will include incidents of wildlife killing and hunting.

(iii) Aquatic ecology and fisheries

Below is given a description and rational for monitoring aquatic ecology and fisheries.

Monitoring during the construction phase

(a) Water quality

Samples from the river
It is relevant to monitor the water quality upstream and downstream of the construction area, due to high activity. There should be about six stations in the river stretch. In addition, possibly one or two stations in tributaries should be monitored as well as a control (no impact expected). Monitoring sites will be decided at design phase.

The sampling frequency should be once every second month. However, the frequency, the number of stations and sampling locations have to be evaluated, and should consider the location of heavy construction activities and its immediate impact areas. Physical, chemical and biological parameters will be measured. The limits of the different parameters suitable

for drinking water are set by National Drinking Water Quality Standard of Vietnam and Laos and the drinking water standard of WHO (2008).

Waste water

The potential polluting constructions sites situated close to the river and with high activity or with a runoff that can end in tributaries and the main river should be selected for sampling at least four times a year (or more) during the construction period. If this is sufficient should be evaluated after the first year. The indicative values for treated sanitary sewage discharges should follow the MIGA guidelines, and the standards of Vietnamese and Lao Governments, i.e. QCVN 08:2008/BTNMT and Lao PDR No 2734 respectively.

(b) Periphyton, phytoplankton, zooplankton and macroinvertebrates

Impacts due to chemicals, erosions or other incidents on aquatic life can be detected a long time after the incident happened, and are in that way more suitable than water quality samples. For example, a spill of chemicals ending up in the river will drift away with the flow and will not be detected in water quality samples a short time after the incident. Both species and abundance of periphyton, phytoplankton and zooplankton and macroinvertebrates should be analyzed. Samples should be collected at six stations two times a year, April and November (before and after rainy season). The number of stations and number of time might be reconsidered based on the experiences gained. The collectors have to be trained in sampling.

(c) Fish diversity / fishery

Fish is the most important topic regarding environmental impacts looked upon from livelihoods point of view. Due to little knowledge of the life history of most of the fish species, more information is needed to follow up with proper mitigation. To get an understanding of what is happening, several stations within the long river reaches are needed. Monitoring should be done twice a year (April and November, before and after rainy season). This will add information about the period after monsoon, which is limited. In addition, important spawning grounds should be examined during spawning time. Every second year, an estimate of density should be collected by electro fishing. This gives a more accurate measurement of density and collects important information about the fry which is the most sensitive to impacts. The ESMP proposes a fish adaptation study which will require regular seasonal sampling of fishes in the river body and the data will be similar to those required above and will serve as a baseline. The above aspects can be included in the Fish Adaption Study.

Monitoring in the operation phase

(a) Water quality

The water quality monitoring in the five first years of the operation phase should be the same as in the construction phase regarding samples taken from the river. This is because the biggest impacts in the operation phase are expected in this period. In addition, water samples should be taken in the reservoir at the deepest point; probably close to the dam (this should not be done when the power plant is operational).

The sampling of frequency should be once every second month. However, the frequency has to be evaluated. The samples in the reservoir will be taken in five different depths. The depths will vary from time to time depending on the filling degree of the reservoir. At each of the sampling sites, the depth should be decided as follows: The shallowest sample should be taken at 1m depth and the deepest one at 5m above the bottom, one sample at the depth of the turbine intake, and one sample midway between 1m and the intake depth, and one sample midway between the intake depth and the bottom.

The samples should be analyzed for the same parameters as above, and in addition the 1m sample should be analyzed for algal species composition.

(b) Greenhouse gas monitoring

The greenhouse gas monitoring will not be done with the aim of assessing the total amount of greenhouse gas emission, i.e. 1) the diffusion of gas from the reservoir surface and 2)

the breakdown of the above-water biomass, will not be included. The release through the turbines, (spillway, if the deep water type is chosen), as well as through the minimum release, will be monitored. This will be done by measuring the concentration of methane and carbon dioxide in the reservoir at the same station and depth as in water quality monitoring in the reservoir. At the same time the corresponding concentration will be measured in the three effluents (turbine, spillway, minimum release) and the river downstream. The differences in concentration will indicate how much has stripped off into the atmosphere by pressure fall combined with turbulent mixing and heating.

To measure the surface diffusion of the gases from the reservoir and from the above water degradation of organic material, is regarded as a too big task for this monitoring program. The degree of super saturation of methane and carbon dioxide in the deep water of the reservoir will tell a lot of the total emission potential from the reservoir, and how it develops. One of the six sampling rounds should be right before the turnover time start to decrease (end of March) because the increased circulation of the water might release gas. The cost shall be included in the water quality programs.

(c) Periphyton, phytoplankton, zooplankton and macroinvertebrates
The monitoring of aquatic life in the first four years of the operation phase should be the same as in the construction phase regarding samples taken from the river. This is because the biggest impacts are expected in this period.

(d) Fish and fishery plans
The monitoring of fish and fishery in the first four years of the operation phase should be the same as in the construction phase regarding samples taken from the river. Adaption of flow regimes may be needed if populations decline (see Fish Adaption Plan also). This is because the biggest impacts are expected in this period.

13.6.5.3 Social and Livelihoods Restoration Program

Under this program, the following will be monitored:

- Monitoring resettlement and livelihood restoration measures;
- Livelihoods status over time, e.g., improvement and enhancement of livelihoods;
- Enhanced forest resources and access to natural resources and continuity in daily cultural and livelihood activities; and,
- Overall wellbeing improvements.

Details are also given in the REMLRP.

13.7 Environmental auditing

In this ESIA, an Environmental Audit (EA) has been proposed to assess the actual environmental impact of the project, the accuracy of impact predictions, the effectiveness of environmental impact mitigation and enhancement measures applied during construction and operation phase, and the functioning of monitoring mechanisms. It is intended that EA should relate actual impacts with predicted impacts, which help in evaluating the accuracy and adequacy of ESIA predictions.

There is a regulatory requirement both in Vietnam and Laos for conducting EA.

Besides fulfilling the formal requirements, an environmental audit is a good tool for promoting environmental best management practices and procedures. In general, environmental auditing is conducted with the following aim:

- Assessing compliance with formal requirement;
- Facilitating management control of environmental practices;
- Promoting good environmental management and minimizing the risks;
- Examining environmental changes arising from Project implementation; and
- Establishing the performance baseline for an environment management system.

13.7.1. Planning an environmental audit

Environmental audit critically examines the methods and approach assessment procedure adopted during the ESIA.

At the Project approval stage, both project proponent and authorizing agency should make a decision on implementation of one or more audits mentioned above with particular attention given to the project cost-effectiveness of audit and to technical difficulties likely to be encountered. The cost estimation for the task depends on the decision made of the number and types of environmental audits. Although the anticipated costs are included into the ESMP, it is recommended that a detailed budget for the audit should be planned during the elaboration of the ESMP.

13.8 The ESMP

The Project will implement environmental programs as compensatory, protective and enhancement measures in the Project area and in the Project influenced villages in the direct impact area. These programs will be implemented directly by the Project in partnership /association with local and district level public and private stakeholders, and by contractors as per contractual agreement under the guidance and supervision of the Project Social and Environment Management Division (Nam Mo 1 HPP SEMD).

Environmental and social programs are summarized in Table 13.1.

Table 14.1. presents the matrix for environmental and social monitoring for the Nam Mo 1 HPP.

13.9 Project costs

The costs of mitigation and enhancement measures will need to worked out as when the ESMP and other safeguards are elaborated.

Table 13.1 Matrix for the environment and social management plan for Nam Mo 1 HPP

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Construction Phase							
Enhancement /Beneficial Impacts							
Livelihoods Enhancement	Employment to local people	Priority given to local people from affected villages and commune	MIGA GoV GoL	Contractor	C	Project-monitoring unit	Contractor's program
Skilled manpower development	Work experience	Contractor will provide on job skill enhancement training to semi-skilled workers	MIGA GoV GoL	Contractor	C	Project-monitoring unit	Contractor's program
Income generation	Increased economic activities	A large work force would create demand for agriculture and livestock products	GoV GoL	Contractor	C	Project-monitoring unit	Workforce and commune
Social safeguard of local community	Provision of drinking water, sanitation and health facility	Project will provide social services to DIA village and DIA households e.g. electricity, drinking water, sanitation facility, health service as compensatory activities	MIGA GoV GoL	Project	PC, C, O	Project-monitoring unit	Project to commune and DIA households
Improvement in mobility and transport	Road construction	Project will construct roads for HPP	GoV GoL	Project	PC, C, O	Project	Project's program ESMP, REMLRP
Adverse Impacts: Physical Environment							
Improvement in the landscape construction area and reservoir	Rehabilitation and revegetation of construction sites	Rehabilitation and revegetation in construction sites, auxiliary area and quarry site	GoV GoL	Contractor & Project	O	Project	Contractor's program
	Reservoir Catchment	The 50m buffer zone along the perimeter of the reservoir will enhance the reservoir landscape	GoV GoL MIGA	Project	O	Project	Involving district & commune

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
	Management Plan, SBZ						state agencies and community
Slope stability in construction area	Rehabilitation and revegetation	Implementation of slope reinforcement and erosion risk measures & regular monitoring of erodible areas • Minimize land clearance, proper disposal of mucks, slope protection methods such as retaining walls, slope stabilization and erosion control works. • Bioengineering works in soil erosion prone area • Avoidance of clearing vegetation along the high erosion prone areas • Modification of slope geometry • Well designed drainage system • Retaining structures	GoV GoL	Contractor	C, O	Project SEMD	Contractor's program
Minimize sediment load to reservoir	Management of reservoir immediate catchment	Plan and implement the **Reservoir Catchment Management Plan (RCMP)** and establish Safeguard Buffer Zone (SBZ). Inventory of high erosion prone area and critical areas in reservoir catchment will be made during design phase and RCMP will be developed and implemented • Implementation of high risk erosion measures • Bioengineering works to control erodible area • Control of faulty road construction in catchment and activities triggering high erosion	GoV GoL	Project	C, O	SEMD	Project though contractor for physical work; collaboration with state agency and community

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		• Maintain slope stability through using new and efficient slope engineering techniques • Install upstream sediment check structures, protect dam outlets • Forest plantation in degraded forest area and in vulnerable areas (See details in Biological Environment)					
Muck and spoil management		• Avoid dumping mucks and spoils in river • Manage the spoil tip area	GoV GoL, MIGA	Contractor	C	SEMD-Monitoring	Contractor's program
Management of air pollution	Construction works	Prepare and implement **Environmental Health and Safety Plan (EHSP)** The following dust control mechanisms and construction good practices will be adopted: • The aggregate crushing plants, batching plants and concrete mixing plants will be located far from the camp areas and provided with smoke/exhaust stacks. • Scrubbers will be installed in vehicles and other machines emitting air pollutants. Heavy vehicles, generators etc should have controlled smoke/exhaust stacks • Periodic maintenance of vehicles and other machinery and monitoring of engine emissions to comply with GOV and MIGA criteria • Reduce dust pollution and minimize dispersion of pollutants through frequently spraying of road surfaces with water during dry days in vulnerable areas	MIGA GoV GoL	Contractor	C	SEMD-Monitoring	Contractor's program

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		• The borrow vehicles will be covered during the transportation of dusty materials in the construction sites. • Monitor air quality monthly at construction sites (a) Health and sanitation program to prevent and cure respiratory infection and other air-borne diseases. Avoid workforce camps in the air pollution prone area (b) Provision of masks to workforce working in air pollution prone area					
Management of water pollution	Construction works	a) Prepare and implement Waste Management component including storage and construction waste of EHSP; this should include use and management of toxic and hazardous materials. b) Prepare and implement **Community Health and Sanitation Plan** which should include toilet facilities in camps and construction sites, waste management etc. including, • Workshop facilities will be located at least 100m away from the water sources. Spilled oil and grease trapping systems will be built in the workshop. • Proper management and regular monitoring of storage sites and scrap-yard sites. Control of spillage of oils, chemicals and other substance.	MIGA GoV GoL	Contractor	C	SEMD-Monitoring	Contractor's program

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		• Carry out the first tunnel flushing during high flow conditions or adopt appropriate measures to dilute polluted tunnel water for protection of downstream aquatic life. • Provision of sanitation and medical support; awareness program as preventive measures; free treatment of water borne diseases to workforce; compensation for the loss of life Regular monitoring of water quality in river (See Biology Environment – Fishery)					
Management of noise pollution	Construction works	a) Control of blast related noise and vibration • Avoid blasting operation during nights, and control blasting using controlled limited detonators in small lot. • Provision of protective gears such as ear mufflers or plugs to the laborers and other workforce working in vulnerable sites b) Control of noise producing vehicles and equipment • Minimize use of pressure horns. Pressure horns in the vehicles will be prohibited. • The noise generating machineries and equipment such as generators, crushers, concrete mixers will be placed far from the residential areas • Periodic maintenance of heavy machinery and generators • Monitor noise intensity level regularly in the major construction sites	MIGA GoV GoL	Contractor	C	SEMD-Monitoring	Contractor's program

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Adverse Impacts: Biological Environment							
Minimize loss of forest vegetation in construction site	Forest Inventory in construction site	• Mechanisms to control damages to standing trees and ground vegetation will be adopted • Avoid cutting saplings and poles for making pegs, • Marking of the trees by enamel or chalk rather than chopping the outer bark of the trees particularly in temporarily acquired forest areas	GoV GoL MIGA	Proponent	PC	Project	Project with commune & district agency
	Construction in powerhouse and auxiliary area	• Clear felling shall be discouraged in project structure and activity areas of temporary nature. Permanently acquired forest areas for building housing and office complexes should not be clear felled; trees and shrubs will be planted in such facility sites • Good phenotypic trees and matured trees will be retained for future seeding and regenerating purpose • Re-consideration of temporary project structures in good forest area	GoV GoL MIGA	Contractor	C	Project ESMP	Contractor-site preparation
Proper utilization of felled trees	Clear felling of vegetation in Inundation area	A proper management of felled trees is recommended which includes: • Contractor will clear fell the inundation area 962ha (20,400mt biomass); timber logs will be segregated and piled up in one place. Similarly, fuel wood will be stacked separately • All the felled trees and other forest vegetation will be handed over to the concerned commune	GoV GoL MIGA	Contractor	C	Project ESMP	Contractor-site preparation

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		• Project will pay approximately US$20 (see GoV/GOL) for each ha as compensatory management cost to the concerned commune. Commune will use this money as well as sale of timber and firewood for forest protection in SBZ • The workforce will require about 450mt fuelwood/year; fuelwood demand of workforce could be met. • Project will consider support for the establishment of Fuelwood Supply Depot managed by commune for the sale of firewood and timber from the felled trees.					
Restoration of vulnerable plant species	Construction in powerhouse and auxiliary area, Inundation area	Seedlings of vulnerable species *Drynaria fortune* & *Hopea mollissima* and other species of high ecological value if found in inundation and construction site shall be transplanted in SBZ. Pole to matured plants would be left growing in construction site. See **Endangered Species Restoration Plan**.	MIGA GoV GoL	Contractor	PC C	Project ESMP	Contractor-site preparation
Forest biodiversity conservation & environmental services restoration	Plantation and management in Reservoir catchment area RCA) including SBZ	Prepare the **Forest Management Plan** based on **BEESRP**. Compensatory plantation in SBZ, and in degraded reservoir catchment area (RCA). Plantation areas will be identified by concerned agency in district/commune. It could be made mandatory to plant at least 10 saplings for each tree felled. (This is to be agreed between the Proponent and GOL/GOV). The following activities will be implemented:	MIGA GoV GoL	Contractor	C	Project ESMP	Contractor-site preparation

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		• Almost 2.1 million tree seedlings will be planted in RCA and SBZ. This is equivalent to 1,050 ha area, if planting numbers are estimated at 2000 /ha. • Production of required number of saplings (20% more than to be planted) in the RCA. • Nurseries will be established in Safeguard buffer area. Village committee will be encouraged to establish nursery and produce saplings • Initially, for the first two years, project will support establishing nurseries in all DIA villages & commune centers. • Provision of logistic and technical support to Nursery; training will be provided to nursery men. • Replacement planting and management of planted areas up to 4 years from the plantation date • Project will sign Memorandum of Understanding (MOU) in line with the Government rules and regulations with district and province Forest Office and district/commune will implement the plantation program. • Species with larger ethno-botanical values will be grown & planted. The sapling species to be planted in the project area will represent the species of the trees felled					

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Reduce pressure on forest resources & enhance biodiversity quality	Distribution of smokeless oven	Implementation of energy efficiency measures which could reduce pressure on forest resource such as: • Distribution of improved smokeless oven to households in DIA villages.	MIGA GoV GoL	Project	C	ESMP	Project's program with community
	Timber and fuelwood management in construction site	The contractors will bring required timber from the timber depots outside the project area. Contractor may establish fuelwood depot in site.	GoV GoL	Contractor	C	ESMP	Contractor's program
Minimizing disturbances to wildlife habitat	Construction work, traffic	• Develop and implement 'Wildlife and Fisheries Management Guidelines' in the project area. This would include working procedure during wildlife movement, control of poaching activity etc. • Avoid blasting, heavy vehicular movement and excessive noise generating activities during the period of wildlife movement. • Awareness to local contractors, supervisors and labor force	MIGA GoV GoL	Contractor	C	ESMP	Contractor's program
Protection of vulnerable wild life species	Awareness and anti-poaching in construction area	**ACBP**. Project will brief contractors, and the later to brief workers regarding GoV / GoL laws and regulations and project requirements (MIGA) for protecting wildlife resources. Project will penalize workforce for their non-compliance • Posters, pamphlets, sign boards & hoarding boards in project area as awareness materials.	MIGA GoV GoL	Project and contractor	C	ESMP	Contractor's program

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Minimizing disturbance to fish habitat at dam site and downstream	Passage to fish movement during dam construction	Maintain river channel at dam site and further down during upward and downward movement of fish	MIGA GoV GoL	Contractor	C	ESMP	Contractor's program
Minimizing habitat disturbances to fish & other aquatic life	Reducing pollution level at dam site and downstream area	Contractor should prepare waste management plans and get approval from Project and implement it. Contractor should: • Maintain proper storage for used petrochemical and other toxic material • The water from the tunnel excavations should pass a sedimentation pond prior to be discharged into the river • Monitor sedimentation pond taking water quality samples both in the dam and downstream the dam in the river. • Runoff water from blasted tunnel material should be controlled with respect to the content of nitrogen and particularly ammonia and pH.	MIGA GoV GoL	Contractor	C	ESMP	Contractor's program
Control illegal & over fishing	Awareness and enforcement of regulatory conditions	• Control Illegal fishing and overexploitation upstream and downstream of dam construction site • Use posters and signboards/ hoarding boards for controlling excessive and illegal fishing.	MIGA	Contractor Project	C	ESMP	Contractor's program
4. Adverse Impacts on Social Environment							
Management of sanitation	Health and sanitation	**Community Health and Sanitation Plan (CHSP)**	MIGA GoV GOL	Project	PC C	ESMP	Project through contractor

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		A health and sanitation program will be developed with the aim of improving health status of communities in the project area. Project will provide all households in the relocation villages with a toilet; support for construction of the toilets with septic systems and flushing mechanisms in other affected villages in the DIA. Project will launch health and sanitation awareness program as a component of 'Awareness Building Plan' in all DIA villages, focusing on water use and treatment practices, pollution of water sources, personal hygiene and households as well as community sanitation.					
Provision of drinking water supply	Health and sanitation	Household water supply will be provided in all the relocated villages with the same type of system as in the existing villages, and with a proper filtering system to allow safer drinking water. Project will also support villages losing land in the DIA to develop drinking water systems. Such support will be in form of remediating and augmenting existing drinking water systems. Project will support drinking water quality analysis in villages.	MIGA	Project	C	ESMP	Project through contractor

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Managing waste in villages	Health and sanitation	**Community waste management** Project will support developing simple waste management systems in relocated villages based on the local culture and designed together with the villagers. It will include construction of an open but fenced area for waste disposal outside the village, composting development for organic waste, and organization of community rubbish collection team.	MIGA GoV GoL	Project	C	ESMP	Project through contractor
Reduce pressure on forest resources	Forest conservation	Project will provide support for Improved Cooking Stoves (ICS) in the relocated households that should be included in the house kitchen design	MIGA	Project	C	ESMP	Project through contractor
Availability of emergency medical assistance	Construction, traffic	Project will establish an Emergency Medical Response Unit (EMRU) at the construction site with a medical doctor and trained staff with sufficient medicines for first aid and emergency assistance. See **EHSP** and **Emergency Preparedness and Response Plan**.	MIGA GoV GoL	Contractor	C	ESMP	Contractor's program
Labor management	Equal opportunity for employment	Plan and implement **Community and Labor Plan** which will include (i) work opportunities to local people on the basis of capability in construction works on priority basis, emphasis on women on job, (ii) equal wages to men and women on similar work, (iii) separate toilet facility for men and women, (iv) drinking water	MIGA GoV GoL	Project / contractor	C	ESMP	Project - contractor

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		and health facilities, and (v) general awareness about sexual harassment.					
STD management	Health improvement	Plan and implement construction workers HIV/AIDS awareness program to reduce the risk of the transfer of the HIV and other STDs between and among the construction personnel and the local communities. See **Influx Management Plan**.	MIGA GoV GoL	Project / contractor	C	ESMP	Project - contractor
Awareness of potential risk and social problems among local people	Community-based Public Awareness Program (Influx management plan)	Plan and implement Community-based Public Awareness Program in Project DIA communities about HIV/AIDS and other STDs and human trafficking prevention to reduce the risk among vulnerable local communities, especially among young women and men, girls and boys.	MIGA GoV GoL	Project / contractor	C	ESMP	Project - contractor
Management of displaced families	Relocation and rehabilitation	The Proponent is responsible for preparing and implementing a Resettlement Action Plan (RAP) for each of the villages that have to be relocated due to the HPP, based on the **Resettlement Policy Framework** and the entitlement matrix for lost land and assets, provided in the **REMLRP**.	MIGA GoV GoL	Project	C	Project	Project and state agency at district and commune
Improvement in upland farming system and increase in	Implementation of upland farming plan	Prepare and implement **Upland Farming Diversification Plan, Soil Fertility Enhancement Plan, Animal Husbandry and Veterinary Services Plan and Fisheries**	MIGA GoV GoL	Project	C	Project	Project and state agency at district and commune

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
crop production for enhancing livelihoods		**Support Plan** as components of the **REMLRP** in the Social Program. **Crop diversification and multiple cropping sub-plan** will compensate the production losses, enhance productivity, diversify production • Capacity building of local community on growing multiple crops, and management of upland farms • Provide seeds, rootstocks, and some fertilizer to participating farmers					
Improvement in upland farming system and increase in crop production for enhancing livelihoods	Implementation of upland farming plan	Prepare and implement **fruit and vegetable production sub-plan** on upland farmlands, and at homesteads in all DIA villages. It will compensate for crop production losses, enhance productivity, and provide nutrition to families and some cash from sale • Capacity building of local community on growing vegetables and fruits, and cultivation technique • Provide seeds, rootstocks, and fertilizer to participating farmers • Install drip irrigation or sprinkle irrigation on riverbank cultivation.	MIGA GoV GoL	Project	PC C	Project	Project and state agency at district and commune
Livelihoods improvement of local community	Implementation of upland farming plan	Prepare and implement **Bee keeping** in all DIA villages, based on available land and interest. It will enhance livelihoods of local community	MIGA GoV GoL	Project	PC C	Project	Project and state agency at district and commune

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		• Capacity building of local community on rearing bees, and beehive management of upland farms • Provide beehives, bees and necessary gear to participating farmers					
Improvement in Soil productivity for increased crop production	Implementation of Soil Fertility Enhancement Plan	Prepare and implement the **soil fertility enhancement plan**. Upland soils are degraded and poor in quality. Its components are: (i) growing leguminous crops on upland usually intercropped with maize/cassava, and (ii) Compost making and mulching. • Implement this plan on pilot project basis as these are new concepts in ethnic minority. • Awareness raising and capacity building will make local farmers to adopt this technique. • Form groups each with 5 households, and practically train them in compost making • Encourage households to make compost pit in home garden and use all biodegradable residues as compost material.	MIGA GoV GoL	Project	PC C	Project	Project and state agency at district and commune
Improvement in animal husbandry practices for	Implementation of Animal Husbandry and	Prepare and implement animal husbandry in all DIA villages: **Animal husbandry and Veterinary Services Plan**. All kind of livestock is free-ranged and productivity is	MIGA GoV GoL	Project	PC C	Project	Project and state agency at district and commune

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
household nutrition and cash income	Veterinary Services Plan	very low. Emphasis has been given on improving husbandry practices and use of improved breeds of small number of animals: 1) Project will financially support construction of pig sty for 5-6 pigs and a small poultry barn for 15-20 poultry birds to households in DIA villages, which express interest and have the basic requirements. 2) Farmers would be encouraged to rear hybrid pigs in pig sties (pigpens) and be able to provide appropriate feed for the growth of these hybrid species. Thus managing resources for this would be necessary for the farmers. 3) It is suggested to manage poultry at semi-free ranged systems. Few of the households will be persuaded to rear improved poultry. 4) Awareness and capacity building would increase adoption of this program. 5) As the households will be relocated, the Project will initially supply at least 2-3 pigs and 5-6 chicks to each household as well as some feed as part of the compensatory program.					

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
		Project will prepare and implement a comprehensive **Extension and Veterinary Services program**. Capacity, technical and support and knowhow is poor in the districts of the DIA. 3 Support to extension service center at commune and district level both in terms of manpower and technology including medicines and vaccines to cater the needs of the DIA villages 4 Awareness on livestock sanitation and health through pamphlets and other means 5 Training of at least 1 person from each DIA household on animal hygiene and primary treatment, 6 Provide basic tools needed for improved husbandry and treatment to all households involved, shared among households. 7 Basic animal health services, treatments and vaccines, to be provided at no cost, at least until households have established income generating activities (monitoring). 8 Prevention and control of diseases 9 Regular visits and extension services of commune animal health staff to DIA villages	MIGA GoV GoL	Project	PC C	Project	Project and state agency at district and commune

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Operation Phase							
Enhancement /Beneficial Impacts: social, biological and physical							
Livelihoods enhancement of DIA community	Implementing livelihoods plans	Project will implement various livelihoods improvement plans, e.g., upland farming improvement, livestock and health program, bee-keeping	MIGA GoV GoL	Project	C O	Project	Project's program
Increased environmental resources for the use of local community	Improving forests, better riverine wildlife habitat implementing RCMP and BEESRP	Various catchment protection (RCMP), revegetation and biodiversity conservation management plans implemented in DIA villages	MIGA GoV GoL	Project	C O	Project	Project's program
Transformation in upland farming	Implementing the REMLRP	Project will implement soil restoration on upland farmland, crop diversification and other related plans in the REMLRP	MIGA GoV GoL	Project	C O	Project	Project's program
Greening of the Safeguard Buffer Zone	Implementing the RCMP	Project will plant trees and other vegetation in the SBZ to maximize a green belt around the reservoir	MIGA GoV GoL	Project	C, O	Project	Project's program
Adverse Impacts: Physical Environment							
Sediment collection and management in the reservoir	Removal of sediment	Remove sediments annually with flushing through bottom gates which are as close as possible to the river bed level to prevent build-up of sediments. A flushing model will be reviewed during design phase. • Develop appropriate flushing schedule – flushing should be done in rainy season (See Biology Environment –Fishery). • Install siren system in the low flow area	GoV GoL	Project	O	Project -	Project's program

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Management of water level fluctuation in reservoir	Reservoir shore	Preventive and corrective measures such as check dams, vegetation plantation and bioengineering works will be carried out to control erosion and landslides in the reservoir shore area. • Regular monitoring of reservoir shores	GoV GoL	Project	O	ESMU	Project's program
Adverse Impacts: Biological Environment							
Forest biodiversity conservation & environmental services restoration	Plantation and management in Reservoir catchment area RCA) including SBZ	Continuation of mitigation and enhancement program as mentioned during Construction Phase	MIGA GoV GoL	Project	O	ESMU	Project's program
Minimizing stress on aquatic life habitat in reservoir and downstream area	Flushing sediments from reservoir	• All flushing should be done during the onset of the wet season to ensure water availability for aquatic life in reservoir & to minimize stress on aquatic life habitat in downstream area due to high sediment load. • Project must increase awareness among affected communities of flushing periods. There needs to be an agreement with cage fish farmers about flushing mechanisms and their impacts.	GoV GoL	Project	O	ESMU	Project's program
Maintain aquatic life habitat in the	Release of environmental flow	• Compensatory release of environmental flow from the dam is recommended to be at least 10% of the monthly average water flow	MIGA GoV GoL	Project	O	ESMU	Project's program

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
immediate downstream area		in the low flow season to maintain riverine ecosystems (water flow regime will be worked out during design phase). Lining riverbed on the immediate downstream stretch will be considered. • Monitor water availability bimonthly in the low flow period and adjust release of environment flow accordingly. • Monitor aquatic habitat at the immediate downstream annually • Adaptation of the required flow based on data from downstream users and fish studies. • Note that the exact release level may be set once the final operation is decided.					
Minimize stress of peaking operation on riverine ecosystems in immediate downstream area	Peaking operation	• Peaking operation mechanism and its duration should be worked out in design phase. • Monitor spawning and feeding area, growth of planktons, fish species /population, stranded fish species in immediate downstream area. • Make the local people aware of the peaking releases downstream of the powerhouse for safety purposes. • Install siren warning systems and signboard warnings all along the riverbanks at critical areas about the peaking releases.	MIGA GoV GoL	Project	O	ESMU	Project's program

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Facilitating movement of migratory fish species	Picking fingerlings at the immediate downstream area	• Since movement of migratory species already blocked by the Nam Can and Nam Mo dams downstream, a bypass *fish ladder* is not a viable option, due to the height of the dam. Fish data indicates that there are populations of fish in the long stretch upstream from these two dams. • Picking up fingerlings of migratory species at the downstream base of dam and manually transferring to upstream area of the dam may be an option to assure survival of mid- to long-range migratory species, which will be monitored in the fish adaptation study.	MIGA GoV GoL	Project	O	ESMU	Project's program

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
Adverse Impacts: Social Environment and Livelihoods							
Improvement in fish resources, livelihoods enhancement	Implementation of Fisheries Support Plan due to loss of river resources	Project will plan **Cage Fish Farming** in reservoir during the design phase and implement it during operation period. Review experiences in other hydropower reservoirs. • An approach may be: form 20 fishermen groups with 5 households each. Each group having 5 fish cages to rear fish • Provide training, technical support, fish cages and fingerlings • Preference should be given to the use of native species of fish	GoV GoL MIGA	Project in collaboration with district/commune agency	O	ESMU	Project's program
Livelihoods enhancement	Implementation of the REMLRP due to loss of river resources	Plan and implement "**Community Fish farming**" with the following components: • Form 15 community pond groups each having 5 households, provide them training and support on pond fish farming. • 15 community ponds, 10 in reservoir area and 2 in downstream area in the first 5 years. Total grant fund to local community • Each pond of up to 625 m^2 size with capacity to culture 1,000 fingerlings, assuming production of 625 kg of fishes annually. • Provide fingerlings and fish pellets in the first 2 years. Use fast growing fish species like carp	GoV GoL MIGA	Project in collaboration with district/commune agency	O	ESMU	Project's program
FPIC	Assessment of the Free, Prior	DIA	Internal: Quarterly,	Number and locality of HHs	PC, C, O	Proponent (SEMD)	MIGA

Objective	Project Activity (reference to ESMP, REMLRP)	Mitigation/Enhancement/ Environmental and Social Management Plan (ESMP), Restoration and Ethnic Minority Livelihood Restoration Plan (REMLRP)	Standards	Institutional Responsibility	Time-line	Monitoring	Implementation Route/Plan
	and Informed Consent process Grievance Redress Process		Independent: Bi-annual	and PAPs consulted, meetings and information disclosure Review the Grievance Redress process. Time taken to address grievances.		Independent third-party monitoring agency	

Note: PC – Pre-construction phase; **C**-Construction phase; **O-**Operation phase
GoV – Government of Vietnam; **GoL** – Government of Lao PDR; **MIGA** – Multilateral Investment Guarantee Agency

CHAPTER 14 MONITORING MATRIX

14.1 Monitoring approach and program

Project shall ensure compliance of the implementation of environmental and social programs and mitigation measures, and shall assess the actual effects of these measures as well as the emerging impacts during project construction and operation phases on environment. The Social and Environment Management Division (SEMD) will develop detailed monitoring for each plan formulated, and will require that construction contractors adhere to the regime set-up and the recommended international standards.

Monitoring aspects of physical, biological and social environments, monitoring actions, location of monitoring, frequency, indicators and monitoring schedule are given in Table 14.1. Physical aspects to be monitored include air, water and noise quality, geological hazards e.g. erosion, river cutting, and hydrological features, e.g., water flow and sediment load. The biological aspects include forest vegetation, wildlife, aquatic life and fish, and their biodiversity and species vulnerability status. Farming and livestock, resettlement of displaced households and restoration of livelihoods are the major social aspects. Implementation progress of various programs, plans and actions are to be monitored.

14.2 Monitoring responsibility and compliance

The ESMP Unit of the SEMD of the Proponent would be responsible for most environmental compliance and monitoring. The construction contractors shall also be responsible for compliance and environmental monitoring during construction works (e.g. monitoring of slope stabilisation and erosion control in dam, construction sites and reservoir). The construction contractor will send monitoring reports to ESMP Unit at agreed frequency, the latter will prepare monthly, quarterly and annual monitoring reports (as agreed) and submit to Social and Environmental Management Division.

Table 14.1 Monitoring matrix for Nam Mo 1 HPP

Monitoring Aspect	Monitoring action and indicator	Location	Frequency	Monitoring criteria/indicators	Monitoring schedule PC, C, O	Responsible agency	Compliance (GoV, GoL, MIGA)
Physical							
Water quality	Water sampling	Reservoir, downstream of dam	Monthly, Quarterly or Biannually based on project activity during development. Ad hoc checks as well.	Water quality parameters (e.g., physical and biological)	PC, C, O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Air Quality	Air sampling	Major construction sites	Monthly, Quarterly or Biannually based on project activity during development. Ad hoc checks as well.	TSP, PM_{10}, SO2, NOx, CO	PC, C, O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Noise Quality	Air sampling	Major construction sites	Monthly, Quarterly or Biannually based on project activity during development.	Noise level	PC, C, O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Geological Hazards	Observation	Construction site, reservoir shore, buffer zone, reservoir catchment area, immediate downstream area	Bi-annually, annually	Number of gully erosion, slides, river cutting	PC, C, O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)

Monitoring Aspect	Monitoring action and indicator	Location	Frequency	Monitoring criteria/indicators	Monitoring schedule PC, C, O	Responsible agency	Compliance (GoV, GoL, MIGA)
Hydrology	Measurement	Reservoir, downstream of dam	Monthly, Quarterly or Biannually based on project activity during development.	Sediment load	PC, C,O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Effluent discharge	Measurements	Construction camps	Quarterly	pH, Arsenic, BOD, COD, Faecal E-Coli	PC, C,O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Waste management	Observation	Permanent site Auxiliary sites	Monthly, Quarterly or Biannually based on project activity during development.	Assessment of Construction waste, solid waste and sanitary waste	PC, C,O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Environmental Health and Safety Plan (EHSP)	Observation, interviews	Construction sites	Quarterly	Assessment of plan	C, O	Proponent (ESMU) Contractor	MIGA
Reservoir Catchment Management Plan	Observation, interviews	Reservoir catchment area (RCA)	Quarterly	Assessment of plan	C, O	Proponent (ESMU) Contractor	MIGA
Road and Transport Management Plan	Observation, interviews	Construction sites and	Quarterly	Assessment of plan	C, O	Proponent (ESMU) Contractor	MIGA
Waste Management Plan	Observation, interviews	Construction area	Quarterly	Assessment of plan	C, O	Proponent (ESMU) Contractor	MIGA
Emergency Preparedness and Response Plan	Observation, interviews	Construction area	Quarterly	Assessment of plan	C, O	Proponent (ESMU) Contractor	MIGA

Monitoring Aspect	Monitoring action and indicator	Location	Frequency	Monitoring criteria/indicators	Monitoring schedule PC, C, O	Responsible agency	Compliance (GoV, GoL, MIGA)
High Erosion Risk Management	Observation, interviews	Construction area	Quarterly	Assessment of plan	C, O	Proponent (ESMU) Contractor	MIGA
Safeguard buffer zone	Observation, interviews	RCA	Quarterly	Assessment of plan	C, O	Proponent (ESMU)	MIGA
Biological							
Forest vegetation	Observation and measurement	Permanent construction site, auxiliary area, inundation area, SBZ	Quarterly, Annually	Tree/shrub/herb species, tree/ pole/ sapling/seedling counts, biomass, ethno-botanical status, forest ecosystem services, biodiversity status	PC, C,O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Wildlife	Observation	Construction area, SBZ, the whole reservoir catchment area	Quarterly, Annually	Habitat, species distribution, abundance, biodiversity status (only of conservation species), ecosystem services	PC, C,O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Fish	Fish catch, Focus Group Discussion	Reservoir, downstream area	Quarterly, Bi-annually	Habitat, species distribution, abundance, biodiversity status	PC, C,O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)
Aquatic life	Measurements	Reservoir, downstream area	Quarterly, Bi-annually	Phytoplankton, zooplankton, zoo - benthos	PC, C,O	Proponent (ESMU) Contractor	GoV, GoL, MIGA)

Monitoring Aspect	Monitoring action and indicator	Location	Frequency	Monitoring criteria/indicators	Monitoring schedule PC, C, O	Responsible agency	Compliance (GoV, GoL, MIGA)
Environment services from forests and river/ stream	Interview at household level	Forests, river/reservoir, streams	Quarterly and adapted as needed	**Vegetation:** kind, season, quantity Wildlife: kind, season, quantity	PC, O	Proponent	Information for Project
Biodiversity Enhancement and Environment Services Restoration Plan	Observation, interviews	Reservoir catchment area (RCA), SBZ	Quarterly and adapted as needed	Assessment of plan	C, O	Proponent (ESMU)	MIGA
Endangered species Restoration Plan	Observation, interviews	Reservoir catchment area (RCA), construction sites	Quarterly and adapted as needed	Assessment of plan	C, O	Proponent (ESMU)	MIGA
Fisheries Support Plan	Observation, interviews	Reservoir and DIA villages	Quarterly and adapted as needed	Assessment of plan	C, O	Proponent (ESMU)	MIGA, GoV and GoL
Social							
Agriculture	Measurements /interview at household level	DIA villages	Quarterly and adapted as needed	**Land:** land cover under various crops, single crop, multiple crop **Crops:** types, area, production Disease/pest: **Use:** Home consumption, feed to livestock, sale	PC, O	Proponent	Information for Project

Monitoring Aspect	Monitoring action and indicator	Location	Frequency	Monitoring criteria/indicators	Monitoring schedule PC, C, O	Responsible agency	Compliance (GoV, GoL, MIGA)
Livestock	Counts at household level	DIA villages	Quarterly and adapted as needed	Livestock kind and their numbers: Cattle, buffaloes, goats, pigs, poultry Diseases: Mortality: no. In one yr Use No.: home consumption, sale	PC, O	Proponent	Information for Project
Demography	Count at household level	DIA villages	Quarterly and adapted as needed	Adult: male/female Children: male/female	PC, O	Proponent	Information for Project
Upland farming Diversification Plan	Observation, interviews	Reservoir catchment area (RCA)	Quarterly and adapted as needed	Assessment of plan	C, O	Proponent (ESMU)	MIGA, GoV, GoL
Soil Fertility Enhancement Plan	Observation, interviews	Reservoir catchment area (RCA)	Quarterly and adapted as needed	Assessment of plan	C, O	Proponent (ESMU)	MIGA GoV, GoL
Animal Husbandry and Veterinary services Plan	Observation, interviews	Reservoir catchment area (RCA)	Quarterly and adapted as needed	Assessment of plan	C, O	Proponent (ESMU)	MIGA GoV, GoL

Monitoring Aspect	Monitoring action and indicator	Location	Frequency	Monitoring criteria/indicators	Monitoring schedule PC, C, O	Responsible agency	Compliance (GoV, GoL, MIGA)
Resettlement and Compensation	Assessment of RAP implementation progress	Inundation area and Project Structure and Activity Area	Internal: Monthly & Quarterly, Independent: Bi-annual	Relocation and compensation based on the Entitlement matrix;	PC, C, O	Proponent (SEMD: RLRU) Independent third-party monitoring agency	MIGA, GoV, GoL
Community health and sanitation plan (CHSP)	Assessment of the implementation progress of the programs of the CHSP	Resettlement villages and DIA	Internal: Monthly & Quarterly, Independent: Bi-annual	Number of activities and beneficiaries according to a detailed plan to be prepared by PO	PC,C	Proponent (SEMD: ESMP) Independent third-party monitoring agency	MIGA, GoV, GoL
Community labor and employment plan	Employment of local labor in HPP construction	Project construction area	Internal: Monthly & Quarterly, Independent: Bi-annual	Gender separated data on construction workers and paid wages	C	Proponent (SEMD: ESMP) Contractor	GoV, GoL, MIGA
HIV/AIDS, STDs and human trafficking prevention plan	Assessment of the implementation progress of the (i) community program and (ii) construction workers' program	DIA	Internal: Quarterly, Independent: Bi-annual	Number and locality of program information meetings; number of information materials distributed, area of distribution	PC, C	Proponent (SEMD: ESMP) Contractor	MIGA

Monitoring Aspect	Monitoring action and indicator	Location	Frequency	Monitoring criteria/indicators	Monitoring schedule PC, C, O	Responsible agency	Compliance (GoV, GoL, MIGA)
FPIC	Assessment of the Free, Prior and Informed Consent process Grievance Redress Process	DIA	Internal: Quarterly, Independent: Bi-annual	Number and locality of HHs and PAPs consulted, meetings and information disclosure Review the Grievance Redress process. Time taken to address grievances.	PC, C, O	Proponent (SEMD) Independent third-party monitoring agency	MIGA GoL

Note: PC – Pre-construction phase; **C**-Construction phase; **O-**Operation phase
GoV – Government of Vietnam; **GoL** – Government of Lao PDR; **MIGA** –Multilateral Investment Guarantee Agency

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CHAPTER 16 TEAMS INVOLVED

The ESIA TEAM is composed of specialists covering the core needs for the impact assessment and impact management planning for Nam Mo 1 HPP. Table 16.1 presents the members of the team involved.

Table 16.1 List of core experts of the international and national consultant teams

Position / Area	Name	Contribution/Role
International Consultant (IC), ENVIRO-DEV		
International Team Leader (TL) ESIA and Safeguards Specialist	Dr. Shivcharn Dhillion	Overall responsible for design-approach and shaping content of ESIA and international compliance. Covered human ecology, mitigation, communication and plans. Liaise with MIGA-GS.
SIA and Socio-economic Development Specialist	Ms. Tiia Riitta Granfelt	Covered social, livelihoods and communication with TL
ESIA-ESMP, Agriculture and Ecology Specialist	Dr. Shree Govind Shah	Covered gap filling on biology-agricultural aspects and E&S management planning
Environment Management Planning Expert	Ms. Leah Bufi	Assisted with environmental aspects of ESIA and ESMP with TL
Assistant to IC Team and Bridging Consultant	Ms. Ngoc Trang Vu	Assisting in report formating, translation, interpretation, communication with NC.
Assistant to IC Team and Bridging Consultant	Ms Mui Phan Thi	Assisting with report formating and document/report web search
Expert Consultations (ad hoc)	Various international	Hydrology, plant operation, technical and aquatic
National Consultant (NC), PECC1: *inhouse and subcontracted specialists*		
NC TL. Environmental Engineering and Sustainable Infrastructure. GoV EIA	Ms. Thi Thu Yen Cao	Overall responsible for providing input for the ESIA and field baseline updates. Interpretation of technical FS
Pedology and Environment, National EIA Expert	Ms. Thi Doan Trang Vu	Key national expert responsible for providing input for the ESIA, field logistics, interpretation of GoV reports
Social Expert	Dr. Thi Thanh Van Khuc	Led the conducting of FGDs, IIK and Reporting (in Vietnamese)
Agriculture and Livelihood Expert	Dr. Duy Phuong Nguyen	Led the conducting of FGDs and IIK related to livelihood and agriculture reporting (in Vietnamese)
Biologist - Flora Expert	Dr. The C. Nguyen	Vegetation field work and reporting
Biologist - Fauna Expert	Dr. Hung Anh Le	Fauna and aquatic reporting
Hydropower- engineer	Mr. Huu Chinh Nguyen	Input during field visits by IC, technical feasibility report clarification
Map creator, GIS Expert	Mr. Anh Tuan Tran	Made maps
Translation /Interpreter	Ms. Ngoc Trang Vu	Conducted translation.
National Consultation Team: *contracted by Proponent under the supervision and guidance of the IC*		
TL for FPIC (Senior)	Ms. Thi Hien Vu	Conducted ICP employing FPIC process.
FPIC consultant (Senior)	Mr. Van Anh Nguyen	Same as above
FPIC consultant (Senior)	Mr. Quoc Long Truong	Same as above
Assistant to FPIC consultant	Mr. Sy Luan Mai	Same as above
Assistant to FPIC consultant	Ms. Thi Hoai An Nguyen	Same as above
Assistant to FPIC consultant	Mr. Hong Quang Mai	Same as above

CHAPTER 17 CONCLUSION

The Nam Mo 1 HPP is planned along a stretch of the Nam Mo River, one of the main tributaries of the Ca River at the border of Vietnam and Laos. The technical feasibility of the project has been performed for an installed capacity of 90 MW.

The main anticipated negative impacts of the Project include:

(i) the loss of land and assets of Project Affected People due to land permanently acquired and used by the Project both in Laos and Vietnam;

(ii) resettlement and social change;

(iii) changes related to the loss of production and protection forests, agricultural land and associated wildlife habitat;

(iv) changes related to the change of the river into a reservoir affecting connectivity/transport and fisheries;

(v) loss of forest-river related ecosystem services affecting livelihoods which are dependent on these systems.

The main anticipated positive impacts of the Project include:

(i) Increase in mobility and accessibility to the affected villages and Project area in general due to improved roads and provisions of new roads to the villages. This may trigger positive impacts on livelihoods, in making markets accessible, easier access to health care and other services;

(ii) Restoration of forest-grassland areas so that the vegetated areas improve in quality, such that sediments are reduced, availability of forest products are assured overtime and wildlife habitat is increased. This will ensure that ecosystem services are enhanced, maintained and is sustainable;

(iii) Improvement in agricultural methods and products whereby food insufficiency does not occur;

(iv) Improved energy availability and use, better cooking methods and electricity; and

(v) Increase in well being is expected, provided proposed measures are implemented.

Mitigation and enhancement measures on potential social-cultural, forest, agricultural, biological and physical impacts are proposed to minimize the effects and therefore enhance community well being and forest-agriculture central to livelihoods. Measures include, among others, plans for livelihood restoration, immediate catchment management, ecosystem services enhancement, health and safety measures. The measures proposed in the ESMP will help minimize the ecological footprint of the Project. Safeguard documents include the REMLRP) and ESMP guided by the PCDP. An adaptive management process should be adopted to adjust plans according to findings from monitoring, consultations, and audits. A Social and Environment Division (SEMD) of Nam Mo 1 HPP will administer the ESMP through the establishment of a Social and Environmental Management Unit (SEMU).