VNECO HOI XUAN INVESTMENT AND ELECTRICITY CONSTRUCTION JSC

REPORT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

HOI XUAN HYDROPOWER PROJECT

THANH HOA AND HOA BINH PROVINCES

Consultant:

EVN PECC4

Power Engineering

Consulting JS Company 4

Thanh Hoa - 30 October 2015

ABBREVIATIONS

AH	:	Affected household
AP	:	Affected people
BOD	:	Biochemical Oxygen Demand
CPC	:	Commune People's Committee
CST	:	Construction supervision team
DO	:	Dissolved Oxygen
DONRE	:	Department of Natural Resources and Environment
DP	:	Displaced people
DPC	:	District People's Committee
EAP	:	Environmental Action Plan
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
ESIA	:	Environmental and Social Impact Assessment
EVN	:	Vietnam Electricity
FSL	:	Full Supply Level
HH(s)	:	Household(s)
HPP	:	Hydropower project
HXHPMB	:	Hoi Xuan Hydropower Management Board
IEMC	:	Independent Environmental Monitoring Consultant
IFC	:	International Finance Corporation
NR	:	Natural reserves
MIGA	:	Multilateral Investment Guarantee Agency
MONRE	:	Ministry of Natural Resources and Environment
MOIT	:	Ministry of Industry and Trade
MSL	:	Minimum Supply Level
PAH(s)	:	Project Affected Household(s)
PECC4	:	Power Engineering Consulting JS Company 4
PO	:	Project Owner
PPC	:	Provincial People's Committee
RLDP/RLEMDP	:	Resettlement, Livelihoood and Ethnic Minority Development Plan
ROW	:	Right of way
TL(s)	:	Transmission Line(s)
VND	:	Vietnam Dong/Vietnam currency
VNECO/ VNECO HOI XUAN	:	VNECO Hoi Xuan Investment and Electricity Construction JSC

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FOREWORD

Report on Environmental and Social Impact Assessment (ESIA) of Hoi Xuan Hydropower Project was developed to solve problems for appraisal of projects funded by MIGA, including the assessment of social environmental impacts (ESIA) and establish environmental management plan (EMP) in accordance with the requirements of MIGA.

The ESIA report is based on the previous EIA which was approved by MONRE and established by the project owner (PO) and Power Engineering Consulting Joint Stock Company 4 (PECC4); the design documentation and reporting components of the project has established by the PO in coordination with other units done previously and to the present time. The PECC4 highly appreciates the contributions of those who carried out these documents. In the process of preparing the ESIA report, the consultant unit has referred much information from these documents.

To prepare the ESIA report, the PECC4 has also carried out research at site to collect and update information related to the present project, including the project implementation situation, existing environmental management of the project; environmental changes in the project area when the project is deployed, especially for components and objects sensitive and easily altered by human activities such as water quality, land use, use water use, aquatic ecology, fish and fisheries, economic conditions, social services, people's opinions about the project, the report ... the results of these studies are summarized in ESIA as a basis for assessing environmental impacts and have updated, adapted environmental management plan proposed earlier through the implementation phase of the project.

We would like to express our sincere appreciation and acknowledge the cooperation, active support and valuable feedback from affected people by the project; local governments at provincial, district and communal level and the relevant agencies of 02 provinces of Thanh Hoa and Hoa Binh in the process of studying, collecting documents and information to establish this report.

SUMMARY OF ESIA REPORT

1. General introduction

Hoi Xuan hydropower project is a medium-scale project. The main purpose of the project is to contribute to meet the growing electricity demand in Vietnam. The project has a design capacity of 102 megawatts (MW), annually contributes 432.00 gigawatt hours (GWh) to the national grid, proposed to come into operation in the 1st quarter of 2015.

The current location of Hoi Xuan HPP has been chosen because the potential impacts on society and the environment is the lowest while meeting the goals of this project with the possibility of a high return on investment.

Without Hoi Xuan hydropower, Trung Son hydropower generates only a few hours in day (7hours/day), so the difference of discharge, water level between peak hours and off-peak hours is very large. Specifically, the difference of the discharge between the peak hours and the off-peak hours is about 536.4 m^3/s while the difference of water level is about 3.2m (in dry season). In the peak hours, the water level at downstream is higher than the water level of natural river about 2.09m. In the off-peak hours, the water level at downstream is lower than the water level of the natural river about 1.11m. When Hoi Xuan hydropower is constructed and come into operation according to daily regulation, generated power 24/24h with the firmed discharge of 70.56m^3/s, so flow in Ma river downstream behind Trung Son hydropower dam will be re-regulated, Ma river flow behind Hoi Xuan hydropower dam will be maintained stably and water volume to supply for the downstream during the dry season will be increased. Besides, power energy generated by Hoi Xuan HPP is a fresh energy source, thus it is used as a replacement energy source to reduce GHG emission causing the greenhouse effect.

In economic terms, taking into account the cost of mitigating the social impact and value of forest loss in the reservoir, and greenhouse gas emissions from the reservoir are consistent with development strategy and hydropower projects, so Hoi Xuan HPP is one of the effective project in terms of electricity prices and investment capital.

1.1. Introduction of the project

Hoi Xuan hydropower project is located on Ma river, it belongs to territory of two provinces Thanh Hoa and Hoa Binh.

According to the selected alternative, damsite of Hoi Xuan hydropower project is located on the territory of Thanh Xuan commune, Quan Hoa district, Thanh Hoa province, with coordinates (Coordinate system VN 2000) as follows:

X: 2 261 585, Y: 505 295

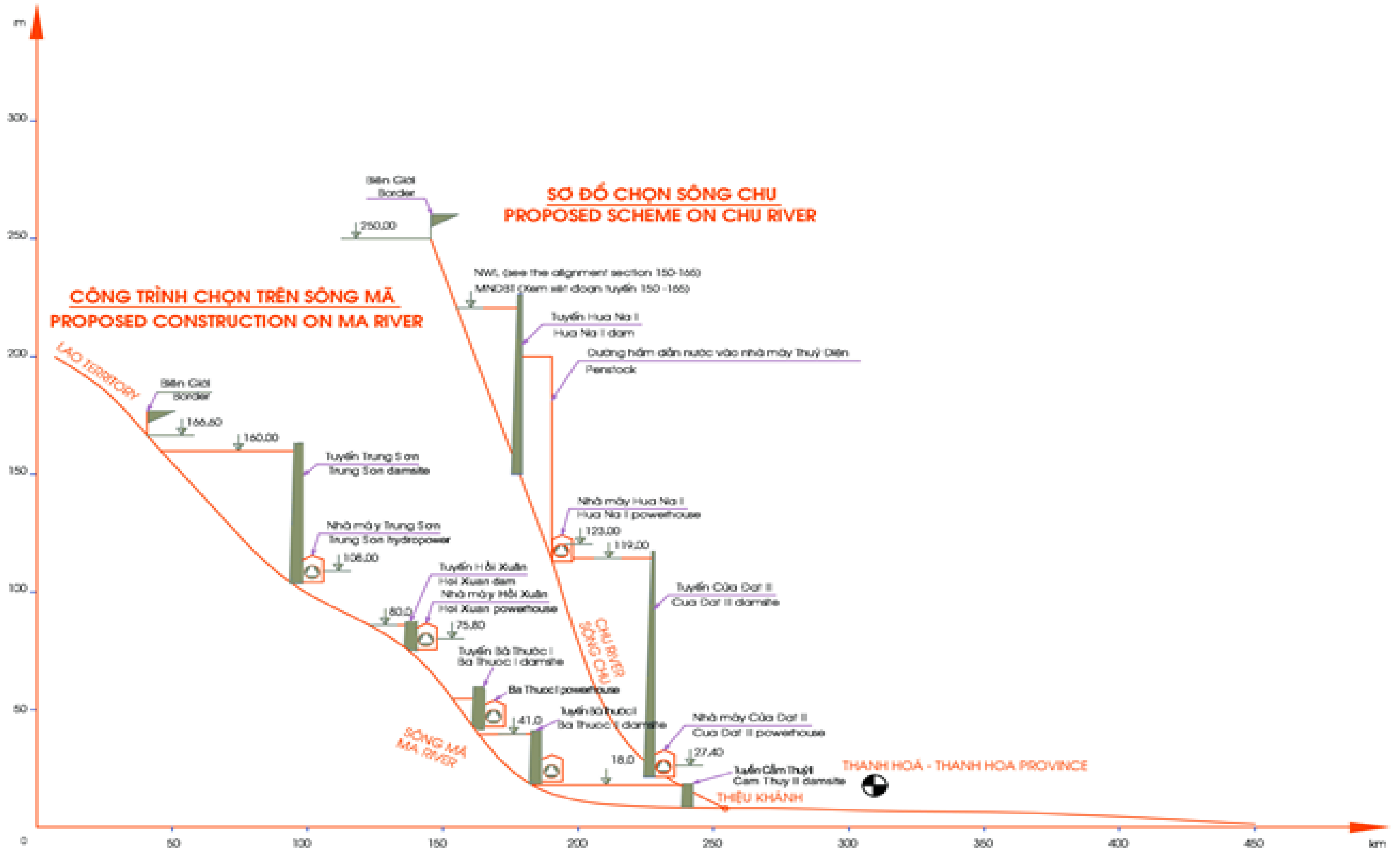
The project is located nearby the National highway 15A, 95km far from Hoa Binh town in the West, 195km far from Thanh Hoa province in the North-west, and 15km far from Hoi Xuan town, Quan Hoa district

The project is located on Ma river hydropower cascade, in the downstream of Trung Son hydropower, with 38.5 km from Trung Son hydropower.

The project will not occupy the land of natural protected areas, national parks and protection forests. The distance from the project's damsite to Pu Hu natural protected area is 6km in the East, and 3.5km in the South-east from Pu Lung natural protected area, to Xuan Nha natural protected area is 30 km in the Northeast.

According to preliminary survey results, in the acquired land area for construction, there is no religious, historical monuments, important historical works. In the reservoir area there are no mineral sources, construction materials.

The location of Hoi Xuan hydropower in relation to surrounding objects is shown in Figure 1 (Location diagram of hydropower projects on Ma river) and Figure 2 (Diagram of regional relations – Hoi Xuan HPP) attached to this ESIA.



HÌNH 1: SƠ ĐỒ KHAI THÁC BẬC THANG THUỶ ĐIỆN TRÊN SÔNG MÃ
FIGURE 1: HYDROPOWER CASCADE SCHEME ON THE MA RIVER

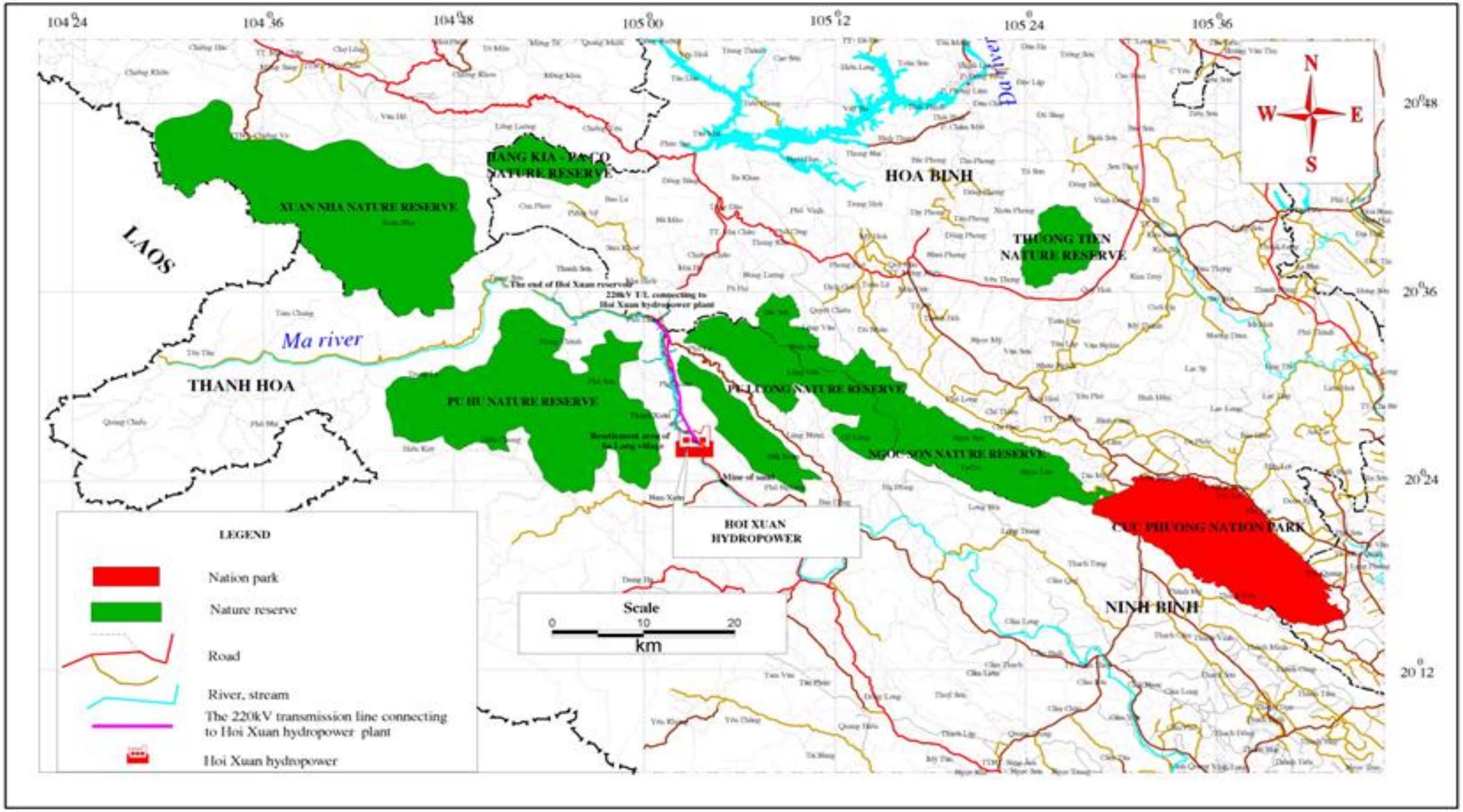


FIGURE 2 : DIAGRAM OF PROJECT LOCATION AND SURROUNDING NATURE RESERVE

Hoi Xuan hydropower project has an installed capacity of 102MW, it will supply to the national grid with an annual average electricity output of 432.00 million kWh contributing to reduce a power shortage for national economy development. Specifically:

According to the National Power Development Master Plan in the period 2011 – 2020 and vision to 2030 established by Institute of Energy in October, 2010, an electricity load demand for the economic development branches is forecasted up to 108,880GWh in 2010 and 194,304 in 2015, corresponding to the maximum capacity demand of 16,048MW in 2010 and 30,803MW in 2015. Average speed of growth in the period 2011 – 2015 is 14.0% (base scenario).

According to the plan to build power sources, a power source's capacity is expected in the period 2011 – 2015 is 22,890MW, a shortage of power source is about 7,913MW, excluding the backup power. Therefore, Hoi Xuan hydropower project has the capacity of 102MW, the energy output of 432.00 million kWh, which contributes to reduce the shortage of electricity for economic development demand of the country.

In the context of climate change is complex and intense, the construction of Hoi Xuan hydropower project will not only meet the energy demand for the economic development but also contribute to reduce greenhouse gas emissions about 68,161.4 tons CO_2/year compared to the use of fossil fuels to generate electricity.

1.2. Classification of the project

According to the evaluation criteria on environment of MIGA, Hoi Xuan hydropower project is classified as category A.

1.3. Objectives of the ESIA report

ESIA report will review, update, supplement the report of environment impact assessment, which was approved in Vietnam (hereafter called the MONRE-approved EIA), and complied guidelines for environmental assessment (EA) of MIGA, as well as in accordance with requirements of Vietnam.

1.4. Scale and scope of the ESIA report

Scope of study is identified including: (i) hydropower project area, (ii) connection transmission line area, (iii) resettlement areas, and (iv) upstream, downstream areas of the project (from the hydropower cascade adjacent with Trung Son HPP to the confluence point with Luong river) on the following points:

(i) Hydropower project area including damsite area, reservoir area, water way, road for construction, operation and other support areas, these are affected directly or indirectly by the activities of the project.

(ii) Connection transmission line area has a mission of transmitting electricity from Hoi Xuan hydropower project to the national power grid, from which the electricity is transmitted to provide for households. The construction of these items will cause Impacts on environment and society, both positive and negative.

(iii) Resettlement area: The focus resettlement area for the displaced households who have expectation of resettlement. The displaced households and other households will be affected directly or indirectly by the resettlement activities of the project.

(iv) Upstream, downstream areas (from the hydropower cascade adjacent with Trung Son HPP to the confluence point with Luong river).

The operation of system of hydropower cascades will cause cumulative impacts on Ma river system. Scope of study of accumulative impacts due to operation of the hydropower cascades system on Ma river system with Hoi Xuan HPP is determined from the hydropower cascade adjacent with Trung Son HPP to the confluence point with Luong river.

These studied areas of the ESIA report, including the upstream and downstream are located in the territory of 11 communes of 2 districts, 2 provinces as Hoi Xuan, Phu Le, Phu Son, Phu Thanh, Phu Xuan, Thanh Son, Thanh Xuan, Trung Son and Trung Thanh communes – Quan Hoa district – Thanh Hoa province, and Mai Hich and Van Mai communes – Mai Chau district – Hoa Binh province. Of which, only 10 communes are impacted on land, houses, auxiliary structures, trees, crops, infrastructures, public works and other works. Specifically, 01 Trung Son commune is only impacted on aquatic ecological environment, not impacted on land and assets on land (eco-social environment).

(Note: Although there are 11 communes to locate in the studied area of this ESIA but there are only 10 communes of them to be impacted on land and assets on lands, for this reason only 10/11 communes are within the studied scope of the RELMDP report in stead of all 11 communes as the ESIA).

1.5. Documents and methods

❖ ***Documents:***

1. Reference document and data source

The report of “Environment Impact Assessment” of Hoi Xuan hydropower project is conducted on the basis of reference documents and data as follows:

- Report No. 152/BC-UBND dated Dec. 5th, 2013 of Thanh Hoa province on reporting economic- social situation in 2013 , economic-society development plan in 2014.

- Decision No. 1832/QD-UBND dated on Jul. 3rd, 2006 of Thanh Hoa province approving the general planning of socioeconomic development of mountainous province in Thanh Hoa in 2020.

- Quan Hoa DPC's report of overall planning of economic – social development of Quan Hoa District until 2020 which have been implementing from 2010.

- Report on relations between ethnic groups in the socio-economic development in mountainous areas of Thanh Hoa in recent years of ethnic board of Thanh Hoa province

- Report No. 60/BC-BCD on the socio-economic situation of the first 6 months, the key task of last 6 months of 2014 is implemented by the PSC, and the economic development programs is implemented by the Western group.

- Report No. 191/BC-UBND dated Dec. 2nd, 2013 reporting on the economic – social, defense-security situation in 2013; guidelines and key tasks in 2014 of Quan Hoa district.

- Report No. 24/BC-UBND dated Jun. 18th, 2014 of Mai Hich PPC on reporting of the implementation of socio-economic, defense-security criteria in the first 6 months; and the key tasks in the last 6 months of 2014

- Report No. 01/BC-UBND of Mai Hich commune dated Jan. 10th, 2014 on reporting of the implementation of socio-economic development criteria in 2013; guidelines, missions and solution of implementing economic development plan in 2014

- Report No. 29/BC-NN&PTNT dated Feb. 10th, 2013 on the results of implementing the policies to support the development of production under Resolution 30a of Quan Hoa district in 2013

- Report on some economic - social indicators implemented in 2013 of Mai Chau Departments of statistics, dated Jan. 15th, 2014

- Report No. 100/BC-UBND dated Jun. 30th, 2014 of Quan Hoa District People's Committee on reporting of the implementation of socio-economic, defense-security criteria in the first 6 months; and the key tasks in the last 6 months of 2014

- Report on land-use planning until 2020, the 5 years plan of land use from 2011 to 2015, of Hoa Binh Province

- Descriptive report of land-use planning until 2020, the 5 years plan of land use from 2011 to 2015 of Mai Chau district, Hoa Binh Province

- Report on the environmental status of Hoa Binh Province in 2013

- Report on the environmental status of period 2006 – 2010 in Thanh Hoa province

- Resolution of the XV Congress party of Hoa Binh province term 2010-2015 on Oct. 20th, 2010

- Decisions on land use planning approval until 2020, the 5 years plan of land use from 2011 to 2015 of Mai Chau district, Hoa Binh Province

- Statistical Yearbook 2012 of Hoa Binh Province.

- Statistical Yearbook 2013of Quan Hoa district.

- Statistical Yearbook 2012 of Thanh Hoa Province.

- Report " Pu Luong natural reserve – the surveys of biodiversity at key areas in order to conserve Pu Luong – Cuc Phuong limestone mountains" was established by "International Union for Conservation of Nature and Natural Resources" in June 2005.

- "Investment project for establishing Pu Luong natural reserve – Thanh Hoa province" was conducted by Forest Inventory and Planning Institute – People's Committee of Thanh Hoa province in 1998.

- "Additional investment project for establishing Pu Hu natural reserve – Thanh Hoa province" was conducted by Management Board of Pu Hu natural reserve in May 2006.

- Thematic component of animal species, proposal of preservation measures and developing animal species on the Pu Luong natural preserve - Investigative project, cataloging the flora and fauna of the Pu Luong natural preserve area in Thanh Hoa province under the management board of Pu Luong nature preserve - Department of Agriculture and Rural Development, established in 2013

- Thematic component of plant species, proposal of preservation measures and developing animal species on the Pu Luong natural preserve - Investigative project, cataloging the flora and fauna of the Pu Luong natural preserve area in Thanh Hoa province under the management board of Pu Luong nature preserve - Department of Agriculture and Rural Development, established in 2013

- Preservation planning and sustainable development of special forest in Pu Luong natural reserve 2020

- The process of formation and development of Pu Luong Nature Preserve Management Board

- Pu Luong Nature Preserve- surveys of biodiversity in key areas to preserve Pu Luong - Cuc Phuong rocky mountain line

- Report of the protection and development of the natural forest project in Hang Kia - Pa Co natural preserve 2011-2020

- Report of protection, planning and development of Quan Hoa forest until 2020 from Jul. 2014.

- The report of review and planning results of three forest types of Thanh Hoa province period 2006-2015 of Thanh Hoa Province People's Committee

- The report of review and planning results of three forest types of Thanh Hoa province period 2006-2015 carried out by the forestry design and planning investigative team on Oct. 22nd, 2006 in Thanh Hoa

- Mineral Map 1/100 000 in scale in Quan Hoa district, Thanh Hoa province

- Map of land use in Quan Hoa district, Thanh Hoa province,

- Map of land use planning in Quan Hoa district, Thanh Hoa province

- Map of land use in Mai Chau District, Hoa Binh Province

- Map of review result of 3 forests types in Thanh Hoa province

And the collected documents of economic - social, environmental, ecological

- Referring study results of Environment Impact Assessment of Trung Son HPP, Trung Son HPP is the upstream cascade of Hoi Xuan HPP.

Sources of the documents and data above were collected by the project owners, the consultant agency during the project implementation, both in field sites and office works. These are the secondary document sources related to the project area, so the reliability of these documents depends on the issuing agencies.

Economic – social factors always change according to the time, which are updated, collected additional according to project implementation phases.

2. Documents, data sources established by the project owner and consultant agency

- Main report of Hoi Xuan hydropower project, Thanh Hoa province in the basic design – feasibility study stage, which was implemented by PECC4 in 2007.

- Report on technical design of the project was established by the project owner coordinate with Construction University Consulting Company in April, 2010 (the technical design – Stage 1) and Investment Joint Stock and Energy Development Company in April, 2014 (the technical design – Stage 2)

- Report of Environment Impact Assessment of Hoi Xuan HPP was established by PECC4 and which is approved by the Ministry of Natural Resources and Environment at the Decision No. 216/QD-BTNMT dated February 01st, 2008

- The investigated and surveyed data of environmental factors at the project area was implemented in the period from June - August 2007, July - Aug. 2014 and updated in Aug. – Nov. 2015.

- Survey documents of topography, geology, hydro-meteorology for Hoi Xuan hydropower project in the FS stage, as well as the investigated and surveyed documents about socio-economy, which were implemented by PECC4 in the period from June - August 2007, July - August 2014 and updated in Aug. – Nov. 2015.

- Measured and analyzed data of water samples were implemented by PECC4 coordinated with Research Centre for Environment and Community Development in the period from June to August, 2007 and updated in July and August 2014.

- Water quality has been measured and sampled for analysis by Environmental Monitoring and Technical Center in coordination with PECC4 in July and August 2014.

- Results of community consultation were implemented by PECC4 in July and August 2014

- The documents of damage to land, houses, trees, crops, public works, infrastructure were implemented by the project owner to the present time.

These above documents are mainly the results of survey, measurement, experiment, sampling on the field of the project area and the impacted surrounding areas, which serve the works of compensation, assistance and resettlement, establishing the report of environment impact assessment in the project. The document will be surveyed, collected additional according the project phases. Therefore, the documents for the report have high reliability and update.

❖ ***Methods used for the ESIA establishment***

The ESIA – Hoi Xuan hydropower project has inherited the results of researches on environmental factors of Research Institutes and agencies related to environmental field. The report also uses the survey data of natural environment, as well as economic-social conditions in the project area. It also refers the results of report on Environment impact assessment of Trung Son hydropower project, which is the upstream cascade of Hoi Xuan hydropower project.

During the process of the analysis, forecast and evaluation of the project's impacts on the environmental factors, the methods and method groups were used in the report such statistical method; investigation, survey methods; rapid assessment method, methods of study, analysis in laboratory (the method groups often use for establishing the report); expert method, comparative method; matrix method; empirical calculation methods including: method for soil erosion calculation, method for forecasting landslides and decrease lakeshore, method of pollution coefficient, method of spread of pollution, method of spread of noise, method for calculating the standing living biomass of reservoir,…(the method groups are used for evaluating and forecasting Impacts). Specifically as follows:

* *Conditions of geography, geology, topography, meteorology, hydrology:*

Expert groups used studied and surveyed documents to serve for designing the project, which were implemented by the project owner in the previous phases; the research results on geography, geology, topography, meteorology – hydrology in the report of environment impact assessment approved by the Ministry of Natural resource and Environment; the results of survey at the project field were implemented by PECC4 in July - August 2014, and updated in Aug. – Nov. 2015.

* *Quality of water, air, soil environment*

Quantity of water, air, soil environment mentioned in the report is evaluated based on the study documents in the previous phases and the results of measurement, analysis were implemented by the expert group in July and August 2014, and compared with the Vietnamese environmental standards to determine level of environmental pollution in the study area.

** Terrestrial ecosystem*

Terrestrial ecosystem in the ESIA report is assessed based on the results of research and survey in the MONRE-approved EIA; the results of survey and interviewing with local people, which has been implemented by PECC4 in July and August 2014, and reference on the documents were studied in the study area, including the research documents of Trung Son hydropower project, Pu Hu, Pu Luong, Hang Kia – Pa Co, Xuan Nha natural reserves, etc...

** Aquatic ecosystems, fish and fisher*

Data on aquatic ecosystems, fish, fisher shown in the report is referred from, research results on Ma river, which was implemented by some domestic experts for projects in the area, including Trung Son hydropower project; and the results of investigation, survey on the project site and the downstream, interviewing fisherman, local people and fish sellers at some local markets, these works were implemented by PECC4 in July and August 2014.

** Impacts on households and local communities*

Impacts on households and local communities are evaluated based on the documents of investigation and inventory implemented by the PO.

** Economics and social issues (population, ethnicity, gender, profession, level of living, education, health, community health, rural environmental sanitation, security, etc.)*

Economics and the social issues were considered and evaluated by the expert group in the ESIA report at different scales: households, hamlets, villages, districts, provinces within the project area. The issues at the scale of hamlets, villages, districts, provinces were evaluated based on the statistical documents, which were collected by PECC4 during the actual survey in July - August 2014, updated in Aug. – Nov. 2015 and inherited the statistical documents of the previous study phases. General information about economic-society, environmental sanitation at the scale of households is based on the investigation data, which was implemented by PECC4 through "Questionnaires of survey, investigation of economic-society" with the participation of the stakeholders. This approach was applied in all progress of collecting information.

Economic-social researches have to assess the general of people living conditions in villages, communes, districts, provinces in the project area, especially directly affected households, as well as the project's issues affecting AHs' life. From these, measures for preventing, mitigating Impacts on AHs (Details of the measures of mitigation, restoration, improvement for AHs are mentioned in another report (resettlement plan).

* *Current situation of infrastructure, land use, water use, etc.*

Current situation of infrastructure, land use, water use are assessed within the project area, the downstream, and the upstream areas from Trung Son HPP to the confluence location with Luong river through the collected documents and the actual observation by PECC4 in July - August 2014, and updated in Aug. – Nov. 2015.

* *Public consultation, disclosure and participation of stakeholders*

The project was implemented according to the approach of information disclosure, consultation and participation of people and stakeholders. According to this approach, during the field survey in July - August 2014, updated in Aug. – Nov. 2015, PECC4 has conducted public consultation with directly affected households (through the questionnaires and the economic-social surveys with the affected households); and implement interviews with fishermen on Ma river from Trung Son hydropower to the confluence with the Luong river, fish consumers, fish traders, some people in project communes, and some representatives of the affected ethnic people. The project also held meetings to disclosure information and public consultation on the framework of the ESIA report after the ESIA was agreed by the project owner and the consultant experts of the MIGA. In addition, the draft ESIA will be disclosed and consulted for communities

According to the guidance of the MIGA, the project owner will continue to implement the information disclosure and the public consultation during the construction and the operation of the project.

After this environmental impact assessment is approved by the credit organization, the owner project will announce information in project communes through media system of communes, on the Company's website, etc. The disclosed content will include general information of the project, potential impacts of the project, measures of prevention and mitigation, and the environmental management plan of the project.

In addition, in the FS phase and during the process of the EIA report establishment approved by the MONRE, the project owner organized the meetings of this report's information with the affected communes (1 meeting/1 commune) for consultation and took the written comments of the CPCs' representatives, the commune Fatherland Front Committees' representatives and some representatives of the affected households

The EIA approved by the MONRE (at the Decision No. 216/ QD-BTNMT dated Feb 01 2008 of the MONRE) was disclosed by the project owner for the project communes' citizens and the affected people in the form of the noticed boards at People's Committee of the project communes. The announcing contents included general information about the project, the potential impacts of the project, the measures of prevention and mitigation, the programs of monitoring and management environment.

* *Methods of statistic and legacy*

Methods of statistic and legacy are used in the process of inheritance, statistic and processing the collected data, documents in all levels of communes, districts and provinces in the project area; as well as the study documents have been done by the related agencies up to now. The data on economic- social condition of local people and the affected households has been synthesized and analyzed by PECC4.

* *Methods of investigation and survey*:

On the basis of the available environmental documents, the project area has been investigated and surveyed in order to update and supplement the latest documents, as well as survey the current situation of environment in the project area.

* *Methods of research and analysis in the laboratory*

The samples of water, air, soil were collected in the field (10 samples of surface water, 4 samples of groundwater, 11 samples of soil, 10 samples of ambient air), which are studied, analyzed in the laboratory according to the methods of analysis and the current standards of Vietnam, in order to serve to assess the status and quality of the environment at the time of establishing the report (sampling locations are shown on Figure 7, the sample analysis results are attached in the annexes).

* *Method of comparison*

The results of measurement and analysis of water, air, soil samples will be compared with the current standards, regulations of Vietnam to assess environmental quality at the project area at this time.

* Method of Empirical calculation:

Using the empirical equations of the authors in the country, as well as the foreign authors to calculate and forecast the reservoir bank erosion, calculate amount of the deposited sediment in the reservoir, calculate inundated biomass, prediction of water quality change, etc.

** Method of map*

Based on the documents such as the topographic map, the diagram of construction layout, etc. PECC4 has been used the geographic information system GIS with the support of the specialized softwares such as Mapinfo, Autocad for stacking the map layers to establish the thematic maps such as the location map of the project area, the diagram of current land use, diagram of sampling location, etc.

* Rapid Assessment Method:

By experiences of experts in the process of field survey at study area, identification of environmental risks, identification of impacts, and preliminary assessment of level of impact of the project on some environmental factors such as ecological environment, economy-society environment etc. have been done.

* *Expert method*:

By experiences, the expert group has studied environmental changes in a number of hydropower, irrigation projects, which have been built and operated such as Son La, Hoa Binh, Thac Ba Yaly, Hinh River, Dau Tieng, Tri An, etc... to predict the probable impacts on the factors: geology, climate, hydrology, water quality, etc. to the project.

On basis of the feasibility study, effectiveness of the implementation of mitigation measures from the project's impacts; feasibility and effectiveness of the implementation environmental protection measures at the hydropower projects such as Srepok 4, Srepok 4A, Trung Son, Song Bung 4, in order to take appropriate adjustments in the process of development of mitigation measures, environmental management programs, including the works of treatment and environmental protection.

1.6. Preparation of the ESIA report and manpower for implement

- Review of the existing EIA report (the MONRE-approved EIA);

- Review of the related reports and the related documents;

- Implementation of the necessary researches to supplement the previous studies in order to satisfy the requirements according to the guidelines of MIGA on the environment and the society;

- Organization of public consultation and information disclosure of the ESIA report for the project area;

- Preparation of the ESIA report in accordance with the requirements of the MIGA.

During the process of implementing the ESIA report, project owner, expert group (PECC4) have received involvement and positive collaboration from local government, the authorities of all levels such as province, district, commune, local officials, forestry officials of Natural reserves' management board sand affected people.

The ESIA report was prepared during the period from 25 July to 15 August 2014, updated in Aug. – Nov. 2015. The human resources for implementing the report are listed in the following table:

Table 1: Team for implementing the ESIA report

No.	Full name	Specialization
I	**Consulting company**	
1	Tran Van Luyen	Meteorological and hydrological Engineer
2	Nguyen Khac Tuan	Hydrological – Environmental Engineer
3	Doan Thi Thu Ha	Master of Ecology – Land Spaces - Environment
4	Tran Dinh Dang	Hydrological – Environmental Engineer
5	Nguyen Duc Hoang	Bachelor of Electrical Engineering
6	Nguyen Nhat Ha Chi	Bachelor of Environmental Science
7	Phan Van Luan	Intermediate of Hydrology
8	Truong Phu Lam	Master of Environmental Science
9	Nguyen Van Minh	Hydrological Engineer
10	Pham Thi Thanh Nhan	Engineer of Environmental Technology
11	To Dang Hai Hoang	Bachelor of Environmental Physics
12	Hoang Trung Phong	Hydrological – Environmental Engineer
13	Pham Hong Thai	Bachelor of Meteorology – Hydrography - Oceanography
14	Pham Huyen	Master of Resources - Environment
15	Nguyen Huu Hao	Engineer of Management of Forest Resources and
16	Huynh Van Hao	Engineer of irrigation – hydropower works
17	Nguyen Duy Khanh	Engineer of irrigation – hydropower works
18	Tran Van Hoc	Engineer of Water resource works
19	Pham Ba Thien	Bachelor of Geography
20	Nguyễn Thị Hà	Hydrological – Environmental Engineer
21	Nguyen Huong Thuy	Hydrological – Environmental Engineer
22	Nguyen Huy Han	Hydrological – Environmental Engineer

23	Nguyen Van Son	Hydrological – Environmental Engineer
24	Ngo Sach Chinh	Master of Agriculture

2. Summary of the ESIA

The report reviews the current state of environment in the study area; assesses impacts on people, the natural environment and the economy – society due to the implementation of the project's items. These impacts include positive and negative impacts, directly and indirect impacts, and cumulative impacts in the relationships with other projects. Based on the forecast, analysis and evaluation of impacts, the report has proposed the measures for enhancing, minimizing negative impacts, for preventing and responding environmental incidents; as well as suggested environmental management and monitoring plans consistent with the public consultation. Also, the report include the cost estimation and implementation schedule of environmental protection activities as a basis for the implementation of the project associated with the environmental protection and sustainable the development.

The research process shows that the most significant impact of the project on the environment, which is affecting 8,043,701.0 m^2 of land, including 7,517,112.3 m^2 of the hydropower area, 321,205.8m^2 of the transmission line area, 78,026.0 m^2 of resettlement, and 95,622.5m^2 of sand mine. In which, there is 7,605,801.0 m^2 of the long-term acquired land, 310,543.1m^2 of land which are restricted for use (under the ROW of the transmission line, and 127,356.9m^2 of the temporary affected land and hired land (Areas of the support works: worker camp, stockpiles,… and sand material area).

Table 2: The area of land acquisition

No.	Items	Area (m^2)
A	***Permanent acquired land***	**7,605,801.0**
I	***Hydropower plants***	***7,517,112.3***
1	Headworks area	680,681.70
2	Reservoir area	6,825,369.40
3	The area for reconstructing public works	11,061.2
II	***Residential area***	***78,026.0***
III	***The 220kV connection transmission lines***	***10,662.7***
B	***Temporary acquired and leased land***	**127,356.9**
I	***Hydropower plants***	***31,734.4***
1	Auxiliary works	31,734.4
II	***Mines of materials***	***95,622.5***
1	Sand mine (42,170m^2 in the area)	95,622.5
C	***Restricted use land***	**310,543.1**
I	***The 220kV connecting TLs***	***310,543.1***

1	ROW	310,543.1
	Total	**8,043,701.0**

The land acquisition for the project implementation (both the long term and the temporary) will directly affect the life of 1,447 Households/6,466 inhabitants, including 1,349 households/6,045 inhabitants in the hydropower plant area, 45 households/169 inhabitants in the transmission line area, and 53 households/252 inhabitants in the resettlement area (the local households will be acquired land to serve the resettlement activity for the affected households in the project area).

Another impact is relatively important that land acquisition for construction the project will impacted permanently and temporarily on 2,412,992.0 m^2 forest (accounting for 31.7% total land area for constructing the project). In which, there are about 2,235,371.0 m^2 forest land which must be permanently acquired and transferred land use purpose (accounting for 29.4% of total). This will reduce significant forest area. However, forest in the project area is the planted forest (bamboo), but it covers the soil surface and contributes to reduce flood intensity in the middle area of Ma river.

In addition, the implementation of Hoi Xuan HPP project has significant impact on the downstream. As the analysis in Section 1.4, of summary of ESIA report, without Hoi Xuan HPP, only Trung Son HPP, the flow regime of downstream depends on the operation regime of Trung Son HPP (operation according to the sub-load diagram with a number of hours in day), so the flow regime between the generating hours and the non-generating hours changes very large. But when Hoi Xuan HPP is built with the daily regulation regime (24h/24h), then the downstream flow is regulated, kept stable. Besides power generation to provide the national grid with the power output of 432.00 million kWh, this is a significant positive impact of the project.

Another impact is also relatively important that the dam construction of Hoi Xuan hydropower projects will affect the movement of fish between the upstream and downstream. However, the study results showed that Ma River in the dam site has no moving fish from the river to the sea and from the sea to the river for breeding and searching for food. Therefore, the construction of the dam only affects the movement and searching for food of fishes and other aquatic species having habit to migrate along the river.

Concerning water traffic between upstream and downstream of the dam: according to survey results, currently in Ma River, there are activities to transport Bamboo trees to the downstream. Therefore, the construction of Hoi Xuan in particular, and the hydropower's dams system on the Ma River in general (including the dam of Trung Son HPP in the upstream) will create obstacles hindering the waterborne transportation of Bamboo trees from upstream to downstream. However, besides the waterborne transportation, the transportation of Bamboo trees are currently mostly done by road transportation. In addition, besides the roads are being upgraded, renovated and newly constructed that ensure freight system and transportation of people, therefore the impact on the Bamboo trees transporting and traveling from upstream to downstream can be fully replaced by road transportation.

Concerning river traffic between the two sides of the Ma River: local residents are still travelling back and forth between the two sides of river by boat. This is horizontal water traffic, so the construction of hydropower dams have no impact during normal operation. However, during flood discharging, especially when the hydropower plants discharge flood simultaneously (water level rise rapidly in the downstream) often creates whirlpool in the downstream area after the dam, which is very dangerous for travelling by boat. People should be carefull to avoid unfortunate incidents. Project owners shall take measures to alert local during flood discharging.

Besides these impacts, the construction of the facilities of the HPP, transmission lines connecting to the national grid, resettlement areas and other works also generate wastes, such as: dust, emission gases,waste water, grease during the process of repairing and maintaining of machinery and equipment, solid waste, trees (during the process of site clearance) and other construction waste that pollute air, water and soil. All of these impacts are only occurred during construction phase.

The construction also causes the loss of surface vegetation, soil disturbance that leads to soil erosion, sedimentation of the river and streams.

The construction of project works and environmental sanitation conditions in camp areas may cause disease, threatening the safety of the workers and people in the surrounding area.

The concentration of workers in contemporary camps and operation staff may also cause problems regarding social security and order in the arrea, including drug trafficking, prostitution, gambling, conflict ... that increase the pressure on the management of local governments, increase pressure on social services in the province, especially the health care services.

In the operation phase, beside the impact on the downstream flow, the project also caused problems related to the sedimentation of reservoir, regeneration of reservoir's bank, water pollution due to the decomposing biomass submerged in the rreseroir and downstream, and the risks related to the safety during operation of the facilities, such as: earthquake, water loss in the reservoir, ... these processes will be inspected and controlled during operation in order to timely detect incidents and implement measures to ensure safe operation.

In order to minimize the project's negative impacts, ensure environment protection and sustainable development, in the report of the MONRE-approved EIA as well as this ESIA report, the project owner has made efforts to minimize displacement during the survey and design of the project through study of 3 damsite alternatives and 4 water level alternatives (see chapter 5 of the report) for comparing and proposing the optimal alternative (alternative 3), and proposed the measures of minimizing impacts and environmental management monitoring programs which are suitable and highly feasible(see chapter 4 and 6 of the report). There are the main recommendations as below:

In order to minimize Impacts of land acquisition for people, project owner will compensate damages according to full replacement cost, implementation of concentrated resettlement for affected households, which are eligible and wish to be resettled concentratively (42 HH belong Sa Lang village) in Sa Lang village, Thanh Xuan commune, Quan Hoa district, and prepare assistance measures in order to ensure for the affected households to quickly stabilize their life, production and income restoration. In which, woman headed and vulnerable households (such as household with woman head), EM household, single elder household, war invalid household,…. will be get priority to consider.

Implementation of planning and construction of the focusing resettlement areas for the households who have the wish of the focusing resettlement based on the consultant and participation of people.

For Impacts on the forest, the project owner will coordinate with the localities and the related agencies for planning and replanting forest trees at other locations with the forest area that is equal to the forest area acquired and changed purpose use to the project implementation. The PO will be responsible for costs of the implementation of this work.

The project will also prepare and ensure the adequate financial resources for the implementation of the compensation, assistance and resettlement, and implementation of environmental management and monitoring programs.

CHAPTER 1. THE LEGAL BASIS, POLICY AND INSTITUTION

1.1. Legal basis for the report establishment

- Decision No. 1195/QD- NLDC dated March 31st, 2005 of the Ministry of Industry and Trade on approval of the planning of hydropower cascades on Ma river.

- Decision No. 1208/QĐ-TTg, dated 21 Jul. 2011 of the GOV on approval of master plan of National Power Development in the period of 2011-2020, with consideration to 2030.

- Letter No. 0147 CV/VNECO-KTKH dated 30 Jan 2007 of Vietnam Power construction J.S Corporation on consulting on investment of Hoi Xuan HPP.

- Letter No. 608/BCN-NLDK dated 05 Feb. 2007 by the Ministry of Industry on Hoi Xuan HPP, Thanh Hoa province.

- Letter No. 1708/CV-EVN-KH, dated 17 Apr. 2008 of the Electricity of Vietnam on the acceptant for purchasing power generated by Hoi Xuan HPP.

- Letter No. 1733/EVN-TĐ dated 17 Apr. 2008 the Electricity of Vietnam on the acceptant for the transmission line connecting Hoi Xuan HPP to the national grid.

- Letter No. 584/UBND-CN, dated 12 Feb. 2007 of Thanh Hoa PPC on survey for construction of Hoi Xuan HPP, Quan Hoa district.

- Letter No. 4663/UBND-CN, dated 07 Nov. 2007 of Thanh Hoa PPC on the construction investment of Hoi Xuan HPP, Quan Hoa district.

- Letter No. 2660 /UBND-CN dated 25 Dec. 2007 of Hoa Binh PPC on the construction of Hoi Xuan HPP, Thanh Hoa province.

- Decision No. 216/QĐ-BTNMT, dated 01 Feb. 2008 of MONRE on approval of environmental impact assessment of Hoi Xuan HPP.

- Letter No. 219 /TB-BCT dated 12 May 2008 on announcement of results of evaluation for basic design, construction investment of Hoi Xuan HPP, Thanh Hoa province.

- Decision No. 014 QĐ/VHX-HĐQT dated 30 May 2008 of VNECO Hoi Xuan investment and electricity construction JSC approving feasibility study of Hoi Xuan HPP, Thanh Hoa province.

- Decision No. 4431/QĐ-BCT, dated 12 Aug. 2008 of the MIT on promulgating reservoir operation Procedure of Hoi Xuan HPP.

- Decision No. 74 QĐ/VHX-HĐQT dated 22 May 2011 of the Director Board, VNECO Hoi Xuan investment and electricity construction JSC approving the technical design phase 2 of Hoi Xuan HPP.

- Decision No. 2832/QĐ-UBND dated 15 Sep. 2008 of Thanh Hoa PPC approving Overall plan on compensation, support and resettlement of the Hoi Xuan project construction in Quan Hoa district.

- Letter No. 348/UBND-CT dated 12 Aug. 2010 of Quan Hoa DPC on the agreement of the policy on compensation, support and resettlement of the Hoi Xuan project construction

- Decision No. 400/QĐ-UBND dated 29 Jan. 2013 Chairman of Thanh Hoa HPP on land acquisition and agreeing for VNECO Hoi Xuan investment and electricity construction JSC to use land for Hoi Xuan HPP construction.

1.2. Decisions related to the project location, design, operation and mitigation measures

- Decision No. 110/2007/QĐ-TTg dated July 18th. 2007 of the Prime Ministry of the GOV on approval of National Power Development Master Plan in 2006-2015 period, with vision to 2025;

- Decision No. 1195/QĐ-NLDK of the Ministry of Industry (now as Ministry of Industry and Trade) on approval of hydropower cascade master plan on Ma river;

- Notification No. 219/TB-BCT's the Ministry of Industry and Trade dated 12 May 2008 of the appraisal of Hoi Xuan HPP’s basis design in feasibility study.

- Decision No. 014 QD/ VHX-HDQT dated 30 May 2008 of Hoi Xuan HPP investment and construction J.S Company’s management board committee on approval of the feasibility study of Hoi Xuan HPP, Thanh Hoa province.

- Decision No. 216/QD-BTNMT dated 1 February 2008 of the Ministry of Natural Resources and Environment on approval of environmental impact assessment of Hoi Xuan Hydropower Project.

According to Decision No. 216/QD-BTNMT, the project owner is required to comply with the content outlined in the report on environmental impact assessment approved in accordance with this decision and the following mandatory requirements (this is mitigation measures compulsively required to implement):

1. The PO has to coordinate with local governments and agencies to carry out the conversion of land use, resource recovery in the reservoir in accordance with the current regulations; coordinate with local authorities and relevant agencies to implement specific

measures to prevent logging and hunting by unauthorized personnel, the project's workers in the project area and the adjacent, especially in Pu Hu and Pu Luong Nature Reserves.

2. The PO has to closely implement monitoring of the cutting trees within the reservoir area, access roads where assigned land by the local authorities;

3. The PO has to collect and handle garbage and other waste during construction works to ensure the hygiene requirements of the current environment; organize the cleaning of reservoirs, ensure that after filling the reservoir, the quality water still meets the current standards of supply water; improve monitoring the changing of water quality in the upstream and downstream damsite of Hoi Xuan HPP in the construction phase and the early years of operation phase; implement measures to protect aquatic species, protect and conserve natural fish species in the upstream and downstream of Hoi Xuan HPP's damsite;

4. The PO has to coordinate with local authorities carry out the clearance, compensation and resettlement in accordance with current regulations;

5. Make the planning, layout, design and operation of the construction camps, warehouses containing materials, dumps and landfills on the places where are appropriate to ensure the required safety and protection environment during the construction and operation;

6. Implement the earth filling and landscape returning in the temporary acquired land for work sites; coordinate with the local authorities to replant forest for the lost forest area due to the project; implement measures to prevent sliding. Subsidence, landslides in the mining areas of building materials, temporary roads, dumps material, etc;

7. Implement safety regulations in construction and fire prevention; make the emergency plan in case of accidents during the construction and operation in order to ensure timely response to accidents; implement measures to mitigate damages, erosion in the upstream and downstream areas of Hoi Xuan HPP's damsite in the operation phase;

8. Coordinate with other hydropower projects in the cascade to prevent and control flood and ensure needs of water use for downstream of Hoi Xuan HPP damsite;

9. Inspect the upstream and downstream area of Hoi Xuan HPP's damsite before operating the project to ensure the safety of people as well as the completion of resources recovery in the reservoir foundation;

10. Inform local authorities and communities affected by the project about the implementation schedule;

11. Coordinate with local authorities and other relevant agencies to implement contents of the environmental management and monitoring as stated in the approved EIA and save data for the stated agency in environmental management and protection to conduct inspection when necessary;

12. Strictly compliance disclosure and dissemination of information regarding the implementation of the approved EIA and the requirements in this decision;

1.3. Legal and institutions in Vietnam on the ESIA report

- **Development and implementation of environment protection policies**

Policies for sustainable development in Vietnam are presented in systematic manner at report “Implementation of sustainable development in Vietnam” at the Summit of United Nations for Sustainable Development (RIO +20) at Hanoi in 2012.

In order to implement the goal of sustainable development in Vietnam, a series of policies have been issued in the fields of economy, society, environment and implementation of international commitments on sustainable development, which were signed by Vietnam government.

In these documents, the viewpoint of sustainable development has been confirmed, particularly evident in the economic – social development strategy 1991 – 2000, which was passed by the seventh national congress of Communist Party of Vietnam (VI Congress), whereby guiding “Economic growth must be associated with progress and social equity, cultural development, environmental protection”. VIII Congress continued to confirm “Economic growth must be associated with progress and social equity, preserving and promoting national identity, protection of ecological environment. Directive No. 36-CT/TW dated 25 Jun. 1998 of Politburo on strengthening environmental protection in the period of industrialization and modernization of the country has emphasized: “Environmental protection is a basis content integrally in the policy, guideline and development planning of all levels and branches, it is an important basis for ensuring sustainable development, successful implementation of the industrialization and modernization of the country. The viewpoint of sustainable developments was reaffirmed in the documents of the ninth national Congress of Communist Party of Vietnam and in Economic- social development strategy in period 2001 – 2010 is: “Fast development, effective and sustainability, economic growth coupled with implementation of progress, social justice and environmental protection” and “Economic-social development closely associated with protecting and improving the environment and ensure the harmony between artificial environment and natural environment, preservation of biological diversity”. In the economic – social development strategy in period 2011 – 2020 has also emphasized “Fast development associated with sustainable development, sustainable development is requirement throughout the strategy”. Sustainable development has become the line, viewpoints of the Party and the policy of State.

In the last period, Vietnam has signed international conventions related to sustainable development such as Montreal Protocol on substances that destroy ozone layer; Vienna Convention for protection of ozone layer; Convention of United Nations on the Law of sea; Framework Convention of United Stations on Climate changes; Convention on biological diversity (1994); Commitments for implementing the century development objectives, etc. The government has delivered these commitments to the related ministries and branches, which have responsible management, co-organization, integrated in the plans and development program at all levels to implement.

- **Pollution control and environmental monitoring**

Since 1994, after the Environmental Law enforced, a series of efforts has been implemented by authorities to control air and water pollution, and forest and land protection; to manage and dispose solid waste, especially as hazardous waste; to work with enterprises that causing pollution; and to have timely respond to environmental incidents such as oil spills at the sea, etc. For enterprises that have operated before 01 Jul. 2006 (the enforced date of the Environmental Law) as stipulated at Decree No. 29/2011/ND-CP day 18 April 2011, they have to prepare a report of environmental protection (in detailed or preliminary type). Environmental monitoring has been implemented at both national and provincial level.

The first national environmental monitoring network was established in 1994 and managed by the Ministry of Science and Technology. By 2013, the monitoring network has had 21 environmental monitoring stations which have been carried out monitoring at 419 points with the quarterly frequency. The basic monitoring criteria have been used for assess the quality of air, inland water, sea water, soil environment, solid waste, traffic noise and radioactivity (radioactivity was measured at the monitoring stations No.1, No.2 and No.3). In addition, there are a number of research institutions who are responsible for water resources, meteorology, hydrology have also implemented the environmental monitoring of water, air environment to serve the purpose of research and management.

- **Legal documents of Vietnam related to ESIA**

The legal and support tools of project, which will be presented this section are compliance. The presented documents are the legal documents and the necessary approvals for project, which were issued by the Government and locality. These documents are established by Vietnamese and just shown document subjects here.

+ **Environmental law**

Environmental impact assessment and environmental management in Vietnam are in accordance with environmental law No. 52/2005/QH11, which was passed on November 29th, 2005 and took effect on July 1st, 2006. The legal documents include 6 Decrees, 7 Circulars and 2 Decisions as follows:

Table 1.1: Laws and regulations on environment protection and related legal documents

Laws and Regulations	**Description**
Laws	
Environment law No. 52/2005/QH11 dated November 29th, 2005	Regulations on environmental protection activities, policies, measures and resources to protect environment, and the rights and obligations of organizations,

Laws and Regulations	Description
	households and individuals related to environmental protection.
Biodiversity Law No.20/2008/QH12, 2009	Based on 1992 Constitution of the Socialist Republic of Vietnam, which was amended and supplemented a number terms of Resolution No. 51/2001/QH10 dated December 25th, 2001 of the tenth National Assembly, the tenth session; This Law regulated on the conservation of biodiversity and sustainable development.
Law on forest protection and development No. 29/2004/QH11 dated December 3rd, 2001 by the 10th National Assembly and effected from the date of April 1st, 2005	Pursuant to the 1992 Constitution of the Socialist Republic of Vietnam, which was amended and supplemented under Resolution No. 51/2001/QH10 of December 25, 2001 of the 10th National Assembly, the 10th session; This Law provides for forest protection and development.
Law on resources No. 17/2012/QH13 dated June 21st, 2012 by the 13th National Assembly and effected from the date of January 1st, 2013	Pursuant to the 1992 Constitution of the Socialist Republic of Vietnam, which was amended and supplemented under Resolution No. 51/2001/QH10; This Law provides on management, protection, exploitation and use of water resources, as well as the prevention of, combat against and overcoming of harmful effects caused by water in the territory of the Socialist Republic of Vietnam.
Decree	
Decree No. 29/2011/NĐ-CP dated April 18th, 2011	Regulation on strategic environmental assessment, environmental impact assessment and environmental protection commitment. This Degree has effected on June 5th, 2011, and replaces the articles 6-17 of the Decree No. 80/2006/NĐ-CP of the Government dated August 9th, 2006, on detailing and guiding a number of articles of Environment protection law and the clauses 3-10, Article 1 of the Decree No. 21/2008/NĐ-CP dated February 28th, 2008 of the Government on amending and supplementing a number of articles of the Decree No. 80/2006/NĐ-CP dated August 9th, 2006 on detailing and guiding a number of articles of environmental law.
Decree No. 04/2009/ND-CP dated January 14th, 2009	Regulation on incentives and supports for environmental protection activities.
Decree No. 179/2013/ND-CP dated November 14th, 2013	Regulations on sanctioning of administrative violations in the field of environment protection
Decree No. 59/2007/ND-CP dated April 6th, 2007	Regulation on solid waste management

Laws and Regulations	Description
Decree No.23/2006/QĐ-CP dated March 3rd, 2006 of the Government on the implementation of the law on forest protection and development	This Decree provides for forest protection and development plannings and plans; forest assignment, lease and recovery, change of forest use purposes, exchange, transfer and donation; recognition, registration, sub-lease, mortgage, guarantee, capital contribution with, and bequeathal of, forest use rights or ownership rights over planted production forests; statistics, inventory and monitoring of changes in forest resources; organization of forest management, protection, development and use.
Decree No. 201/2013/ND-CP dated November 27th, 2013 on regulation in detail the implementation of a number of articles of the law on water resources	This Decree regulates on the gathering the opinions representatives of communities their opinions in the exploitation and use of water resources, discharge of wastewater into water sources; baseline survey of water resources; licensing of water resources; granting and transferring the exploitation right of water resources in advance; Organizing the river basin and the coordination of monitoring activities of exploitation, use and protection of water resources; prevention and remediation of harmful effects caused by water in the river basin.
Circulars and Decisions	
Circular No. 26/2011/TT-BTNMT dated July 18th, 2011 of the Ministry of Natural Resource and Environment	Regulation in detail of a number of articles of the Decree No. 29/2011/ND-CP of the Government dated April 18th, 2011 on strategic environmental assessment, environmental impact assessment and environment protection commitment.
Circular No.12/2011/TT-BTNMT dated April 14th, 2011 of the Ministry of Natural Resource and Environment	Regulations on hazardous waste management.
Circular No. 39/2010/TT-BTNMT dated December 16th, 2010 of the Ministry of Natural Resource and Environment	Regulation on National technical standards regarding noise (QCVN26:2010/BTNMT) and vibration (QCVN 27:2010/BTNMT).
Circular No. 25/2009/TT-BTNMT dated November 16th, 2009 of the Ministry of Natural Resource and Environment	Regulation on National technical standards regarding hazardous waste threshold (QCVN 07: 2009/BTNMT).
Circular No. 16/2009/TT-BTNMT dated October 7th, 2009 of the Ministry of Natural Resource and Environment	Regulation on National technical standards regarding air environment (QCVN 05:2009/BTNMT) and toxic substances in the air (QCVN 05: 2009/BTNMT).
Decision No. 16/2008/QĐ-	Regulation on surface water quality standards (QCVN 08:

Laws and Regulations	Description
BTNMT dated October 7th, 2009 of the Ministry of Natural Resource and Environment	2008/BTNMT), groundwater quality (QCVN 09: 2008/BTNMT), urban garbage (QCVN 14: 2008/BTNMT), etc.
Decision No. 186/2006/QĐ-TTg on promulgating the regulation on forest management	This promulgates the Regulation on management of special-use forests, protection forests and natural production forests including the areas with or without the forest which has been assigned, rent or planned for forestry sector.

+ **Other related Law, Decrees and Circulars**

Protection of power system: details in energy industry on fields such as planning on development and investment, privileges, responsibilities of related organizations and individuals, protection of electric equipment and facilities and electric safety (listed in below table).

Table 1.2: Electricity law and related legal documents

Law	Description
Electricity Law No. 28/2004/QH11 dated December 3rd, 2003	Regulation on the electricity development planning and investment; electricity saving; electricity market; rights and obligations of organizations and individuals conducting electricity activities and using electricity; protection of electric equipment and facilities, electricity works and electric safety.
Decree	
Decree No. 14/2014/ND-CP dated February 26th, 2014	Regulation in detail on the implementation of the Electricity Law regarding electricity safety.
Circular	
Circular No. 22/2010/TT-BXD dated December 3rd, 2010	This Circular provides for labor safety in work construction, covering construction and installation of equipment in works which are newly built, repaired, renovated, relocated, embellished or restored; dismantlement of works, and warranty for and maintenance of works.
Circular No. 03/2010/TT-BXD dated January 22nd, 2010	Regulation on some contents regarding the safety protection of high-voltage power grid works.

Land and building: Guiding for implementation of land laws, amendments, regulation on land use and details on compensation, support and resettlement is specified in Decrees, Circulars of the Government. Building legal documents and labor safety for workers during the FS phase are shown in below table.

Table 1.3: Laws, regulations on land

Law	Description
Land law No. 45/2013/QH13 dated November 29th, 2013	Governs the powers and responsibilities of the State as owner of land and representative of the entire people for uniform administration of land and the rights and obligations of land users.
Decrees	
Decree No.43/2014/NĐ-CP dated 15 May 2014	Detailed rules for implementation of some articles of the Land Law.
Decree No.47/2014/NĐ-CP dated 15 May 2014	Regulations on compensation, assistance and resettlement when the State acquires land.
Decree No.44/2014/NĐ-CP dated 15 May 2014	Regulations on land prices.
Circulars	
Circular No. 22/2010/TT-BXD dated 03 Dec. 2010	Provides labor safety in work construction; construction and installation of equipment which are newly built, repaired, renovated, relocated, embellished or restored; dismantling of works; and warranty for and maintenance of works.

+ **Legal documents supporting the project**

The following legislation will also be applied to the project:

Sand and gravel extraction operations are governed by the Mineral Law 2010 and its regulations on mineral activities. All organizations and individuals that exploit river sand and gravel must be licensed by the state management agency- DONRE. Thus the contractor can only source materials from suppliers or sites approved by DONRE. The contractor has no authority to extract sand or gravel without DONRE's approval. Legal documents related minerals sector include:

- Mineral Law No. 60/2010/QH12 dated 17 November 2010;
- Decree No. 15/2012/ND-CP dated 9 March 2012 Detailing and guiding the implementation some article of Mineral Law;
- Government Decree No. 142/2013/NĐ-CP dated 24 Oct. 2013 stipulates for sanctioning of administrative violations in the field of water resources and minerals.

Vietnam Labour Code No. 10/2012/QH13 - 18 June 1912. The Labour Code protects the right to work, the interests and other rights of labors. At the same time it protects the rights and lawful interests of labour uses. Therefore creating conditions for the establishment of harmonious and stable labour relations, helping to develop the creativeness and talent of the intellectual and manual workers, of the labour managers in order to achieve productivity, quality and social progress in labour, production, service, efficiency in the use and management of labour, thus contributing to the industrialization and modernization of the country in the cause of bringing prosperity to people and strength to the nation and building a just and civilized society.

Conditions of the Code are relevant to the health and safety of workers employed during construction and are reflected in the IEE.

Law on Cultural Heritage No. 28/2001/QH10 of June 29th, 2001.

This law aims to protect and promote cultural heritage value, meet people's increasing cultural demands, contribute to the building and development of progressive Vietnamese culture deeply imbued with national identity and contribute to the world cultural heritage treasure; to enhance the State management effectiveness and raise the people's sense of responsibility for taking part in the protection and promotion of the cultural heritage value.

Law amending and supplementing a number of articles of the Law on Cultural Heritage (Law No. 32/2009/QH12). The National Assembly has promulgated the Law Amending and Supplementing a Number of Articles of Law No. 28/2001/QH10 on Cultural Heritage.

- **Environmental management agencies and their responsibilities in Vietnam**

The Ministry of Natural Resources and Environment is the management agency of the State in the field of land management, water resource, mineral resource, geological environment, hydrometeorology, survey, mapping, integrated management, joint part on sea and island. It supports the State administration, public services in the fields, which belongs to the management of Ministry of Natural Resources and Environment.

The Ministry of Natural Resources and Environment has 24 boards/units, with 18 boards which have function of State management on the implementation and 6 other boards have management functions. Department of environmental management of Vietnam (the General Department of Environment) was established according to Decision No. 132/2008/QD-TTg of the Prime Minister. The General Department of Environment is an agency under the Ministry of Natural Resources and Environment, to advise the Minister of Natural Resources and Environment in the field of environment management and it provides the public services in accordance with the law. Representation for the Minister of Natural Resources and Environment at provincial and district levels is Departments of Natural Resources and Environment, passed by Provincial People's Committees. In order for the ESIAapproval, it requires the project owner to prepare a quarterly monitoring report on the environmental management planning and submit to the Department of Natural resource and Environment of Thanh Hoa province.

- **Development of institutional system for environment management activities**

Vietnam has issued the Law of environmental protection since 1993 and it was amended in 2005, since then the policies of environmental protection have been widely implemented, in-depth, harmonious combination between environmental protection and economic-social development.

Besides the Environmental Protection Law, the system of legal documents on environmental protection, there also have the laws, ordinances on protection of environmental component (also known as the laws and ordinances on resources). Currently there are 33 laws and 22 ordinances, which have contents related to environmental protection activities, such as: Law on Biodiversity in 2008, Law on Forest Protection and Development in 2004; Law on Land in 2003; Law on Aquaculture in 2003; Law on Water Resource in 1998; Law on Minerals in 1996 (be amended and supplemented in 2005), etc. In addition, regulations on environmental protection obligations or obligation comply with the provisions of the legislation on environmental protection for organizations and individuals, which are also scattered in many other laws.

The bylaws were issued to provide the regulations and guidance regarding: National technical regulations on environment of Vietnam; process of environmental impact assessment and strategic environment assessment; environment licenses; environmental inspections; the measures for handling administrate violations in the field of environmental protection; environmental protection institutions (organization, apparatus, segregation of duties between the environmental protection agencies). The above documents along with documents of international law were approved by the State of Vietnam which is the important basis for the implementation of State management of environmental protection.

The National Strategy for Environmental Protection to 2010 and orientation to 2020 was approved by the Prime Minister in 2003 (2001), it has set the major orientations of environmental protection through the 5 basic tasks, 8 implementation solutions, and 36 programs, projects and schemes in order to achieve the specific objectives to 2010 and 2020.

Currently, Vietnam is developing the National Strategy for Environmental Protection to 2020 with vision to 2030 in order to consider the context, assess the works of environmental protection over time, identifying the challenges, from that setting out point of views, objectives, contents, duties, solutions for next time in accordance with the new context of Vietnam and the world today. Accordingly, the Environment Protection Law is planning to update to the Environment Law, which sets the management objectives, environmental monitoring as the focus, it creates a legal framework for environmental protection and sustainable development when giving out policies and the implementation of development activities on social-economics.

Environmental protection from policy, legislation has been translated into action of the mass organizations, become conscious and regular action of people and it is a remarkable step forward.

- **Current capacity of the environmental management agencies:**

The current capacity of the environmental management agencies in Vietnam is still weak and not appropriate with the performing task yet. The staffs working in environment management and coordination are not equal in the system. In particular, according to the report of the Ministry of Natural Resources and Environment at the human resource training and development seminar of the environment and natural resources branch in the Highland and Central Coast Regions, the current total number of staffs of 45,600 people in whole profession; of which the staffs in the central and local Government are about 12,000 and 33,600 people respectively (about 12,000 administrative officials directly carry out responsible for state management). In the Highland and Central Coast Regions, total number of staffs in the profession is 8,700 people; of which there are 2,500 people in provincial level, 2,200 people in district level and about 4,000 people in commune level. Structure of human resource between the specialized professions is quite imbalanced. Human resources of land management and map surveying branch account for over 80% of workforce while of the water resources and hydrometeorology branches account for only 1%, and 1.8% in the geological and mining branch.

Assess the situation above, the participants in the seminar identified that because the Environment and Natural Resources is a young branch, its functions and duties are still being finalized so it therefore does not meet the requirements for human resources development in quantity and quality, qualification as well as profession structure. In its seven branches, the current environmental staffs working in state management are about 10,000 people, of which about 25% of staffs are trained in accordance with their profession. On a national scale, the number of staffs trained in fields not related to the Environment and Natural Resources accounts for a high proportion; this proportion in the provincial, district and commune levels is about 49%, 42% and above 36% respectively. The difficulties in increasing the number or renewing staffs have caused the retraining workforce of Environment and natural resources profession become more and more urgently.

Representatives of the universities and colleges in the seminar considered that because of incorrect public awareness of environment and natural resources, this branch therefore did not attract many good and qualified students in their selection of profession.

Currently, apart from three training institutions under the Ministry of Environment and Natural Resources that are Hanoi University of Environment and Natural Resources, Central College of Environment and Natural Resources and College of Environment and Natural Resources - Ho Chi Minh City, there are also 92 training facilities consisting of from intermediate professional to university degree, major in natural resources and environment. The human resources training of these facilities have just met a part of human resources demand for the profession. However, the human resources training for natural resources and environment profession in the past year was still insufficient and unbalanced among the professions and levels. The system of training facilities also lack in the uniformity and without association and continuity.

The seminar also notified that the overall goals to 2015 of the Ministry of Environment and Natural Resources are to develop and train the human resources for the profession including retraining, new and advanced training to meet the requirements in sufficient quantity, good quality and reasonable career structure; and enough quality and capacity to serve the development of the profession and the country.

1.4. Policies on society and environment of the lending institution.

To apply the Performance Standards 1 - Assessment and Management of Environmental and Social Risks and Impact in the document "Performance Standards on Environmental and Social Sustainability" isued by MIGA October 1st, 2013.

1.5. Environmental provisions of related international organization to which Vietnam is a member.

The Ramsar Convention (formally, the Convention on Wetlands of International Importance, especially as Waterfowl Habitat);

MARPOL Convention - the International Convention for the Prevention of Pollution from Ships;

The Rio Declaration on Environment and Development; the Global Agenda 21; The United Nations framework Convention on Climate Change;

Vietnam became a member of the International Union for Conservation of Nature and Natural Resources;

The Convention on International Trade in Endangered Species, the Montreal Protocol on Substances that Deplete the Ozone Layer; the Vienna Convention for the Protection of the Ozone Layer, the United Nations Convention on the Law of the Sea; the Convention on Biological Diversity;

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal;

The United Nations Convention to Combat Desertification, Kyoto Protocol on climate change;

The International Declaration on Cleaner Production;

Implementation of the Millennium Development Goals;

Subsequent Agreement on Sustainable Development at World Summit, at Johannesburg;

Vietnam became the Member of the World Trade Organization.

CHAPTER 2. PROJECT DESCRIPTION

2.1. General introduction

2.1.1. Introduction

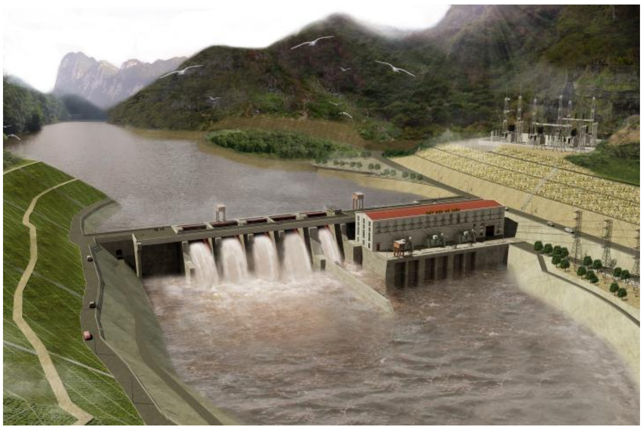
In order to meet the demand of power use increasing more and more of the national economy, the Ministry of Industry and Trade has established the Power Development Master Plan of 2011 – 2020 with consideration to 2030 (called PDMP VII), which was approved by the Prime Minister via the Decision No. 1208/QĐ-TTg dated July 21st, 2011.

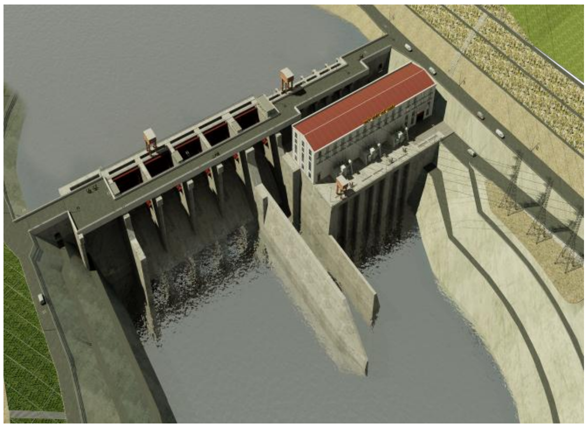
Hoi Xuan hydropower project has been included in the PDMP VII with the installed capacity of 102MW, and expected to commission in 2016. Hoi Xuan HPP is a significant power source for the local and national power system.

Hoi Xuan HPP is one of plants in the power cascade on Ma river. It locates in Quan Hoa district, Thanh Hoa province, 140km far from Thanh Hoa city to the Northwest.

Hoi Xuan HPP has powerhouse behind the damsite with compositions such as spillways and waterway routes. Waterway routes include intake, water channels, and powerhouse. Water used for power generation will be returned Ma river through an outlet channel.

Some illustrative photos of Hoi Xuan HPP after the construction completion





2.1.2. Background

Ma river, which is one of large rivers in the Northland – VietNam, brings much hydroelectric potentiality. Master plan of hydropower cascade in Ma river was set up by Power Engineering Consulting Joint Stock Company 1 and it was approved under Decision No. 1195 /QĐ – NLDK dated on 31 March 2005 by the Ministry of Industry. According to petition of this plan, 5 hydropower cascades can be built on Ma river: Pa Ma, Huoi Tao, Trung Son, Hoi Xuan, and Cam Ngoc. Hoi Xuan hydropower belongs to hydropower system on Ma river, it is placed between upstream of Cam Ngoc hydropower and downstream of Trung Son hydropower.

The capacity of Hoi Xuan hydropower project is 102 MW, which shall contribute electricity to the national grid and average annual power production of about 432.00 x 10^6 kWh. In addition, the project also takes role of adding water in dry season to prevent intrusive saltwater and improve environment in downstream of Ma river with assured flow rate of 70.56 m^3/s.

2.1.3. Project location

Hoi Xuan hydropower project is built on the territories of Thanh Hoa and Hoa Binh provinces. The primary dam on Ma river belongs to Thanh Xuan commune, Quan Hoa district, Thanh Hoa province. Location of the project is far from Hoa Binh province about 95km to the West; far from Thanh Hoa city 195 km to the North West. The project is near the National road No.15A, far from Trung Son hydropower project about 38.5 km to the downstream direction.

Geographical co-ordinate of the dam site 3 (petition) of Hoi Xuan hydropower project:

X: 2 261 585 Y: 505 295

The project doesn't occupy land of natural conservation areas, national park, and protective forest. The dam of the project far from Pu Hu natural conservation area about 6 km to the West; far from Pa Co – Hang Kia natural conservation area 26 km to the South west; far from Pu Luong 3.5 km to the South west; and far from Hoi Xuan commune, Quan Hoa district 15 km.

According to survey, it has not detected historical relics, important cultural object and religious project in the construction area of Hoi Xuan hydropower project. There is not any valuable mineral in the reservoir area.

2.1.4. Relations of the project with local development master plans

Hoi Xuan HPP is consistent with PDMP VII approved by Prime Minister via Decision No. 1208/QĐ-TTg dated July 21st, 2011. According to this decision, the project will commission in 2016 with 102 MW of installed capacity.

The project also follows the master plan of power cascade on Ma river approved by the Ministry of Industry (now as MOIT) at via Letter No. 1195 /QĐ – NLDK, dated March 31st, 2005. Under the plan, the project is the fourth power plant in total five plants. It is located at the downstream of Trung Son HPP and the upstream of Cam Ngoc HPP.

2.2. Task and grade of the project

2.2.1. Task of the project

Hoi Xuan hydropower project will take the power generation for its main task with 102.0MW for the installed capacity and 432.00 million kWh for average annual energy output. After putting into operation, it will be a remarkable power source for the Northern and the National power grid systems.

In addition, the construction of Hoi Xuan reservoir will not only create a water source for agricultural, industrial and small scale industrial production in the area, but also positively impacts on improvement of ecological environment around the reservoir, ensures the flow discharge for reducing salt in dry season as well as for developing the local tourism.

2.2.2. Grade of the project

Basing oneself on the project scale and geological and hydrological conditions, the project grade is classified in accordance with the Vietnamese Construction Standard TCXD VN 285: 2002 as bellows:

- For the headwork:

The main dam is designed with concrete structure arranged on rock foundation with 46.3 meters for the maximum height; it is therefore classified as grade III construction.

- For the powerhouse:

The powerhouse with the installed capacity of 102MW is classified as the grade II construction.

In conclusion, the whole project is proposed to be the grade II.

- The design and check frequencies:

According to the TCXD VN 285: 2002, the frequencies used to calculate for the design of main work items are taken as P = 0.5% for the design flood and P= 0.1% for the check flood.

2.3. The main work items of the project

2.3.1. Headworks

1. Dam

The main gravity concrete dam of Hoi Xuan hydropower project will be arranged on the two abutments with the dam crest elevation of 86.0 meters. The dam on the right abutment will border the spillway and the right bank with 47.7 meters for the dam crest length and 6.4m for the dam crest width. The dam on the left abutment will be arranged bordering the Intake and the left bank with 31.0 meters for dam crest length and 31.0 meters for the maximum dam height.

The dam crest elevation of 86.0 meters will be selected on the bases of flood regulation calculation, possibility of flood discharge through spillway and wave caused by wind, etc.

The cross section of the main dam will be designed with vertical front face; and for the downstream face, it will be designed with 16.5 meters high vertical part from the dam crest; the rest part will be designed with 1:0.8 slope.

A gallery with dimensions of B*H=3*3m will be arranged inside dam body for collecting and draining leakage water. It runs along the centers of dam and spillway away from the front face 2.0 meters.

2. *Spillway*

The gated spillway will be arranged at the riverbed position where borders the Intake and the main dam on the right abutment. Its structure will be the conventional vibrated concrete (CVC). The spillway will be divided into five 15 meters wide cells with the weir elevation of 65.0 meters.

The spillway's cross section will be identified according to the proposed cross section of the main dam. The spillway crest profile will be the curve type of Ophixerop (non-vacuum) with the downstream face slope of 35^o in comparison with horizontal direction. Energy of flow through spillway will be dissipated at the toe of the spillway and by submerged flow regime.

The radial gates, maintenance gates, and lifting devices will be arranged over the spillway weir in order to install, operate and repair the hydro-mechanical equipment of spillway, intake and diversion culvert.

The gallery inside the spillway will be arranged continuously with the one inside dam body and intake. Its dimensions of B*H = 3*3 meters will ensure the specification required for implementation of grouting curtain as well as draining leakage water.

The diversion culvert serving for construction diversion in the dry season will be arranged at the bottom of spillway and bordering the Intake. It includes two cells with dimensions of 6.0x6.0 meters for each cell. The culvert sill is at the elevation of 48.5 meters; it will be blocked by reinforced concrete after finishing its task.

3. *Reservoir*

The reservoir spreads about 29 kilometers along Ma river with its main parameters shown in the table - Main parameters of the project.

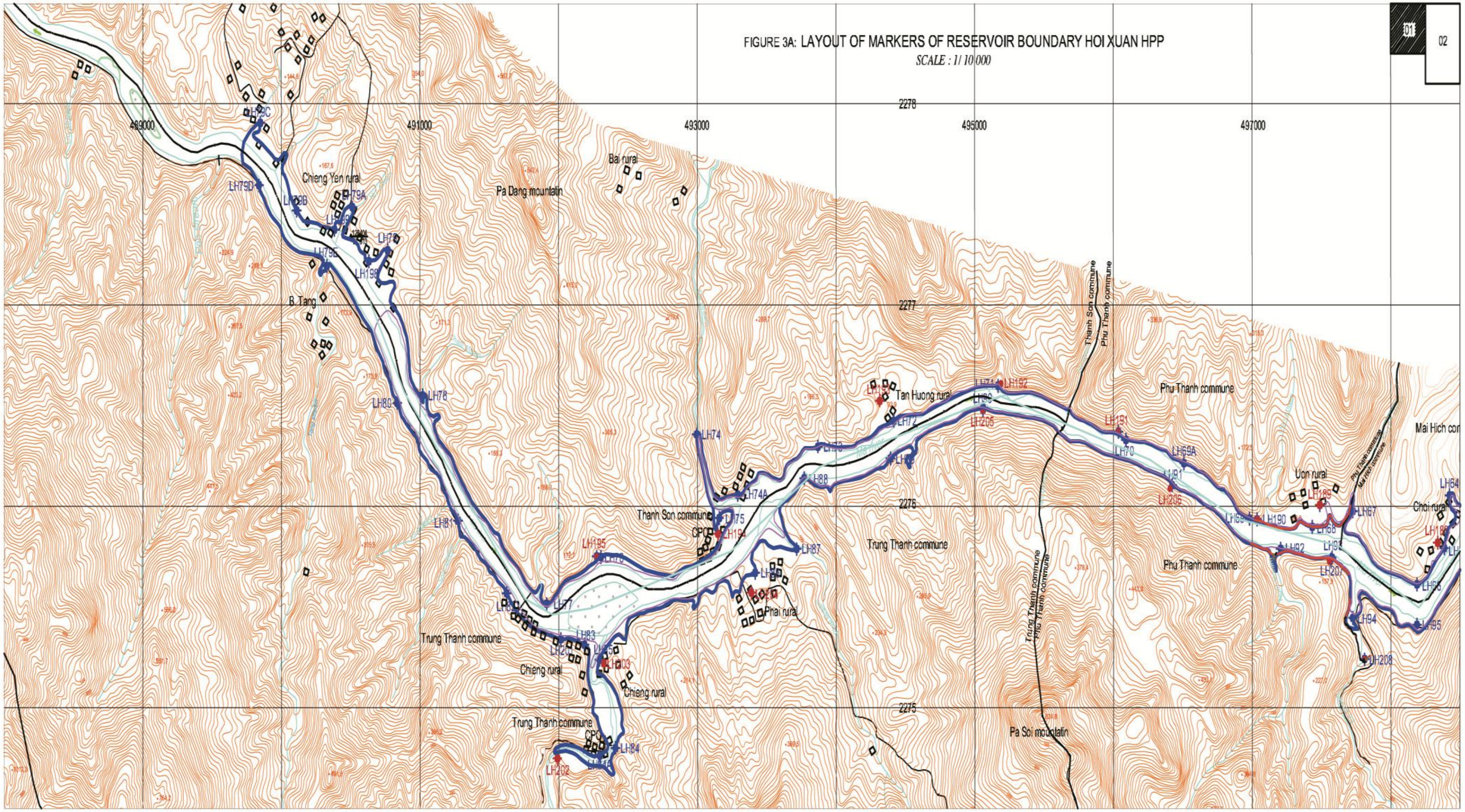


FIGURE 3A: LAYOUT OF MARKERS OF RESERVOIR BOUNDARY HOI XUAN HPP
SCALE : 1/ 10 000
01
02
Chieng Yen rural
Pa Dang mountain
Bai rural
B. Tang
Tan Huong rural
Phu Thanh commune
Mai Hich co
Thanh Son commune
Trung Thanh commune
Phai rural
Uon rural
Choi rural
Chieng rural
Pa Soi mountain
CPC
489000
491000
493000
495000
497000
2278
2277
2276
2275

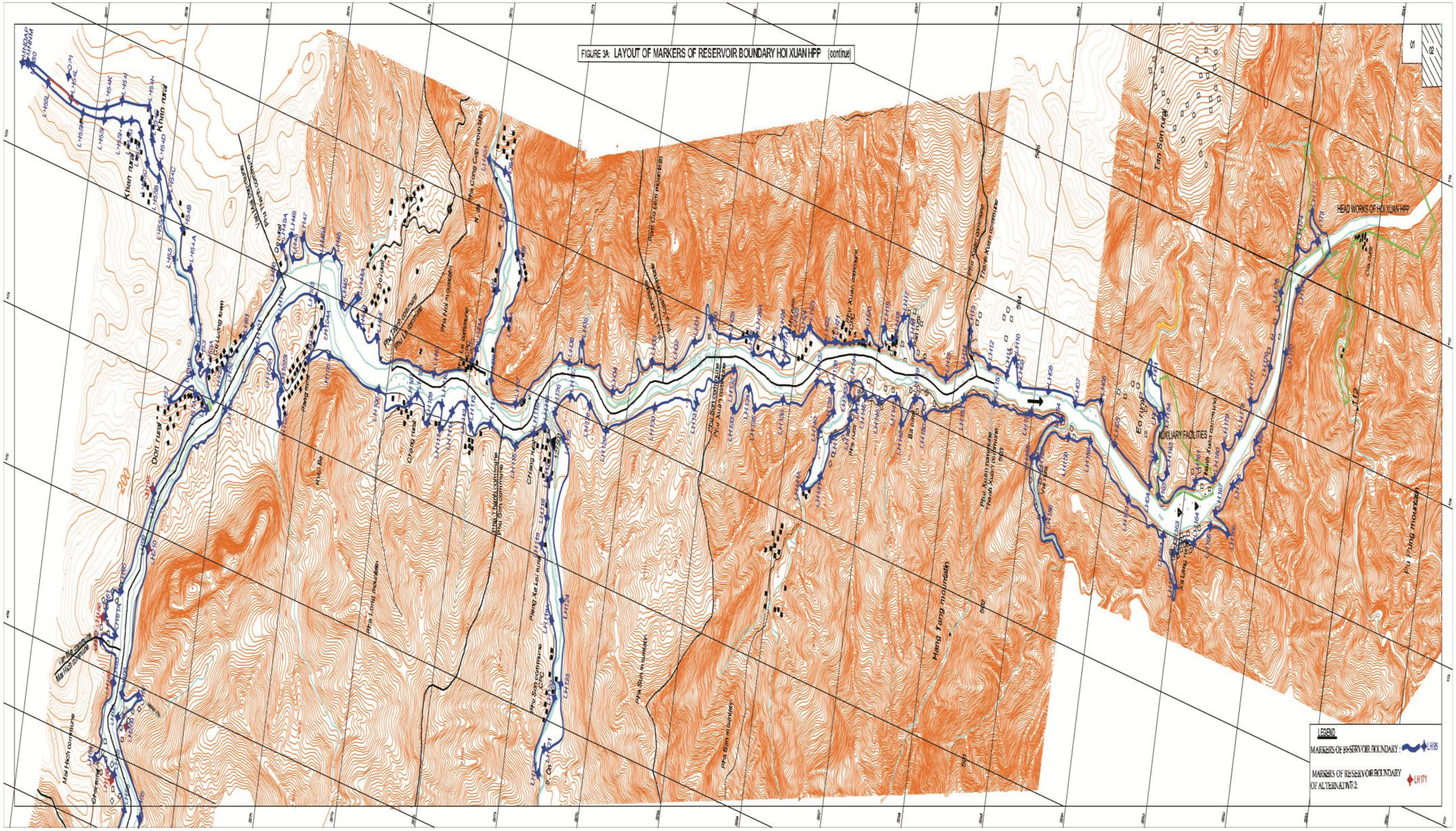


FIGURE 3A: LAYOUT OF MARKERS OF RESERVOIR BOUNDARY HOI XUAN HPP (continue)
HEAD WORKS OF HOI XUAN HPP
AUXILIARY FACILITIES
LEGEND:
MARKERS OF RESERVOIR BOUNDARY :
MARKERS OF RESERVOIR BOUNDARY OF ALTERNATIVE 2:

2.3.2. Waterway

1. *Inlet channel*

The inlet channel will be arranged on the left bank of Ma river with the task of directing the flow to the Intake. Its cross section has the trapezoidal shape with elevation of 57.0 meters for the channel bottom.

2. *Intake*

The intake includes six cells with clearance of 14 meters. The height of Intake at the trash rack position is 14 meters. The intake sill elevation is 65.0 meters.

The intake is designed how to ensure the hydraulic regime in front of trash rack position, water head loss along the waterway to the minimum and not create the funnel as operating at all discharge regimes.

Arranging the trash rack, maintenance and operation valve gate and lifting devices serves for the installation, repair and operation processes.

3. *Outlet channel*

The outlet channel takes water from the powerhouse to Ma river. It is separated from the construction by the spillway lateral pier and runs along the river. It is designed to ensure the powerhouse operation at all discharge regimes.

4. *110kV outside power yard (OPY) station*

The outside power yard station, dimensions of B*H=78.0*123.0 meters, will be arranged at the elevation of 127.0 meters on the left bank. The operation road named VH3 will connect from Highway 15 to the OPY station serving for the installation, repair and operation processes later. In the stage of as-built drawing, as having all specifications of equipment, the layout of equipment, cable ditch and water drainage system will be described in detail.

2.3.3. Powerhouse

Based on the adjusted hydrological document, the water head and discharge through turbines have been calculated and checked to decide the scale of powerhouse.

The powerhouse will be arranged at the toe of main dam on the original solid and hard rock foundation of layer IIA. It has three Units with total installed capacity of 102 MW; the vertical shaft Kaplan turbine type will be installed with capacity of 34.0MW for each Unit. In addition, in the machine hall, the crane with lifting capacity of 250/32/5T will be installed to ensure that the installation and combination of equipment will be done in a safe and favorable way.

The powerhouse has the structure of reinforced concrete with the main parameters as bellows:

- Width of powerhouse: 21.2m

- Length of powerhouse: 88.4m

- Elevation of erection bay: 75.8m

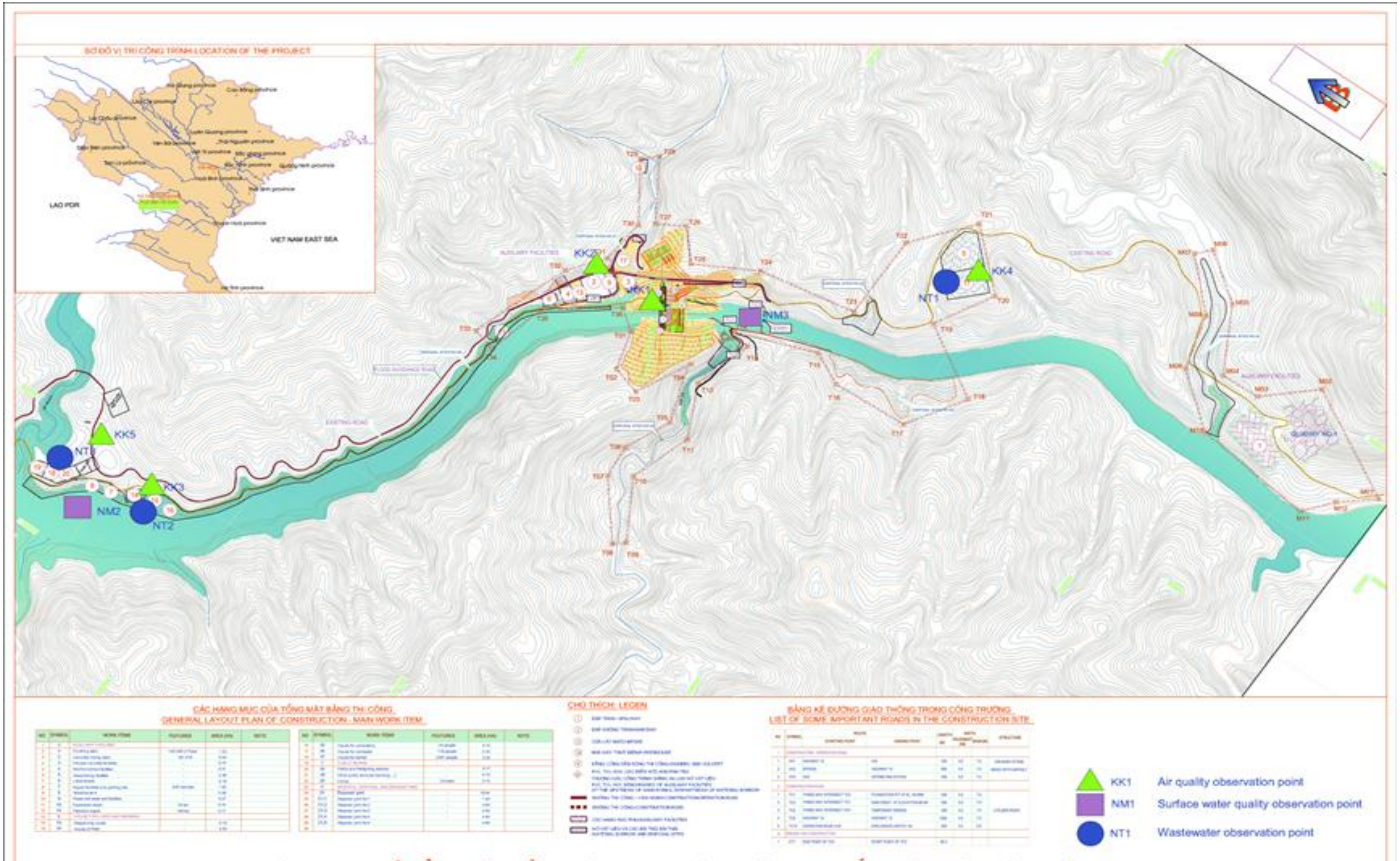
- Elevation of turbine center: 47.9m

Table 2.1: Main parameters of the project

No.	***Parameter***	***Unit***	***Value***
A	***PROJECT GRADE***		II
B	***MAIN PARAMETERS***		
I	***Basin***		
1	Basin area	km^2	14,975
2	Average annual rainfall X_o	mm	1,500
3	Average annual flow Q_o	m^3/s	244.1
4	Module of flow M_o	$l/s.km^2$	18.6
II	***Reservoir***		
1	Normal water level (NWL)	m	80
2	Dead water level (DWL)	m	78.5
3	Check flood water level (CFWL, P = 0.1%)	m	85.55
4	Design flood water level (DFWL, P = 0.5%)	m	81.96
5	Total volume at NWL	10^6m^3	63.65
6	Total volume at DWL	10^6m^3	55.92
7	Effective volume	10^6m^3	7.73
8	Reservoir surface area at NWL	km^2	6.19
III	***Discharge through the powerhouse***		
1	Firm discharge Q_f (p=90%)	m^3/s	70.56
2	Maximum discharge Q_{max}	m^3/s	529.2
IV	***Waterhead***		
1	Maximum water head H_{max}	m	27
2	Minimum water head H_{min}	m	16.5
3	Average water head H_{aver}	m	21.5
V	***Tailrace water level***		
1	Maximum tailrace water level corresponding with check flood (p= 0.1%)	m	74.93
2	Maximum tailrace water level corresponding with design flood (p= 0.5%)	m	73.01

No.	***Parameter***	***Unit***	***Value***
3	Corresponding with Q_{max} through the powerhouse	m	55.65
4	Corresponding with Q_f through the powerhouse	m	53.00
VI	**Capacity**		
1	Installed capacity (N_{lm})	MW	102
2	Firm capacity N_f (p=90%)	MW	16.61
VII	**Energy output**		
1	Average annual energy output (E_o)	10^6kWh	432.00
2	Annual operating hours of installed capacity	hour	3815
C	**MAIN WORK ITEMS**		
I	**HEADWORKS**		
1	**Main dam**		
	- Type: Gravity concrete dam		
	- Elevation of dam crest	m	86
	- Maximum height of dam	m	43
	- Length of dam crest	m	243.2
	- Width of dam crest	m	10
	- Upstream slope factor		0
	- Downstream slope factor		0.8
2	**Spillway**		
	- Elevation of spillway weir	m	65.00
	- Number of spillway cells		5
	- Dimensions of each cell (BxH)	m	15 * 15
	- Maximum discharge through spillway (p= 0.1%)	m^3/s	12,367.82
	- Maximum discharge through spillway (p= 0.5%)	m^3/s	9,193.39
	- Maximum water head over spillway weir (p= 0.1%)	m	20.55
	- Maximum water head over spillway weir (p= 0.5%)	m	16.96
	- Type of energy dissipation		At the toe of
II	**WATERWAY**		
1	**Intake gate**		
	- Elevation of intake sill	m	65.0
	- Dimensions of trash rack (n* B*H)	m	6*7.7*14
	- Dimensions of operating valve gate (n* B*H)	m	6*6.2*9.67
2	**Powerhouse**		
	- Type of turbine		Kaplan
	- Elevation of turbine center	m	47.9

No.	***Parameter***	***Unit***	***Value***
	- Elevation of erection bay	m	75.8
	- Number of Unit		3
	- Dimension of powerhouse (L*B)	m	88.4*21.2
3	**Outlet channel**		
	- Elevation of the channel bottom at starting point	m	50
	- Width of channel bottom	m	45
	- Length of channel	m	190
	- Slope of channel bottom	%	0.01
	- Structure		Concrete + base rock
4	Outside power yard (OPY) station		
	- Elevation of station	m	122
	- Dimension of 110 kV station	m	85*120
III	**Diversion works for construction**		
	- Dimension of cross section	m	2 * 5 * 6
	- Length of diversion culvert	m	24.31
	- Sill elevation	m	50
	- Bottom slope	%	0
	- Elevation of upstream cofferdam crest	m	72
	- Elevation of downstream cofferdam crest	m	70.40



HÌNH 3: SƠ ĐỒ TỔNG MẶT BẰNG XÂY DỰNG VÀ VỊ TRÍ QUAN TRẮC, GIÁM SÁT MÔI TRƯỜNG
FIGURE 3: GENERAL LAYOUT PLAN OF CONSTRUCTION AND POSITION OF MONITORING AND ENVIRONMENT SUPERVISION

2.3.4. Transmission lines

The 220kV transmission lines, which connect the powerhouse of Hoi Xuan hydropower project to the national power grid, will be located in Quan Hoa district, Thanh Hoa province and Mai Chau district of Hoa Binh province.

Its main parameters are as follows:

- Voltage grade: 220kV;
- Starting point: at the 220kV bus bar of Hoi Xuan hydropower project (which will be constructed);
- Ending point: connecting to the electric Post 46 (G13) of the 220kV transmission lines, which connects Trung Son hydropower project to the national power grid (which will be constructed);
- Length: 15.4 kilometers (including section connecting to the station);
- Circuit type: double circuit;
- Conductor type: ACSR300/39 (two-phase two wire);
- Insulator method: suspension insulator fabricated according to IEC;
- Tower, girder, support frame: with galvanized steel structure;
- Foundation structure: cast-in-place reinforced concrete.

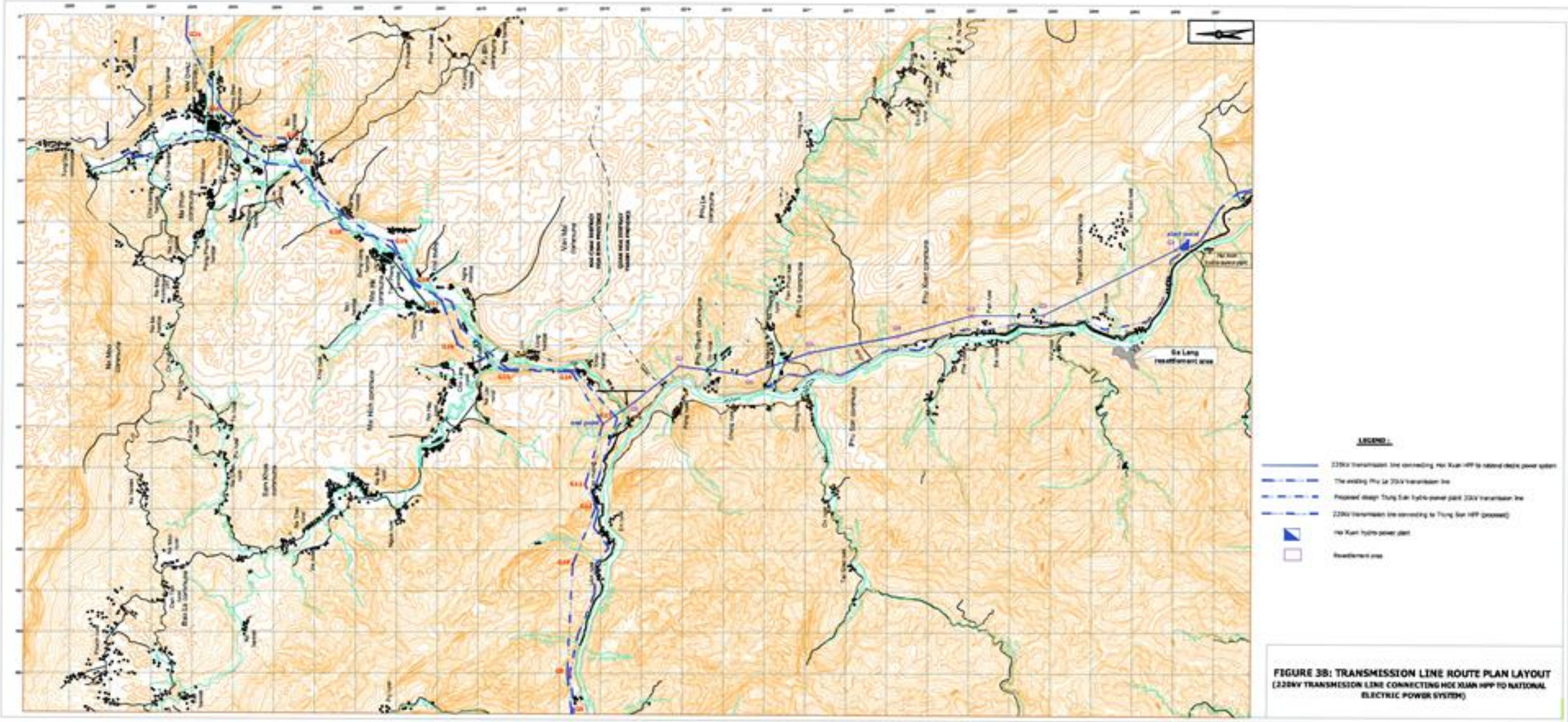


FIGURE 3B: TRANSMISSION LINE ROUTE PLAN LAYOUT
(220KV TRANSMISION LINE CONNECTING HOI XUAN HPP TO NATIONAL ELECTRIC POWER SYSTEM)

2.3.5. Construction and operation road system

The road system inside construction site is designed in accordance with the 14.TCN43:85. In addition, the operation road must be designed in accordance with the current standard for design of traffic road.

The construction road system inside the construction site will be divided into two types that are construction-operation road and temporary road.

1. Construction and operation road, and bypass road

They will be used as the construction road during the construction process and as the operation road later.

- The operation road VH1: 350 meters in length, connects from Highway 15 to operation road VH2. During construction period, it will be used for construction of foundation pit and concreting works. It is designed with 7 meters wide base and 5 meters wide surface, which is made from asphalt macadam.
- The operation road VH2: 900 meters in length, connects from Highway 15 at the downstream through dam crest to bypass roads at the upstream. This will be used for construction of dam on the left abutment, powerhouse and in taken as an operation road later. It is designed with 7 meters wide base and 5 meters wide surface, which is made from asphalt macadam.
- The operation road VH3: 900 meters in length, connects from the operation road VH2 to the OPY station at the elevation of 115.0 meters. During construction period, it will be used for construction of concrete works, and installation of equipment for the OPY station. It is designed with 7 meters wide base and 5 meters wide surface, which is made from asphalt macadam.
- The bypass road: is the road avoiding submerged status for Highway 15.

2. Construction road

These roads will be used only for construction operation but have the fixed position during construction period. They are included as bellows:

- The construction road TC1: used for construction of spillway with 5 meters wide surface and 300 meters in length.
- The construction road TC3: used for construction of dam on the right abutment and a part of spillway with 3.5 meters wide surface and 800 meters in length.
- The construction road TC5: used for construction to the temporary bridge with 5 meters wide surface and 150 meters in length.
- The construction road TC9: used for construction of rock quarry with 5 meters wide surface and 1,000 meters in length.
- The construction road: used for access to the dynamite storehouse with 3.5 meters wide surface and 200 meters in length.

(Construction and operation road see on figure 3)

2.3.6. Auxiliary facility area and material exploitation area serving for the project construction

1. Auxiliary facility area

The general construction plan of Hoi Xuan hydropower project will be planned on the bases of the layout plan of the main work items and conditions of topography, geology and hydrology. Because almost the main work items of the project such as the powerhouse, intake, one cell of spillway, diversion culvert and diversion walls are located on the left bank of Ma river, and they have a large volume of concrete, the main auxiliary facilities should be arranged on the left bank including concrete mixing plant, manufacturing facilities for construction, camps, domestic house for worker and staffs, storage yards of materials and equipment, working offices for the contractor and public works.

All auxiliary facilities and camps will be arranged at positions where the terrain is relatively even, flat, and following along the operation and construction roads.

The industrial dynamite storehouse will be arranged on the left bank far away from the auxiliary facilities.

(Auxiliary facilities see on figure 3)

2. *Material exploitation area*

a. Sand borrow at Khoam village:

The sand borrow is located on Ma river in Hoi Xuan Commune, Quan Hoa district, Thanh Hoa province away from the central of Thanh Hoa city about 150 kilometers to the Northwest and from position of Hoi Xuan hydropower project about 15 kilometers along Highway 15. The area sand borrow is 95,623 square meters with reserves of 59,207 cubic meters and exploited capacity of 12,000 cubic meters per year. It is owned by the VNECO Hoi Xuan Investment and Electricity Construction Joint Stock Company. It is located in the area where the transportation system is very convenient both by water and by road.

b. Rock quarry and soil borrow

- Besides the main work items of the project with structure of concrete, the other auxiliary work items, such as cofferdams, have the structure of soil and rock fill. The excavated rock and soil from the construction of main work items' foundation will be used for filling these works.

- The raw materials providing for crushing and screening facilities will be exploited from the rock quarry at the downstream. In addition, rock material can be purchased directly from rock quarrying enterprises around the construction site.

2.3.7. Resettlement area

According to a survey, only 42 households/ 199 people in Sa Lang hamlet /617 affected households of the whole project whose house affected and have to displaced wish to move to resettlement area. The project owner has coordinated with the local government and people to find a suitable location located in the Sa Lang Village - Thanh Xuan Commune - Quan Hoa Province to arrange resettlement for these affected household.

In fact, the whole Sa Lang Village has 53 households but only 42 households affected by the project that need to be relocated. However, after reservoir impoundment and the hydropower plant is put into operation, the rest of the 11 households are not affected but isolated. Therefore, the project will arrange resettlement for all the households, including those who affected and isolated. Thus, the scale of the resettlement area is as follows:

The number of relocated households: 53 households, 252 people in 2014 and around about 300 people in 2020 (population growth rate estimated at 1.03%).

Area: 7.8026 ha. Currently this is production forest land (planting Bamboo tree) of the people of Sa Lang Village and land projected for the construction of educational facility (under management of the Communal PC).

Each household will be allocated a minimum of 300 m^2 of residential land and garden renovated from the remaining area.

The proposed infrastructures for the project resettlement include:

+ grading work for residential area
+ Local and external transportation
+ 0.4 kV Power System.
+ Water supply system.
+ Construction of rural culture center.
+ Construction of the elementary classroom.
+ Construction of cemetery area.

The number of designed plots designed: 53 plots with average area of 330 - $400m^2$ depending on the terrain, spare area for contingency until 2020.

Domestic water supply system: is witdrawed from the spillways (newly constructed) on Sa Lang stream (Lot spring) and is distributed to the water tanks which are arranged in the resettlement area.

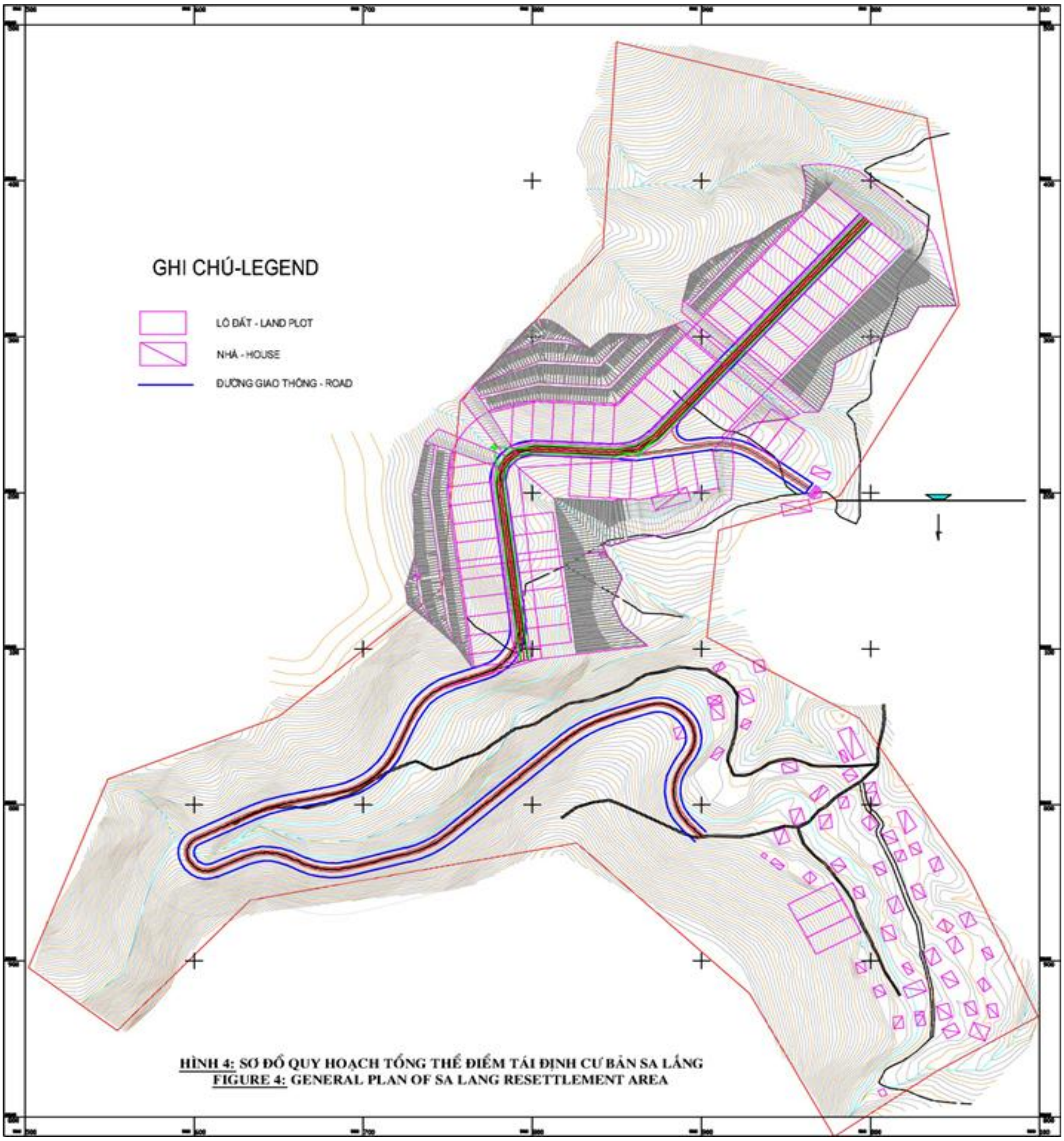
Power supply system: from the 35/0.4kV-31,5kV substations at Eo Village.

Transportation system: Currently, to reach this area, the only option is to go across the river by boat. Therefore, during the implementation of this resettlement area, it is necessary to consider about constructing a new ferry landing or a suspension bridge.

Average building density: 20%.

Building height: 1 to 1.5 floors.

Location of the resettlement area are shown in Figure 3. Overall planning of the resettlement area is shown in the Figure 4 as follows:



HÌNH 4: SƠ ĐỒ QUY HOẠCH TỔNG THỂ ĐIỂM TÁI ĐỊNH CƯ BẢN SA LẰNG
FIGURE 4: GENERAL PLAN OF SA LANG RESETTLEMENT AREA

CHAPTER 3. DATA BASE

3.1. General context

3.1.1. The context of Vietnam

Vietnam is located on the Eastern margin of the Indochinese Peninsula and occupies about 330,000 square kilometers with the north-to-south distance of about 1,600 kilometers.

Three quarters of Vietnam's area are mainly hills and mountains. Vietnam has a humid tropical climate with great rainfall; it therefore has quite abundant water resources with a total amount of water estimated about 880 billion cubic meters. Average annual rainfall is 2,000 millimeters but it is not distributed evenly. It is mainly concentrated in May to November with the rainfall accounting for from 70% to 75% of total annual rainfall so usually causes floods every year. Hilly terrain and abundant water resources are the enormous potentiality for hydropower development to meet the power demand for the social and economic development of the country.

Ma river originates from the Southern of Dien Bien province, it flows in the Northwest - Southeast direction through Song Ma district of Son La province, through Laos territory and then to Thanh Hoa province. From there, it continues through the province in the northern districts and then incorporates into the Chu River before draining into the Gulf of Tonkin through the Hoi estuary located between Hoang Hoa district and Sam Son town. Ma river's basin covers on a wide area of about 28,400 square kilometers. Of which, the part in Vietnam covers about 17,600 square kilometers with average elevation of 762 meters, average slope of 17.6% and the river density of about 0.66 kilometer per square kilometers for whole basin. Ma river system is enormously potential in hydropower of about 4.7 billion kW; in addition, it also takes the tasks of supplying water for agriculture as well as preventing the downstream area from flood.

Vietnam is the 14th populous country in the world with the estimated average 88.78 million people in 2012, an increase of 1.06% in comparison with 2011, of which the men and women was 43.92 and 44.86 million people respectively. The urban population was 28.81 million accounting for 32.5% of total population, increasing 3.3% over the previous year; the rural population was 59.97 million accounting for 67.5% of total population. Gender ratio of the population in 2010 was at 97.7 men per 100 women (In 2009, this ratio was at 97.6 men per 100 women). Labor force at the age of from 15 and over in 2010 was 52.58 million, up 2.3% in comparison with 2009, of which male and female labour accounted for 51.3% and 48.7% respectively. Labor rate in the agriculture, forestry and fishery professions decreased from 48.4% in 2011 to 47.5% in 2012; in the industry and construction professions also decreased from 21.3% to 21.1%; by contrast, labor rate in the service profession increased from 30.3% to 31.4%. Unemployment rate in the age of work was 1.99% in 2012.

Vietnam currently has 54 ethnic groups, of which about 80% of population is the Kinh people and the rest are the ethnic minority people like Tay, Thai, Muong, China, Nung, Dao, Jarai, Ta Oi, etc.

Gross Domestic Product (GDP) in 2012 was about 136 billion USD, an estimated increase of 5.03% in comparison with 2011. In which, the proportion of the agriculture, forestry and fishery profession increased 2.72%; the industry and construction profession went up 4.52% and the service profession raised 6.42%.

Total per capita income of Vietnam is growing continuously, it reached $1,540 per person in 2012. Also, the status poverty decreased from 14.2% in 2010 to 9.6% in 2012. The percentage of under 5-year-old children suffering from malnutrition is at 16.3%.

The proportion of the rural population using the hygienic water was 86%, while this proportion was 79% for the urban population. The hospital beds were 21.5 per ten thousand people. The urban housing area per capita was 19.6 square meters.

The proportion of facilities causing serious environmental pollution which were treated is 85%. The proportion of industrial and export processing zones which were under operation equipped wastewater treatment systems in accordance with environmental standards is 70%. The rate of forest coverage is 40%.

3.1.2. In the context of Thanh Hoa and Hoa Binh provinces

1. *Thanh Hoa province*

Thanh Hoa province is in the Central Region of Vietnam away from Ha Noi Capital about 150 kilometers to the South and from Ho Chi Minh City about 1,560 kilometers. It has borders with Son La, Hoa Binh and Ninh Binh provinces on the North; Nghe An province on the South; Hua-Phan province (Lao PDR) on the West and bordering the Gulf of Tonkin on the East.

The terrain of Thanh Hoa province is relatively diverse as it lowers steadily from the West to the East and divided into three distinct areas:

- High mountain and midland areas have the natural land area of 839,037 hectares accounting for 75.44% of the land area of whole province; average elevation of the mountain area is from 600 to 700 meters with the slope of above 25^0; average elevation of the midland is from 150 to 200 meters with the slope of 15^0-20^0.

- The delta has a natural land area of 162,341 hectares accounting for 14.61% of the land area of whole province. It has been filled in by the enormous alluvial deposits of the system of Ma river, Bang River, Yen River and Hoat River. It has average elevation of 5 to 15 meters alternating with low hills and lime-stone mountains. Ma river delta is the third largest delta by area in Vietnam after the Mekong Delta and the Red River Delta.

- Coastal region has an area of 110,655 hectares accounting for 9.95% of the land area of whole province with 102 kilometers long stretch of coast and the terrain is evenly flat. There are many river estuaries situated along the coastline. The stretches of sandy beach have an average elevation of 3 to 6 meters above the sea level, which are famous for Sam Son beach and other resorts like Hai Tien (in Hoang Hoa district) and Hai Hoa (in Tinh Gia district), etc. There are several enormous areas of land which are favorable for development of aquaculture, industrial zones as well as marine economy services.

Thanh Hoa province has the humid tropical climate with four distinct seasons.

Average annual rainfall is about 1,600 to 2,300 millimeters with approximately 90 to 130 rainy days each year. The relative humidity ranges from 85% to 87% and average number of sunny hours ranges from 1,600 to 1,800 hours. Average annual temperature, from 23^0C to 24^0C, is generally higher in the plain than in the mountains and plateaus.

- Prevailing wind directions are Northwest and Northeast for the winter, and East and Southeast for the summer.

- The climate characteristics of great rainfall, high temperature and abundant sunlight are the favorable conditions for the development of agriculture, forestry and fishery.

Thanh Hoa province's four main river systems, the Hoat River, Ma river, the Bang River and the Yen River with a total length of 881 kilometers and total catchment area of 39,756 square kilometers, contribute to its high water volume each year, which averages 19.52 billion cubic meters. The rivers in Thanh Hoa province flow through complex terrain; this creates a great potentiality for hydropower development. Also, underground water resources in Thanh Hoa province are quite abundant in both reserves and types because there are a full range of sedimentary, metamorphic, and erupted magmatic rocks.

Thanh Hoa is one of the largest provinces for forest resource with the land area covered by 484,246 hectares of forest which has the wood reserves of about 16.64 million cubic meters, of which the exploitable reserves ranges from 50,000 to 60,000 cubic meters each year. The Thanh Hoa province's forests are mainly broadleaf forest with abundant and diverse flora in both families and species. There are many valuable and rare types of wood such as chukrasia tabularis (or Indian Redwood), fokienia hodginsii, cunninghamia, erythrophleum fordii (also known as green ironwood), vatica, madhuca pasquieri, magnolia fordiana, michelia mediocris dandy and parashorea chinensis, etc. There are also many types of bamboo including woody bamboo (Dendrocalamus Membranceus munro), Schizostachyum Aciculare, Bambusa nutans, maclurochloa, Bambuseae, Calamus tetradactylus, Calamus platyacanthus, cinnamomum and lacca, etc. In addition, there are also the artificial forests such asdendrocalamus membranaceus, pinus latteri, manglietia conifera, eucalyptus, Casuarinaceae, cinnamomum and rubber. Thanh Hoa province has the largest area of dendrocalamus membranaceus all over the country with an area of over 50,000 ha.

Thanh Hoa province's forests are also the places where many animals congregate and live such as deers, roe deers, gibbons, monkeys, wild pigs, reptiles and birds all kinds, etc. Especially, the Ben En national forest on the Southwest and the wildlife parks such as Pu Hu, Pu Luong and Xuan Lien on the Northwest, are the special-use forests where preserve and protect the valuable and rare resources of plants and animals, and they are also the attractive destinations for tourists.

Thanh Hoa is one of the few provinces in Vietnam which has the abundant and diverse mineral resources. There are 296 mineral mines and points with 42 different types. Of which, many have a large reserves such as granite and marble (2 to 3 billion cubic meters), limestone (for cement production, 370 million tons), clay (for cement production, 85 million tons), chromium (about 21 million tons), iron ore (2 million tons), serpentine (15 million tons), dolomite (4.7 million tons) and placer as well as many other minerals.

Thanh Hoa province has a 102 kilometers long coastline and 17,000 square kilometers wide territorial waters with the fishing and shrimp grounds which have large reserves. There are 5 river estuaries along the coast; it is favorable for the access of fishing boats. This is also the center of the fishery of the province. Many thousand hectares wide alluvial sediments areas surrounding the river estuary are favorable for development of agriculture and planting sedge, trees to prevent from waves, and salt production. The areas of salt water in the Me and Bien Son islands can be used to do husbandry of garrupa, bivalvia, lobster; and tens thousand hectares wide of coastal saltwater areas are favorable for husbandry of living shelledmollusc like clams, oysters, etc.

The seafood reserves of Thanh Hoa province’s territorial waters are about 100,000 to 120,000 tons with many seafood types having high economic value.

In 2012, Thanh Hoa province has the population of about 3.426 million people of seven ethnic groups that are the Kinh (also called Vietnamese), Muong, Thai, Hmong, Dao, Tho and Hoa. The ethnic minorities live mostly in the mountainous and border areas.

There are about 2.16 million people in the working age accounting for 58.8% of total population in province. Thanh Hoa province's workforce is relatively young with medium academic standard. The workforce had been trained accounting for 27%, of which the proportion of employees who have college, university qualification or higher accounts for 5.4%.

The economy of Thanh Hoa province grew by 10.3% in 2012. The economic structure of Thanh Hoa province is divided into three distinct professions: the agriculture, forestry and fishery profession accounted for 21.6%, down 2.2% in comparison with 2011, the industry and construction profession accounted for 43.6%, up 1.8% in comparison with 2011 and the service profession accounted for 34.8%, up 0.4% in comparison with 2011.

2. *Hoa Binh province*

Hoa Binh is a mountainous province in the Northwest of Vietnam contiguous to

Hanoi capital. Its natural area is 4,662.53 square kilometers including 10 districts and one city with many ethnic groups living there. After being re-established (October 1991), Hoa Binh province has become a clue of economic and culture exchange between the Northwestern provinces, the Red River Delta and the key economic area of the North, including Ha Noi - Hai Phong - Quang Ninh through the traffic roads (Highway 6, Ho Chi Minh Highway, Highway 12B and Highway 15) and waterway (Da River and Boi River). Hoa Binh province's geographical position is not only favorable for economic and society development, but it is also the strategically important position in the defense of region and country.

The remarkable features of Hoa Binh province's terrain are high mountains, strongly separated with steep slope running in direction of Northwest-Southeast and divided into two regions:

- The area of high mountains in the Northwest: includes Mai Chau, Da Bac districts extending to Tan Lac and Lac Son districts. Average elevation is not over 1,000 meters with the highest mountain is Pu Canh (1,373 meters in height). Average elevation of the mountains trend to decrease in the Southeast direction, for example, the mountain in Bac Son commune (Tan Lac district) is 1,136 meters high, in Phu Luong commune (Lac Son district) is 934 meters high and in Tu Do commune (Lac Son district) is 820 meters high. Almost mountains in this region compose of intrusive rocks which are mostly granite and gaboro.

The area of low mountains and hills on the Southeast: includes Ky Son, Luong Son, Kim Boi, Lac Thuy and Thuy Yen districts. The terrain in this area has the alternation between Cat-to and erosion terrain types; this leads to the formation of several caves and the dehydration of land. Mountains have average elevation of 200 to 500 meters and separated into several discrete massifs.

Hoa Binh province has a humid tropical climate characterized by hot, humid summer and generally mild winter. Average annual temperature is 23^0C; the annual rainfall is 1,800 millimeters per year and the humidity averaging 85% throughout the year; average annual evaporation is 704 millimeters. The climate in the year is divided into two distinct seasons:

Due to topographical features, Hoa Binh province is characterized by the Northwest climate with cold and dry winter together with hot and humid summer (in the area of high mountain on the Northwest); and by the North Delta climate with more mild weather (in the area of low mountains and hills).

Agricultural land accounts for only 14% of the natural land area of the whole province, but it is suitable for many crops which have high economic efficiency such as paddy rice, food crops (maize, sweet potato, manioc, ...), industrial crops (beans, peanuts, cane, tea, ...) and other fruit-trees (longan, litchi, bananas, oranges, ...). In which, cane and Shan Tuyet tea trees are two specialties of the province. Also, the development potential in breeding of Hoa Binh province is considerable, especially is breeding of cattle and buffalo, pigs and poultry in large numbers; and some other species such as goats, dairy cows, etc. With the system of streams, rivers, ponds, lakes which are distributed evenly, especially the wide basin of Da River reservoir together with a large surface area as well as water quality, have become the advantages for the aquaculture development.

Forest resources of Hoa Binh province are relatively abundant and the most valuable resource of whole province. In particular, it has the area of above 200 thousand hectares of different plants such as wood, bamboo, Dendrocalamus sp, Dendrocalamus barbatus Hsueh et D.Z.Li, Calamus platyacanthus Warb, Calamus tetradactylus Hance, etc. In which, the natural forest area is 150 thousand hectares with the wood reserves of about 2.32 million cubic meters; and artificial forest area is 50 thousand hectares with the wood reserves of approximately 5 million cubic meters; these will be used to serve for industries of pulp, floorboard, plywood production. In addition, Hoa Binh province's forests have many valuable medicinal herbs such as Stephania cepharantha, pandanus (Pandanus tectorius Sol.), Ehretia asperula Zoll. & Moritzi, etc.

In addition, Hoa Binh province has a rich mineral resource which can be fully exploited for industry and construction development as granite (reserves of about 8.1 million cubic meters), limestone (over 700 million tons), fossil coal (around 01 million tons), clay (nearly 10 million cubic meters) and some other minerals such as coal, gold, iron, etc.

With the system of rivers and streams together with large reserves, Hoa Binh province has favorable conditions for development of small-sized hydropower on the wide scope, in including the enormous energy resources of the Da River. In 1979, with the help of the Soviet Union (formerly), Hoa Binh hydropower project on the Da River had been constructed. After finishing in 1994, Hoa Binh hydropower became the largest hydropower construction in South East Asia. It consists of 8 Units with installed capacity of 240 MW per Unit and total installed capacity of 1,920 MW, the energy output reaches 8.16 billion kWh each year.

With the majestic and particularly interesting natural scenery, Hoa Binh province has many advantages in tourism development. It has many amazing landscapes such as the Trai cave (in Lac Son district), Dong Noi cave (in Lac Thuy district),… where imprinted the cultural heritages of Hoa Binh province as well as the mountain village of the Thai people (Lac and Poom Coong mountain villages in Mai Chau district) and the Muong people (Giang Mo mountain village in Cao Phong district). The Kim Boi mineral water spring (in Kim Boi district) is both a tourist destination, sanatorium place and a valuable resource for manufacturing soft drinks. Especially, the Hoa Binh hydropower project - "the century work" and its reservoir are beautiful and exciting landscapes. These landscapes, together with handmade products (brocade, Hoa Binh wine – wine drunk out of the jar through pipes, etc.) showing the cultural character of ethnic groups of Hoa Binh province, have shown copious potential of Hoa Binh province's tourism.

Furthermore, Hoa Binh is proud to be the "cradle" of the Hoa Binh civilization, where the ancient Vietnamese lived ten thousand years ago. Its valuable archaeological relics, together with the originally and abundantly intangible culture values and the majestic and particularly interesting natural scenery as well as the original products, are the ideal conditions for developing various types of tourism. In 2005, Hoa Binh officially became the national major area of travel and the tourism is considered as a leading-edge economic profession of the province in the coming time.

Hoa Binh is the place where many ethnic groups densely populated; each ethnic group has its own cultural character representing through many aspects such as folk-song and folk literature treasures, traditional festivals and costumes, etc. However, people of all ethnic groups in Hoa Binh province have the same features of hardworking, energetic, honest, sincere, charitable and friendly.

Though there are many fundamental advantages, to become the province with a developed industry, tourism and service professions as well as quality of people's lives constantly improved in all aspects, Hoa Binh province has been being enlarged its potential, exploited its strengths and brought into play the internal resources and collective solidarity. In addition, it has been being actively promulgated appropriate policies to become an attractive and reliable market to be invested by both domestic and foreign investors.

Hoa Binh now has eight industrial zones of national stature approved by the Prime Minister to be added to the Planning on development of Vietnam industrial zones to 2020. Apart from the industrial zones above, Hoa Binh province has also planned 20 industrial zones in the districts and cities in order to contribute positively to change the face of the local economy. Moreover, its economic structure is strongly converting to a tendency of industrialization. The industry and construction profession accounts for nearly 35% of province's GDP (in 2005, this proportion was only 23.5%); while the proportion of agriculture-forestry-fishery field has been decreased to around 30% (in 2005, it was 43%); the operation of services continues to grow and maintains a high proportion.

Economic growth rate in 2012 was about 11%; in which, growth rate of agriculture, forestry, fishery, industry-construction and service profession were 3.8%, 16.08%, 11.5% respectively. For the economic structure: the agriculture-forestry-fishery accounted for 30.7%, the industry-construction profession accounted for 35.2% and the service accounted for 34.1%.

3.1.3. The context of districts impacted by the project

1. Quan Hoa district - Thanh Hoa province

Quan Hoa is a mountainous district away from the center of Thanh Hoa province about 140 kilometers to the West along Highway 47 and Highway 15A. It's surrounded by the Son La and Hoa Binh provinces on the North, Ba Thuoc district on the East, Quan Son district on the South and Muong Lat district on the West; it also has border (4.2 kilometers in length) with Lao PDR at Hien Kiet commune.

The Quan Hoa district has 17 communes and 01 town, 123 village groups and wards with a total natural area of 99,013.68 hectares. Of which, agricultural land area is 3,947.02 hectares accounting for 4%; forest land area is 82,200.83 hectares accounting for 83.02% (of which, the area of woody bamboo accounts for nearly 25,000 hectares) and other land area is 12,865.83 hectares accounting for 12.98%.

The Quan Hoa district has 10,444 households with 46,736 people of five ethnic groups living together. In which, the Thai, Muong, Kinh, Hmong people and Chinese account for 65.61%, 24.48%, 8.97%, 0.82% and 0.12% respectively. The number of ethnic minority households is 9,555 households with 42,921 people accounting for 91.84% of the district’s population. Quan Hoa district is one of 62 poor districts under the Resolution No. 30A of the Government.

For economic structure of the district: agriculture-forestry-fishery accounted for 60.5% (down 0.7% in comparison with 2010), industry-construction accounted for 20.3% (up 0.6% in comparison with 2009) and commercial service accounted for 19.2% (up 0.7 from 2010).

2. *Mai Chau district - Hoa Binh province*

Mai Chau is a mountainous district located in the Northwest of Hoa Binh province with geographical coordinates at 20^{o}24'- 20^{o}45' North latitude and 104^{o}31'- 105^{o}16' East longitude; It is surrounded by Da Bac and Tan Lac districts on the East district, Quan Hoa district of Thanh Hoa province on the West and South and Van Ho district (Son La province) on the North.

According to the statistics in 2012, Mai Chau district has a total natural area of 57,127.98 hectares with the population of 52,540 people.

The administrative boundary of Mai Chau District is stable with 22 administrative units that are 21 communes such as: Cun Pheo, Pieng Ve, Bao La, Xam Khoe, Mai Hich, Van Mai, Mai Ha, Tan Mai, Chieng Chau, Na Phon, Na Meo, Tong Dau, Dong Bang, Phuc San, Tan Son, Noong Luong, Ba Khan, Thung Khe, Pu Bin, Hang Kia, Pa Co and one town of Mai Chau.

Mai Chau terrain is quite complex and strongly fragmented by the system of rivulet, streams and high mountain. Average humidity reached 82%. The Climate of Mai Chau has two distinct seasons. The rainy season lasts from May to October, rainfall is mainly concentrated from July to September with an average of 122 rainy days (the maximum is 146 days).

In 2012, Gross Domestic Production reached 867.9 billion VND with a growth rate of 9.3%. In which, agriculture-forestry-fishery reached 341.9 billion VND accounting for 39.39%; industry-construction 296 billion VND, accounting for 34.11% and commercial service reached 230 billion VND, accounting for 26.50%.

3.1.4. Communes affected in the project area and the upstream and downstream up to the confluence with Luong river

Affected communes are defined the communes affected by the project within the project area, the upstream area and the downstream area from the dam to the confluence with Luong River. As this definition, there are 11 affected communes. Most of them, 09 communes, belong to Quan Hoa district, Thanh Hoa province (Hoi Xuan, Phu Le, Phu Son, Phu Thanh, Thanh Xuan, Thanh Son, Thanh Xuan, and Trung Thanh). The two others are Mai Hich and Van Mai communes of Mai Chau district.

These communes locate along Highway 15C, this route is under the re-construction.

Of 11 communes in the environmental affected area of the project, Trung Thanh is the largest commune with area of 80.27 km . Mai Hich commune has not only the highest population with 3,991 people, but also the highest population density with 94.48 people/km . Trung Son commune is impacted on land and assets on land, only impacted on aquatic ecological environment.

Most of citizens (83.22% of total population) of 11 environmental affected communes have engaged in agriculture and forestry. Some others households (5.72%) have engaged in small business like selling daily consumer goods such as clothing, electronics, or preparing motorbikes. A few people do farming and fishing, accounting for 0.1%. The rate of people working in other occupations like solders, officials is only 0.52%.

Table 3.1a. The area, number of households and people, population density of the affected communes

No.	**Communes**	**The area** (km)	**Number of village**	**Number of household**	**Number of people**	**Population density** (people/km)
1	Hoi Xuan	68.93	7	841	3,364	48.80
2	Mai Hich	42.24	7	913	3,991	94.48
3	Phu Le	43.47	5	400	1,801	41.43
4	Phu Son	63.87	5	538	2,507	39.25
5	Phu Thanh	32.33	6	437	1,761	54.47
6	Phu Xuan	24.31	5	431	1,886	77.58
7	Thanh Son	55.49	8	562	2,419	43.59
8	Thanh Xuan	78.30	6	635	2,868	36.63
9	Trung Son	76.95	6	742	3,100	40.29
10	Trung Thanh	80.27	10	617	2,806	34.96
11	Van Mai	36.48	7	730	3,020	82.79

(Note: Of 11 communes in above table, there is Trung Son commune not to be impacted on land and assets on land, be only impacted on aquatic ecological environment)

3.1.5. Risks to natural resources and rural likelihood

The landscape ecology of Vietnam has been seriously influenced by deforestation caused by both the subjective and objective factors although the plans on forest development and protection are available. There are many large scale reforestation and forest restoration plans such as the replanting 5 million hectares of forest program, the national afforestation program 327, together with policy of the Government on land and forest delivery. However, the lost forest area was still much more than the new-planted area (In particular, the proportion of forest cover declined from 43% in 1943 to 33% in 1976 and only at 27% in 1990, then increased to 28.8% in 1999. The target was set forth at that time is that the proportion of forest cover could reach to 45% by 2010 through the replanting 5 million hectares of forest program). The landscape ecology was destroyed by the following reasons: dense population (clearance of forest land for house construction, crop production, firewood, timber, etc.), building operation, the destruction of war, no sensible forest management methods as well as by the natural phenomena such as storms or forest fire disaster, etc... These all caused the pressure on the environment such as the degradation of ecological services (reducing the productive feature of forest, losing the landscape ecology of mangrove swamps, etc.), increase in violence of the natural disasters (floods, landslides and forest fires, etc.) and caused the degradation of ecological diversification as well as the loss of valuable and rare genetic resources. The conservation and restoration of watershed forest have great importance in protecting water resources. Water resource is used for irrigation at the downstream area, power generation and civil and industrial purposes of locality. In addition, the sensible management of watershed forest will limit the influences of floods, droughts and provide livelihoods for a large number of ethnic minority people groups who live on high mountains.

The main reasons causing degradation of the natural environment are included industrialization, urbanization, industrialization and modernization of agriculture and rural areas, exploitation and development of natural resources such as minerals, water and wind, etc. and the development of services such as transport and tourism. The main environmental problems of Vietnam, related to these developments, continues to be considered such as forest loss and degradation, loss of ecological diversification, land degradation, water pollution and waste management. Vietnam has been being carried out and implemented several operations to protect the environment in a sustainable way that are continue to complete and propagate widely the regulation system of environmental protection, make plans for implementation, supervise the environment and control pollution as well as build up and consolidate the strong institution system of environmental management at all levels.

3.1.6. The ethnic minorities – Gender, poverty and development in communes and districts in the project area, in Hoa Binh and Thanh Hoa provinces and in Vietnam.

1. *In Vietnam*

Vietnam currently has 54 ethnic groups, of which about 80% of population is the Kinh people and the rest are the ethnic minority people like the Tay, Nung, Dao, Jarai and Ta Oih, etc. According to the list of the ethnic groups of Vietnam issued by the General Directorate of Statistics in 1979, the Ta Oih ethnic group is one of the 54 ethnic groups living in Vietnam.

The name of Ta Oih ethnic group is used as the common name and only for the ethnic groups of Ta Oih, Pa Koh and Pa Hy. The two Pa Koh and Ta Oih ethnic groups have not been clearly distinguished for a long time both in administrative documents and perceptions of the scientific world.

In fact, the Pa Koh language is an independent language and the Pa Koh ethnic group has about 18,000 people living mostly in A Luoi district (Thua Thien Hue province) and Huong Hoa district (Quang Tri province). The Pa Koh people currently account for the largest number of population in ethnic minority communities in Thua Thien-Hue province. The Pa Koh people live alternately with the Co Tu, Ta Oih, and Van Kieu people and have many characteristics in common with the Mon - Khmer ethnic groups in dress, housing and farming way.

In terms of social organization, there is no the demarcation the villages of the Pa Koh people, but the villages of the Ta Oi people is demarcated clearly by the bamboo fence. The Pa Koh people worship elephants which show the wealth while the Ta Oih people consider that the most precious wealth is expressed through the ivory white pearl rings.

In terms of the family, most of the Pa Koh people take the Tang Koal (means dog) for their family name while the Ta Oih people take the A Ke, Pe Ke (means bird). The Men in the Ta Oih people's family are resourceful and very good cook while this work, for the Pa Koh people, is just for the women. Although being the same custom of living in the long-house but the Pa Koh people's houses have inclined roof and partition wall, while the Ta Oih people's houses have nearly vertical roof and without partition wall.

Currently, the Pa Koh people community desires to be recognized as an official ethnic group in the community of Vietnamese ethnic groups. In order to meet the aspiration of the Pa Koh people community, Thua Thien Hue province is promoting and preparing to submit the Government for approval to supplement this ethnic group into the current category of 54 ethnic groups.

2. *In Thanh Hoa province*

The entire mountainous area of Thanh Hoa province has 1,074,522 people. In which, the Kinh people are the most with 448,593 people accounting for 43% and the six ethnic groups has 621,436 people. The number of population of the Muong, Thai, Mong, Tho, Dao and Kho Mu ethnic groups are 364,622; 223,165; 14,917; 11,530; 6,215 and 978 people respectively. The remaining 21 ethnic groups have 4,493 people, of which 444 Tay people, 151 Nung people, 327 Chinese, 31 Khmer people, 27 Jarai people and 68 E De people, etc; the population of the Ta Oih ethnic group is the least with 02 people.

The Muong ethnic group*:* in the scientific data and according to researchers, there were many ethnic minority people admitted the Muong on their ethnic group name long time ago. Like in Hoa Binh and PhuTho provinces, the Muong people in Thanh Hoa province have the origin of ancient Vietnamese and are of the Vietnamese-Muong language group which is closely related to Vietnamese(in the sense it can be said relatively 70-75%). The Muong people in Thanh Hoa province include two branches that are Muong Trong (ancient Muong from Ba Thuoc district) and Muong Ngoai (a part of migration fromHoa Binh province).

The Muong people in Thanh Hoa province are mainly concentratedinNgoc Lac district with 94,676 people, ThanhThanh district with 76,106 people, Ba Thuoc district with 53,046 people and Cam Thuy district with 55,570 people and also in some mountainous communes bordering Trieu Son, Tho Xuan, Yen Dinh and HaTrung districts.

The Thai ethnic group*:* has the long-standing origin living inThanh Hoa province with 223,316 people. The Thai people account for about 35.6% of thee thnic minority population of Thanh Hoa province. The Tay Dam (Black Thai) and Tay Do (white Thai) are the two main branches of the Thai ethnic group in Thanh Hoa province.

The white Thai people (or Tay Do) mainly reside in Thuong Xuan district (48,142 people) and in several mountainous communes of Nhu Xuan and Trieu Son districts. The majority of the black Thai people reside in the high mountain areas such as Quan Hoa, Ba Thuoc, Quan Son, Muong Lat, Lang Chanh districts. Some large families of the Thai people are Ha, Pham, Lang, Lo and Vi family, etc. Along with many large mountain villages such as Muong Khoang, Muong Ca Da, Muong Xia, Muong Min, Muong Ha, Chieng Van, Muong Ky, etc.

The Dao ethnic group*:* includes two groups that are Dao Quan Chet and Red Dao. The first group residing in the low mountain area includes 10 villages (in which 9 villages are full up with the Dao people, the rest one is the village where the Muong, Thai and Kinh people live together). In particular, there are Phu Son, Thach An, Oi villages in Cam Thuy district and Ha Son, Tan Thanh, Phung Son villages in Ngoc Lac district.

While the second group residing in the mountain area in Muong Lat district includes 3 small hamlets such as Tut spring, Con Dao and Pu Quan.

The Dao Quan Chet people in Thanh Hoa province are mostly emigrant from Tuyen Quang, Hoa Binh and Vinh Phuc province in early twentieth century.

The Red Dao people living in Muong Lat district are people emigrated from Laos to Vietnam in 1945.

The H'Mong ethnic group: The H'Mong ethnic group in Thanh Hoa province has 2,361 households with 14,917 people living in 46 villages, 6 communes and 3 districts of Quan Hoa, Quan Son and Muong Lat.

The Kho Mu ethnic group: the Kho Mu people reside long-standing in the mountain area in the Northwest and North Central Coast regions of Vietnam being mainly concentrated from Lai Chau, Dien Bien, Lao Cai, Son La to Thanh Hoa and Nghe An provinces.

The Tho ethnic group: the residence area of the Tho people is the intersection place of migration currents. The Tho people currently live in Nhu Xuan, Nhu Thanh districts.

In Hoa Binh province

There are six ethnic groups in Hoa Binh province. The Muong people accounts the most of population of 63.3%, the next one is the Vietnamese (the Kinh) accounting for 27.73%; the Thai, Dao, Tay and Mong people account for 3.9%, 1.7%, 2.7% and 0.52% respectively. Furthermore, there are also Chinese dispersedly living in the province. In the past, the Chinese were concentrated in Ngoc Luong communes, Yen Thuy district; but after 1979 some families left and now live dispersedly in Yen Tri, Ngoc Luong and Phu Lai communes of Yen Thuy district. In addition, there are a number of people from other ethnic groups mainly getting married with Hoa Binh people who are working in other mountainous provinces.

Hoa Binh is one of the four provinces of Vietnam which the Vietnamese (Kinh) is not the majority. It is also considered to be the capital of the Muong people because most of the Muong people are living in here. In terms of culture and society, the Muong people are most closely related to the Kinh. The resident areas of the Muong are in overall localities in the province living with the Kinh and other ethnic groups.

The Thai people mostly reside in Mai Chau district. Though the Thai people lived near the Muong people long time ago and affected by many customs and lifestyle (especially costumes), but they still preserve their cultural characters. This is valuable for development community tourism and preservation of the traditional culture. Ban Lac is currently one of the most attractive tourist destinations of Hoa Binh province for both domestic and foreign travelers.

The Tay people are mainly concentrated in Da Bac district living with the Muong and Dao people. The Tay people have many customs and culture which are similar to the Thai people, especially the language. However, in terms of costumes, the Tay people in Da Bac district area similar to the white Thai people residing in Phu Yen and Bac Yen districts of Son La province.

The Dao people live in a community in Da Bac, Luong Son, Kim Boi, Cao Phong, Ky Son districts and Hoa Binh city. The Hmong people are mainly concentrated in Hang Kia and Pa Co communes of Mai Chau district. In the past, these two ethnic groups had nomadic farming and life habits, but from 1970-1980 they had switched to settled cultivation and settlement and achieved significant achievements in socioeconomic aspect.

3. *Quan Hoa district*

The district has 17 communes and one town (Quan Hoa), its average population is 47,015 people in 2013, with 29,675 people in working age, and population density of 47.5 persons/km , the rate of natural population growth is 1.0%. in the population components in ethnic groups, the Thai accounts for 65.61% of total population, the Muong people for 24.48% Muong, Kinh people for 8.97%, H'Mong for 0.82%, and Chinese for 0.12%.

Total number of poor households throughout the district in 2011 was 5,175 households, or 51.01% of total population while this figure in 2013 was 3,492 households, or 33.16% that is 17.85% reduction compared to 2011. This decrease has an annual average of 5.95%.

The number of households in nearly poor in 2011 was 2,301 households, or 22.68% while it was 2,100 households in 2013, or 19.99% that is 2.74% decrease.

The communes which have well done the local poor poverty alleviation programs are Phu Xuan, Thien Phu, Nam Xuan, and Hien Chung.

These communes with high poverty rates also are striving to decrease rapidly. They are Hien Kiet, Nam Tien, Trung Thanh, and Phu Son communes.

4. *Mai Chau district*

According to data provided by Ethnic Office of Mai Chau district updated to 31 Dec. 2013, total number of households of the district is 12,763 households, with 53,315 people. Total number of poor households is 2,949, total number of nearly poor households is 1,764 households.

- Thai people have 7,409 households, 30,512 people; 1,331 poor households; 1,001 nearly poor households.

- The Kinh have 1,667 households; 5,895 people; 158 poor households; 104 nearly poor households.

- Muong people have 2,164 households; 9,660 people; 934 poor households; 511

nearly poor households.

- Hmong people have 1,091 households; 5,819 people; 344 poor households; 84 nearly poor households.

- Dao people have 238 households; 969 people; 97 poor households; 29 nearly poor households;

- Hoa people have 13 households; 46 people; 01 poor households.

Under customary of indigenous people at all Thai, Muong, Kinh, Dao, Hoa, and Hmong groups, women are to be respected and involved in family decisions. In addition, they also support the government in the capital, production tools to improve their lives.

5. *The communes in the project are*

Among 11 studied communes, the Thai people accounts for 72.80% of total population with 21,494 people; Muong people for 20.66% with 6,099 people, Kinh people for 4.85% with 1,432 people, 396 Hmong people 1.34%; and 101 Hoa people for 0.34%.

Table 3.1b: Population in ethnic components of the affected communes

No.	Communes	Population	Kinh	Thai	Muong	H'Mong	Hoa	Kho Mu
1	Hoi Xuan	3,364	336	2,691	236		101	
2	Mai Hich	3,991	31	3,412	548			
3	Phu Le	1,801	19	1,764	18			
4	Phu Son	2,507	16	1,802	315	374		
5	Phu Thanh	1,761	67	1,688	6			
6	Phu Xuan	1,886	5	1,179	702			
7	Thanh Son	2,419	41	1,664	712	1		1
8	Thanh Xuan	2,868	25	1,460	1,383			
9	Trung Son	3,100	43	2,114	943			
10	Trung Thanh	2,806	3	1,670	1,112	21		
11	Van Mai	3,020	846	2,050	124			
Total		**29,523**	**1,432**	**21,494**	**6,099**	**396**	**101**	**1**
Percentage (%)		**100**	**4.85**	**72.80**	**20.66**	**1.34**	**0.34**	**0.00**

The proportion of poor households in the commune project area is higher than average of 2 project communes, Quan Hoa and Mai Chau, and tends to decrease over the recent years. In 2011, average poverty rate of 11 studied communes was 45.28%, reducing to 38.43% in 2012 and to 33.97% in 2013. This shows that because of the Government's support for the poors, economic condition of the poors have considerably improved and gradually escaped poverty.

Table 3.1c: the poverty proportion of project communes over the recent years

No.	Communes	2011	2012	2013
1	Hoi Xuan	51.45	47.78	43.15
2	Mai Hich	17.36	15.70	14.54
3	Phu Le	35.60	30.70	28.90
4	Phu Son	58.60	46.90	38.10
5	Phu Thanh	48.62	40.37	38.11
6	Phu Xuan	52.81	48.00	36.11
7	Thanh Son	58.60	46.90	38.10
8	Thanh Xuan	48.60	43.70	39.20
9	Trung Son	51.96	38.88	38.75
10	Trung Thanh	51.45	47.78	43.15
11	Van Mai	23.00	16.00	15.60
Average		***45.28***	***38.43***	***33.97***

3.2. Scope of the studied area

*** Construction site of work items:**

- For the construction sites: research area within the boundary of the land recovery for construction of work items including dams, waterway, powerhouse, auxiliary facility area, construction and operation roads and material exploitation areas. This area is located in Hoi Xuan and Thanh Xuan communes, Quan Hoa district, Thanh Hoa province.

- For the reservoir: research area within the boundary of the land recovery for construction of reservoir. This area is located in the territory of 10 communes: Trung Son, Trung Thanh, Thanh Son, Phu Thanh, Phu Son, Phu Le, Phu Xuan and Thanh Xuan in Quan Hoa district, Thanh Hoa Province; and Mai Hich and Van Mai communes in Mai Chau district, Hoa Binh province.

- For the transmission line: research area within the ROW of the transmission lines. The area is located in the communes of Thanh Xuan, Phu Xuan, Phu Le and Phu Thanh in Quan Hoa district, Thanh Hoa Province; and Van Mai commune in Mai Chau district, Hoa Binh province.

- For resettlement areas: research areas within the boundary of the land recovery for construction of resettlement areas.

*** Areas out of the construction site:**

Due to the homogeneity of the natural environment, ecological system and living environment of people in the studied area, the areas out of the construction site will be therefore studied in detail for the scope as follows:

- For the construction works: research the area that expands 200 meters from the boundary of the land recovery for construction

- For the reservoir foundation: research the area that expands 200 meters from the boundary of the land recovery for reservoir.

- For the transmission line: research the area that expands 200 meters from the both sides of secure corridor.

- For the resettlement area: research the area that expands 200 meters from the boundary of the land recovery for the project.

- For the nature reserve areas: preliminary study in the nature reserve areas of Xuan Nha, Pu Hu, Pu Luong and Hang Kia - Pa Co.

- For the temple and historical monuments: research the areas of temple works, historical monuments, shrine works and sensitive areas surrounding the project within 1 kilometer.

- For the upstream area of the reservoir: research the upstream area of the reservoir from the reservoir of Trung Son hydropower to the end of Hoi Xuan hydropower project's reservoir, within the range of 200 meters from the riverbed to both sides.

- For the downstream area of the reservoir: research the area from the dam site to the confluence of Luong River, within the range of 200 meters from the riverbed to both sides.

3.3. Biology and physics environment

3.3.1. Geographical conditions

Hoi Xuan hydropower project is expected to be constructed on Ma river. It is the second hydropower cascade of Ma river (in the territory of Vietnam). The entire project area is located in Hoi Xuan, Thanh Xuan, Phu Xuan, Phu Son, Phu Le, Phu Thanh, Trung Thanh, Thanh Sơn, Trung Son communes in Quan Hoa district, Thanh Hoa province; and Van Mai and Mai Hich communes in Mai Chau district, Hoa Binh province. The dam site and reservoir foundation are far from the Pu Hu natural conservation area about 5.5km and 2km respectively to the Southeast; and from the Pu Luong natural conservation area about 3km and 300m respectively to the Southwest. They are far from the Hang Kia – Pa Co natural conservation area about 26.7km to the Southeast and from Hoi Xuan town, Quan Hoa district about 15km.

3.3.2. Geology

1. Overall geological conditions of project area

a. Overall geological structure of project area

The studied area in particular and Northwest region in general located in the tectonic plate, which suffered from being collided and sucked by the Indian-Australia Plate into and down to the Eurasian Plate 50 million years ago. This created the repressed and heterogeneously stretched status in lithosphere of Vietnam's territory. In addition, the differentiated movements created the topography and new tectonic structure of Vietnam's territory in general and the studied area in particular with the general appearance divided into blocks and tending to incline gradually towards the East and Southeast.

In the geological structure of Hoi Xuan hydropower project, there is also the presence of sediment and eruption formations in the Paleozoic to the Kainozoic age, of which the age of Paleozoic sediment formations is the oldest.

Within the studied area of Hoi Xuan hydropower project, Ma river formation is widely distributed and accounted for the largest volume. Its lithological composition consists of two-micaquartz-schist, garnet biotitequartz-schist, sericite quartz-schist, argilit, lenses of black shale and thin seams of quartzite. The rocks in the formations of Ma river are strongly influenced by the activities of regional metamorphism, thermal metamorphism and dynamic metamorphism.

Cam Thuy formation is distributed near Cam Thuy town. According to description of geologists, it consists of only mafic eruptions covered the older Paleozoic formations at the Cam Thuy anticline and Triassic sediments with accordant lying position upper. Within the geological maps, the Cam Thuy formation accounts for a small area. Its lithological compositions consist of aphyric basalt and gray green porphyric basalt, which are sharply divided into shale. Hydrothermal metamorphism activities of epidote, chlorite and quartz albite chemical process strongly develop.

Within the studied scope of Hoi Xuan hydropower project, the Co Noi formations account for a small volume in the Northeastern part of the map 1/50.000 in scale. Its components consist of sandstone, siltstone, claystone, limestone clay.

The Quaternary System presents as the forms of grade I shelf, alluvial grounds and sand bars located on low terrain along the banks of rivers and large streams. Its compositions consist of sand, gravel, sandy loam and clay loam. The sand bars, whose compositions consist of sand and pebble, distributed along the river banks generally in the semi-submerged status. Some larges and bars have high quality, which can be exploited as the building materials.

On the geological maps of headwork area (1/2,000 in scale), the stratigraphic formations in the project area include Ma river and Quaternary System formations. Ma river formation is widely distributed and accounted for the largest volume in the headwork area. All work items of Dam route alternative No.3 will be arranged on the rock foundation of Ma river formation. According to the characteristics of lithological composition and structure, the rock and soil in the headwork area is classified into episode 2 of Ma river formation, which is characterized by sericite-quartz schist alternated episodes, lenses of argilit shale and ampelite shale, and thin lenses of limestone shale, quartzite-form sandstone.

b. Fault system

In the project area, two seismic faults are deep faults at the edges of Song Ma and Son La zone of faults (the dam route alternative No.1 away from the Song Ma and Son la zone of faults about 16 kilometers and 4 kilometers respectively).

**** Ma river zone of faults:*** in new and modern tectonics, its main characteristics are as follows:

- Ma river zone of faults extends more than 390 kilometers in length (of which nearly 100 kilometers located on territory of Lao PDR). It is NW-SE in general direction with many sections changing their directions. It starts from the Muong Ang (Tuan Giao district) and ends at coastal area of Quang Xuong commune - Tinh Gia district (Thanh Hoa province).

- This zone of faults has the complex structure with many sub-branches mostly on the Northeast.

- It has undergone two phases of activity in the new tectonic structure with property of sliding.

- The geomorphic formations in age of Pliocene - Quaternary right deformed in the zone of faults will be the basis to confirm that the later phase had occurred during this period. The amplitude B_p of deformation is from 900 to 2,000 meters corresponding with rate of from 0.15 to 0.2-0.3mm per year if calculated for 6 million years ago and from 0.9 to 1.7mm per year if calculated for 1 million year ago.

- Also based on the geomorphic signs, the left deformation amplitude of the fault zone may reach about 7-7.5 kilometers corresponding with a rate of about 0.4mm per year if calculated for the period from 23 million to 6 million years ago.

- The modern activity of fault zone is evident in many places. Along the fault zone, there are presences of high geochemical and geothermal anomalies, landslide activity in many places, strong seismic activity and the potential in generate great earthquakes with magnitude of 6.5-7, 0 in Richter scale.

- In the studied area, Ma river fault zone showed intermittent status and weak geomorphic deformation.

**** The Son La zone of faults:***Approximately 360 kilometers in length, starting from Tuan Giao district (Lai Chau province) and ending at the Nga Son coast (Thanh Hoa province), it is NW-SE in general direction, apart from the section of Chieng Ve - Mai Chau, which is sub-latitude in direction.

- Most of the Son La - Bim Son fault (Southeast half part) is developed in Son La zone. The rest (Northwest half part) is cut into architecture zones of Thuan Chau and Nam Co.

- The fault zone has a complex architecture, besides the main fault runs along throughout the zone; the auxiliary faults develop at both sides that creating the different architectures, mainly the types of "parallel and horse-tail". There are also some places where appear the pull-apart and separated architecture styles.

- The sliding surface of the main fault inclined towards the Northeast with angle of 60-80^{o}. While the sliding surface of the auxiliary faults at both sides inclines towards Northeast or Southwest with angle ranging from 40-70^{o}.

- In the Cenozoic, the fault zone mainly slides in horizontal direction with two phases of sliding that are the early phase B_t and the late phase B_p. Within the phase B_p, total sliding amplitude of the fault in some places about of 550-2,000 meters with rate averaging from 0.09 to 0.3 mm per year (6 million years). Particularly during the Q_{III-IV}, the movement speed of zone fault can reach over 1.6 mm per year.

- The modern activities of zone of faults are quite strong and inherit the Pliocene period - Quaternary on spatial aspect as well as movement characteristics.

- The main property of this fault zone is right horizontal slide with the negative manifestation at the section of Chieng Ve - Xuan Nha.

- In this period, the main fault is a set of serial sections, which are separated with each other at a not great distance. In some places, these distribute alternately. In fact, each section is a set of specific faults, which are parallel to each other and they might move at the same time during the modern Holocene period.

- The movements along the fault zone, mainly along the main fault, are generally large and uneven overall the zone. There are some sections with movement amplitude of hundreds of meters, also some show weaker movement and even some show no clearly signs of movement.

- The length of the continuous faults can reach 40 to 50 kilometers and trending to decrease gradually.

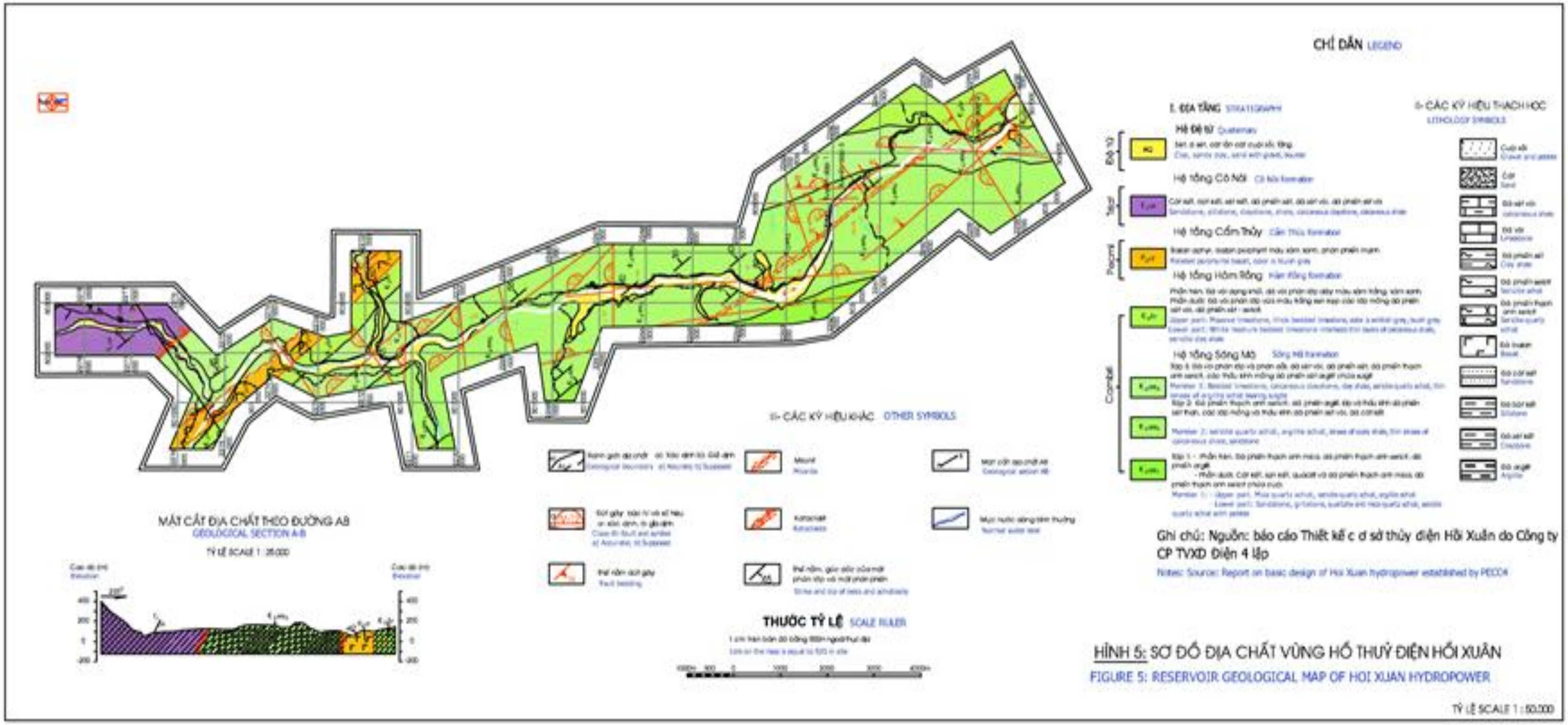
- The right slide amplitude of the specific faults at the positions, which cause deformation of geomorphic factors, is generally high. There are many locations with height of 50 meters or more, there particularly are some positions with height of more than 100 meters.

The slide amplitude of the faults belonging to the Northwest half part is greater than one of the Southeast half part of the fault zone.

- Besides the slide and movement occurring along the faults, which has been determined by the geomorphic signs; there are also many other signs confirming the nature of its movements such as: the highly geochemical and geothermal anomalousness, the crack and landslides in many places (particularly in the Lai Chau-Tuan Giao) as well as many strongly seismic shocks and the great earthquakes with the amplitude of 6.5-7 in the Richter scale.

- In the studied area, the Son La fault zone show intermittent signs and weakly geomorphic deformation.

- On the geological map in scale of 1/2,000 of the project area, there are four tectonic demolishment systems of Northwest-Southeast, Northeast-Southwest, sub-meridian and sub-latitude. There are only the faults of grade III, IV and V in the project area.



HÌNH 5: SƠ ĐỒ ĐỊA CHẤT VÙNG HỒ THUỶ ĐIỆN HỒI XUÂN

FIGURE 5: RESERVOIR GEOLOGICAL MAP OF HOI XUAN HYDROPOWER

2. Geological condition at the reservoir area

In terms of the topography: the cross section of reservoir is quite narrow, the slope surface at both sides with slopes from 5 to 30^o, strongly developed on the grade I shelf, alluvial ground and sandbars along the river.

In terms of the *geology:* It formed by the terrigenous-carbonate formations and terrigenous-eruption base formations. In the reservoir area, it can meet Ma river formation (ϵ_2 *sm*) consists of mica quartz-schist, sericite quartz-schist, shale, ampelite shale limestone, etc. The Ham Rong formation ($\epsilon_3 hr$) consists of limestone, ampelite shale, sericite quartz-schist, etc. The Cam Thuy formation ($P_2 ct$) includes basalt and tuff basalt. The Co Noi formation ($T_1 cn$) consists of sandstone, siltstone, sandstone siltstone, claystone, clay limestone, etc and Quaternary formations. The direction of rock in the reservoir area is mainly Northwest - Southeast to sub-meridian with the angle ranging from 20-70^o. The Quaternary cover soil layer consists of clay, gray, gray-yellow and red-brown sandy clay. Its thickness varies significantly from 2-10 meters and more than 10 meters in some places. The river alluvial sediment is 2-10 meters in thickness, consisting of sandy gravel.

Hydrogeological characteristics*:* most of aquifer complexes are impressed and poor in water. Due to the strictly hydraulic relationship between aquifers, they are in fact considered as an aquifer. The rock and soil in the reservoir area are divided into zones with different levels of permeability as follows:

- For very high permeability: zones include aQ alluvial formations at riverbed and alluvial ground along riverbanks.

- For high permeability: zones include strongly weathered IA2, weathered IB, the demolishment zone and tectonic influence zone in bedrock.

- For medium permeability: zones include deluvium and eluvium coating layer and extremely weathered zone edQ + IA1, fractured zone of the original rocks.

3.3.3. Topography and geomorphology

1. Characteristics of topography

- The Hoi Xuan hydroelectric project located on Ma river basin on the West of Thanh Hoa and Hoa Binh provinces. This is the high mountains in the Northwest of Vietnam with the mountain chains extending in direction of NW-SE and trending strongly to moderately; the surface slopes is quite steep, from 10-30^o. The massifs long the riverbanks usually slope gently, the absolute elevation ranges from a hundred meters to several hundred meters. Ma river system originates in Va Pu mountain area (in Dien Bien and Lai Chau province) with 512 kilometers in length. It flows through the territory of Laos, then through Son La and Thanh Hoa province before draining into sea through river estuaries such as Lach Sung, Lach

Truong and Lach Hoi located along coastline of Thanh Hoa province. According to statistics, Ma river basin has an area of about 28,400 square kilometers. Within the project area, Ma river flows in the East direction and then in the South-Southeast direction at the position of Quan Muc village. The dam site area will be expected to be arranged at the middle part of Ma river where the flow runs in the South-Southeast direction and the riverbed slope averages 1-2%.

- Within the project area, besides the main Ma river, there are branches of Quanh streams originating in the mountains area in Yen Chau district of Son La province and flowing into Ma river at the position of Quan Nhuc village. The level 2, 3 spring branches of Ma river have a relatively high density. They distribute in fishbone shape with length of from 2-3 kilometers to tens of kilometers. Striking characteristic of this system is that the springs are sub-meridian in direction and winding. The degree of longitudinal separation of the stream is usually quite low at the downstream part and the suddenly increase at the upstream.

2. Geomorphological characteristics

Based on the principle of structural forms, the entire studied area is divided into primary geomorphic units as follows:

+ The erosion terrain

This is one of the largest scale forms of terrain in the entire project area; they coincide with the hills with high level of cleavage. Based on the level of cleavage and the slope of the terrain, it can be divided into the following massifs:

The erosion massifs with the weak level of cleavage

This occupies small area on the map 1/50,000 in scale, coincides with the distribution area of basalt belonging to the Cam Thuy formation. The terrain has medium to low level of cleavage. The surface slope ranges from 5 to 10^o with saddle and the large area of ridge surface.

The erosion massifs with the medium level of cleavage

This includes most of the massifs in the project area formed by the sediment rock of Co Noi formations, metamorphosed sedimentary of Nam Co and Ma river formations. The massifs extend in the NW-SE and sub-meridian directions with saddle shape. The terrain has quite high level of cleavage, surface slopes are relatively steep, narrow watershed ridge with hog’s back shape, sandy clay weathered crust with great thickness and the bedrock typically located deeply.

+ The Karst terrain

This occupies for not much of area, located on the North and South Pole of maps 1/50,000 in scale corresponding with the distribution area of limestone, dolomite limestone of the Ham Rong formation; and limestone shale, shale of Ma river formation. The terrain has quite high level of cleavage, surface slopes are relatively steep, the original limestone and dolomite occur on the terrain surface. The clay and coating layers are insignificantly thick.

+ The accumulation terrain

- On the map, the terrain shape coincides with the distribution area of the sediment Quaternary in the form of a narrow land strips. In elevation, this terrain can be classified into types of grade I shelf, high and low sediment grounds, sandbars and sand ground along the riverbanks.

- The grade I shelf: distributed at the elevation of 7-8 meters to 10-11 meters higher than river water level. The shelf surface is generally narrow and slightly inclines towards the riverbed. Its compositions consist of two layers. The bottom layer consists of quartz pebbles mixed with clay sandstone, 3-5m in thickness. The top layer consists of clay, sandy clay mixed with gravel, 2-4 m in thickness.

- The high sediment grounds: located at the elevation of 2-4 meters higher than river water level, and often submerged in the rainy season. Their surface area is quite narrow and slightly inclines toward the riverbed. Their compositions include clay, sandy clay, sand and clay sand. These are the areas where local people develop rice and crops.

- The sandbars and sand grounds along the riverbanks: are distributed dispersedly in the winding river segments. The area of sandbars and sand grounds extends from a few tens of meters to several hundred meters in length, and a few tens of meters in width. Their compositions include many various kinds of pebbles, gravel and sand. Their thickness ranges from 1-2 meters to tens of meters.

3.3.4. Ambient air, noise

3.3.4.1. Overview of air quality and noise in the project provinces

1. Thanh Hoa province

Change of ambient air quality and noise of Thanh Hoa province had been observed by Thanh Hoa Environmental Protection and Monitoring Center in 2006 – 2010. Monitoring results were compared with the current standards and regulations. Conclusions of the ambient air quality and noise during the 2006-2010 period in Thanh Hoa province are as follows:

**** Air environment in traffic areas:***

Ambient air in traffic intersections in the province was mainly contaminated by dust, from 1.03 to 6.8 times higher than the standard.

Other toxic emissions were at light pollution level: Annual average concentration of NO_2 and SO_2 were beyond the standard with 1.09-1.7 times higher and 1.057-1.371 times higher, respectively.

Annual average noise (6am - 20pm) was 3 to 14dBA higher than the standard while this figure at 22pm - 24pm was 10 - 34.5dBA higher than the standard.

*** Air environment at residential areas near industrial zones:**

Air environment at the residential areas near key industrial zones in the province was contaminated by dust at slight to moderate levels. The annual average dust concentration was 1.043 to 3.23 times higher than the standard.

Harmful emissions in most monitoring locations were in accepted limit of the standard. However, the SO_2 concentration was contaminated at low level (1.03 times higher than the standard).

Annual average noise (22pm - 24pm) was 4 to 10.7dBA higher than the allowable levels.

*** Air environment at crowding residential areas:**

Dust pollution level of air environment at the crowding residential area was from slight to moderate. The annual average dust concentration was 1.253 to 2.73 times higher than the standard.

Most harmful emissions were in accepted limit of the standard. However, the SO_2 pollution concentration was 1.314 to 1.371 times higher than the standard.

The annual average noise (6am – 20pm) was 4 to 19dBA higher than the standard while this figure at 22p.m - 24p.m was 3 to 22.5dBA higher than the standard.

2. Hoa Binh province

The ambient air quality and noise of Hoa Binh province was assessed in each district. Particularly, the project district as Mai Chau has air quality and noise as follows:

Table 3.1d: The ambient air quality and noise in Lai Chau district, Hoa Binh province

Paramater	**Year**	**Mai Chau distict**			QCVN 05:2009/ BTNMT	QCVN 26:2010/ BTNMT
		The Gate DPC	**Dong Bac Hapaco paper manufactory**	**Tong Dau intersection (or market)**		
	2012 Đ1	32.4	33.1	32.2	-	-
	2012	25.8	31.2	26.4		

Temperature (^0C)	Đ2					
Humidity (%)	2012 Đ1	75.3	69.5	73.8	-	-
	2012 Đ2	78.2	82.3	78.5		
Wind (m/s)	2012 Đ1	1.8	1.6	1.9	-	-
	2012 Đ2	1.9	1.8	1.8		
Noise (dBA)	2012 Đ1	62.5	61.3	64.2	-	70
	2012 Đ2	67.2	60.4	67.2		
Dust (mg/m^3)	2012 Đ1	0.23	0.23	0.24	0.3	-
	2012 Đ2	0.20	0.2	0.22		
CO (mg/m^3)	2012 Đ1	1.67	1.84	2.37	30	-
	2012 Đ2	1.82	2.31	2.52		
CO_2 (mg/m^3)	2012 Đ1	218	225	238	-	-
	2012 Đ2	225	237	249		
SO_2 (mg/m^3)	2012 Đ1	0.14	0.16	0.15	0.35	-
	2012 Đ2	0.18	0.18	0.19		
NO_2 (mg/m^3)	2012 Đ1	0.03	0.04	0.04	0.2	-

Source: Environmental status report in Hoa Binh province, in 2013.

*: - QCVN 05:2009/BTNMT - National technical regulation on ambient air quality

- QCVN26-2010/BTNMT - National Technical Regulation on Noise

Comment: the analytic result of air environment in Mai Chau district in 2012 shows that most of the analyzed parameters were in accepted limit of regulation No. 26: 2010/BTNMT and 05:2009/BTNMT. In the areas with the high concentrations of economic activities with many transportation means, the pollutant concentrations were usually higher than other areas but they still in acceptance limit of the regulations. Thus, the ambient air quality and noise in Mai Chau district were relatively good for ensuring clean environment for people.

3.4.2.2. The ambient air quality and noise of Hoi Xuan hydropower project area:

a) Ambient air quality during implementation years of the project

Monitoring of ambient air quality and noise has been carried out through years of project implementation.

From 2012 until now, the project owner has implemented measuring, monitoring ambient air quality and noise of Hoi Xuan hydropower project area. The results are shown in the table below:

Table 3.2: The analytic results of air quality and noise

Parameters	**Unit**	**The analytic results in 2012**				**The analytic results in 2013**				**QCVN 05; 06: 2009/BTNMT**	**QCVN 26:2010/BTNMT**
		K1	**K2**	**K3**	**K4**	**K1**	**K2**	**K3**	**K4**		
Temperature	(^oC)	37.4	37.0	37.2	37.8	20.1	20.3	19.5	23.4	-	
Humidity	(%)	54.1	54.7	54.4	53.9	76.9	76.7	77.2	75.2	-	
Wind speed	(m/s)	0.4 - 0.7	0.2 - 0.6	0.3- 0.8	0.5-1.0	0.3-0.4	0.4-0.5	0.2-0.3	0.2-0.4	-	
Noise	dB(A)	48-54	40 - 44	43 - 48	41- 45	63-67	57-61	51-53	52-55	**-**	**55**
Suspended	$\mu g/m^3$	180	240	145	157	210.5	135.6	108.3	228.5	**300**	**-**
CO	$\mu g/m^3$	1,800	2,100	2,050	1,942	3,879	3,050	2,150	1,920	**30,000**	
SO_2	$\mu g/m^3$	94.2	107.0	95.1	87.4	172.7	150.5	140.5	120.7	**350**	**-**
NO_2	$\mu g/m^3$	66.1	71.2	68.4	51.2	120.5	110.5	127.7	100.7	**200**	**-**
H_2S	$\mu g/m^3$	Not detected	1.2	1.5	Not detected	3.7	Not detected	4.2	Not detected	**42**	**-**

Source: The annual environmental monitoring reports of Hoi Xuan hydropower, carried out in 2012, 2013 by VNECO.

- *Monitoring locations*: The ambient air monitoring during construction phase of Hoi Xuan project has been done at 04 locations:

+ K1 (Coordinates: 0505409; 2261503): The dam construction area

+ K2 (Coordinates: 0505625; 2263957): The landfills No.3 (2,000 m away from downstream of dam)

+ K3 (Coordinates: 0505182; 2261910): The housing area of staff

+ K4 (Coordinates: 0508242; 2256724): Pu Luong Nature reserve

* Comments: Analytic results show that:

In 2012, the ambient air quality and noise at the project area was quite good, all parameters at the four monitoring points were in acceptance limit of the standard.

In 2013, this was the time of clearance activities and construction at the dam site and landfill No.3. The noise parameter was higher than the standard because of the operation of machinery, trucks. Particularly:

+The noise parameter at the dam construction site was 1.1 to 1.2 times higher than the standard.

+ The noise parameter at the landfill was 0.03 to 1.1 times higher than the standard.

+ The other parameters were in acceptance limit of the standard.

b) The current status of ambient air quality during the time of the ESIA preparation:

For a basis of environmental quality assessment in the project area at the time of the ESIA preparation, PECC4 in collaboration with the Centre of environmental monitoring techniques has performed sampling and analysis of the environmental components in the project area. The analyzed results are as below:

Table 3.3: The analytic results of air quality and noise in the ESIA preparation time (August 2014)

No.	Parameter	Unit	Results										QCVN 05:2013 (average in 1 hour)
			KK1	KK2	KK3	KK4	KK5	KK6	KK7	KK8	KK9	KK 10	
1	Noisy	dBA	58.6	56.4	55.2	66.3	60.1	57.2	54.8	53.9	57.6	56.6	
2	TSP	µg/m^3	85.4	78.5	92.4	154.9	106.5	95.1	68.5	69.2	98.8	106.2	300
3	PM10	µg/m^3	16.8	15.4	19.1	36.7	32.4	26.4	13.4	15.9	27.6	29.1	
4	CO	µg/m^3	3,562	3,628	3,748	4,570	3,925	3,584	3,215	3,062	3,958	4,012	30,000
5	SO_2	µg/m^3	49.5	47.2	45.1	60.3	52.8	46.8	43.1	42.1	56.4	53.8	350
6	NO_2	µg/m^3	50.6	51.9	46.2	62.2	50.6	47.5	44.6	43.9	57.2	55.4	200
7	O_3	µg/m^3	12.8	13.8	10.9	23.6	16.4	19.1	12.8	13.9	24.5	26.9	200
8	Pb.	µg/m^3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	

Locations of the sampling are specified in below table:

Table 3.4: Sampling locations of ambient air in the ESIA preparation time

Symbol	Sampling locations	Sampling time	Coordinate	
KK1	Kham village - Hoi Xuan commune - Quan Hoa district - Thanh Hoa province.	5 Aug. 2014	X = 2256931	Y = 508273
KK2	Chom Coc - Hoi Xuan commune - Quan Hoa district - Thanh Hoa province	5 Aug. 2014	X = 2258331	Y = 506526

KK3	Muop village- Hoi Xuan commune - Quan Hoa district - Thanh Hoa province	5 Aug. 2014	X = 2260393	Y = 506778
KK4	At damsite - Gia village - Thanh Xuan commune - Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2261940	Y = 505543
KK5	Vui village - Thanh Xuan commune - Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2263733	Y = 503508
KK6	Pan village - Phu Xuan commune - Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2266963	Y = 503430
KK7	N, Ruoi Ba- Phu Thanh commune - Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2272126	Y = 502231
KK8	Pom Co Muong- Phu Thanh commune - Quan Hoa district - Thanh Hoa province..	6 Aug. 2014	X = 2273358	Y = 502097
KK9	Tan Hung- Van Mai commune - Quan Hoa district - Thanh Hoa province..	7 Aug. 2014	X = 2276140	Y = 499418
KK10	Thanh Yen- Thanh Son commune - Quan Hoa district - Thanh Hoa province..	7 Aug. 2014	X = 2277163	Y = 490879

The change of air quality's parameters is presented in the below charts

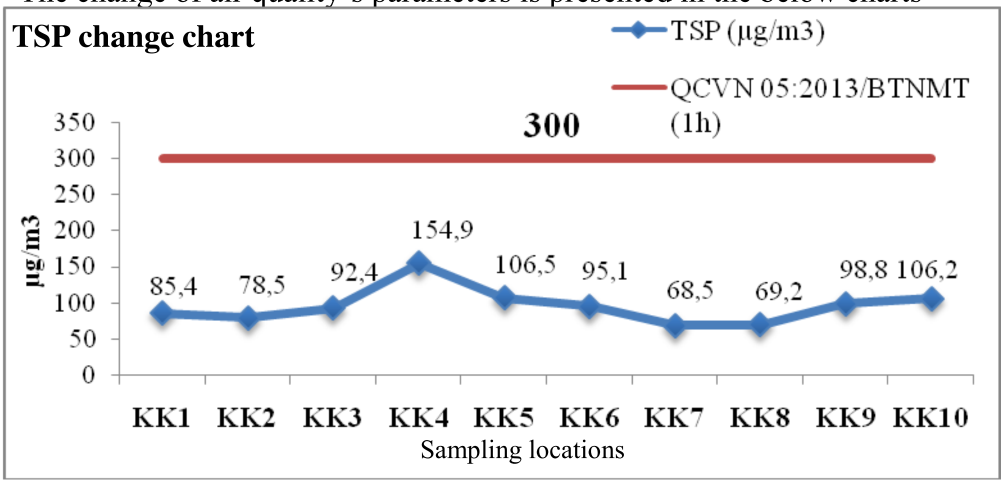


Chart of TSP parameter change

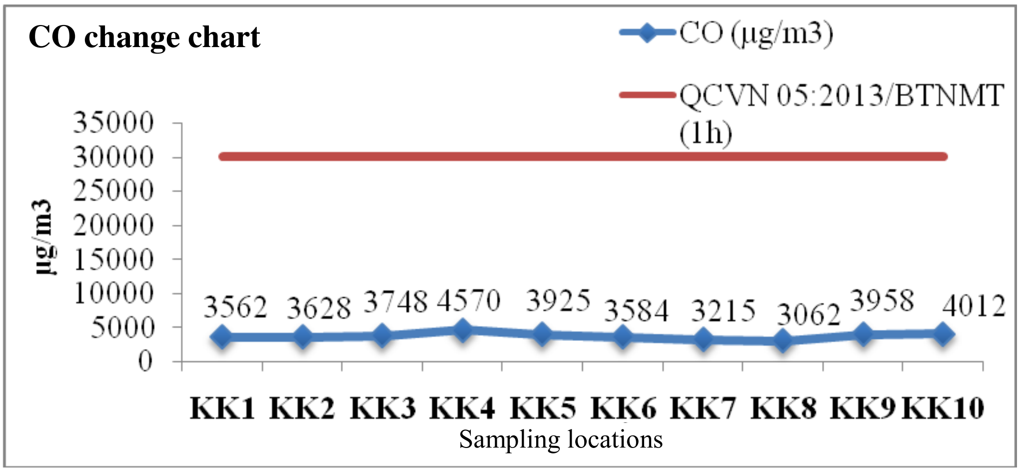


Chart of CO parameter change

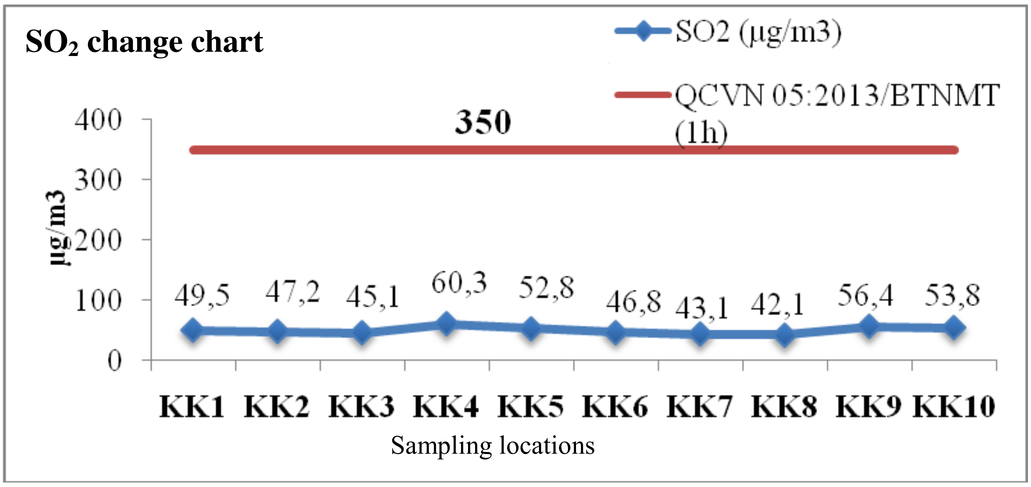


Chart of SO_2 parameter change

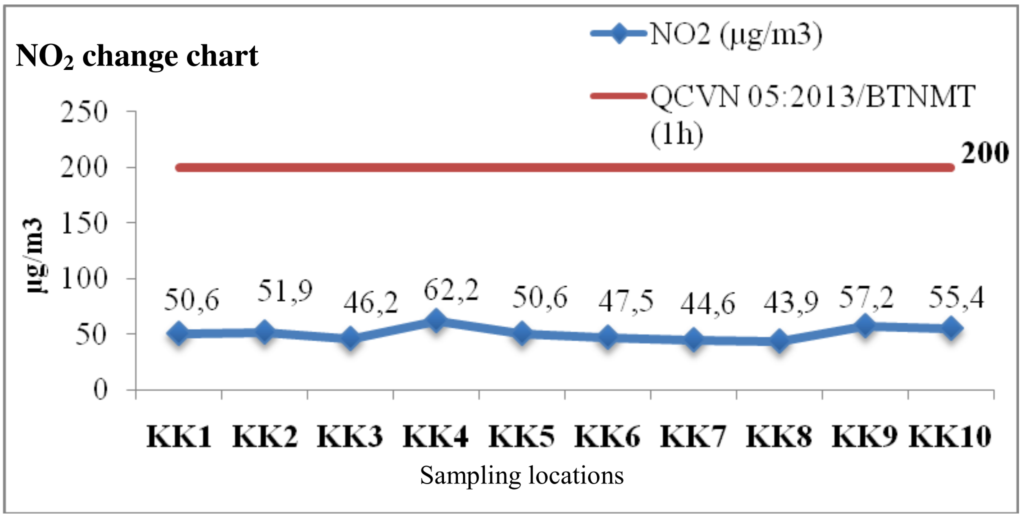


Chart of NO_2 parameter change

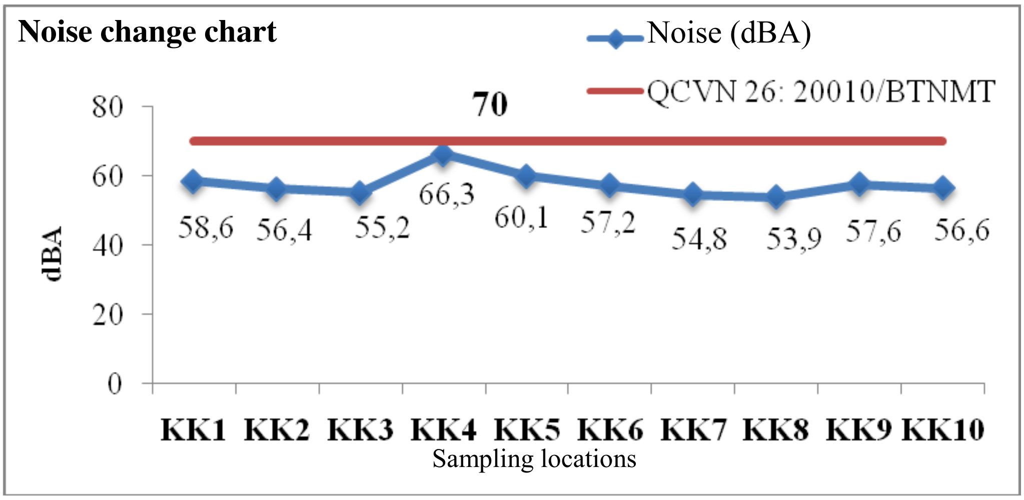


Chart of Noise change

Comments:

The concentrations of NO_2 SO_2, CO, O_3, and particles at the time of observations at the monitoring positions (as Figure No.7 - maps of sampling points for analyzing the environment - Hoi Xuan HPP) are under permissible limits as prescribed by QCVN 05: 2013/BTNMT (average 1 hour) - National technical Regulation on ambient air quality.

Levels of lead dust, PM10 have not been compared with the standard because there is no regulated value at average 1 hour.

Noise at the time of observations at the monitoring positions is less than QCVN 26:2010/BTNMT (From 6h - 21h) - National Technical Regulation on noise.

As comparison to the monitoring results in 2013, noise parameter in the current time (August 2014) is smaller. This is because the ambient air has been measured in the time that is not happen any construction activities.

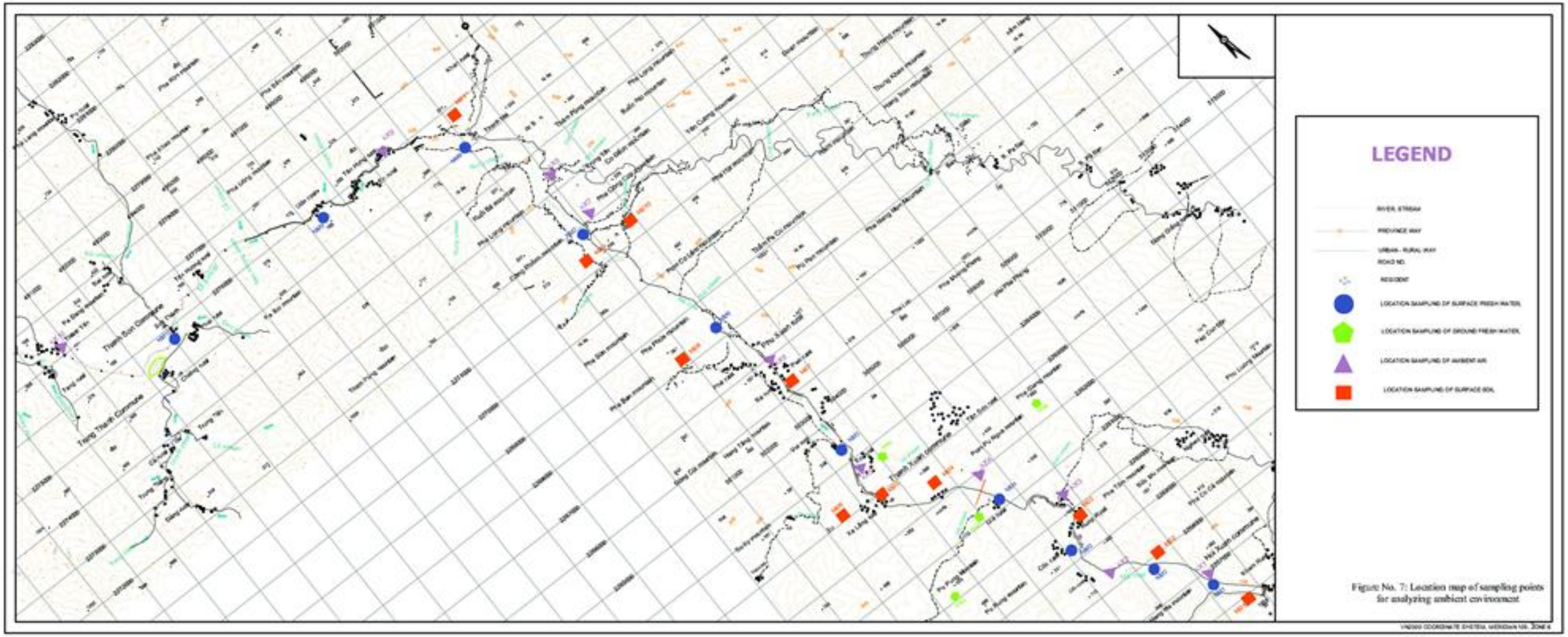


Figure No. 7: Location map of sampling points for analyzing ambient environment

3.3.5. Climate

- Ma river basin is characterized by the climate of the Northwest mountain area including the mountain areas of Northwest region from the western slope of Hoang Lien Son mountain chain. This is a rugged mountain and highland area, whose terrain is arranged nearly in one direction from the Northwest to Southeast, including the long-running mountains alternating valleys, rivers and wide highlands. Most of area is not more than 1,000 meters in height, but some mountain tops have the height of exceeding 2,000 meters in the Northwestern most (Lung Pu Si mountain chain) and at the border area between Vietnam and Lao PDR (Pu Den Ding and Pu Sam Sao mountain chains). Being hidden behind the Western slope of the Hoang Lien Son mountain chain, the climate of the Northwest mountain area is distinctly different from the rests of the Northern Region. It can be said among the classified climate zones of the Northern climate zone, the Northwest climate shows the most anomalous characters, as compared with the general climate of the whole region. The most important character of the Northwest climate is that there is a relative warm winter the maintenance of dry weather, which is the typical of the humid tropical climate.

- In general, due to the quite high terrain in this mountainous area (from 300 to 700 meters in height), the winter is therefore relative cold with possibility of having hoard frost and heavy frozen status. A remarkable feature of the Northwest climate, which related to the westernmost location of this area, is that the summer comes earlier than the other eastern areas. The effect of sucking air on the Southern terrain of the low-pressure area creates conditions for the earliest carrying the hot and humid air from the Bay of Bengal to this region. In the Northwest region, sometimes the temperature exceeds 30^0C right from March, then the hot season really begins in April and the month with the highest average temperature is generally June. The rainy season in this region also begins one month earlier (in April) and ends one month earlier (in September). The maximum rainfall is often in June or July.

- The special character of weather on Ma river basin is the dry and hot weather in the early summer and hail during the late winter to summer. In the valleys, the “front” effort of the upper Laos Mountains on the airflow from the western causes the dry and hot status. In Yen Chau, it averages more than 40 dry and hot days, of which including 10 extremely dry and hot days. However, the period of hot and dry wind in the Northwest region lasts only 2 months from mid-April to mid-June. Because of locating deeply in mainland, the effects of the storm on the Northwest mountain area are therefore limited. However, the remnants of low pressure of the storm moving to this area can cause prolonged heavy rain, which is very dangerous if the flashing flood phenomenon occurs.

The meteorological factors

a. Heat regime

The heat regime in the basin is divided into two seasons: the summer and the winter.

- The summer lasts from April to October with the hot and humid weather and high temperature. The highest temperature usually occurs in July, measured at Thanh Hoa T_{max} = 42^oC (in July 1910) and at Nhu Xuan T_{max}= 41.7^oC (in May 11th, 1996). In the space, the temperature increases from the upstream to the downstream of Ma river, which is consistent with the geographical location and the terrain conditions on the basin: At Tuan Giao T_{year} = 20.9^oC in the upstream and in the downstream at Thanh Hoa T_{year} = 23.6^oC.

- The winter lasts from November to March with the cold and dry weather and the temperature decreases rapidly, the low temperature usually occurs in January. The lowest temperatures were measured in January at a number of stations as follows: at Ma river T_{min} = -0.8^oC (January 3rd, 1974), in Son La T_{min}= -0.8^oC (January 1st, 1940), in Bai Thuong T_{min} = 2.6^oC (January 2nd, 1974) and in Thanh Hoa province T_{min} = 5.4^oC (in July 1910).

Here is the change process of temperature of the representative stations inside and outside of Ma river basin:

Table 3.5: Mean monthly temperature of the representative stations on Ma river (^oC)

Station\Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean
Tuan Giao	14.8	16.4	19.4	22.6	24.5	25.1	25.2	24.8	23.7	21.5	18.3	15.0	20.9
Dien Bien	16.2	17.9	20.7	23.6	25.4	26.0	25.8	25.5	24.6	22.5	19.1	16.1	21.9
Son La	14.8	16.6	20.2	23.1	24.7	25.1	25.0	24.6	23.6	21.4	18.1	15.3	21.0
Song Ma	16.4	18.1	21.3	24.3	26.1	26.3	26.1	25.7	24.9	22.8	19.6	16.4	22.3
Moc Chau	12.2	13.4	16.9	20.3	22.5	23.1	23.0	22.5	21.2	18.8	15.7	12.9	18.5
Mai Chau	15.8	18.1	21.2	24.7	26.9	27.6	27.6	27.0	25.7	23.4	20.4	17.6	23.1
Lac Son	16.4	17.5	20.3	24.1	27.1	28.5	28.4	27.6	26.3	23.8	20.5	17.4	23.2
Hoi Xuan	17.0	18.1	20.9	24.4	26.6	27.5	27.5	27.1	25.9	23.7	20.5	17.7	23.1
Nho Quan	16.6	17.5	20.0	23.8	27.0	28.6	29.0	28.2	26.8	24.3	21.0	17.9	23.4
Yen Dinh	17.1	17.7	20.1	23.6	27.0	28.6	28.9	28.0	26.7	24.4	21.2	18.1	23.4
Bai Thuong	16.9	17.7	20.2	23.9	26.9	28.3	28.5	27.8	26.6	24.3	21.2	18.1	23.4
Nhu Xuan	17.0	17.7	20.0	23.7	27.2	28.8	28.9	27.9	26.5	24.2	21.0	18.0	23.4
Tinh Gia	17.1	17.5	19.7	23.4	27.1	29.1	29.4	28.4	26.9	24.5	21.4	18.3	23.6
Thanh Hoa	17.0	17.4	19.8	23.5	27.2	28.9	29.2	28.3	27.0	24.6	21.5	18.4	23.6

b. Rain regime

The rain in basin changes according the time and the space, it is divided into two distinct seasons: rainy season and dry season.

The rainy season has the Southwest monsoon blowing from Bengal Bay, which carries more water vapor, hot, humid and rainy. If it identifies the rainy season including the months, which have the rainfall greater than 100mm, then Ma river has the rainy season from April to September (in the upstream area), and from May to October (in the downstream area). The rainfall of the rainy season accounts for 80 – 85% total annual rainfall, the largest rainfall months are June, July, August (in the upstream area), and July, August, September (in the downstream area).

- The dry season begins from October or November and finishes in March – April in next year, the lowest rainfall months are January, February, March, the rainfall in this season account for 10 – 30% total annual rainfall. The rainfall distribution is unevenly in the basin shown in Table 3.6. The basin area part belongs to the territory of Lao PDR account for 39% total basin area, according to the foreign document, the rainfall ranges from 1200 to 1,500mm, in which the rainfall at Sam Nua station is 1,500 mm, this station is 180km far from Moc Chau station of Vietnam, at Luang Prabang of 1,250mm rainfall.

Table 3.6: Monthly rainfall at the representative stations in Ma river basin

Station\Month	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Total**
Tuan Giao	23	29	57	129	214	307	306	282	135	70	40	21	1,616
Dien Bien	23	32	52	106	192	267	304	306	150	67	34	22	1,556
Son La	19	29	50	113	197	257	269	274	132	68	35	15	1,459
Moc Chau	22	22	42	101	181	245	265	323	264	126	38	15	1,645
Ban Kha	33	34	44	126	187	226	256	341	153	79	41	21	1,543
Sop Cop	19	20	43	108	164	214	232	237	115	63	32	20	1,268
Song Ma	13	18	36	91	157	218	219	233	112	41	25	14	1,179
Mai Chau	14	12	30	95	199	267	314	336	292	171	37	11	1,779
Lac Son	30	29	52	98	224	272	303	362	311	212	86	25	2,006
Yen Chau	11	15	39	98	150	212	220	249	134	61	21	11	1,222
Hoi Xuan	15	17	34	93	224	260	341	342	279	147	40	16	1,809
Nho Quan	25	26	52	92	191	242	264	347	348	235	89	25	1,935
Xam Nua	21	21	38	92	165	223	241	294	241	115	35	14	1,500
Luang	10	10	30	100	160	150	230	290	160	70	30	10	1,250

(Source: Report of hydrometeorology established by PECC4)

c. Humidity regime

The humidity on Ma river changes not large increasing gradually from the upstream to the downstream. Mean annual relative humidity in the basin ranges from 80% to 86%. The humidity regime on Ma river is corresponding to the summer and the winter.

- In the summer, the air is very hot and humid. The highest humidity usually occurs in August to October and the mean humidity in these months ranges from 85% to 88%.

In the summer, the weather is dry and cold, the humidity decreases rapidly, the lowest humidity usually occur in January to March. The lowest relative humidity was measured at some stations as follows: At Ma river R_{min} = 6% (February 1967), Son La R_{min} = 6 % (March 1940) Bai Thuong R_{min} = 18 % (January 1961) and Thanh Hoa R_{min} = 9% (April 1930).

- Change of the relative humidity air at the representative stations inside and outside of Ma river basin, which are shown in Table 3.7.

Table 3.7: Mean monthly relative humidity at the representative stations at Ma river (%)

Month/Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean
Tuan Giao	83	80	78	80	83	86	87	88	87	86	85	84	84
Dien Bien	84	80	80	82	83	85	87	88	87	86	84	84	84
Son La	79	76	72	75	78	84	85	86	85	81	81	80	80
Song Ma	81	77	75	77	81	86	88	88	87	85	84	83	83
Moc Chau	88	88	85	84	83	85	87	89	89	87	86	86	86
Mai Chau	80	79	79	80	80	83	83	86	86	84	82	80	82
Lac Son	85	86	87	86	83	84	85	87	88	86	85	84	86
Hoi Xuan	86	85	85	84	83	85	86	87	88	87	86	85	86
Nho Quan	85	87	89	88	84	83	83	87	87	85	83	82	85
Yen Dinh	86	88	90	90	86	84	84	88	88	86	84	83	86
Bai Thuong	87	88	89	89	85	84	84	87	86	85	84	84	86
Nhu Xuan	88	89	90	90	84	80	80	86	87	85	84	84	86
Tinh Gia	88	80	92	91	85	80	79	84	87	85	83	84	86
Thanh Hoa	85	88	91	90	85	81	81	85	86	84	82	82	85

d. Evaporation regime

The evaporation changes annually on the basin in contrast to the change of rainfall, temperature, humidity: somewhere has much rain and large humidity, then the evaporation is small and vice versa. At Lac Son, Bai Thuong, the rainfall X ≈ 2,000 mm then the evaporation $Z_{pic.year}$ = 770 mm, while the small rain area as Ma river has the rainfall X ≈ 1,200mm then the annual evaporation reaches $Z_{pic.year}$ > 900 mm. Via the analysis of evaporation on all basin shown that the evaporation change largely according to the time and the space, which was shown in the following table:

Table 3.8: Monthly evaporation the representative stations at Ma river (mm)

Month/Stationn	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Tuan Giao	60	71	94	91	87	64	61	58	60	60	54	54	815
Dien Bien	68	83	100	92	93	75	65	58	59	68	67	63	892
Son La	73	90	123	114	100	69	61	55	58	60	63	67	939
Song Ma	72	85	113	112	106	70	62	58	63	67	62	63	933
Moc Chau	55	61	92	98	105	86	80	63	58	60	58	58	874
Mai Chau	69	70	85	90	97	82	82	66	63	70	68	68	910
Lac Son	48	44	50	63	85	75	75	58	54	59	56	57	726
Hoi Xuan	42	45	56	66	79	67	65	55	49	48	42	49	664
Nho Quan	66	52	54	68	104	106	112	82	73	87	84	81	970
Yen Dinh	63	50	50	53	82	92	97	67	63	81	79	77	854
Bai Thuong	48	42	44	54	77	80	85	67	64	73	70	65	770
Nhu Xuan	48	39	42	53	99	126	134	86	67	80	79	71	925
Tinh Gia	46	33	34	45	86	114	123	88	67	74	75	65	850
Thanh Hoa	53	39	38	48	85	97	104	76	68	79	75	70	832

(Source: Report of hydrometeorology established by PECC4)

Distribution of monthly evaporation losses in year is determined based on the distribution of the evaporation that was measured by Piche pipe at Hoi Xuan station. The calculation results of mean monthly evaporation loss are shown in the following table:

Table 3.9: Evaporation loss of reservoir

Feature calculation	Month												Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
ΔZ	20	21	26	31	37	31	31	25	23	23	20	23	310

e. Wind regime

Due to the influence of basin terrain morphology is located between two mountain ranges run parallel according to the northwest – southeast direction, so the wind regime here is divided clearly:

- The summer: The Southwest wind blowing from Bengan bay brings the steam, so the weather is humid, hot and rainy, but the wind pass the mountain ranges in the North of the basin, the airflow becomes dry and hot, it causes the phenomenon of “Foehn”, also known as the wind "Lao" in the period from March to July. The strongest wind usually occur in the summer, the maximum wind speed is greater than 40m/s.

- The winter: The Northeast monsoon blows into the basin, which is blocked by Hoang Lien Son mountain range and the mountain range between Da river and Ma river, so the Northeast monsoon has the fewer influence to the upstream of Ma river. This causes the dry, cold winter coming earlier than the other regions.

3.3.6. Hydrology

a. Geographic location and general characteristics of river, basin

Ma river is originated from the mountainous area Pu Huoi Long (Lai Chau district) at the elevation of 2,179m, the basin terrain are mainly the mountain interspersed the plateau. Average elevation of the basin is about 760m, the highest peak reaches over 2,000m.

Limitation of Ma river basin as follows: the basin is contiguous to Da River basin in the Northeast, the boundary is the watershed between Ma river and Da River including the high mountain over 1,000m of height. The basin is contiguous to Boi River in the Southeast, contiguous to the watershed of Ma river and Me Kong River in the West, in the Northwest contiguous to the high mountain area Pu Huoi Long divided between Ma river, Nam Ron and Nam Muc Rivers, and the basin is contiguous to the sea in the Southeast.

Thus Ma river basin is located between two high mountain ranges running parallel according to Northwest – Southeast direction: the first mountain range belongs to the left bank of Ma river extending from Tuan Giao to Hoi Xuan, the second mountain range belongs to the right bank of Ma river and Chu river. The best features of the basin topography are the plateau evident in the upstream, downstream areas.

Hoi Xuan hydropower project is located on the main branch of Ma river, which is reviewed, studied according to the selected alternative of dam site located in Hoi Xuan commune, Quan Hoa district, Thanh Hoa province. Geographical coordinates and the morphological characteristics of the basin are shown in the table as follows:

Table 3.10: Morphological characteristic calculated to construction alignment

Alignment	North latitude	East longitude	Flv (km^2)	Ls (km)	X (mm)
Selected alternative	20°26'	105°2'	13,595	295	1,500

b. Annual flow

Calculating the annual flow series for the project

Hoi Xuan hydrological station is located on Ma river basin, far from the main dam site about 9km in the downstream. The area of the basin is 15,500 km^2. Select the similar methods for calculating the annual flow series of Hoi Xuan hydropower project, the calculated results are shown in table as follows:

$$Q_{tđ} = Q_{tv} K_F$$

In which: $K_F = \frac{F_{tđ}}{F_{tv}}$

- $Q_{tđ}$,Q_{tv}: flow at the dam and at hydrological stations

- $F_{tđ}$, F_{tv}: The catchment area until the dam and hydrological station.

The results are shown in the following table:

Table 3.11: Features of the annual hydrological flow of Hoi Xuan HPP

Station-Dam site	**F (km^2)**	**Q_o (m^3/s)**	**M_o (l/skm^2)**	**Cv**	**Cs**	**Q_p (m^3/s)**				
						10%	15%	50%	85%	90%
Hoi Xuan station	15,500	288	18.6	0.23	0.46	376	357	283	219	206
Hoi Xuan dam site	14,975	244.1	18.6	0.23	0.46	330	313	248	192	180
Trung Son dam site	13,175	235	18.6	0.23	0.46	319	303	241	187	176

(Source: Report of hydrometeorology established by PECC4)

In which:

F: Basin

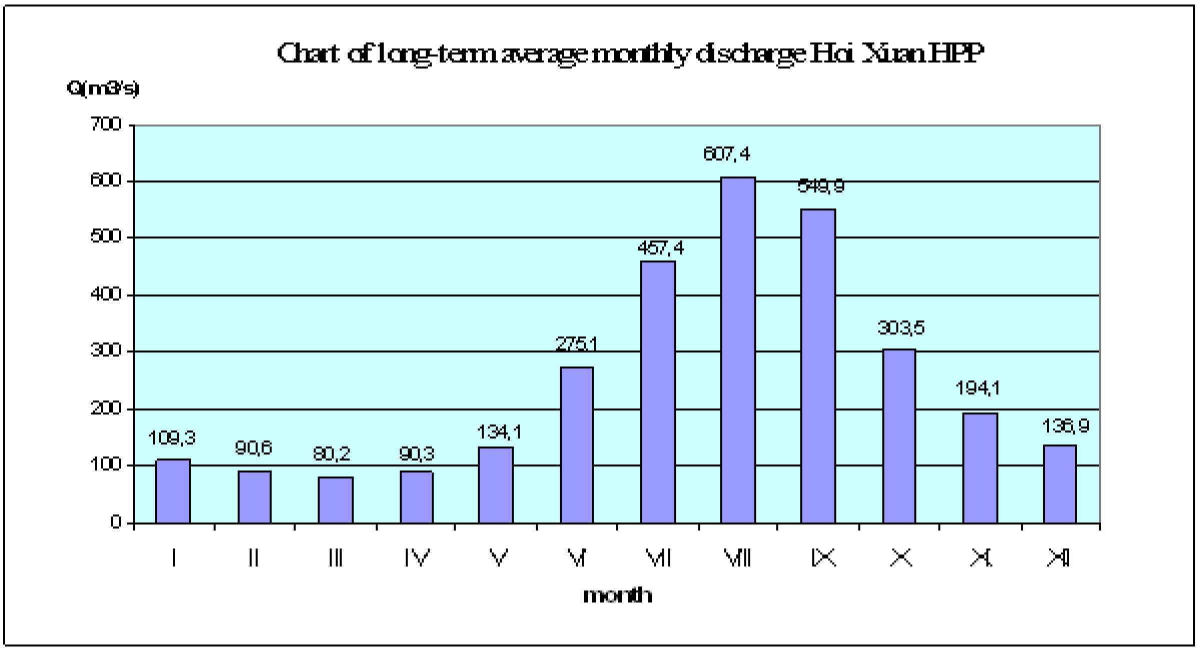
Q: Long-term average annual discharge

M_o: Long-term average flow module

C_v: Variation coefficient

C_s: Dispersion coefficient

Q_p: Discharge corresponding to design frequencykế



Based on the criteria exceeding average, the flow regime at dam site is divided into two seasons: Flood season and Dry season.

Flood on the river starts from June and finishes in August (extending 5 months), the dry season is from November to May in next year.

The flow in flood season accounts for 67% total the annual flow, and 33% of total the annual flow is the flow in the dry season.

Table 3.12: Distribution of the seasonal flow according to design frequencies

Frequencies	**Flood season (VI-X)**		**Dry season(XI-V)**		**Year**
	α(%)	W (10^6m^3)	α(%)	W (10^6m^3)	W (10^6m^3)
P=10%	72%	7,461	28%	2,966	10,427
P=50%	67%	5,251	33%	2,584	7,835
P=90%	65%	3,681	35%	2,017	5,697

Table 3.13: Distribution of monthly flow of some typical years

Frequency	**Feature**	**Month - Year**												
		VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	Year
10%	Q(m^3/s)	409	537	740	729	420	256	183	153	130	112	114	179	330
50%	Q(m^3/s)	279	313	524	496	384	247	146	139	98.8	83.6	107	161	248
90%	Q(m^3/s)	84.4	215	373	301	426	170	115	94.5	84.3	85.8	82.4	135	180

(Source: Report of hydrometeorology established by PECC4)

c. Flood flow

Design peak flood discharge

Peak flood discharges corresponding to the design frequencies (Q_{maxp}) are calculated from the design discharge at Cam Thuy station.

Table 3.14: Design peak flood discharge at some alignments

Alignment	**F(km^2)**	**$Q_{0.1\%}$**	**$Q_{0.2\%}$**	**$Q_{0.5\%}$**	**$Q_{1\%}$**	**$Q_{2\%}$**	**$Q_{5\%}$**	**$Q_{10\%}$**
Cam Thuy station	17,500	15,000	13,600	11,700	10,300	8,880	7,090	5,760
Hoi Xuan dam site	13,595	13,600	12,200	10,500	9,200	7,950	6,340	5,140
Trung Son dam site	13,175	13,400	12,100	10,400	9,080	7,840	6,250	5,070
Value of n		0.61	0.59	0.58	0.57	0.56	0.55	0.55

(Source: Report of hydrometeorology established by PECC4)

Frequency	Period	**Month**						
		XI	XII	I	II	III	IV	V
	1-5	461	255	196	137	141	190	215
	6-10	432	238	194	165	153	181	245
	11-15	438	249	194	174	164	172	293
	16-20	380	219	173	162	162	221	479
5%	21-25	263	211	175	148	135	187	480
	26-31	243	250	167	151	184	216	554
	1-10	472	258	207	165	160	216	255
	11-20	458	249	195	181	178	229	504
	21-31	263	262	180	160	188	224	616
	1-5	378	228	176	127	126	163	189
	6-10	360	214	173	143	132	154	209
	11-15	367	215	170	148	136	149	237
	16-20	324	196	157	141	135	181	363
10%	21-25	242	188	156	133	120	164	367
	26-31	223	208	150	133	154	183	453
	1-10	394	231	182	144	139	182	224
	11-20	383	216	172	155	146	187	391
	21-31	242	219	160	141	158	193	501

Volume of the largest flood

Calculated to Hoi Xuan dam site, the volume of design flood is as follows:

Table 3.15: Flood volume according to design frequencies

Frequencies %	Q_{max} (m^3/s)	Flood volume W (10^6 m^3)			
		1	3	5	7
0.1%	13,585	1,037	2,188	2,776	3,086
0.5%	10,175	802	1,705	2,181	2,460
1%	9,200	703	1,502	1,931	2,197
5%	6,340	486	1,056	1,382	1,620
10%	5,140	395	868	1,152	1,377

(Source: Report of hydrometeorology established by PECC4)

Maximum design discharge for flow block

Maximum design discharges for the flow block at the construction alignments are calculated from the maximum mean daily discharge at Hoi Xuan station.

The calculated results of the maximum flow in the period 10 days of the dry season months are shown in table as follows:

Table 3.16: Calculated results of maximum mean daily discharge of dry season months in the period of 5 days, 10 days

Frequency	**Time**	**month**						
		XI	XII	I	II	III	IV	V
	1-5	461	255	196	137	141	190	215
	6-10	432	238	194	165	153	181	245
	11-15	438	249	194	174	164	172	293
	16-20	380	219	173	162	162	221	479
5%	21-25	263	211	175	148	135	187	480
	26-31	243	250	167	151	184	216	554
	1-10	472	258	207	165	160	216	255
	11-20	458	249	195	181	178	229	504
	21-31	263	262	180	160	188	224	616
	1-5	378	228	176	127	126	163	189
	6-10	360	214	173	143	132	154	209
	11-15	367	215	170	148	136	149	237
	16-20	324	196	157	141	135	181	363
10%	21-25	242	188	156	133	120	164	367

Frequency	Time	month						
		XI	XII	I	II	III	IV	V
	26-31	223	208	150	133	154	183	453
	1-10	394	231	182	144	139	182	224
	11-20	383	216	172	155	146	187	391
	21-31	242	219	160	141	158	193	501

(Source: Report of hydrometeorology established by PECC4)

Maximum design discharge for diversion

Maximum discharge for designing the temporary works to serve the construction diversion is calculated from the maximum discharge immediately appears in each month diversion.

At the construction alignment, the maximum design discharge for diversion is calculated from the maximum discharge observed at Bao Lac station (1960 – 2006).

Table 3.17: Calculated results of maximum discharge in dry season months

Frequency	Month						
	XI	XII	I	II	III	IV	V
p=5%	723	335	236	253	292	353	839
p=10%	585	288	212	216	235	302	694

(Source: Report of hydrometeorology established by PECC4)

d. Volume of sediment deposited in reservoir

Due to Hoi Xuan hydropower project is the downstream cascade of Trung Son hydropower project, which has studied the investment project, therefore the sediment into dam site of Hoi Xuan hydropower project is equal to total of the sediment discharged from Trung Son HPP and the sediment of the between region. Calculated results of the sediment into the reservoir area shown in the table as follows:

Table 3.18: Annual sediment into reservoir of Hoi Xuan HPP

Sediment density (ton/m^3)		**Sediment from Trung Son reservoir**				**Sediment from the between region**				**Sediment into Hoi Xuan reservoir**					**Sediment deposited in reservoir**	
γ_{ll}	$\gamma_{dđ}$	W_{ll}(10^6 T/year)	W_{dd}(10^6T/year)	V_{ll}(10^6 m^3/year)	V_{dd}(10^6 m^3/year)	W_{ll}(10^6T/year)	W_{dd}(10^6T/year)	V_{ll}(10^6 m^3/year)	$V_{dđ}$(10^6 m^3/year)	W_{ll} (10^6T/year)	W_{dd}(10^6T/year)	V_{ll}(10^6 m^3/year)	$V_{dđ}$(10^6 m^3/year)	Total	E	V_{ll}(10^6 m^3/year)
1,182	1,554	0.433	0.0	0.3661	0.0	0.052	0.01	0.044	0.007	0.485	0.01	0.41	0.007	0.417	0.37	0.159

(Source: Report of hydrometeorology established by PECC4)

Note: W: Total amount of sediment (ton); V: volume of sediment; ll: suspended load; dd: bed load; E: sedimentation coefficient

Thus, total amount of annual sediment deposited in Hoi Xuan reservoir with the selected alternative is 159,000 m^3/year.

3.3.7. Soil all kinds

According to the results of field studies and soil map in the project area, there are several soil group sand types in the project basin, as follows:

Table 3.19: Soil types in the project basin

Soil Classification of Vietnam	Soil Classification of FAO-UNESCO
I- Đất Phù sa 1. Đất Phù sa sông Mã	**I- Fluvisols** 1. Umbric Fluvisols
II- Đất Đen 2. Đất Đen trên sản phẩm phong hoá của đá vôi	**II- Luvisols** 2. Calcic Luvisols
III- Đất Xám- Bạc màu 3. Đất xám-bạc màu trên các sản phẩm phong hoá của đá macma axit	**III- Haplic Acrisols** 3. Arenic Acrisols
IV- Đất Đỏ vàng (đất Feralit)	**III- Ferralsols**

4. Đất Nâu đỏ trên đá macma trung tính và bazơ 5. Đất Đỏ nâu trên đá vôi 6. Đất Đỏ Vàng trên các đá sét và đá biến chất 7. Đất Vàng đỏ trên đá granit	4. Rhodic Ferralsols 5. Rhodic Ferrasols 6. Rhodi-Leptic Acrisols 7. Chromi- Leptic Acrisols
V- Đất Mùn - Vàng xám (đất Mùn - Feralit) 8. Đất Mùn - Vàng đỏ và Mùn - Vàng xám trên núi	**IV- Humic Acrisols** 8. Humic Acrisols, Humic Ferralsols
VI - Đất Mùn Alit trên núi cao 9. Đất Mùn Alit trên núi cao	**V- Alitic Humic Acrisols** 9.Alitic Humic Acrisols
VII- Đất Dốc tụ 10. Đất Dốc tụ	**V- Mixed Gley Sols** 10. Mixed Gley Sols

Main characters of soil types in the project basin

1. The Fluvisols (P)

The Fluvisols is dispersedly distributed into the narrow strips along Ma river and tributary streams in Quan Hoa and Muong Lat districts (Thanh Hoa province) and in Van Mai commune, Mai Chau district, Hoa Binh province, etc. Its main characteristics are as follows:

- The Fluvisols on Ma river has a light to medium mechanical composition

- It has acid property with the pH_{KCl} value ranges from 4.5 to 5.5

- The percentage of organic matter averages from 1.16 to 1.50%

-The content of total soil nitrogen ranges from 0.11 to 0.15%.

- It is poor in phosphate with the P_2O_5% averages 0.06%.

The Fluvisols of the reservoir basin is quite rich in fertility, concentrated in the alluvial grounds along the river, which are extended with deposits annually. It is suitable for crops, beans and mulberry, etc.

2. Haplic Acrisols (X)

The Haplic Acrisols formed on the weathered products of granite or ancient alluvial and deluvial (called Arenic Acrisols) is dispersedly distributed at the deluvial zone of slight-slope hill's base at the granite mountain zones. It is alternated with the deluvial ground at slope base of granite mountain or on the 8-12 meters high ancient alluvial steps in Muong Lat and Quan Hoa districts, Thanh Hoa province.

The Haplic Acrisols has the gray and white agricultural layer, which is poor in clay with the proportion of clay, is usually less than 10%. It has a light mechanical component, acid property and low fertility. It is divided into small spots for growing rice, crops, vegetables, beans and fruit trees, etc.

3. *Luvisols (R)*

The Luvisols in the basin includes one type formed on weathered products of limestone (called Calcic Luvisols) which is eroded and then deposited in the narrow valleys or gaps between the limestone mountains in Mai Chau district (Hoa Binh province), and in Van Mai commune and areas surrounding the Quan Hoa district, Thanh Hoa province.

The Luvisols is colored gray black to black with the layer thickness averages from 0.6 to 1.0 meter and high proportion of clay, generally more than 60%, and containing clay mineral like monmorilonit. Its cation exchange capacity (CEC) is quite high (60-80 miliequivalents per 100 grams of soil). It is light steep and rich in organic matter (4-5%) and nutrients; It is therefore favorable for growing rice, crops, vegetables, beans and fruit trees, etc. that bring the high productivity.

4. *Ferralsols*

The Ferrasols is usually distributed at the elevation of less than 900 meters and it is largest overburden layer in the basin.

As known, under the direct impact of hot and humid tropical climate, many original rock types were weathered quite deep and thorough. This made the primary minerals, apart from quartz, leave almost nothing. The clay mineral components of the Ferrasols, mainly kaolinite and haloizit, etc form the popular Feralit covering almost the areas of the hills and low-medium mountains whose elevation of less than 900 meters in Ma river basin.

The Ferrasols in the basin includes four types as follows:

- The Ferrasols formed on the neutral and basic igneous rocks (called Rhodic Ferralsols).

- The Ferrasols formed on limestone (called Rhodic Ferrasols).

- The Ferrasols formed on clay and metamorphic rock (called Rhodi-Leptic Acrisols).

- The Ferrasols formed on granite rock (called Chromi- Leptic Acrisols).

****) The Ferrasols formed on the neutral and basic igneous rocks (Fk)***

The weathered crust of basalt - Suoi Be formation in the basin is 15-20 meters deep. Therefore, the reddish brown coating soil layer is very thick and rich in nutrients.

- It has a heavy mechanical composition because of the high clay proportion of more than 50%. If including physical clay (particles smaller than 0.01mm) this proportion can reach 80-90%. However, its property is nothard and discrete, so it is therefore very porous, airy, good capacity of water retaining and permeability; this will limit the washing away and surface erosion processes.

- It has high proportion of organic matters with the proportion of humus can average 34%.

- It is quite rich in total soil nitrogen (total N% generally ranges from 0.15 to 0.20% as forest is available, but after years of cultivation it can still achieve 0.10 to 0.15%).

- It is quite rich in total soil phosphate with total P_2O_5 % can average from 0.2-0.3%.

- However, it is poor in kalium soil phosphate (K_2O %) and digested easily.

In the dry season, it usually gets the drought status. The moisture of surface layer is usually lower than the humidity causing wilting, so for the plants have root systems plugging shallowly into the soil layer, they are easily wilted due to lack of water.

The Rhodic Ferralsols distributing in Quan Hoa and Thach Thanh districts (Thanh Hoa province) is quite fertile, it is therefore exploited and utilized to develop coffees, teas, fruits, corns, potatoes, and beans all kinds, etc. that bring high and stable productivity. However, the operation of encroaching on forest plots of the Rhodic Ferralsols for planting agricultural crops should be terminated quickly; if not the hills and hillock areas in Thanh Hoa province will get drought status more and more.

) The Ferrasols formed on limestone (Fv)

The Ferrasols formed on the weathered products of limestone distributing concentratively in Moc Chau district (Son La province) and in Co Luong commune, Mai Chau district, Hoa Binh province; and on the limestone mountain area, which disperses along Ma river closely to the Quan Hoa town, Thanh Hoa province. Its main characteristics are as follows:

- The soil layer of Ferrasols is 0.7-1.0 meter thick.

- Its cation exchange capacity (CEC) usually ranges from 16.60-15.50 miliequivalents per 100 grams of soil

- It has slightly acid-nearly neutral property (the pH_{KCL} value ranges from 5.5 to 6.5)

- The proportion of organic matter ranges from 2.5 to 4.5%, the soil therefore has strength structure of small clot. As a result, the Ferrasols is well-structured, porous, airy, high permeability and easy drainage.

- Its total soil nitrogen (N%) usually ranges from 0.12 to 0.50%.

- Its total soil phosphaste (P_2O_5 %) is quite rich averaging more than 2.5% but poor in disgested phosphaste content (in many soil samples, this content reaches only 2-3 milligrams per 100 grams of soil).

- Its total soil kalium (K_2O%) is quite rich averaging more than 1.1% (for all layers), but poor in disgested kalium content.

- Average analysis data described above shows that the Ferrasols formed on the weathered products of limestone has high fertility and nutrients, it is suitable for many crops. Therefore, local people took the advantage of exploitation and usage to create fixed milpa for maize, sweet potato, manioc, vegetables and beans all kinds, etc that bring high and stable productivity.

5. ***The Ferrasols formed on clay and metamorphic rocks (called Rhodi-Leptic Acrisols, Fs-Fj)***

The Ferrasols formed on striking yellow and red clay and metamorphic rocks, distributed widely in Xuan Nha commune, Moc Chau district (Son La province) and in Mai Chau district (Hoa Binh province); and on the low hill and mountain areas in Quan Hoa and Muong Lat districts of Thanh Hoa province. The weathered crust of clay rock in the basin is quite deep (4-7 meters), the cover layer of Rhodi-Leptic Acrisols averages 1.5-2.0 meters in thickness. The soil profile generated enough 3 distinct stratums A, B and C. The stratum C usually contains many pieces of original rocks, which are being weathered, and a lot of moisture, the large roots may plug deeply down.

Main characteristics of the Rhodi-Leptic Acrisols are as follows:

- It usually located on area of strongly dissected topography with slope ranges from 15-20^o; or steep slope of 30-35^o at somewhere.

- Due to the layering feature of shale and steep terrain, the soil layer on the slopes and the road slopes is easily slided during the rainy season.

- Its mechanical composition is medium to heavy, rich in clay, tight structure, less durable and porous than the Ferrasols formed on metamorphic rocks.

- The pH_{KCL} value is usually less than 4.0. Its cation exchange capacity (such as Ca^{++}, Mg^{++}) is quite low; all the soil layers therefore have the acid to strongly acid reaction.

- The proportion of organic matter changes depending on the vegetable matter (averaging from 1.50 to 2.50%, it can be achieved 2.50 to 3.50% where covered by forests).

- Total N% is quite rich ranging from 0.10 to 0.12% .

- Total K_2O % ranges from 0.40 to 0.53%.

- The both digested and total P_2O5 % are poor (P_2O_5%is usually less than 0.09%).

Ferrasols formed on clay and metamorphic rocks has a medium fertility and possibility of keeping moisture, but its surface layer easily gets the rapid exhaustion of rich soil after burning the forest and pruning away the milpa, local people in Mai Chau and Quan Hoa districts has taken the advantages of this soil type to develop bamboo and forest for material exploitation used for paper production; and the land areas with slope of less than15^o are also used to develop crops, industrial trees (especially sugar cane, tea) and fruit-trees.

6. Chromi- Leptic Acrisols (Fa)

Chromi- Leptic Acrisols formed on granite in the basin concentratively distributed in Muong Lat district (Thanh Hoa province) where the terrain is rugged, steep to very steep (usually from 25-35^o). Its main characteristics are as follows:

- It usually averages from 0.7 to 1meterin thickness and thinner than the Ferrasols formed on clay and metamorphic rocks. The stratum C is weakly weathered and relatively rigid original rock in which the small root scan not plug deeply.

- Mechanical composition of surface layer is quite slight, very rough because of mixing with a lot of gravel. It has discrete structures, so easily be washed away and eroded during the rainy season but rigid in the dry season.

- It has acid property with the pH_{KCL} value usually less than 4.0.

- It has the medium to low fertility: the Humus% is generally less than 1.50%, the N% ranges from 0.08 to 0.09%. Total P_2O_5% is very poor (less than 0.07%) but rich in K_2O% (varying from 0.12 to 0.15%).

- It easily gets the rapid exhaustion of rich soil and be degenerated after deforesting for farming development.

- The status of excessive deforestation and exploitation of forests, especially the watershed forests surrounding the border area between Vietnam and Laos, make the organic matter content and the possibility of soil in keeping moisture content decline rapidly. This will promote the process of land erosion, which has been being expanded strongly, being likely to spread over the area of the Chromi- Leptic Acrisols formed on granite in Moc Chau and Muong Lat districts, etc.

Therefore, in order to maintain the water source for the basin, not any measures are feasible and effective than the strict protection of all watershed forests because most of them are able to regenerate and grow up on all and areas of the Chromi- Leptic Acrisols formed on granite.

7. Humic Acrisols (HFs -HFa)

- The Humic Acrisols - Humic Ferralsols formed on high zone at the elevation of from 900-1,800meters in the medium-height mountain area around the borders between Thanh Hoa – Son La and Thanh Hoa-Hoa Binh. In addition, being formed on the medium- high mountain area around the border between Vietnam and Laos (such as Phu Quan-1,888m, Pu Si Lung-1,287m, Phu Luong-1,676m and Chom Pan-1,700m), it mainly formed on clay rock, metamorphic rock and granite, etc with the following main characteristics:

- Its weathered crust has the thickness of more than 3-4meters at few places, average thickness of soil ranges from 0.6 to 1.2m. In the soil stratum, there could be mixed with the pieces of debris caused by weathered processes of feralit or by deluvial deposit.

- The organic matter content can reach 3.5-5.0% at some places where still covered by the forest; and there usually be a thin layer of leaves and dry twigs, which are being decomposed, on the ground surface.

- Its mechanical component is mainly light-medium clay.

- It has acid property with the pH_{KCL} value is usually less than 4.5.

- It has a low cation exchange capacity (CEC) averaging less than 15 miliequivalents per 100 grams of soil.

The Humic Acrisols - Humic Ferralsols formed on clay rock, metamorphic rock and granite in the basin has a medium-quite rich organic matter content and fertility. It usually distributed on the watershed ridge (also known as water parting) of a series of main rivers flowing into Ma river. On this land zone at somewhere still covered by forests, the soil layer is relatively rich inorganic matter, rapidly absorbent, greater water-holding capacity, is the watershed aquatic area of most of the streams in the basin. So the forest in this land zone must be strictly protected.

8. Alitic Humic Acrisols (HA)

The study of humid tropical soil in Vietnam showed that the Alitic weathering crust formed and developed on the high zone at the elevation of 1,800-2,800meters under the impact of cool, cold and humid climatic conditions with fog over the year.

Its original rock is weakly weathered and the soil coating layer is very thin. The main characteristics of the Alitic Humic Acrisols are as follows:

- Its tratums are quite thin, usually less than 0.60 meters. There are the stratums of A and C in the studied profile while the stratum B is mostly lost.

- The aluminum oxide content is much higher than the iron oxide.

- Due to the thick humic layer (probably 20-30centimeters), it has a high organic matter content usually reaching over 8%, but a weak decomposition. In the humus components, the humic acid content is as approximately much as the fulvic acid.

At the slight steep hill top, the podzolization process can occur: appearing the gray and white soil stratum A_2 beneath the gray humic stratum and the next is light yellow thin soil layer (about 20-30 centimeters) due to be less iron oxide.

- It is dripping wet all the time and quite acid, the pH_{KCl} value is usually less than 4.5.

The Alitic Humic Acrisolssoilis mainly distributed on the high and steep Phu Quan mountain (1,888 meters in height). However, due to the high content of organic matter and the thick humus layer, the Alitic Humic Acrisols is capable of storing and creating watershed flow for many rivers and streams. Therefore, the protection of forests is the most necessary measure to protect the frequent water source for the basin.

9. Mixed Gley Sols (D)

The Mixed Gley Sols formed and developed on the washed away products of the soils accumulated at the base of slight steep slopes or narrow slots, it is therefore dispersedly distributed. Its fertility as well as mechanical composition depends greatly on characteristics of the soils on the areas surrounding hill and mountain. The Mixed Gley Sols area is the place where the major farm produce and food are developed by local people in Mai Chau district (Hoa Binh province), Quan Hoa and Muong Lat districts of Thanh Hoa province.

- Mineral resources used as building materials

+ The mineral resources

According to the Correspondence No.49/DCKS-DC with regard to the Announcement of the mineral resources situation in the reservoir area of Hoi Xuan hydropower Project dated January 09th, 2007. Based on the submerged area caused by the reservoir in Hoi Xuan and Phu Le communes, Quan Hoa district, there has been investigated and established the geological and mineral maps in scale of 1:200,000 (Thanh Hoa-Vinh sheet, 1981) and 1: 50,000 (Muong Lat sheet, 2003). According to the survey results of current minerals (with the selected dam route alternative No.3), in the construction site as well as reservoir foundation, it has not discovered any other valuable mineral for industry yet besides the common minerals used as building materials.

Soil quality at the time of ESIA preparation

The analyzed results at the time of the ESIA implementation are as follows:

Table 3.20- a: Soil quality measured in the ESIA preparation time

No.	Location	Parameters					
		Humidity	Density (NTU)	Porosity ($mgCaCO_3/l$)	Tightness (mg/l)	pH (KCl (mg/l)	Volume for exchanging cation (CEC) (mg/l)
1	**MD1**	34.4	2.4	1.3	95	5.95	18
2	**MD2**	35.7	2.1	1.1	93	6.3	17
3	**MD3**	32.5	3.1	1.5	97	6.2	15
4	**MD4**	37.1	2.5	1.3	94	5.72	17
5	**MD5**	40.2	3.5	1.7	95	6.32	18
6	**MD6**	35.8	3.2	1.6	93	5.75	19
7	**MD7**	32.7	2.7	1.8	93	7.2	17
8	**MD8**	38.9	3.1	1.5	94	6.8	16
9	**MD9**	37.5	2.9	1.7	95	7.2	15
10	**MD10**	33.8	2.5	1.8	97	6.5	18
11	**MD11**	35.6	2.4	1.5	93	5.7	15
QCVN 03:2008/BTNMT (Agricultural land)		-	-	-	-	-	-

Table 3.20 - b: Soil quality measured in the ESIA preparation time (cont.)

No.	Locations	Parameters							
		K_2O (mg/l)	N- total (mg/l)	P- total (mg/l)	Pb (mg/l)	As (mg/l)	Cd (mg/l)	Fe (mg/l)	Cu (mg/l)
1	**MD1**	0.7	0.12	0.18	7.6	0.25	<0.01	2,737	75.1
2	**MD2**	0.5	0.15	0.2	5.7	0.19	<0.01	2,579	76.3
3	**MD3**	0.8	0.2	0.15	6.2	0.21	<0.01	2,673	73.5
4	**MD4**	0.7	0.15	0.16	5.8	0.23	<0.01	2,872	78.5
5	**MD5**	0.6	0.17	0.2	7.3	0.15	<0.01	2,739	75.5
6	**MD6**	0.7	0.16	0.17	8.1	0.23	<0.01	2,689	74.8
7	**MD7**	0.8	0.15	0.18	7.5	0.25	<0.01	2,589	73.1
8	**MD8**	0.7	0.13	0.19	6.9	0.18	<0.01	2,756	75.2
9	**MD9**	0.7	0.15	0.21	7.1	0.21	<0.01	2,865	77.3
10	**MD10**	0.5	0.23	0.19	5.2	0.17	<0.01	2,735	76.8
11	**MD11**	0.8	0.19	0.24	7.2	0.21	<0.01	2,854	75.3
QCVN 03:2008/BTNMT			**-**	**-**	**70**	**12**	**2**	**-**	**50**

(Agricultural land)								

Table 3.20 - c: Soil quality measured in the ESIA preparation time (cont.)

No.	Locations	Parameters							
		Zn (mg/l)	Cr (mg/l)	Mn (mg/l)	Coliform (MPN/100ml)	% clay (%)	% rough sand (%)	% smooth sand (%)	% rich soil (%)
1	**MD1**	65.1	16.98	30.4	30	41	4	3	52
2	**MD2**	66.2	15.71	29.5	15	38	8	4	50
3	**MD3**	62.7	14.8	25.9	35	40	5	2	53
4	**MD4**	63.7	15.2	27.9	30	41	4	5	50
5	**MD5**	62.4	17.1	25.8	15	45	5	3	47
6	**MD6**	63.7	18.5	29.8	15	40	5	3	**52**
7	**MD7**	65.7	16.2	26.8	30	42	6	4	48
8	**MD8**	66.8	15.7	29.8	35	41	5	4	50
9	**MD9**	65.5	16.4	28.9	30	37	9	4	50
10	**MD10**	67.5	15.8	29.7	35	40	8	5	47
11	**MD11**	66.8	17.5	28.7	15	41	4	5	50
QCVN 03:2008/BTNMT (Agricultural land)		**200**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

These 11 samples of soil are collected along Ma river with the specific points as follows:

Table 3.21: Sampling locations for soil quality in the ESIA preparation time

Symbol	Sampling location	Sampling time	Coordinates	
MD1	Kham village - Hoi Xuan commune- Quan Hoa district - Thanh Hoa province.	5 Aug. 2014	X = 2255904	Y = 508629
MD2	Chom Coc - Hoi Xuan commune- Quan Hoa district - Thanh Hoa province	5 Aug. 2014	X = 2258010	Y = 507662
MD3	Muop village- Hoi Xuan commune- Quan Hoa district - Thanh Hoa province	5 Aug. 2014	X = 2259756	Y = 506786
MD4	Rocky mountain – Thanh Xuan commune- Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2262413	Y = 504635
MD5	Pieng Heo Luong - Thanh Xuan commune- Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2262951	Y = 503515
MD6	Xa Lang village - Thanh Xuan commune- Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2263112	Y = 502524
MD7	Pan village- Phu Xuan commune- Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2266246	Y = 503515
MD8	Chom Mu - Phu Son commune- Quan Hoa district - Thanh Hoa province.	6 Aug. 2014	X = 2268188	Y = 501835
MD9	Than Chiang - Phu Thanh commune- Quan Hoa district - Thanh Hoa province	7 Aug. 2014	X = 2271290	Y = 501511
MD10	N, Ruoi Ba - Phu Thanh commune- Quan Hoa district - Thanh Hoa province	7 Aug. 2014	X = 2271404	Y = 502870
MD11	Nam Dien village- Van Mai commune- Quan Hoa district - Thanh Hoa province	7 Aug. 2014	X = 2275781	Y = 501192

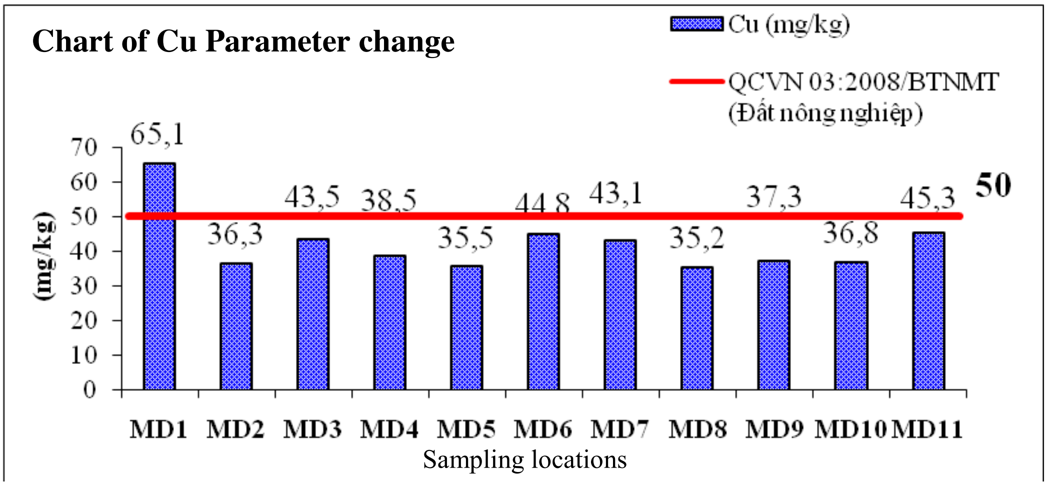


Chart of Cu parameter change

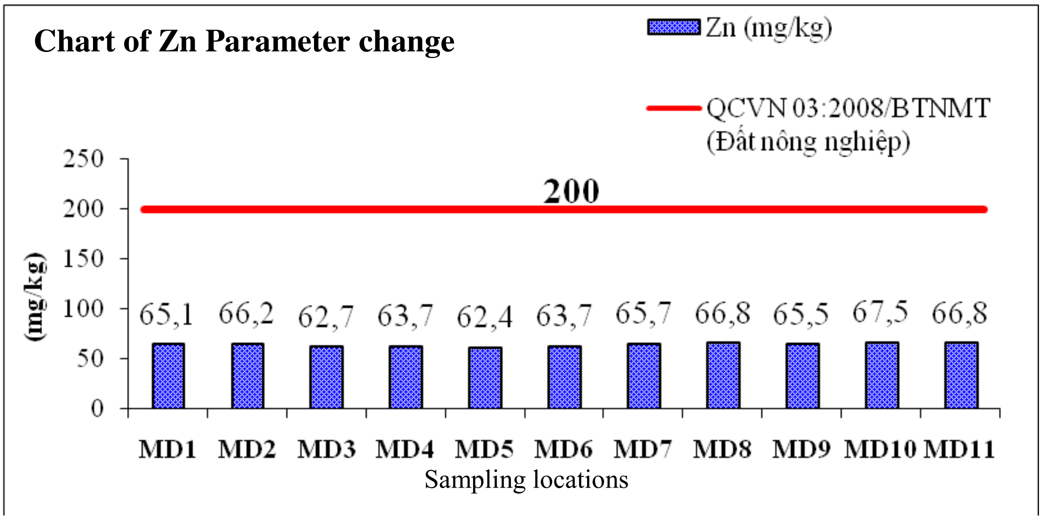


Chart of Zn parameter change

<u>Comments:</u>

The concentrations of Pb, As, Cd, Cu, Zn at the time of observations at sampling points (as figure 7) are below the permissible limits prescribed by regulation QCVN 03:2008/BTNMT - National Technical Regulation on limitations of heavy metals in soil (agricultural soil column).

However, Cu concentration in MDD1 point (In Kham Village - Hoi Xuan Commune - Quan Hoa district - Thanh Hoa province) is 1.3 times higher than the permissible limit prescribed by QCVN 03:2008/BTNMT.

Currently, there are no regulations to assess the level of contamination in the soil environment of the parameters pH (KCl), K_2O, Nitrogen - total, Phosphorus - total, Cr, Mn, coliform, so the contamination of the parameters is not assessed.

3.3.8. Mineral resources and building materials

3.3.8.1. Mineral resources

- Within reservoir foundation

According to letter No.49/DCKS-DC dated January 09, 2007 regarding announcement of mineral resources situation in Hoi Xuan HPP’s reservoir area, Thanh Hoa province, the reservoir area in the territory of communes Hoi Xuan, Phu Xuan, of Quan Hoa district was surveyed and investigated to make maps of geology and minerals. These maps are in 1: 200,000 (Thanh Hoa–Vinh sheets, 1981), and in 1: 50,000 (Muong Lat sheets, 2003). Also, according to the current mineral investigated results, and based on the selected alternative of dam site (alternative No.3), the project site and the reservoir have discovered only normal building materials while industrial value minerals have been not found yet.

- Outside of the reservoir:

According mineral map Quan Hoa ratio of 1:100,000, an iron ore mine is found near Hoi Xuan HPP’s reservoir area and the dam site in Phu Xuan commune, and another iron ore mine is also found in the dam site downstream in Hoi Xuan town. These mines still exist in the potential state, which have not been researched, explored, detailed assessed, and licensed for exploitation. Both the two mines are within the acquired land area for the project construction.

3.3.8.2. Building materials

The common building material in the study area is mainly sand and stone for construction. In addition to VNECO who is licensed to exploit sand mine at the territory of Kham village, Hoi Xuan commune in Ma river for Hoi Xuan HPP’s construction, there is not any enterprises/companies licensed to exploit sand, in there are only some households exploiting sand with small scale for their family purpose.

3.3.9. Water quality

3.3.9.1. Water quality of the project provinces

1. Thanh Hoa province

Surface water quality assessment of Thanh Hoa province had been implemented by Thanh Hoa environmental protection and monitoring Center – Thanh Hoa Department of Natural Resources and Environment in the period of 2006- 2010 at some rivers/lakes in the province. The observation result during this period showed that the surface water quality in some rivers, lakes had symptom of pollution at slight to severe levels; especially as parameters of BOD, TSS, Fe, Ammonium, NO_2, total of oil and grease. It is noted that total amount of oil and grease in most monitoring locations was many times higher than the regulated levels, even including locations of domestic water supply. This was due to the operation of boats of people which involved mining and fishing.

Particularly Ma river which was directly affected by the project, water quality was evaluated as follows:

- Concentrations of Suspended solids (SS):

Figure 3.1: Diagram of the SS concentration in Ma river

The chart shows that the concentrations of suspended solids at three of five monitoring points were 1.3 to 2.4 times higher than the standard.

In these observation points, Na Sai Bridge is the nearest Hoi Xuan HPP with 10 km from the dam to the downstream and near Quan Hoa town - Quan Hoa district. The parameter SS at this position in the years from 2006-2008 was 2 times higher than the regulated level. This is due to the impact of wastewater discharged without treatment directly from some furniture factories. This wastewater flowed along Ma river from the upstream Na Sai bridge. Specifically, at Co Luong residential area of Van Mai commune, Mai Chau district – Hoa Binh province had some furniture factories without wastewater treatment systems, and Quan Hoa district also had some pulp and bamboo toothpick factories.

However, in 2009-2010, water quality was improved significantly at all monitoring points. This suggests that the management of waste source and water quality in the province have been made more stringent.

- NO_2^- concentration:

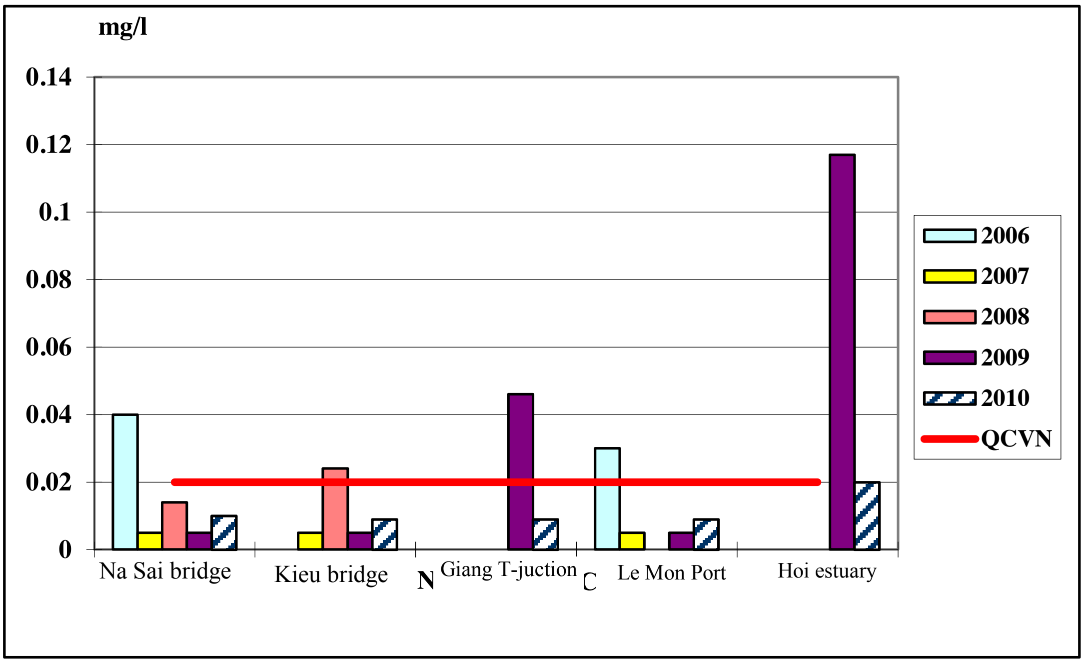


Figure 3.2: Diagram of the NO_2-concentration in Ma river

The chart shows that the concentrations of NO_2^- at all monitoring points are from 1.2 to 5.5 times higher than the standard.

2. Hoa Binh province

The water environment quality of Hoa Binh province is annually observed by Provincial department of Natural Resources and Environment in each district. In Mai Chau district (The affected district by the project), water quality has been observed at Dau Lake and Vang stream through 2012 and 2013.

Table 3.22: The analysis results of surface water quality in Mai Chau district - Hoa Binh province in 2012-2013

Parameters	Unit	In 2012				In 2013	QCVN:08 2008 Column B	
		MC1 Đ1	MC1 Đ2	MC2 Đ1	MC2 Đ2	MC1 Đ1	B1	B2
pH	-	7.43	7.21	8.21	7.52	7.15	5.5-9	5.5-9
BOD_5^*	mg/l	14	11	24	25	17	15	25
COD	mg/l	32	24	58	55	35	30	50
DO	mg/l	5.5	5.6	5.4	5.5	5.2	> 4	> 2
TSS	mg/l	50	30	68	60	21	50	100
Asen(As)*	mg/l	< 0.001	<0.001	0.001	0.001	< 0.001	0.05	0.1
Cd	mg/l	Not detected	Not detected	Not detected	Not detected	Not detected	0.01	0.01

Pb	mg/l	Not detected	Not detected	Not detected	Not detected	Not detected	0.05	0.05
VI	mg/l	0.00	0	0.00	0	0.00	0.04	0.05
Cu	mg/l	0.003	0.002	0.002	0.003	0.002	0.5	1
Zn	mg/l	0.005	0.004	0.010	0.012	0.004	1.5	2
Fe	mg/l	0.23	0.2	0.24	0.21	0.21	1.5	2
Hg*	mg/l	Not detected	Not detected	Not detected	Not detected	Not detected	0.001	0.002
NH_3	mg/l	0.34	0.36	0.115	1.12	0.31	0.5	1
FF^-	mg/l	0.00	0	0.002	0.002	KPT	1.5	2
NO_3^-	mg/l	3.18	3.14	3.54	3.62	3.22	10	15
NO_2^-	mg/l	0.005	0.004	0.013	0.012	KPT	0.04	0.05
CN	mg/l	Not detected	Not detected	Not detected	Not detected	KPT	0.02	0.02
Oil and	mg/l	0.07	0.06	0.10	0.1	0.06	0.1	0.3
Coliform*	MPN/100ml	745	752	1560	1830	723	7500	10000

Notes:

MC1D1: The surface water sample of Dau Lake - Mai Chau district- stage 1.

MC2D1: The surface water sample of Vang Stream - Mai Chau district- stage 1.

MC1D2: The surface water sample of Dau Lake - Mai Chau district- stage 2.

MC2D2: The surface water sample of Vang Stream - Mai Chau district- stage 2.

KPT: No analyzed.

The surface water in the Dau Lake - Mai Chau district was collected and analyzed in 2012 and stage 1 of 2013. The results show that only COD concentration is in excess of the standard. The others such as anion, cation and heavy metal were under acceptance limit of the standard. Through in comparison with other district, water quality of Mai Chau district was quite good. Only organic elements were slightly high. Thus, it should be interested to reduce the concentration of this parameter in the next time to ensure environmental quality.

3.3.9.2. Water environment quality of Hoi Xuan hydropower area

Water environment quality is monitored through years of project implementation.

From 2012 to now, the project owner has done measuring and monitoring water environment quality of Hoi Xuan hydropower area. The results are shown in the table below:

Table 3.23: The analytic results of surface water quality

No	Parameters	Unit	Analytic result in 2012		Analytic result in 2013		QCVN 08:2008/ BTNMT(B1)
			NM1	NM2	NM1	NM2	
1	Turbidity	NTU	734.7	167.7	189.1	195.5	-
2	pH	-	7.1	7.0	7	6.8	5.5-9
3	BOD_5	mg/l	72.0	16.0	17.06	18.9	15
4	COD	mg/l	112.0	23.7	27	28.3	30
5	DO	mg/l	6.5	6.8	5.5	5.2	≥4
6	Pb	mg/l	Not detected	Not detected	Not detected	Not detected	0.05
7	NH_4^+	mg/l	0.92	1.45	1.15	0.52	0.5
8	NO_3^-	mg/l	1.91	0.969	0.082	0.093	10
9	PO_4^{3-}	mg/l	0.019	-	0.091	0.106	0.3
10	Fe	mg/l	3.241	-	1.39	1.56	1.5
11	Suspended solid	mg/l	1,792	303	203.2	209.5	50
12	Oil and grease	mg/l	Not detected	0.25	Not detected	0.26	0.1
13	Coliform	MPN/100ml	68	110	1,100	1,300	7,500

(Source: the reports on annual environmental monitoring of Hoi Xuan HPP, in 2012, 2013)

The locations of water quality monitoring of Ma river:

+ M2 (Coordinates: 0503861, 2262357) is located on the reservoir area.

+ M3 (Coordinates: 0505439; 2261436) is located behind the dam.

- *Applicable regulation*

+ QCVN 08:2008/BTNMT (column B1): National Technical Regulation on surface water quality for irrigation purposes or other purposes which require similar water quality.

- *Comment:*

The analytic result in 2012:

+ The parameters of BOD_5 at two points M2 and M3 are higher than the standard with 4.8 times and 1.06 times, respectively.

+ The parameter of COD at point M2 is 3.73 times higher than the standard.

+ The parameters of NH4 at two points are M2 and M3 are higher than the standard with 1.84 and 2.9 times, respectively.

+ The parameter of Fe at point M2 is 2.16 times higher than the standard.

+ Total of suspended solids at two points M2 and M3 are higher than the standard with 35.84 and 6.06 times, respectively.

+ Total of oil at point M3 is 2.5 times higher than the standard.

+ The others are in acceptance limit of the standard.

The sampling time was the rainy season, the rainwater overflowed on the ground of construction work and disposal area. Therefore, it swept away materials, friable materials, mineral salts on the surface into the surface water sources. This leaded to the increasing concentration of suspended solids, organic matters and turbidity of Ma river.

The analytic result in 2013:

+ The parameters of BOD_5 at two points M2 and M3 are higher than the standard with 1.13 times and 1.15 times, respectively.

+ The parameters of NH_4 at two points are M2 and M3 are higher than the standard with 2.3 and 1.04 times, respectively.

+ The parameter of Fe at point M3 is 1.04 times higher than the standard.

+ Total of suspended solids at two points M2 and M3 are higher than the standard with 4.06 and 4.2 times, respectively.

+ Total of oil at point M3 is 2.6 times higher than the standard.

+ The others are in acceptance limit of the standard.

The sampling time was the rainy season, the flow from upstream carry much alluvium and sediment, and the rainwater overflowed on the ground of construction work and disposal area. It swept away materials, friable materials and mineral salts on the surface ground to the water sources. This leads to the increasing concentration of suspended solids, organic matters and turbidity of Ma river.

Recommendation: Because the project will locate near Ma river, the project owner and contractors shall conduct more closely monitoring of waste disposal.

Water quality at the time of ESIA preparation:

* Surface water

Table 3.24: Analysis results of surface water in the ESIA preparation time

No.	Parameter	Unit	Results									
			NM1	**NM2**	**NM3**	**NM4**	**NM5**	**NM6**	**NM7**	**NM8**	**NM9**	**NM10**
1	pH	-	7.15	6.92	7.08	7.46	6.95	7.59	7.05	6.52	7.19	6.84
2	Turbidity	NTU	12	13	15	16	10	14	8	15	5	11
3	Total hardness	mgCa CO_3/l	69.8	72.5	78.2	74.5	95.8	108.5	106.5	95.5	92.4	78.8
4	DO	mg/l	5.91	5.62	5.84	5.87	6.5	6.2	6.92	5.41	6.58	5.98
5	TSS	mg/l	38.5	45	39	730	32.5	44.5	35	40.5	31	36
6	COD	mg/l	27.2	24.6	28.5	42.5	18.4	17.2	16.4	26.3	19.5	24.4
7	BOD_5	mg/l	13.6	12.9	14.2	20.3	7.05	6.26	6.85	12.5	7.85	13.5
8	Amoni (NH_4^+) (Under N)	mg/l	0.21	0.32	0.25	0.35	0.28	0.51	0.12	0.29	0.32	0.15
9	Clorua (Cl^-)	mg/l	1.02	0.95	0.86	0.88	1.09	1.13	0.98	1.35	1.35	1.02
10	Florua (F^-)	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
11	Nitrit (NO_2^-) (under N)	mg/l	0.02	0.008	0.012	0.01	0.025	0.04	<0.002	0.036	<0.002	0.029
12	Nitrat (NO_3^-) (under N)	mg/l	1.02	0.96	0.51	0.41	1.21	1.09	1.52	1.05	1.46	0.96
13	PO_4^{3-} (under P)	mg/l	0.05	0.08	0.09	0.04	0.12	0.03	0.02	0.058	0.042	0.075
14	CN^-	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
15	As	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
16	Cd	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
17	Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Cr^{3+}	mg/l	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
19	Cr^{6+}	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
20	Cu	mg/l	0.081	0.052	0.045	0.062	0.048	0.07	0.065	0.066	0.025	0.059
21	Zn	mg/l	0.21	0.19	0.32	0.084	0.27	0.18	0.11	0.26	0.17	0.11
22	Ni	mg/l	<0.01	<0.01	<0.01	0.13	<0.01	**0.56**	<0.01	<0.01	<0.01	<0.01
23	Fe	mg/l	0.59	0.36	0.68	**5.9**	0.85	**7.64**	0.93	0.67	0.89	0.88
24	Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
25	Surface active agents	mg/l	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
26	Total oil (oil)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
27	Phenol (total)	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
28	Organochlorine chemical for plant protection	µg/l	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
29	Organophosphorus chemical for plant protection	µg/l	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
30	Herbicide	µg/l	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
31	E-coli	MPN/100ml	11	21	3	7	Not detected	Not detected	Not detected	9	Not detected	Not detected
32	Coliform	MPN/100ml	450	750	300	240	23	15	35	430	36	350

Sampling locations are as below:

Table 3.25: Sampling locations of surface water in the ESIA preparation time

Symbol	Sampling locations	Sampling times	Coordinates	
NM1	On Ma river – Kham village - Hoi Xuan commune - Quan Hoa district, Thanh Hoa province	5 Aug. 2014	X = 2256664	Y = 508199
NM2	On Ma river - Hoi Xuan commune - Quan Hoa district, Thanh Hoa province	5 Aug. 2014	X = 2257768	Y = 507360

NM3	On Ma river - Chom Coc - Hoi Xuan commune - Quan Hoa district, Thanh Hoa province	5 Aug. 2014	X = 2259286	Y = 506132
NM4	On Ma river – Thanh Xuan commune - Quan Hoa district, Thanh Hoa province	6 Aug. 2014	X = 2261219	Y = 505559
NM5	Vui stream - Vui village- Thanh Xuan commune - Quan Hoa district, Thanh Hoa province	6 Aug. 2014	X = 2264337	Y = 503417
NM6	Pan stream - Pan vilalge- Phu Xuan commune - Quan Hoa district, Thanh Hoa province	6 Aug. 2014	X = 2268329	Y = 503001
NM7	Pung stream - Phu Thanh commune - Quan Hoa district, Thanh Hoa province	6 Aug. 2014	X = 2271846	Y = 501820
NM8	On Ma river – Thanh Mai - Phu Thanh commune - Quan Hoa district, Thanh Hoa province	6 Aug. 2014	X = 2275071	Y = 500926
NM9	Quyen stream – Uon village –Van Mai commune - Quan Hoa district, Thanh Hoa province	7 Aug. 2014	X =2275821	Y = 497395
NM10	On Ma river – Sơn Thanh – Thanh Son commune - Quan Hoa district, Thanh Hoa province	7 Aug. 2014	X = 2275768	Y = 493012

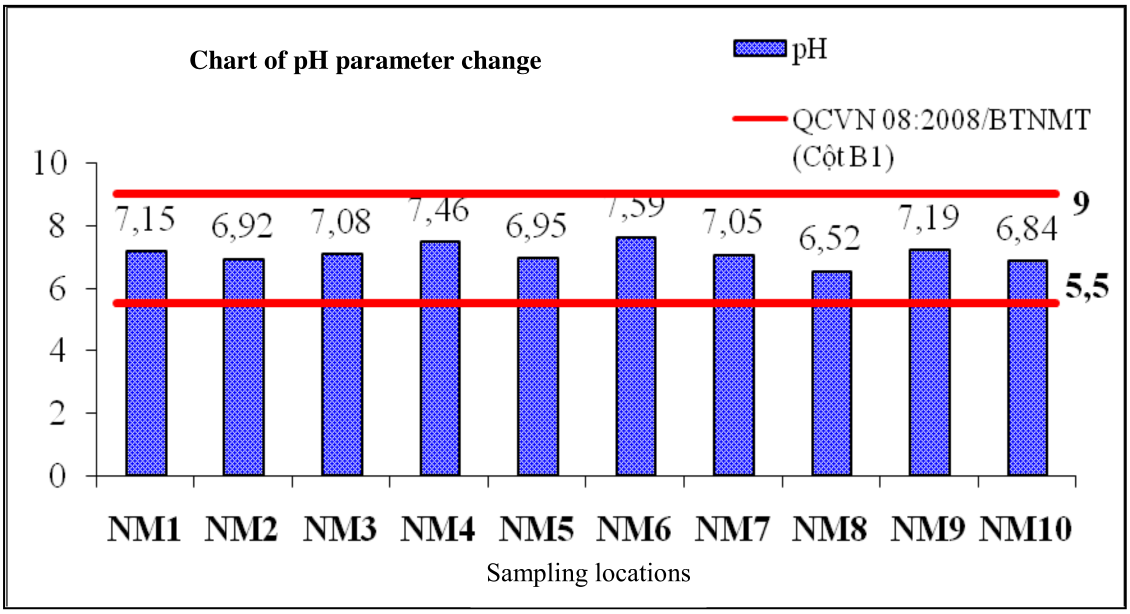


Chart of pH parameter change

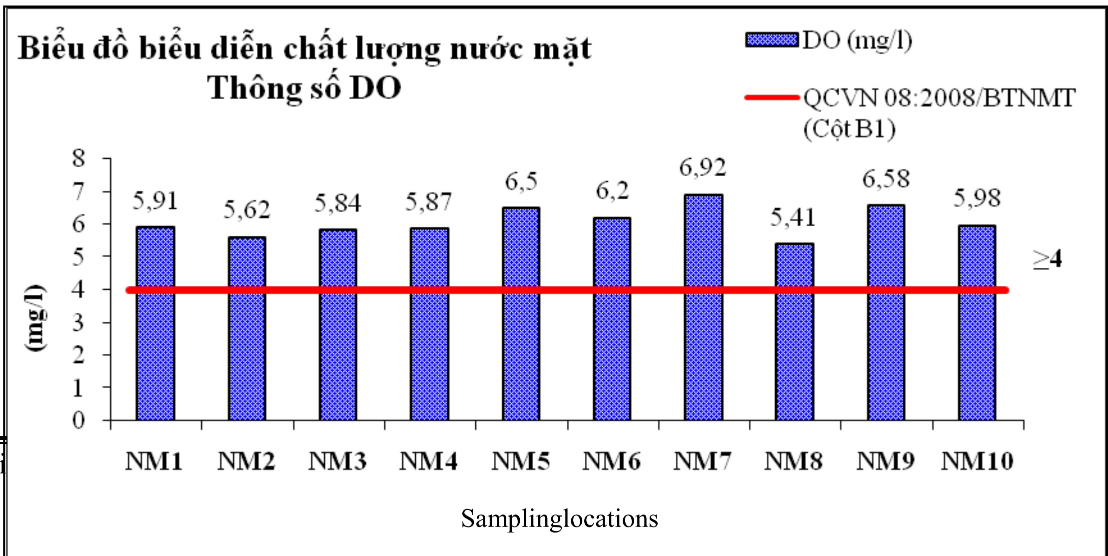


Chart of DO parameter change

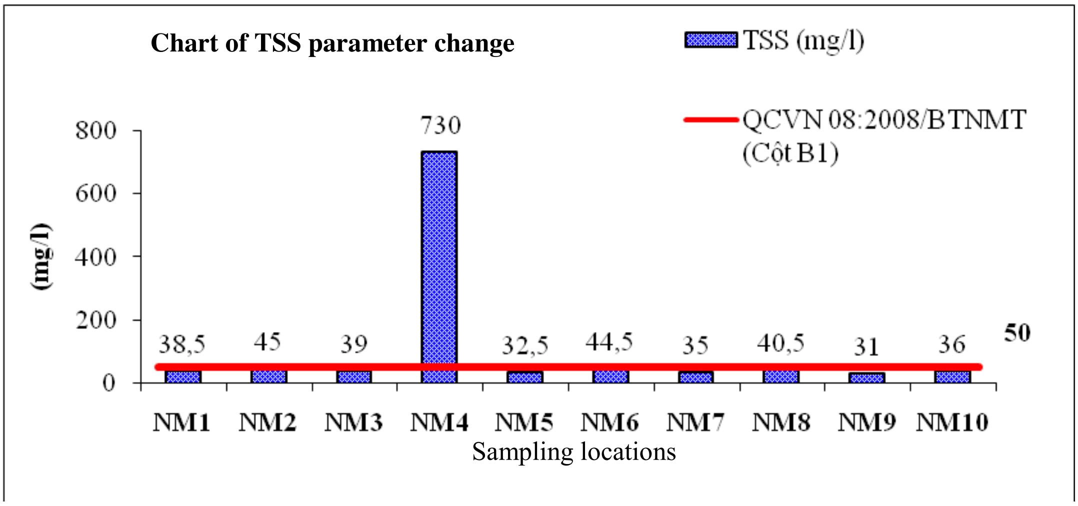


Chart of TSS parameter change

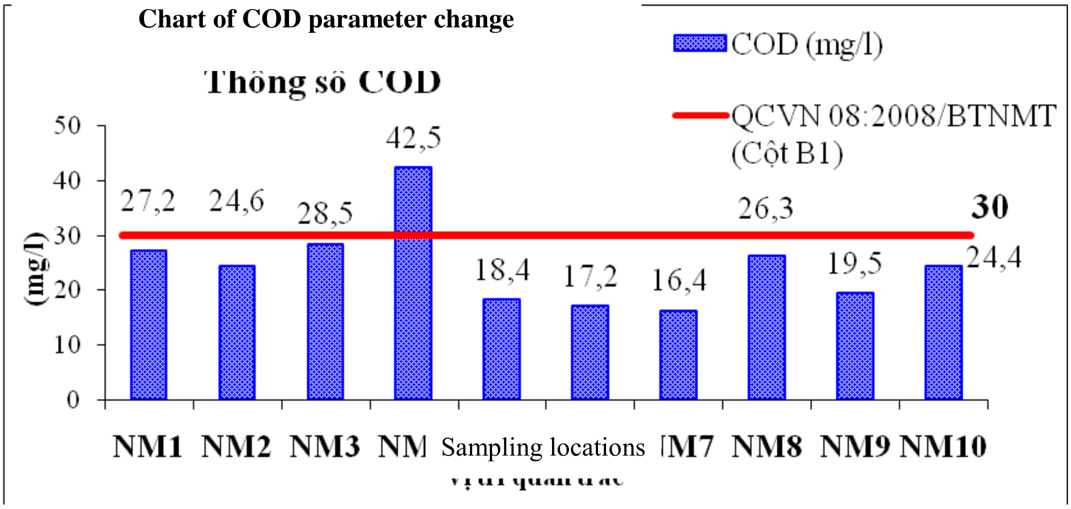
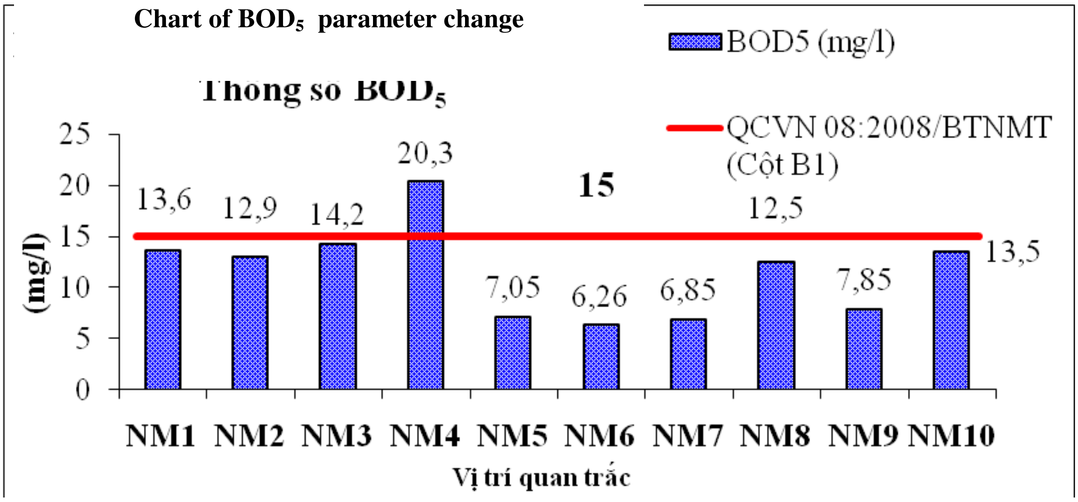


Chart of COD parameter change



Sampling locations

Chart of BOD_5 parameter change

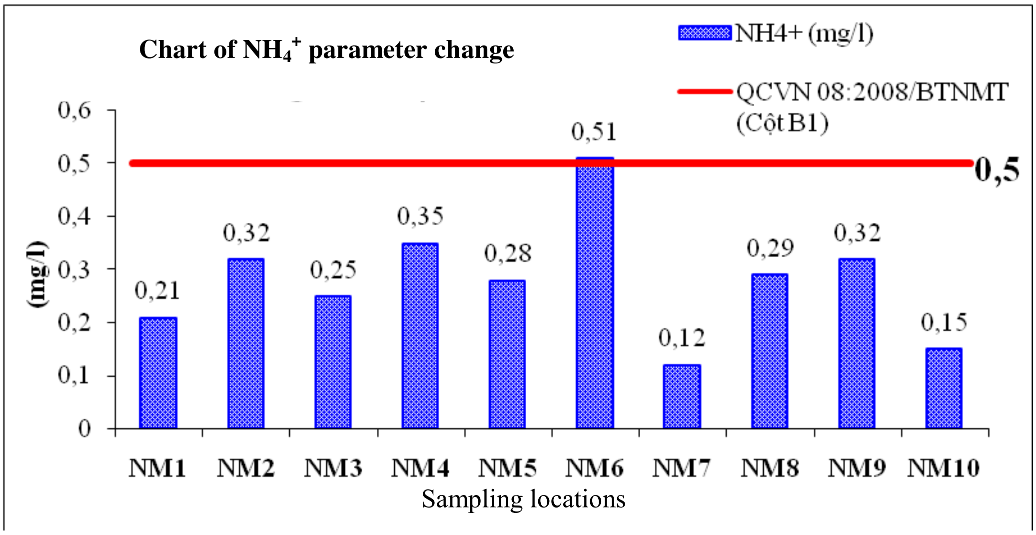


Chart of NH_4^+ parameter change

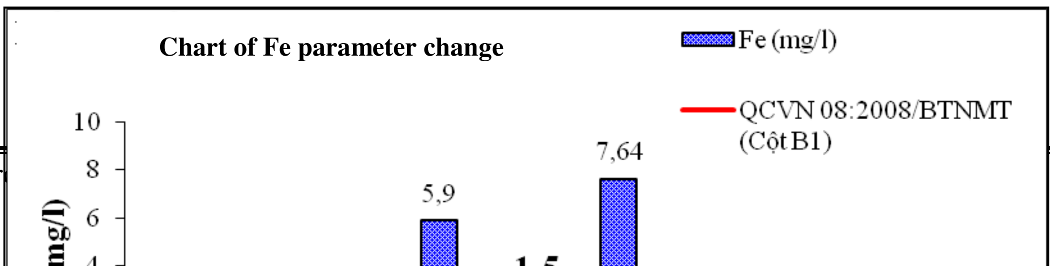
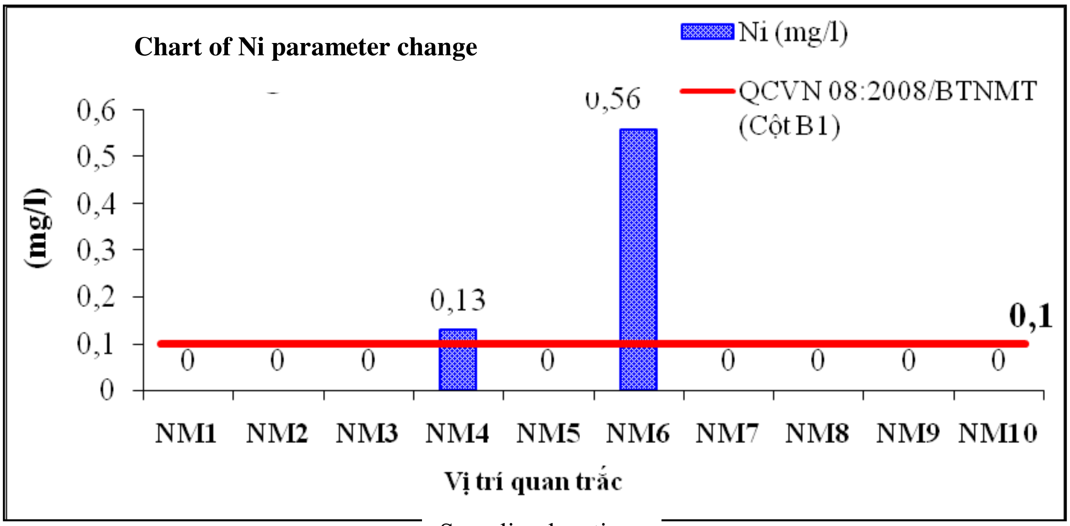


Chart of Fe parameter change



Sampling locations

Chart of Ni parameter change

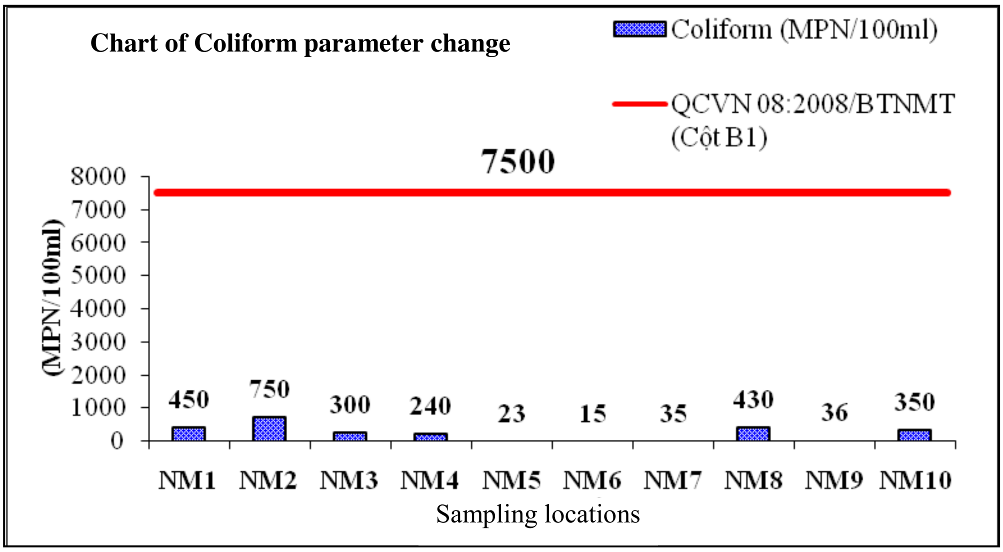


Chart of Coliform parameter change

Comments:

Content of most parameters at the time of observations at sampling locations (as figure 7) are smaller than permissible limits as prescribed by QCVN 08:2008/BTNMT (column B1) - National Technical Regulation on surface water quality, excepting for NM4 and NM6.

- NM4 (on Ma river- Thanh Xuan - Quan Hoa district, Thanh Hoa province) has some parameters such as TSS, COD, BOD, Ni, Fe are higher than the standard level at 14, 1.4, 1.35, 1.3 and 3.9 times higher than, respectively.

- NM6 (at Pan Stream - Pan village - Phu Xuan - Quan Hoa district, Thanh Hoa province) has parameters such as NH_4^+, Fe, Ni higher than stipulated level at QCVN 08:2008/BTNMT (column B1) - National technical Regulation on surface water quality (1.02, 5.1, 5.6 times higher than, respectively).

*** Undergound water:**

Table 3.26: Analysis results of underground water in the ESIA preparation time

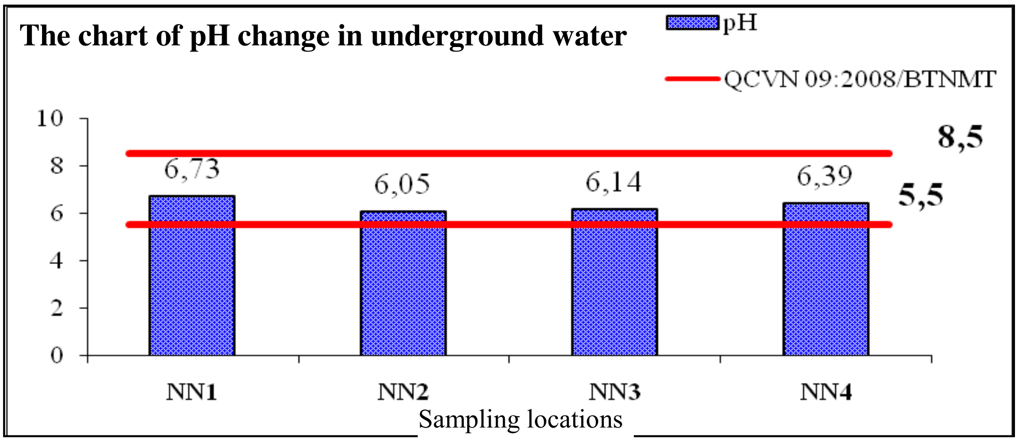
No.	Parameter	Unit	Results			
			NN1	NN2	NN3	NN4
1	pH	-	6.73	6.05	6.14	6.39
2	Transparency (according to $CaCO_3$)		143.5	152.6	139.7	158.8
3	Total suspended solids (TSS)	mg/l	4	6	8.5	3
4	COD ($KMnO_4$)	mg/l	0.5	1.1	0.9	1.8
5	Ammonium (NH_4^+) (Calculated according to N)	mg/l	<0.01	<0.01`	<0.01	<0.01
6	Clorua (Cl^-)	mg/l	1.38	1.68	2.05	1.31
7	Fluoride (F^-)	mg/l	0.62	0.52	0.48	0.65
8	Nitrite (NO_2^-) (Calculated according to N)	mg/l	<0.002	<0.002	<0.002	<0.002
9	Nitrate (NO_3^-) (Calculated according to N)	mg/l	0.3	0.6	0.4	0.9
10	Sulfate (SO_4^{2-})	mg/l	5.99	6.84	70.5	6.24
11	Cyanide (CN^-)	mg/l	<0.005	<0.005	<0.005	<0.005
12	Phenol	mg/l	<0.003	<0.003	<0.003	<0.003
13	Asenic (As)	mg/l	<0.0005	<0.0005	<0.0005	<0.0005
14	Cadmium (Cd)	mg/l	<0.003	<0.003	<0.003	<0.003
15	Lead (Pb)	mg/l	<0.01	<0.01	<0.01	<0.01
16	Chromium VI (Cr^{6+})	mg/l	<0.05	<0.05	<0.05	<0.05
17	Copper (Cu)	mg/l	<0.008	<0.008	<0.008	<0.008
18	Zinc (Zn)	mg/l	<0.01	<0.01	<0.01	<0.01
19	Mangan (Mn)	mg/l	<0.015	<0.015	<0.015	<0.015
20	Mercury Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001
21	Iron (Fe)	mg/l	0.04	0.08	0.05	0.12
22	Selenium (Se)	mg/l	<0.002	<0.002	<0.002	<0.002
23	E - Coli	MPN/100ml	0	0	0	0
24	Coliform	MPN/100ml	4	<3	<3	<3

Sampling locations are below:

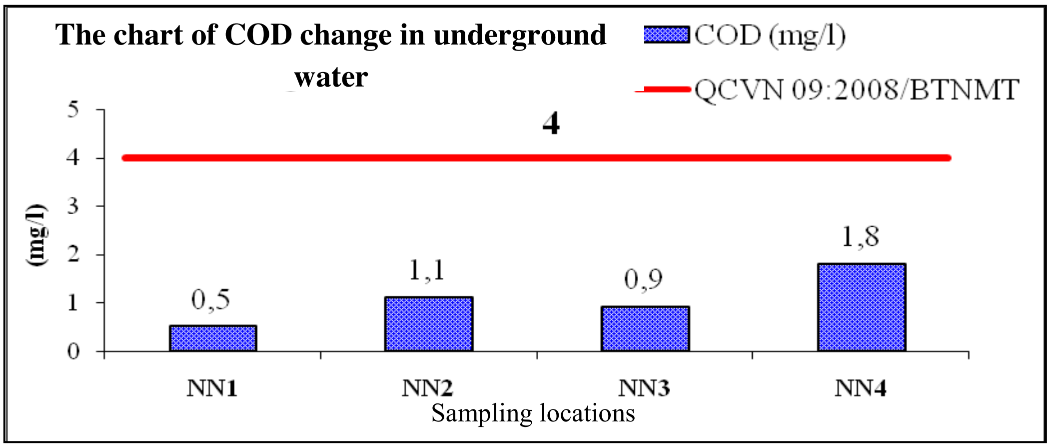
Table 3.27: Sampling locations of underground water in the ESIA preparation time

Symbol	Sampling locations	Sampling times	coordinates	
NN1	At a household in Eo village – Thanh Xuan commune, Quan Hoa district,	5 Aug 2014	X = 2263631	Y = 504060

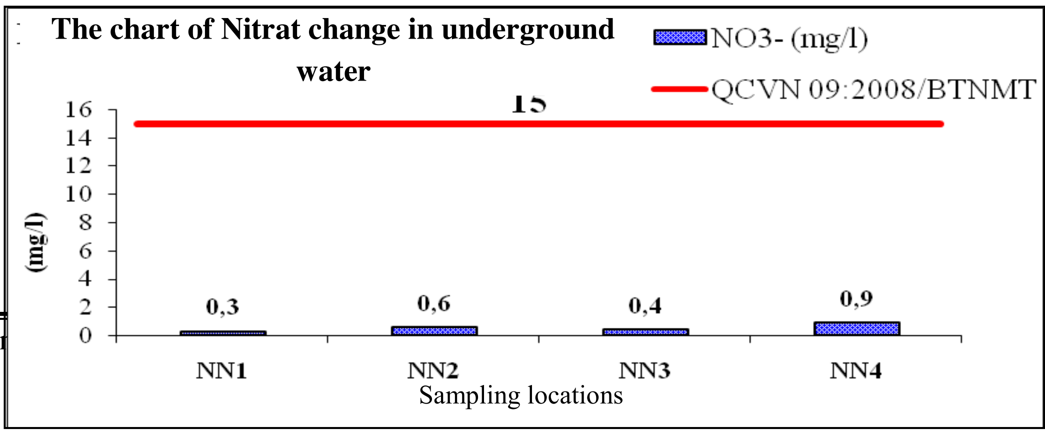
	Thanh Hoa province			
NN2	At a household in Gia village- Thanh Xuan commune, Quan Hoa district, Thanh Hoa province	5 Aug 2014	X = 2261170	Y = 504953
NN3	At a household in N, Pu Pung - Thanh Xuan commune, Quan Hoa district, Thanh Hoa province	5 Aug 2014	X = 2260093	Y = 503398
NN4	At a household in N, Pha Giang - Thanh Xuan commune, Quan Hoa district, Thanh Hoa province	5 Aug 2014	X = 2262409	Y = 507580



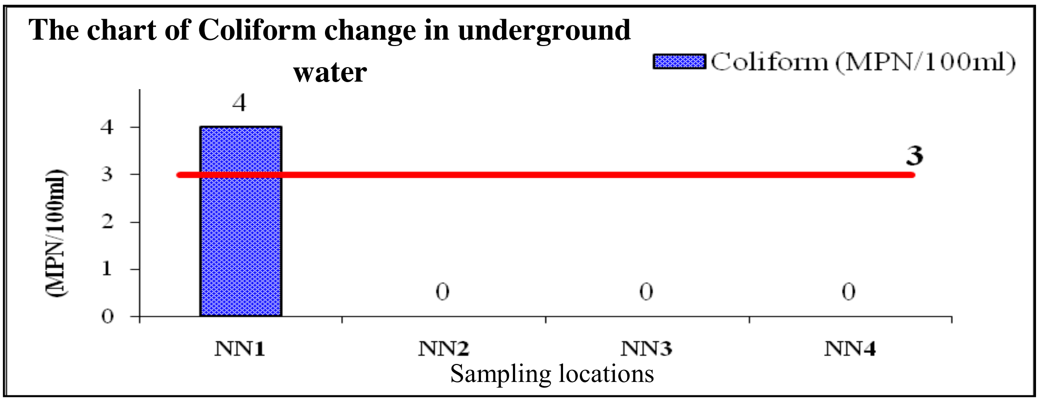
The chart of pH change in underground water



The chart of COD change in underground water



The chart of Nitrat chage in underground water



The chart of Coliform change in underground water

Comments:

Content of most parameters at the time of observations at sampling positions (as figure 7) are under permissible limits as prescribed by QCVN 09:2008/BTNMT - National Technical Regulation on groundwater quality, excepting for NN1.

- Sample NN1 (at a household in Eo village - Thanh Xuan - Quan Hoa district, Thanh Hoa) has coliform parameter with 1.3 times higher than QCVN 09:2008/BTNMT - National Technical Regulation on groundwater quality.

3.3.10. Biological environment

3.3.10.1. *Terrestrial ecosystem*

1. ***Terrestrial ecosystem in the study and surrounding area***

a. Flora and vegetation cover

Flora:

According to the survey of PECC4, the survey result of Forest Inventory and Planning Institute, and the announced documents of botanists, it is preliminary statistic that the project and surrounding area has 552 species belonging to 413 flora genera, 138 flora families, 5 flora phyla

Table 3.28: Classification of flora at the project site and surrounding area

No.	Flora phyla	Families	Genera	Species
1	*Equiselophyta*	1	1	1
2	*Lycopodiophyta*	3	2	3
3	*Polypodiophyta*	12	16	23
4	*Pinophyta*	4	5	7
5	*Magnoliophyta*	119	389	518
Total		139	389	552

In which 8 flora families have dominant species such as *Poaceae* with 21 species; *Euphorbiaceae*: 23 species; *Asteraceae*: 19 species; *Aspidiaceae*: 17 species; *Lauraceae*: 23 species; *Polypodiaceae*: 18 species; *Rubiaceae*: 18 species and *Thelypteridaceae*: 15 species.

In the flora, there have many woody vines and herbaceous vines, growing quite popularly in the vegetation cover:

- The woody vines are commonly found with species of families as Celastraceae, Annonaceae, Vitaceae, Gnetaceae, Asclepiadaceae and Myrsinaceae.

- The herbaceous vines are commonly found with species of families as *Berberidaceae*, *Menispermaceae*, *Stemonaceae*, *Convolvulaceae* and*Cucurbitaceae*...

Epiphytes are commonly found with species of *Orchidaceae family*.

Vegetation cover:

The study and adjacent area include types of vegetation cover as follows:

(See Figure 8, 8A attached)

- ***Natural vegetation cover:***

+ Low-land broadleaf forest on limestone mountain:

The forest type distributes at mountain sides with high, medium and low slopes of strong-eroded limestone peaks.

In the highest layer of forest, *Aglaia* sp., *Anogeissus acuminata* and *Heritiera macrophylla* are typical species at wet areas while *Burretiodendron hsienmu* and *Millettia Ichthyochtona* are dominant species at dry and steep slopes. Sometimes, some trees of species *Anogeissus acuminate*, *Heritiera macrophylla* and some species of Ficus genus grow to 50-55m tall, with a trunk diameter of up to 2m and roots of 3m tall. All the lower forest layers have typically different tree densities. In this forest type, a new species was found for science in the 4th layer, namely *Trevesia vietnamensis* sp. Nov. (*Araliaceae* family).

The number of epiphyte species has been significant changes. On the southern dry mountain slopes, their number is low because of dry conditions while in shade and humid areas of narrow valleys, they are very plentiful. The typical and dominant species of this floral community in the humid habitats are the orchid and fern species. Similarly, flora species growing attached to rocks are indicated by humidity. They are very plentiful in shade and humid areas, including are orchid species as *Anoectochilus elwesii, Goodyera hispida, Liparis cordifolia* var. *argentopunctata* and *Paphiopedilum hirsutissimum*. The liana species (woody vine, herbaceous vine and epiphytic vine) are also popular in everywhere.

Table 3.29: Classification of low-land broadleaf forest on limestone mountains

Layers of forest	Height	Rate of cover (%)	Trunk diameter (*cm*)	Typical and dominant species
1	35-40 (45)	30-50 (80)	60-110	*Aglaia* sp., *Anogeissus acuminata, Burretiodendron hsienmu, Heritiera macrophylla, Millettia ichtyochtona, Ficus* sp., *Allospondias lakonensis, Dimocarpus longan & Dracontomelon duperreanum*
2	15-30 (35)	20-40	25-40	*Streblus macrophyllus, Nageia wallichiana, Alstonia* sp., *Antidesma* sp., *Castanopsis indica, Cinamomum* sp., *Deutzianthus tonkinensis & Garcinia* sp.
3	5-15	30-45 10-20	(20-50) (25)	*Streblus macrophyllus, Nageia wallichiana, Arenga pinnata, Caryota bacsonensis, Caryota mitis, Celtis cinnamomea, Lagerstroemia balasae, Taxotrophis macrophylla & S. tonkinensis*
4 *(bush layer)*	1.5-5 (7)	10-30 (1-80)		*Brassaiopsis phanrangensis, Caryota sympetala, Dendrocnide urentissima, Diaspyros mollifolia, Flacourtia ramonchi, Polygala tonkinesis, Silvianthus tonkinensis & Trevesia vietnamesis. Nov*
5 (grass layer)	0.2-1.5	1-100		*Amischolotype hispida, Begonia balanseana, Cyrtococcum patens, Impatiens eberhardtii, Adiantum philippense, Diplasium maximum, Alocasia macrorhiza, Costus speciosus & numerous orchid species.*

+ Low-land broadleaf forest on schist and sandstone.

Previously, the low-land primary forests on schist and sandstone was widely distributed from elevations from 50-60m to 400-700m. At these elevations, the sedimentary rocks are taken place by crystalline limestone in Pu Luong Mountains area.

The large timbers as *Heritisea macrophylla* and 2 species of *Ficus* genus grow to 45-50m tall. They are typical for emergent layer of this forest type. The species growing attached to trees are generally common without diversity. The plants growing attached to rocks are also common, and they have species composition similar to species composition of grass layer. The liana species are very popular, including woody vines as *Bauhinia khasiana* and *Combretum griffithii,* half herbaceous vines as *Dioscorea bulbifera* and *Paederia scandens,* and epiphytic vines as *Rhaphidophora decursiva*.

Table 3.30: Classification of low-land Broadleaf forest on schist and sandstone

Layers of	Height	Rate of	Trunk	Typical and dominant species

forest		cover (%)	Diameter (*cm*)	
Emergent layer	45-50		150-200	*Heritiera macrophylla* & *Ficus* sp.
1	40 (45)	30%	80-100	*Aglaia* sp. & *Duabanga grandiflora*
2	20-30	50-60	40-50	*Anogeissus acuminats, Castanopsis indica, Millettia ichthyochtona* & *Pterospermum* sp.
3	10-20	40-50	10-25	*Aglaia* sp., *Callicarpa* sp., *Dillenia india, Pterospermum* sp., *Saurauia nepalensis, Vitex* sp., *Livistona chinensis* & *Cyathea latebrosa*.
4 *(the bush layer)*	2-6	10-15		*Psychotria* sp., *Strobilanthes* sp., *Aranga pinata, Caryota bacsonensis, Ficus okigodon, Mycetia balansae* & *Oxyspora balansaei* and *Silvianthus tonkinensis*.
5 (grass layer)	0.2-2	60-80 (100)		*Begonia baviensis, Pelliania* sp., *Pteris khasiana, Selaginella dolichoclada, Alocasia macrorrhiza, Alpinia henry* & *Stachyphrynium placentarium*.

+ Low-mountain broadleaf forest on limestone

Low-mountain broadleaf forest on limestonewidely distributes in the area, from the elevations from 700m to 950m. This forest type mainly distributes in the high mountain slopes and limestone peaks in the project area. This type is less destructive than other forest types.

The most popular species of this forest type is *Dacrycarpus imbricatu* which usually appear on the southern mountain slopes. This type's features are the strong development of scrub and grass layers, many fern species and young plants. The epiphytic species components are diverse, including *mosses, lichens, orchids* and the big ferns that grow primarily on leaves of the emergent layer and canopy layer. Plant communities growing attached to rocks developed poorly although they have the rare species such as *Calanthe argentea striala*.

Table 3.31: Features of Low-mountain broadleaf forest on limestone

Layers of forest	Height	Rate of cover (%)	Trunk Diameter (*cm*)	Typical and dominant species
Emergent layer	45-50	25	120	*Dacrycarpus imbricatus*
1	40	40-60	40-80 (110)	*Burretiodendron hsienmu, Calophyllum* sp., *Ficus* sp., *Heritiera macrophylla, Quercus* sp.

				& *Ayzygium* sp.
2	20-30	30-70	20-40	*Acer tonkinense, Aglaia* sp., *Cinnamomum* sp., *Garicinia* sp., *Heritiera* sp., *Michelia* sp., *Magnolia* sp., *Planchonella* sp., *Polyalthia* sp. & *Sterculia* sp.
3	6-15	30-40	10-15 (20)	*Livistona chinensis, Schefflera* sp., *Cinnamomum* sp., *Euonymus* sp., *Eurya* sp., *Litsea* sp., *Podocarpus neriifolius, Polyalthia* sp., *Pterospermum* sp., & *Streblus macrophyllus*
4 *(the bush layer)*	2-6	(10) 15-20		*Aglaia* sp., *Ardisia* sp., *Breynia* sp., *canthium* sp., *Carallia* sp., *Caryot bacsonensis, Cinnamomum* sp., *Lasianthus* sp., *Magnolia* sp., *Pandanus* sp., *Psychotria* sp. & *Sapium* sp.
5 (grass layer)	≤ 1.5 (2)	(5) 15-20		*Strobilanthes* sp., *Aspidistra* sp., *Rhapis cyperifolia, Adiatum* sp., *Anoetochilus calcareous, Peliosanthes teta, Sonerila cantonensis, Tacca chantiera* & *Tupistra wattii*.

+ Low–mountain pine forest on limestone

The low–mountain pine forest on limestone represents a rare forest state remaining in Pu Luong Nature Reserve. In this place, *Pinus kwangtungensis* is a rare and dominant species. It is the unique typical species in canopy layer of this forest type although in a few other places, it is sometimes the species of the emergent layer. Populations of *Pinus kwangtungensis* in thisNature Reserve represent its southern most distribution area. Another one, *Taxus chinensis,* sometimes is a co-dominant species in the second layer. The type of forest has a high sensitivity and in the danger of extinction.

The herbaceous species in this forest type have structure and species composition similar to type of low-mountain broadleaf forest with short trees on limestone. Similarly, this forest type has epiphytes which grow attached to trees and rocks. Their density is very much and often covers 100% of the surface of the trunks and rocks. The orchid species as *Coelogynefimbriata, Dendrobium dentatum, Epigeneium chapaense and Eria thao* appear very popular. The plant community growing on rocks includes common species and endemic species, in which a few species have only a very narrow distribution, and only appear in this forest type.

Table 3.32: Classification of low–mountain Pine forest on limestone

Layer of forest	Height	Rate of cover	Diameter (*cm*)	Typical and dominant species

		(%)		
1	15-20	5-25	(25) 35-80	*Pinus kwangtungensis, Carpinus* sp., *Eriobotrya bengalensis* & *Platycarya strobilacea*.
2	6-12 (15)	40	20-30	*Illicium petelotii, Eriobotrya bengalensis, Pistacia weinmannifolia, Pistacia cucphuongensis, Platycarya strobilacea, Schefflera pes-avis, Sinosideroxylon wightianum, Podocarpus neriifolius, Quercus* sp., &*taxus chinensis*.
3 *(the bush layer))*	2-4 (1-8)	30-40		*Ardisia* sp., *Calophyllum* sp., *Campylotropis* sp., *Dracaena cochinchinensis, Myrsine kwangsiensis, Pittosporum* sp., *Rhapis* sp., *Sophora* sp., & *Vaccinium triflorum*.
4 (grass layer)	0.1-1 (1.5)	25-40		*Carex* sp., *Scleria* sp., *Adiantum caudatum, Cymbidium ensifolium, Elatostema* sp., *Anoectochilus elwesii, Paphioipedilum malipoense, Goodyera virdiflora, Malaxis acuminata, Ophiorhirza* sp., *Peliosanthes teta, Pilea* sp., *Polystichum* sp., *Rhomboda petelotii* & *Selaginella* sp.
5 *(The moss layer)*	≤ 2	1-10%		*Unknown species*

+ Low-mountain boardleaf forest on basalt in the slopes and ridges:

The southwest core area of Pu Luong Nature Reserve which belongs to the basin area where has the ridge running along the northwest - southeast direction, at elevations from 300 to 1,500 meters. This mountain range is composed entirely by basalt mixed with quartz gullies, with very steep slopes and many prominent peaks. This mountain range is the unique geological formation in Vietnam where basalt creates fields or ancient highlands covered by a thick layer of weathered materials.

Previously, the basalt in elevations from 900m to 1,000m was covered by the primary forests. However, nowadays primary forests in this area can only be found at elevations above 1,200m. The lower slopes are covered with the secondary forests which have very different quality. Higher places where are typically covered by clouds all year round created conditions for the development of a forest type much different from all the other types in the basin area.

Low-mountain boardleaf forest on basalt has many ancient species from the Late Cretaceous period and 3rd century in Europe, East Asia and North America which are stored in fossils. They are the species of the families *Actinidiaceae, Annonaceae, Chloranthaceae, Fagaceae, Hamamelidaceae, Lardizabalaceae, Lauraceae, Magnoliaceae, Menispermaceae, Theaceae* and some flora genera of the rare gymnosperm phylum as *Amentotaxus* (Cephalotaxaceae), *Cephalotaxus* (Cephalotaxaceae), *Podocarpus* and *Nageia*

(Podocarpaceae). Primary forests in the area have very high flora-diversity, including endemic elements. The two new species to science discovered during the survey in this forest type are *Hamularia puluaonesis (*Orchidaceae*)* and *Spatholirion puluongense (*Commelinaceae).

Table 3.33: Classification of Low-mountain boardleaf forest on basalt

Layers of forest	Height	Rate of cover (%)	Trunk Diameter (*cm*)	Typical and dominant species
1	(25) 30-40	50-70 (45-120)	50-100	*Castanopsis acuminatissima, Castanopsis armata, Lithocarpus pseudosundaicus, magnolia* sp., *Michelia fovealata, Quercus* sp., *Amentotaxus argotaenia, Smentotaxus yunnanensis, Cephalotaxus mannii, Nageia wallichiana, Diplopanax vietnamensis* & *Rhodoleia champianii*.
2	20-25	40-60	20-40	*Acer* sp., *Actinodaphne pilosa, Aglaia* sp., *Anneslea fragrans, Cephalotaxus mannii, cinnamomum* sp., *Diplopanax vietnamensis, Elaeocarpus* sp., *Lithocarpus lepidocarpus, Litsea* sp., *Magnolia* sp., *Michelia* sp., *Nageia wallichiana* & *Quercus chapaensis*.
3	8-15	30-40 (50)	10-15 (20)	*Acer tonkinense, Acer* sp., *Lietsea* sp., *Schefflera* sp., *Anneslea frangrans, Archidendron robinsonnii, Beilschmiedia* sp., *Camellia* sp., *Cinnamomum* sp., *Elaeocarpus* sp., *Helicia* sp., *Illicium majus, Illicium* sp., *Litsea* sp. & *Sorbus* sp.
4*(The bush layer)*	2-6	20-40		*Lasianthus* sp., *Ardisia* sp., *Schefflera kornasii, Brassaiopsis phanrangensis, Camellia assamica, Dichroa febrifuga, Embelia pulchella, Oxyspora* sp., *Eurya* sp., *Psychotria* sp., & *Rhododendron* spp.
5 *(The moss layer)*	0.1-2	40-80		*Carex* sp., *Strobilanthes* sp., *Laportea bulbifera, Tupistra wattii, Alocasia macrorhizza, Stachyphrynium placentarium, Deparia unfurcata, Diplazium donianum, Anoectochilus roxburghii, calanthe alismifolia, Dianella nemorosa* & *Cymbidium sinense*.

- *Artificial vegetation cover:*

+ Artificial forest

+ The artificial forest in the basin accounted for a small percentage of the vegetation area. The bamboo forest occupies the most area compared to other species such as *Acacia auriculiformis, Acacia mangium, Eucalyptus* and *Pinus latteri*. Especially, *Dendrocalamus* *membranaceae* is the most popular because it is very suitable the ecological conditions and bring high economic efficiency for people.

+ Industrial crops: sugar-cane, *vernicia Montana*, tea crops…

+ Fruit trees: Pineapple, pomelo, etc.

+ Annual crops: vegetables and beans.

+ Food crops: rice, sweet potato, cassava, corn.

Flora resources:

According to using purpose, fauna in the area is classified the following groups:

- Timber: Including 158 species accounted for 26.6% of total number of species recorded in the study area and the adjacent area. The timber species are mostly concentrated in families *Pinaceae, Cupressaceae, Podocarpaceae, Annonaceae, Betulaceae, Dipterocarpaceae, Ebenaceae, Elaeocarpaceae, Euphorbiaceae, Fabaceae, Fagaceae, Lauraceae, Meliaceae* and *Sapindaceae*….

- Medicinal plant: 212 species accounted for 38.4% of total number of species recorded in the study area and the adjacent area. *Pteridophyta* has 4 families and 4 species. *Angiospermatophyta* has 39 families and 94 species (Including Monocotyledon with 3 families and 13 species, and Magnoliopsida with 31 families and 69 species).

The medicinal plant species are mostly concentrated in families as Polypodiaceae, Arliaceae, Aristolochiaceae, Euphorbiaceae, Fabaceae, Loranthaceae, Menispermaceae, Myrsinaceae, Sargentodoxaceae, Simaroubaceae, Symplocaceae, Thymeleaceae, Araceae,...

- Ornamental plant: 64 species accounted for 11.6% of all flora species found in the study area, including *Lycophyta* with 1 families and 1 species, *Pteridophyta* with 8 families and 12 species, and *Magnoliopsida* with 14 families and 24 species.

- Fibre plant: 35 species accounted for 6.3%, including 15 species of fruit trees accounted for 2.7%, 30 species of vegetable crops and livestock or 95.4% of all species found in the study area.

Rare flora species:

In the project basin area, the natural forest is severely damaged by people. They exploit wood, firewood and non-wood products, including many rare flora species with high economic value.

According to Vietnam's Red Data Book (1996), in the basin have listed 23 species of rare flora, including Endangered: 3 species; Vulnerable: 8 species; Rare: 6 species; Threatened: 6 species; Data deficient: 4 species.

Table 3.34: List of rare flora species in the project basin area

No.	***Scientific name***	***Vietnamese name***	***Status***
1	*Aquilaria crassna* Pierre ex Lecomte.	Trầm hương	E
2	*Amentotaxus argotaenia* (Hance) Pilg.	Dẻ tùng sọc trắng hẹp	R
3	*Burretiodendron tonkinensi* (A. Chev.) Kosterm.	Nghiến	V
4	*Calamus platyacanthus* Warb	Song bột	V
5	*Cinnamomum balansae* Lecomte	Gù hương	R
6	*Chukrasia tabularis* A. Juss.	Lát hoa, Lát da đồng	DD
7	*Colona poilanei* Gagnep.	Xuân liên thanh hoá	R
8	*Dendrobium nobile* Lindl.	Hoàng thảo dẹt	R
9	*Drynaria fortunei* (O. Kuntz ex Mett.) J. Smith	Bổ cốt toái	T
10	*Fallopia mutifora* (Thunb.) Haraldson	Hà thủ ô đỏ	V
11	*Fokienia hodgisii* (Dunn) A. Henry et Thomas	Pơ mu	DD
12	*Madhuca pasquieri* (Duybard) H.J. Lam	Sến mật	DD
13	*Markhamia stipulata* (Roxb). Seem	Đinh	V
14	*Mouretia tonkinensis* Pit	Mua re bắc bộ	T
15	*Nageia fleuryi* (Hiekel.) de Laut	Kim giao	V
16	*Panax pseudoginseng Wall*.	Tam thất	E
17	*Parashorea chinensis* Wang S.Hsieh	Chò chỉ, mạy kho	DD
18	*Pauldopia ghorta* (Buch.-Ham.ex G.Don) Steenis	Đinh vang	V
19	*Pinus kwangtungensis* Chun ex Tsiang	Thông pà cò	V
20	*Podocarpus pilgeri* Foxw	Thông tre lá ngắn	R
21	*Podophyllum tonkinense* Gagnep.	Bát giác liên	E
22	*Rauvolfia verticillata* (Lour.) Baill.	Ba gạc	V
23	*Taxus chinensis* (Pilg.) Rehder	Sam hạt đỏ lá ngắn	R

Note:

E - Endangered

V - Vulnerable

R - Rare

T - Threatened

DD - Data deficiency

b. Fauna

Species component

Through survey and initial study, the fauna in the study area and the adjacent area is relatively abundant, as shown in the table below.

Table 3.35: Classification of fauna

No.	Phylum	Number of ordines	Number of families	Number of species
1	*Mammalia*	8	22	59
2	*Aves*	13	41	169
3	*Reptilia*	2	13	25
4	*Amphibia*	1	4	12
Total		***24***	**80**	**265**

The diversity of fauna

- The Tropical and subtropical moist broadleaf forest, animals found are monkey, gibbon, Gaur, Tiger, Clouded Leopard and woodpecker. Especially in the rocky mountain area has *Trachypithecus delacouri* as an endemic species in Vietnam which should be protected.

- The bamboo forests are habitats of *Ursidae, Sus scrofa, Arctonyx collaris, Rhizomys sumatrensis, Pholidota, Mus, Copsychus malabaricus*. As same as the broadleaf evergreen forest, this forest type is also habitats of Rufous-headed Parrotbill species.

- The Shrubland and grassland are habitats of species Deer, *Cervus unicolor, Viverridae*, *Mustelidae*, mouse, Porcupine, Tokay gecko, True owl, Red-whiskered bulbul, etc.

The distribution of species

Animal species distribution in the Hoi Xuan HPP basin shows that most of the species are widely distributed, throughout regions of Vietnam. Some species distribute along the Truong son forest such as *Bos gaurus, Muntiacus, etc*. have been found in the Hoi Xuan HPP basin.

Big-size species and wide-distributed species such as monkey*, Trachypithecus,* Sun bear, Asian black bear, Asian golden cat, Leopard, tiger, Gaur mainly distribute in the primary and secondary forest, away from residential areas. Other species living near to residential areas include Deer, *Muntiacus*, Wild boar, and *Viverridae;* these species usually live in secondary forests, forest edge, fields or along rivers, streams.

The big-size birds such as Lophura nycthemera, Anthracoceros albirostris, Buceros bicornis and Aceros nipalensis usually live in low forest. The species live near water, such as Lutrinae, Ardeidae, Rallidae, Alcedidae, Varanidae and Amphibians; they usually concentrate in lake shorelines, river banks and stream banks. Most small animals, birds, lizards, snake usually live in secondary forests, shrublands, grasslands.

However, the number of individuals of the species in Hoi Xuan hydropower basin has declined severely because habitats were destroyed and the frequently overexploitation of animal species.

Wild animals are used for many purposes such as for food, medicine, ornament and commercial purpose.

Rare and conservative value animals:

Table 3.36: List of mammals under conservation in Hoi Xuan hydropower basin

No.	***Vietnamese name***	Scientific name	**Status**	
			Vietnam	Internation
1	Tê tê vàng	*Manis pentadactyla*	V	
2	Cu ly lớn	*Nycticebus bengalensis*	V	
3	Cu ly nhỏ	*Nycticebus pygmaeus*	V	VU
4	Khỉ đuôi lợn	*Macaca nemestrina*	V	VU
5	Khỉ mốc	*Macaca assamensis*	V	VU
6	Khỉ mặt đỏ	*Macaca arctoides*	V	VU
7	Voọc mông trắng	*Trachypithecus delacouri*	E	CR
8	Voọc xám [1]	*Trachypithecus crepusculus*	V	CR[1]
9	Sói đỏ	*Cuon alpinus*	E	VU
10	Gấu ngựa	*Ursus thibetanus*	E	VU
11	Gấu chó	*Ursus malayanus*	E	
12	Triết chỉ lưng	*Mustela strigidorsa*		VU
13	Rái cá thường	*Lutra lutra*	V	VU
14	Cầy gấm	*Prionodon pardicolor*	R	
15	Cầy mực	*Arctictis binturon*	V	
16	Cầy vằn bắc	*Hemgalus owstoni*	V	VU
17	Beo lửa	*Catopuma temminckii*	E	VU
18	Báo hoa mai	*Panthera pardus*	E	
19	Báo gấm	*Pardofelis nebulosa*	V	VU
20	Sơn dương	*Naemorrhedus sumatraensis*	V	VU
21	Sóc bay lớn	*Petaurista philippensis*	R	
22	Sóc bay lông tai	*Belomys pearsonii*	R	
23	Nhím đuôi ngắn	*Hystrix brachyura*		VU

National conservation status: E - Endangered, V – Vulnerable, R – Rare

International conservation status: CR – Critically Endangered, EN – Endangered, VU– Vulnerable.

[(1)]*According to Nadler et al. (2003).*

Here are some pictures of the current status of vegetation cover and terrestrial ecosystem in the study area and the adjacent area (including the nature reserves and upstream and downstream areas from Trung Son hydropower to the confluence with the Luong River).

2. Current status of vegetation cover and terrestrial ecosystem in the acquired land area for the project construction

a. Flora

Species composition:

In the reservoir bed area has initially listed 271 species with 170 genera of 45 families of 5 phyla.

Table 3.37: Classification of flora in the project area

No	Flora phylum	families	Genera	Species
1	***Equiselophyta***	**1**	**1**	**1**
2	***Lycopodiophyta***	**2**	**2**	**3**
3	***Polypodiophyta***	**3**	**2**	**9**
4	***Pinophyta***	**2**	**3**	**5**
5	***Magnoliophyta***	**37**	**162**	**253**
Total		45	170	271

Flora resources:

Among 271 species, there are 36 species for timber, 61 species for food, 78 species for medicine, 17 species for fiber, 5 species for essential oil, 10 species for tannin and dye, 27 species for ornament and 15 species for animal feed.

In the area, there are also some rare flora species such as Chukrasia tabularis, Rauvolfia verticillata, Panax pseudoginseng Wall, *Parashorea chinensis,* Erythrophloeum fordii, Nageia fleuryi, Senna siamea, etc. but the species are grown people.

Vegetation cover:

According to the result of the field survey was carried out in July – Aug. 2014, updated in Aug. – Nov. 2015, the acquired land area for the project is mostly rivers and streams (about 53%) while the land of governmental works, public works and non-agricultural land account for about 5% of total area, and vegetation covered land accounting for 37%. The remaining area is unused land use and others.

Table 3.38a: Current land use in the acquired land area for the project construction (Land use of individual and household)

Unit: m^2

No.	Location	Total (m^2)	Classification of land (m^2)							
			Land use of individual and household							
			ONT	Garden	NHK	LHK	LUC	TSN	RST	SKC
I	**Head works area**	**536,489**	**22,332**	**13,444**	**1,225**	**253**	**15,734**	**3,755**	**479,746**	
1	Hoi Xuan commune	204,117							204,117	
2	Thanh Xuan commune	332,372	22,332	13,444	1,225	253	15,734	3,755	275,629	
II	**Reservoir bed area**	**2,659,345**	**333,128**	**27,093**	**104,067**	**47,184**	**468,716**	**11,321**	**1,665,051**	**2,785**
II.1	**Quan Hoa district. Thanh Hoa province**	**2,455,976**	**302,480**	**27,093**	**89,216**	**36,629**	**465,379**	**11,321**	**1,521,073**	**2,785**
1	Thanh Xuan commune	595,175	44,771	27,093	13,886		36,687	851	471,887	
2	Phu Xuan commune	775,221	123,892		11,855	7,220	169,259	4,091	458,904	
3	Phu Le commune	351,771	42,348		16,410	17,410	125,568	5,495	144,540	
4	Phu Son commune	300,553	30,374		5,054	11,999	115,876		137,250	
5	Phu Thanh commune	379,117	48,648		40,867		17,989	884	267,944	2,785
6	Trung Thanh commune	19,530	7,480		1,049				11,001	
7	Thanh Son commune	34,609	4,967		95				29,547	
II.2	**Mai Chau district. Hoa Binh province**	**203,369**	**30,648**		**14,851**	**10,555**	**3,337**		**143,978**	
1	Van Mai commune	180,864	30,648		9,823	10,555	3,337		126,501	
2	Mai Hich commune	22,505			5,028				17,477	
III	**Rebuilding area of public works**	**11,061**	**900**	**4**					**10,157**	
1	Thanh Xuan commune	11,061	900	4					10,157	
IV	**Sand quarry area for project construction**	**0.00**								
1	Hoi Xuan commune	0.00								
V	**Residential area**	**78,026.0**	**789.5**						**77,236.5**	
	Thanh Xuan commune	78,026.0	789.5						77,236.5	

No.	Location	Total (m^2)	Classification of land (m^2)							
			Land use of individual and household							
			ONT	Garden	NHK	LHK	LUC	TSN	RST	SKC
VI	**The 220kV connection TL**	**10,662.7**							**10662.7**	
1	Thanh Xuan commune	2,644.1							2644.1	
2	Phu Xuan commune	2,903.9							2903.9	
3	Phu Le commune	2,858.2							2858.2	
4	Phu Thanh commune	1,153.2							1153.2	
5	Van Mai commune	1,103.3							1103.3	
	Total	**3,295,584**	**357,150**	**40,541**	**105,292**	**47,437**	**484,450**	**15,076**	**2,242,854**	**2,785**

Table 3.38b: Current land use in the acquired land area for the project construction (Land use of commune People Committee and other organizations)

Unit: m^2

No.	Location	Total (m^2)	Classification of land (m^2)														
			Land use of Commune People's Committee and other oraganizations														
			BCS	DBV	DCH	DGD	DGT	DNL	DTL	DTT	DVH	DYT	NTD	SKC	SON	TSC	MNC
I	**Head works area**	**144,192**					**24,092**								**120,100**		
1	Hoi Xuan commune	43,471					11,518								31,953		
2	Thanh Xuan commune	100,721					12,574								88,147		
II	**Reservoir bed area**	**4,166,024**	**72,002**	**217**	**568**	**10,156**	**190,232**	**113**	**9,610**	**11,981**	**377**	**3,871**	**2,751**	**3,757**	**3,856,347**	**3,672**	**372**
II.1	**Quan Hoa district. Thanh Hoa province**	**3,755,833**	**70,583**	**217**	**568**	**9,923**	**186,597**	**113**	**9,406**	**11,981**	**265**	**3,871**	**2,751**	**2,785**	**3,452,729**	**3,672**	**372**
1	Thanh Xuan commune	755,686				3,106	66,730	9		211		1,088			682,466	2,076	
2	Phu Xuan commune	593,582	435			4,374	59,424	83	3,274	2,018	265		2,751		520,927		32
3	Phu Son village	309,287	666			637	8,825		1,752	3,212		1,425			292,430		340
4	Phu Le village	296,700	2,774	217	568	1,565	34,951	20	4,380	3,888		1,358			245,688	1,290	
5	Phu Thanh village	1,175,952	107			242	16,666			2,619				2,785	1,153,226	306	

No.	Location	Total (m^2)	Classification of land (m^2)														
			Land use of Commune People's Committee and other oraganizations														
			BCS	DBV	DCH	DGD	DGT	DNL	DTL	DTT	DVH	DYT	NTD	SKC	SON	TSC	MNC
6	Thanh Son commune	257,613													257,613		
7	Trung Thanh village	367,014	66,602							33					300,379		
II.2	**Mai Chau district. Hoa Binh province**	**410,191**	**1,419**			**232**	**3,634**		**204**		**112**			**972**	**403,618**		
1	Van Mai commune	320,824	1,419			232	3,634		204		112			972	314,251		
2	Mai Hich commune	89,367													89,367		
III	**Rebuilding area of public works**	0															
1	Thanh Xuan commune	0															
IV	**Sand quarry area for project construction**	**95,623**													**95,623**		
1	Hoi Xuan commune	95,623													95,623		
	Total	**4,405,839**	**72,002**	**217**	**568**	**10,156**	**214,324**	**113**	**9,610**	**11,981**	**377**	**3,871**	**2,751**	**3,757**	**4,072,069**	**3,672**	**372**

Note: The area of rebuilding public works: The area of rebuilding public works which are affected by the project in other locations to meet the needs of use with local people (e.g schools, kindergartens, health centers, houses of culture) ...

SYMBOLS OF LAND CLASSIFICATION BASED ON LAND USE SITUATION

Agriculture land			
LUC	Specialized wet paddy land	RPN	Land with protective natural forest
LUK	Remaining wet paddy land	RPT	Land with protective artificial forest
LUN	Land for upland paddy	RPK	Land for zoning off for protective forest regeneration and restoration
COC	Grass for husbandry livestock	RPM	Land for protective afforestation
BHK	Flat land for other annual trees	RDN	Land with special-purpose natural forest
NHK	Milpa for other annual trees	RDT	Land with special-purpose artificial forest

LNC	Land for perennial industrial trees	RDK	Land for zoning off for special-purpose forest regeneration and restoration
LNQ	Land for perennial fruit trees	RDM	Land for special-purpose afforestation
LNK	Land for other perennial trees	TSL	Land for salt water and brackish water aquaculture
RSN	Land with productive natural forest	TSN	Specialized land for fresh water aquaculture
RST	Land with productive artificial forest	LMU	Land for salt production
RSK	Land for zoning off for productive forest regeneration and restoration	NKH	Other agricultural land
RSM	Land for productive afforestation		
Non-agricultural land			
ONT	Rural residential land	DYT	Land for health bases
ODT	Urban residential land	DGD	For education bases
TSC	Land used by offices, headquarters and non-profit agencies	DTT	Land for sports and gyms
TSK	Land used by other offices, headquarters and non-profit agencies	DKH	Land for science research bases
CQP	Defense land	DXH	Land for socio-services
CKS	Land for business and production bases	DVH	Land for non-profit cultural works
CSK	Land for mineral activities	DCH	Market land assigned without payment
CAN	Security land	DDT	Land with heritages and landscapes
SKK	Land for industrial area	DRA	Land for disposal sites and wastes treatment
SKC	Land for business and production bases	TON	Religious land
SKS	Land for mineral activity	TIN	Faith land
SKX	Land for producing materials and ceramics	NTD	Cemetery land
DGT	Land for non-profit traffic	SON	River, canal
DTL	Land for non-profit irrigation	MNC	Land for special-purpose water bodies

DNL	Land for energy works	PNK	Other non-agricultural land
DBV	Land for post and telecommunication works		
Unused land			
BCS	Unused flat land	DCS	Unused mountainous land
NCS	Mountainous land without trees		

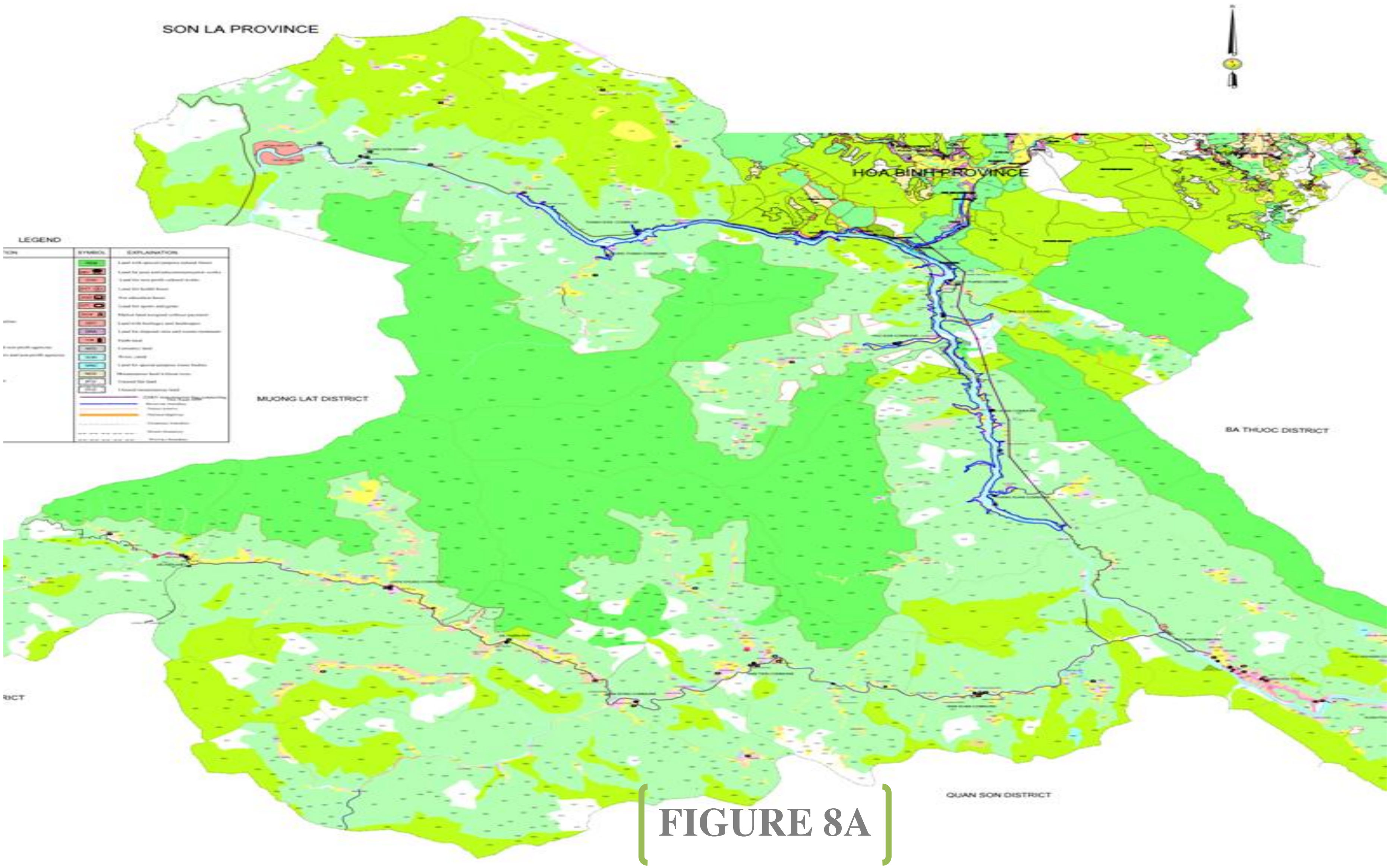


FIGURE 8A

E 8: DIAGRAM OF CURRENT LAND USE SITUATION IN HOI XUAN HYDROPOWER RESERVOIR

SCALE 1 : 25 000

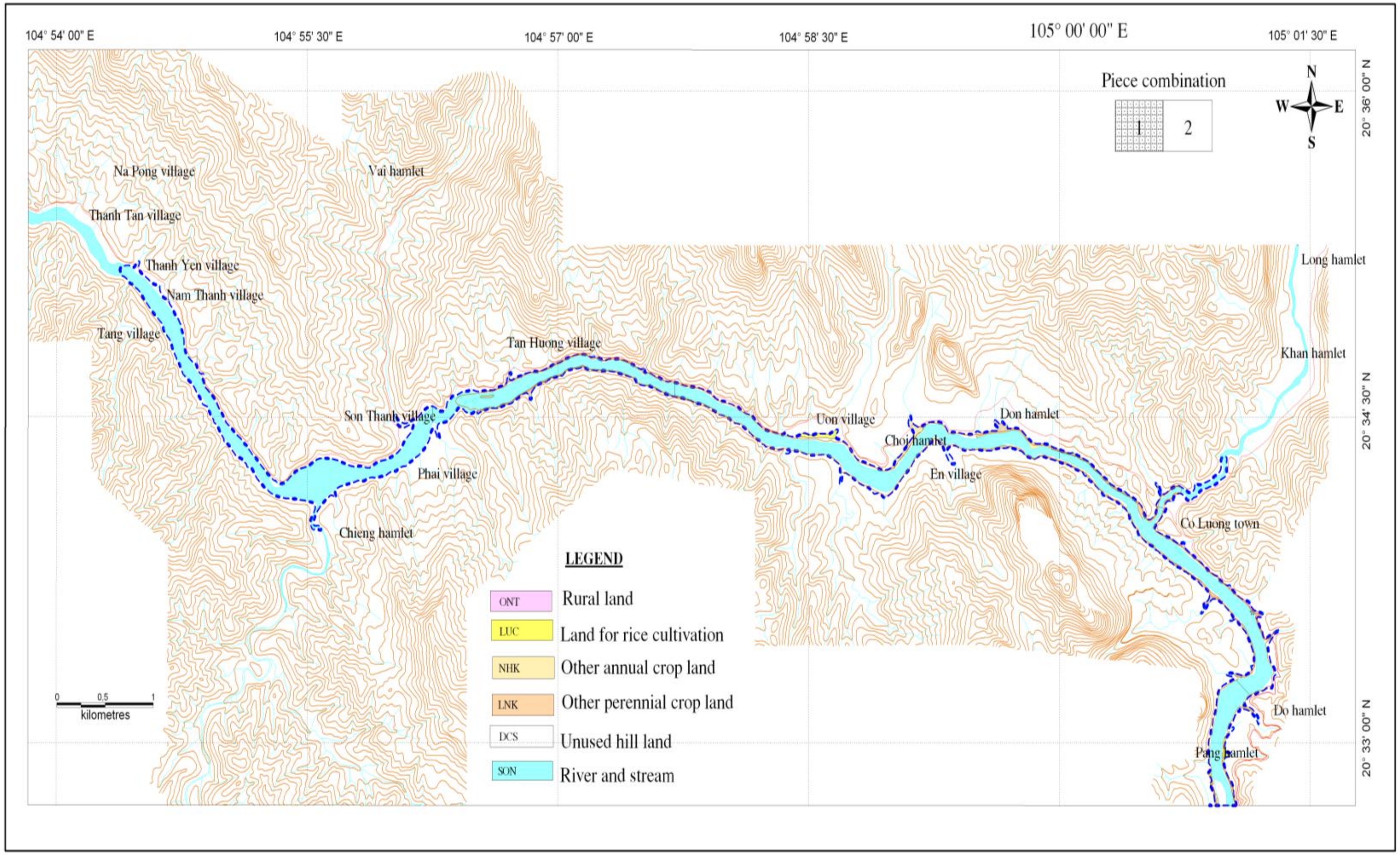


FIGURE 8: DIAGRAM OF CURRENT LAND USE SITUATION IN HOI XUAN HYDROPOWER RESERVOIR (PIECE NO.1)

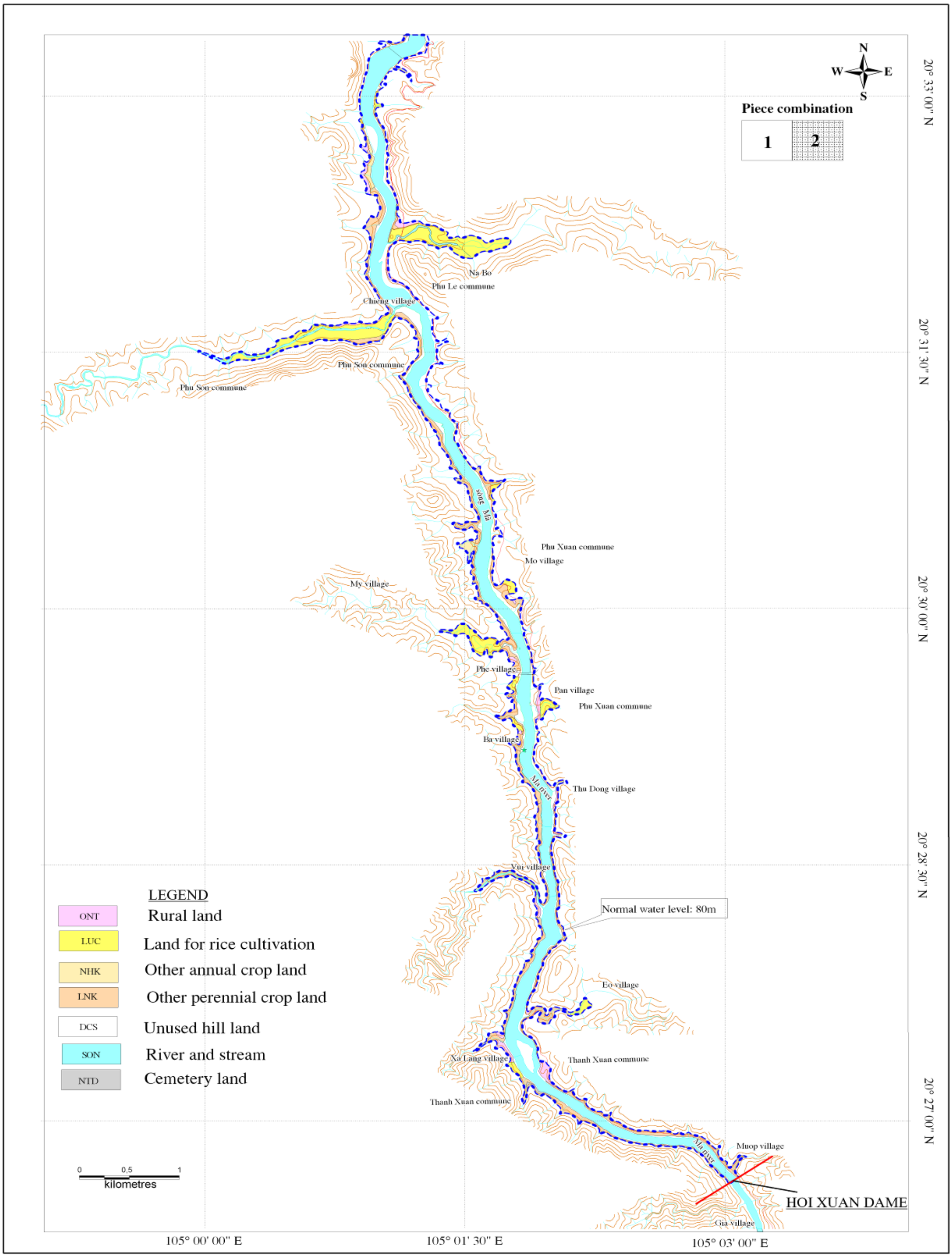


FIGURE 8: DIAGRAM OF CURRENT LAND USE SITUATION IN HOI XUAN HYDROPOWER RESERVOIR (PIECE NO.2)

The above table shows that vegetation cover in the acquired land area of Hoi Xuan HPP is mostly artificial vegetation. The artificial vegetation is mostly forest (28.4%) and rice (6.44%). The others are perennial and annual plants (Figure 8 attached to this report). Natural vegetation includes grassland, shrubland and mixed forest with bamboo and broad-leaved trees.

- *Natural vegetation:*

+ Mixed forest of bamboo and broadleaf species: This type of vegetation has a very small proportion of the project area, mainly distributes on unused land areas.

The dominant bamboo species belong to genera *Bambusa*, *Dendrocalamus*, *Neohouzeaua* (Poaceae). Common timber species belong to the families *Dilleniaceae*, *Elaeocarpaceae*, *Euphorbiacea, etc*.

+ Shrubland:

Including shrubs and small timbers are lower than 5 m. Common timber species belong to genera and families *Mallotus*, *Aporusa*, *Acalypha*, *Macaranga*, *Alchornea* (Euphorbiaceae); *Helicteres* (Sterculiaceae); *Fissistigma*, *Desmos* (Annonaceae); *Ilex* (Aquifoliaceae); *Osbekia* (Melastomaceae), *Myrtaceae*.

+ Grassland:

Most grassland is low (<50 cm), with the dominant species belonging to families Poaceae; Brachiaria mutica, Chrysopogon aciculatus, Cynodon dactylon, Imperata cylindrica, Panicum repens, Pennisetum setosum, Eleosine indica, Brachiaria mutica, etc.

- *Artificial vegetation:*

+ Artificial forest: The acquired land area for the project covers quite a large area of bamboo forest, in which woody bamboo is grown much more. There are also a number of other timber species are thinly grown as *Bambusa nutans, Indosasa, Ormosia balansae, Melia azedarach, Khaya senegalensis, Eucalyptus sp, Acacia auriculiformis, Peltophorum pterocarpum, Chukrasia tabularis, Podocarpus fleuryi, Cassia siamea, M. tonkinensis A. Chev, Magnolia fordiana, Parashorea chinensis, Dalbergia tonkinensis, Cinnamomum cassia.BL, Ricinus communis, etc*.

+ Fruit plants: Orange, Lemon, Grapefruit, Jackfruit, rambutan, banana, etc.

+ Annual plants: vegetables, beans, etc.

+ Food plants: rice, corn, sweet potato, etc.


01/08/2014


05/08/2014


05/08/2014


01/08/2014


01/08/2014


05/08/2014


05/08/2014

b. Fauna

Because vegetation cover in the acquired land area is mostly artificial vegetation, most animal species are domestic animals. Several species of animals, birds and reptiles adaptably live with human activities such as *Muridae*, *Bambusicola fytchii*, *Serilophus lunatus*, *Ptyas korros*, *Dendrelaphis pictus*, *Hemidactylus frenatus*, *Bulalus bulalis, Bos gaurus*, *Susdomestica*, *Cochinchina-Bankivahuhn*, *Felis catus*, ... there is not any big animals and rare wild animals.

3.3.10.2. Aquatic ecosystem, fish and fishery

Currently, the researches carried out in the region are mainly researching on fish, researches on phytoplankton, zooplankton and benthos are very few. Based on the results of the research team and reference materials to study fish and the aquatic ecosystem in the basin and downstream projects by Ho Thanh Hai, Phan Van Mach, Nguyen Huu Duc et al, characteristics of aquatic ecosystems, fish and fisheries in the research areas are as follows:

a. Phytoplankton

The study results have discovered a total of 56 species of *phytoplankton* belonging to three (03) phyla of alga such as *Bacillariophyta*, *Cyanophyta, and Chlorophyta*. The species component is poor; this may be because of the lack of water body types and short investigation period. In the compositions of *phytoplankton*, *Bacillariophyta and Chlorophyta* predominate in the number of species. In addition, the specific species of flowing water bodies in mountains are unicellular algae of *Bacillariophyta*, including genera of *Navicula, Nitzschia, Diatoma* while the usually appeared species of *Cyanophyta and Chlorophyta* are filamentous multi-cellular algae of *Oscillatoria* genus and *Spirogyra* genus, respectively. This is the preferred clean water species which often occur in natural streams and water bodies.

The quantity of *phytoplankton* varies between ecosystems, with low densities in running water ecosystems (river, stream), and high density in still water ecosystems (pond, lake). Density of *Phytoplankton* varies from 2,567 cells/l to 18,593 cells/l, with an average of 9,375 cells/l in the streams, from 24,944 cells/l to 77,097 cells/l, with an average of 49,093 cells/l in the river and from 15,873 cells/l to 106,577 cells/l in ponds and streams. The highest densities of floating plants in the streams and ponds are in the form of *Silic* algae (16% & 36% respectively), meanwhile, the highest density of *phytoplankton* in the river is in the form of blue-green algae (49%) and green algae (32%), while *Silic* algae only comprises 19%. (Phan Van Mach and Ho Thanh Hai 2004).

b. Zooplankton

The research in the project areas found 32 planktonic animals including copepods *(Copepoda),* cladocerans *(Cladocera),* rotifers *(Rotatoria), Ostracoda* crustacean and insects *(Insecta).* Of the planktonic animal components, *Cladocera* are the most plentiful, which is followed by cladocerans *(Cladocera) and Trichodinidae* while *Ostracoda* crustacean are the least abundant.Planktonic animals mainly appear natural flowing water bodies which are not strongly affected by human activities.

The analyzed results indicate that the densities of planktonic animals are very low, varying from 14 to 16 individuals/ m^3. The density of zooplankton in all 3 types of water bodies (river, stream, pond and lake) is dominated by *Copepoda* (60%) (Phan Van Mach and Ho Thanh Hai, 2004).

c. Benthic and aquatic insects

The benthic samples showed that there were 15 benthic species comprising *Gastropoda, Crustacae-Macrura* and *Crustacae-Brachiura*. Of which *Gastropoda* are the most quantities of species (7 species), the other orders has a few number of species and low density of distribution.

Aquatic insects include 16 species of orders appearing natural rivers and streams on highland, they are *Ephemeroptera, Plecoptera*, *Tricoptera*, *Odonata, Hemiptera*, and *Diptera*. Of which, *Ephemeroptera* and *Odonata* are the most pentifule with the highest number of species. The orders have small number of species. Most of aquatic insects live in natural rivers, streams. At streams, the component and density of insect species are the most plentiful.

There are no species of Phytoplankton, Zooplankton or Benthos found in the study area that are recorded in the Red Data Book of Vietnam 2000 or the Red List of IUCN (Phan Van Mach and Ho Thanh Hai, 2004).

d. Benthic and aquatic insects

The benthic samples showed that there were 15 benthonic species comprising *Gastropoda, Crustacae-Macrura* and *Crustacae-Brachiura*. Of which *Gastropoda* are the most quantities of species (7 species), the other orders have a few number of species and low density of distribution.

Aquatic insects include 16 species of orders appearing natural rivers and streams on highland, they are *Ephemeroptera, Plecoptera*, *Tricoptera*, *Odonata, Hemiptera*, and *Diptera*. Of which, *Ephemeroptera* and *Odonata* are the most pentifule with the highest number of species. The orders have small number of species. Most of aquatic insects live in natural rivers, streams. At streams, the component and density of insect species are the most plentiful.

There are no species of Phytoplankton, Zooplankton or Benthos found in the study area that are recorded in the Red Data Book of Vietnam 2000 or the Red List of IUCN (Phan Van Mach and Ho Thanh Hai, 2004).

e. Fish and fisheries

Integrating results of the above research and the present study on biodiversity of Ma river in general and in the project area in particularly. There is clear difference of the species component between the upstream and downstream area. In the midstream, there is the mixture of species components of the upstream and downstream area. According to the research data, it is recorded a list of 198 species of fish belonging to 141 genera and 57 families, within 13 orders, of which 190 are of local origin (96%), 8 imported species (4%), 95 fresh water ones (48%) and 103 salt and brackish water species (52%). Of the species, 56 salt and brackish water fish migrate into the river but there are no species going beyond the Trung Son damsite (under construction) toward the upstream.

Of total fish species on Ma river, there are 10 species in the downstream (55.5%), 75 in the midstream (37.9%), and 63 in the upstream (31.8%) which including 49 (20.2%) in the upstream of Trung Son HPP (the next cascade HPP of Hoi Xuan HPP), 55 (27.8%) in the Hoi Xuan HPP area (the downstream of Trung Son HPP).

There are 10 species which only appear in the upsteam, Pseudolaubuca sinensis, Toxabramis maensis, Tor (Parator) zonatus, Acrossocheilus iridescens, Acrossocheilus microstoma, Acrossocheilus krempfi, Sinilabeo lemassoni, Sinilabeo dorsoarcus, Sinilabeo xanthogenys, and Balitora brucei.

There are three species only appear in the midstream, *Tor (Folifer) brevifilis, Oreochromis mossambicus* and *Percottus tonkinensis* while 64 species only distribute in the downstream.

Table 3.39: The list of species in Ma river from Muong Lat District to downstream (estuary)

Order	Vietnamese name	Scientific name	Upstream		Midstream	Downstream	Remark
1	2	3	4	5	6	7	8
I	**BỘ CÁ CHÌNH**	**ANGUILLIFORMES**					
I.1	**Họ cá Chình**	**Anguillidae**					
1	Cá Chình hoa	*Anguilla marmorata* Quoy&Gaimard, 1824			1	1	VU
I.2	**Họ cá Chình rắn**	**Ophichthyidae**					
2	Cá Lịch cu	*Pisodonophis boro* (Hamilton, 1822)▲				1	
3	Cá Chình râu Trung hoa	*Cirrhimuraena chinensis* Kaup, 1856▲					
I.3	**Họ cá Da**	**Muraenesocidae**					
4	Cá Dưa	*Muraenesox cinereus* (Forsskal, 1775) ▲				1	
II	**BỘ CÁ TRÍCH**	**CLUPEIFORMES**					
II.1	**Họ cá Lanh**	**Chirocentridae**					
5	Cá Lanh	*Chirocentrius dorab* (Forsskal, 1775)▲					
II.2	**Họ cá Trích**	**Clupeidae**					
	Phân họ cá Mòi	***Dorosomatinae***			1	1	
6	Cá mòi cờ hoa	*Clupanodon thrissa* (Linnaeus, 1758) ▲				1	EN
7	Cá mòi cờ chấm	*Konosirus punctatus* (Temminck & Schlegel, 1846)▲					VU
	Phân họ cá Trích	***Clupeinae***					
8	Cá Trích vảy xanh	*Herklotsichthys quadrimaculatus* (Ruppell,					

	mắt to	1837)▲					
9	Cá Trích vảy xanh	*Sardinella zunasi* (Bleeker, 1854)▲					
10	Cá Trích lầm	*S. lemuru* Bleeker, 1853▲					
11	Cá Trích bụng trắng	*Amblygaster clupeoides* Bleeker, 1849 ▲					
12	Cá Mai	*Escualosa thoracata* (Valenciennes, 1847) ▲					
II.3	**Họ cá Trỏng**	**Engraulidae**					
	Phân họ cá Lành canh	***Coiliinae***					
13	Cá Lành canh trắng	*Coilia grayii* Richardson, 1844▲				1	
14	Cá Lành canh đỏ	*C. mystus* (Linnaeus, 1758) ▲				1	
	Phân họ cá Trỏng	***Engraulinae***					
15	Cá Cơm sông	*Stolephorus tri* (Bleeker, 1852) ▲					
16	Cá Cơm thường	*Scomberomorus commersonii* Lacépède, 1803▲				1	
III	**BỘ CÁ CHÉP**	**CYPRINIFORMES**					
III.1	**Họ cá Chép**	**Cyprinidae**					
	Phân họ cá Lòng tong	***Danioninae***					
17	Cá Cháo	*Opsariichthys bidens* Gunther, 1873	1	1	1		
	Phân họ cá Trắm	***Leuciscinae***					
18	Cá Trắm đen	*Mylopharyngodon piceus* (Richardson, 1846) ∴	1			1	
19	Cá Trắm cỏ	*Ctenopharyngodon idellus* (Cuv. &Val., 1844) Ξ∴			1	1	
20	Cá Chày mắt đỏ	*Squaliobarbus curriculus* (Richardson, 1846) ∴		1	1		
21	Cá Măng	*Elopichthys bambusa* (Richardson, 1844)	1	1		1	VU
	Phân họ cá Mương	***Cultrinae***					
22	Cá Thiên hô sông	*Pseudolaubuca sinensis* Bleeker, 1864	1	1			
23	Cá Dầu sông thân mỏng	*Pseudohemiculter dispar* (Peters, 1880)	1	1	1		
24	Cá Dầu sông thân dày	*P. hainanensis* (Nichols&Pope, 1927)					
25	Cá Dầu hồ bằng	*Toxabramis swinhonis* Gunther, 1873			1	1	
26	Cá Dầu hồ sông Mã	*T. maensis* Ngọc& Dực, 2006		1			
27	Cá Mương xanh	*Hemiculter leucisculus* (Basilewsky, 1853)	1	1	1	1	
28	Cá Mương nâu	*H. songhongensis* Hảo&Nghĩa, 2001				1	
29	Cá Mương gai	*Hainania serrata* Koller, 1927	1	1		1	
30	Cá Thiểu bắc	*Cultrichthys erythropterus* (Basilewsky, 1855)			1	1	
31	Cá Vền	*Megalobrama skolkovii* Dybowsky, 1832			1		
32	Cá Vền dài	*M. terminalis* (Richardson, 1845)			1	1	
33	Cá Ngão gù	*Culter recurvirostris* Sauvage, 1884		1	1		
34	Cá Mại bầu	*Rasborinus lineatus* Pellegrin, 1907			1	1	
35	Cá Mại an	*R. albus* Tự, 1991					
	Phân họ cá Nhàng	***Xenocyprinae***					
36	Cá Nhàng bạc	*Xenocypris argentea* Gunther, 1868	1	1	1		
	Phân họ cá Mè	***Hypophthalmichthyinae***					
37	Cá Mè trắng Trung Quốc	*Hypophthalmichthys molitrix* (Cuv.&Val., 1844) Ξ∴			1	1	
38	Cá Mè hoa	*Aristichthys nobilis* (Richardson, 1844)Ξ∴			1	1	
	Phân họ cá Đục	***Gobioninae***					
39	Cá Đục ngộ	*Hemibarbus medius* Yue, 1995	1	1	1		

40	Cá Lổ	*H. lehoai* Hảo, 2001		1	1		
41	Cá Đục đanh chấm râu	*Microphysogobio labeoides* (Nichols&Pope, 1927)		1	1		
42	Cá Đục trắng dày	*Squalidus chankaensis* Bybowsky, 1872	1		1		
43	Cá Đục trắng mỏng	*S. argentatus* (Sauvage&Dabry, 1874)	1	1			
44	Cá Đục đanh đốm	*Saurogobio dabryi* (Bleeker, 1871)		1	1	1	
45	Cá Đục đanh	*S. immaculatus* Koller, 1927	1	1	1		
	Phân họ cá Thè be	**Acheilognathinae**					
46	Cá Thè be râu	*Acheilognathus barbatulus* Gunther, 1873		1	1	1	
47	Cá Thè be thường	*A. tonkinensis* (Vaillant, 1892)	1	1	1	1	
48	Cá Thè be vây dài	*A. macropterus* (Bleeker, 1871)			1	1	
49	Cá Bướm chấm.	*Rhodeus ocellatus* (Kner, 1867)	1	1	1		
	Phân họ cá Bỗng	**Barbinae**					
50	Cá Ngựa bắc	*Tor (Folifer) brevifilis* Peters, 1881			1		VU
51	Cá Cầy chấm.	*Tor (Parator) zonatus* (Lin, 1935)	1				
52	Cá Cầy	*Paraspinibarbus macracanthus* (Pellegrin & Chevey, 1936)	1	1	1	1	
53	Cá Bỗng	*Spinibarbus denticulatus* (Oshima, 1926) ∴	1	1	1		
54	Cá Chày đất	*S. hollandi* Oshima, 1919	1	1	1		
55	Cá Thần	*S. sinensis* (Bleeker, 1873)					
56	Cá Dốc	*S. maensis* Duc, Ngoc & Hau 2007			1		
57	Cá Đòng đong	*Capoeta semifasiolata* (Gunther, 1868)	1	1	1	1	
58	Cá Chát hoa	*Acrossocheilus iridescens* (Nichols & Pope, 1927)		1			
59	Cá Chát vằn	*A. microstoma* (Pellegrin&Chevey, 1936)		1			
60	Cá Chát trắng	*A. krempfi* (Pellegrin&Chevey, 1936)	1				
61	Cá Sỉnh	*Varicorhinus (O.) gerlachi* (Peters, 1880)	1	1	1		
62	Cá Sỉnh gai	*V. (O.) laticeps* Gunther, 1868	1		1		
63	Cá Mọm	*Scaphiodonichthys microcorpus* (Hảo&Hoa, 1969)	1	1	1		
	Phân họ cá Trôi	**Labeoninae**					
64	Cá Rôhu	*Labeo rohita* (Hamilton, 1822) Ξ∴		1	1	1	
65	Cá Rầm xanh	*Sinilabeo lemassoni* (Pellegrin&Chevey, 1936)	1	1			VU
66	Cá Rầm xanh lưng gù	*S. dorsoarcus* (Yên, 1978)	1				
67	Cá Rầm vàng	*S. xanthogenys* (Pellegrin&Chevey, 1936)	1				
68	Cá Trôi	*Cirrhinus molitorella* (Cuvier&Valen., 1842) ∴	1	1	1	1	
69	Cá Trôi Ấn độ	*C. mrigala* (Hamilton, 1822) Ξ∴		1	1	1	
70	Cá Dầm đất	*Osteochilus salsburyi* Nichols & Pope, 1927	1	1	1		
71	Cá Đo	*Garra pingi* Tchang, 1929	1	1	1		
72	Cá Bậu	*G. orientalis* Nichols, 1925	1	1	1		
	Phân họ cá Chép	**Cyprininae**					
73	Cá Diếc	*Carassius auratus* (Linnaeus, 1758)	1	1	1	1	
74	Cá Chép	*Cyprinus carpio* Linnaeus, 1758 ∴	1	1	1	1	
III.2	**Họ cá Chạch**	**Cobitidae**					
	Phân họ cá Chạch bùn	**Cobitinae**					
75	Cá Chạch hoa đốm tròn	*Cobitis taenia* Linnaeus, 1758			1	1	
76	Cá Chạch bùn	*Misgurnus anguillicaudatus* (Cantor, 1842)	1	1	1	1	
III.3	**Họ cá Chạch vây**	**Balitoridae**					

	bằng						
	Phân họ cá Chạch suối	***Nemacheilinae***					
77	Cá Chạch cật	*Micronemacheilus pulcher* (Nichols & Pope, 1927)	1	1	1		
78	Cá Chạch đá sọc	*Schistura fasciolata* (Nichols & Pope, 1927)		1	1		
79	Cá Chạch đá chín sọc	*S. hingi* (Herre, 1934)		1	1		
	Phân họ cá Chạch bám	***Gastromyzoninae***					
80	Cá Bám khuyết sông Đà	*Beaufortia daon* (Yên, 1978)					
	Phân họ cá Chạch vây bằng	***Balitorinae***					
81	Cá Vây bằng vẩy	*Balitora brucei* Gray, 1833	1				
IV	**BỘ CÁ HỒNG NHUNG**	**CHARACIFORMES**					
	Họ cá Hồng nhung	**Characidae**					
82	Cá Chim trắng nước ngọt	*Colossoma brachypomus* (Cuvier, 1818) Ξ∴					
V	**BỘ CÁ NHEO**	**SILURIFORMES**					
V.1	**Họ cá Lăng**	**Bagridae**					
83	Cá Bò	*Pelteobagrus fulvidraco* (Richardson, 1846)			1	1	
84	Cá Huốt	*Hemibagrus vietnamicus* Yên, 1978	1	1	1		
85	Cá Lăng chấm	*H. guttatus* (Lacépède, 1803)	1	1	1	1	VU
V.2	**Họ cá Ngạnh**	**Cranoglanididae**					
86	Cá Ngạnh	*Cranoglanis henrici* (Vaillant, 1893)	1	1	1	1	
V.3	**Họ cá Nheo**	**Siluridae**					
87	Cá Nheo	*Silurus asotus* Linnaeus, 1758		1	1	1	
88	Cá Thèo	*S. cochinchinensis* Cuvier & Valenciennes, 1839	1	1	1		
89	Cá Niết cúc phương	*Pterocryptis cucphuongensis* (Yên, 1978)			1		
V.4	**Họ cá Chiên**	**Sisoridae**					
90	Cá Chiên Bắc	*Bagarius rutilus* Ng&Kottelat, 2001	1	1	1		VU
91	Cá Chiên suối Hải Nam	*Glyptothorax hainanensis* (Nichols&Pope, 1927)	1	1	1		
V.5	**Họ cá Trê**	**Clariidae**					
92	Cá Trê đen	*Clarias fuscus* (Lacépède, 1803) ∴	1	1	1	1	
V.6	**Họ cá Úc**	**Ariidae**					
93	Cá Úc Trung Hoa	*Arius sinensis* (Lacépède, 1803) ▲				1	
V.7	**Họ cá Ngát**	**Plotosidae**					
94	Cá Ngát Bắc	*Plotosus lineatus* (Thunberg, 1791)▲				1	
VI	**BỘ CÁ SUỐT**	**ATHERINIFORMES**					
	Họ cá Suốt	**Atherinidae**					
95	Cá Suốt	*Atherina bleekeri* Gunther, 1861▲					
VII	**BỘ CÁ ỐT ME**	**OSMERIFORMES**					
	Họ cá Ngần	**Salangidae**					
96	Cá Ngần vây dài	*Salanx longianalis* (Regan, 1908) ▲				1	
97	Cá Ngần đầu nhọn	*S. cuvieri* Valenciennes, 1850▲					
98	Cá Ngần trắng	*Leucosoma chinensis* (Osbeck, 1765)▲				1	
VIII	**BỘ CÁ NHÓI**	**BELONIFORMES**					
VIII.1	**Họ cá Sóc**	**Adrianichthyidae**					
99	Cá Sóc	*Oryzias latipes* (Temminck & Schlegel,					

		1846)					
VIII.2	**Họ cá Nhái**	**Belonidae**					
100	Cá Nhái đuôi chấm	*Strongylura strongylura* (Van Hasselt, 1823) ▲					
VIII.3	**Họ cá Kìm**	**Hemiramphidae**					
101	Cá Kìm bắc	*Hyporhamphus limbatus* (Valen., 1847) ▲				1	
102	Cá Kìm Trung hoa	*H. sinensis* (Gunther, 1864) ▲				1	
IX	**BỘ CÁ MANG LIỀN**	**SYNBRANCHIFORMES**					
A	**Phân bộ cá Mang liền**	SYNBRANCHOIDEI					
IX.1	**Họ Lươn**	**Synbranchidae**					
103	Lươn	*Monopterus albus* (Zuiew, 1793)	1	1	1	1	
B	**Phân bộ cá Chạch sông**	MASTACEMBELOIDEI					
IX.2	**Họ cá Chạch sông**	**Mastacembelidae**					
104	Cá Chạch sông	*Mastacembelus armatus* (Lacépède, 1800)	1	1	1	1	
X	**BỘ CÁ MÙ LÀN**	**SCORPAENIFORMES**					
	Họ cá Chai	**Platycephalidae**					
105	Cá Chai Ấn độ	*Platycephalus indicus* (Linnaeus, 1758) ▲				1	
XI	**BỘ CÁ VƯỢC**	**PERCIFORMES**					
A	**Phân bộ cá Vược**	PERCOIDEI					
XI.1	**Họ cá Chẽm**	**Centropomidae**					
106	Cá Chẽm (Vược)	*Lates calcarifer* (Bloch, 1790) ▲			1	1	
XI.2	**Họ cá Sơn**	**Ambassidae**					
107	Cá Sơn sọc bạc	*Ambassis commersonii* Cuvier, 1828 ▲					
108	Cá Sơn xương	*A. gymnocephalus* (Lacépède, 1802)▲				1	
XI.3	**Họ cá Sơn biển**	**Apogonidae**					
109	Cá Sơn Amboi	*Apogon amboinensis* Bleeker, 1853▲					
110	Cá Sơn đuôi vân	*A. urotaenia* Bleeker, 1852▲				1	
XI.4	**Họ cá Rô mo**	**Percichthyidae**					
111	Cá Rô mó	*Coreoperca whiteheadi* Boulenger, 1899	1		1	1	
XI.5	**Họ cá Mú**	**Serranidae**					
112	Cá Mú sao	*Epinephelus fario* (Thunberg, 1792)▲					
113	Cá Mú đen	*E. bleekeri* (Val.&Boc., 1877) ▲				1	
XI.6	**Họ cá Căng**	**Teraponidae**					
114	Cá Ong	*Terapon jarbua* (Forsskal, 1775) ▲				1	
115	Cá Căng	*T. theraps* (Cuvier&Valenciennes, 1829) ▲				1	
116	Cá Căng dài	*T. puta* (Cuvier&Valenciennes, 1829) ▲				1	
117	Cá Căng mõm nhọn	*T. oxyrhynchus* Temminck&Schlegel, 1846▲				1	
XI.7	**Họ cá Đục biển**	**Sillaginidae**					
118	Cá Đục trắng	*Sillago sihama* (Forsskal, 1775) ▲				1	
XI.8	**Họ cá Khế**	**Carangidae**					
	Phân họ cá Khế	***Caranginae***					
119	Cá Hiếu	*Carangoides malabaricus* (Bloch&Schneider, 1801)▲					
120	Cá Ngân	*Caranx kalla* Cuvier & Valenciennes, 1831 ▲					
121	Cá Khế vây đen	*Caranx melanpigus* (Cuv.&Val., 1833) ▲				1	
122	Cá Hiếu miệng đen	*Uraspis helvola* (Forster, 1775)▲				1	
	Phân họ cá Bè	***Scomberoidinae***					

123	Cá Bè hải nam	*Scomberoides hainanensis* (Chu&Cheng, 1985) ▲					
XI.9	**Họ cá Liệt**	**Liognathidae**					
124	Cá Liệt lớn	*Liognathus equulus* (Forsskal, 1775) ▲				1	
125	Cá Ngãng sọc	*L. rivulatus* (Temminck & Schlegel, 1824)▲				1	
126	Cá Liệt vân lưng	*Secutor ruconius* (Hamilton, 1822)▲					
XI.10	**Họ cá Móm**	**Gerridae**					
127	Cá Móm gai dài	*Gerres filamentosus* Cuvier, 1829 ▲				1	
128	Cá Móm gai ngắn	*G. lucidus* Cuvier, 1830 ▲					
XI.11	**Họ cá Sạo**	**Haemulidae**					
129	Cá Sạo	*Pomadasys hasta* (Bloch, 1790) ▲					
130	Cá Sạo chấm	*P. maculatus* (Bloch, 1797) ▲					
XI.12	**Họ cá Tráp**	**Sparidae**					
131	Cá Tráp	*Acanthopagrus latus* (Houttuyn, 1782) ▲				1	
132	Cá Tráp bơđa	*A. berda* (Forsskal, 1775) ▲					
133	Cá Tráp đỏ	*Chrysophrys major* Temm.&Schlegel, 1843 ▲					
134	Cá Tráp gai dài	*Parargyrops edita* Tanaka, 1916 ▲					
XI.13	**Họ cá Sủ (Đù)**	**Sciaenidae**					
135	Cá Sủ	*Boesemania microlepis* (Bleeker, 1858) ▲				1	
136	Cá Uốp	*Johnius belengerii* (Cuvier&Valenciennes, 1830)▲					
137	Cá Uốp	*J. fasciatus* Chu, Lo et Wu, 1963 ▲					
138	Cá Đù môi vàng	*Bahaba taipingensis* (Herre, 1932)▲				1	
139	Cá Đù mắt to	*Argyrosomus macrophthamus* (Bleeker, 1850) ▲					
XI.14	**Họ cá Nhụ**	**Polynemidae**					
140	Cá Nhụ	*Eleutheronema tetradactylum* (Shaw, 1804) ▲				1	
XI.15	**Họ cá Chim mắt to**	**Monodactylidae**					
141	Cá Chim trắng mắt to	*Monodactylus argenteus* (Linnaeus, 1758) ▲			1	1	
B	**Phân bộ cá Đối**	MUGILOIDEI					
XI.16	**Họ cá Đối**	**Mugilidae**					
142	Cá Đối mục	*Mugil cephalus* Linnaeus, 1758▲				1	
143	Cá Đối đất	*Liza dussumieri* (Cuv.&Val., 1836)▲				1	
144	Cá Đối lng gờ	*L. carinatus* (Cuvier&Valenciennes, 1836) ▲				1	
145	Cá Đối cồi	*Valamugil seheli* (Forsskal, 1775)▲				1	
146	Cá Đối anh	*V. engeli* (Bleeker, 1858) ▲				1	
147	Cá Đối vảy to	*Chelon macrolepis* (Smith, 1846)▲					
C	**Phân bộ cá Hàng chài**	LABROIDEI					
XI.17	**Họ cá Rô phi**	**Cichlidae**					
148	Cá Rô phi đen	*Oreochromis mossambicus* (Peters, 1880) Ξ∴			1		
149	Cá Rô phi vằn	*O. niloticus* (Linnaeus, 1758) Ξ∴			1	1	
D	**Phân bộ cá Bống**	GOBIOIDEI					
XI.18	**Họ cá Bống tròn**	**Odontobutididae**					
150	Cá Bống suối Bắc bộ	*Perccottus tonkinensis* Yên, 1978			1		
XI.19	**Họ cá Bống đen**	**Eleotridae**					
151	Cá Bớp	*Bostrichthys sinensis* (Lacépède, 1802) ▲				1	CR
152	Cá Bống suối đầu ngắn	*Philypnus chalmersi* (Nichols & Pope, 1927)		1	1	1	

153	Cá Bống mọi	*Eleotris fusca* (Schneider&Forster, 1801) ▲			1	1	
154	Cá Bống cấu	*Butis butis* (Hamilton, 1822) ▲				1	
155	Cá Bống cửa	*Prionobutis koilomatodon* (Bleeker, 1849) ▲				1	
XI.20	**Họ cá Bống trắng**	**Gobiidae**					
	Phân họ cá Bống lụa	***Tridentigerinae***					
156	Cá Bống vân	*Tridentiger trigonocephalus* (Gill, 1859) ▲				1	
157	Cá Bống râu	*T. barbatus* (Gunther, 1861)▲				1	
	Phân họ cá Bống trắng	***Gobiinae***					
158	Cá Bống chấm bụng	*Acentrogobius chlorotigmatoides* (Bleeker, 1849)▲				1	
159	Cá Bống Cát tối	*Glossogobius giuris* (Hamilton, 1822)			1	1	
160	Cá Bống trắng	*G. sparsipapillus* Akihito&Meguro, 1976					
161	Cá bống râu mắt nhỏ	*Chaeturichthys stigmatias* Richardson, 1844 ▲					
	Phân họ cá Bống đá	***Gobionellinae***					
162	Cá Bống đối	*Mugilogobius abei* (Jordan&Snyder, 1901) ▲				1	
163	Cá Bống đá	*Rhinogobius giurinus* (Rutter, 1897)	1	1	1	1	
164	Cá Bống khe	*R. brunneus* (Temminck&Schlegel,1847)	1	1	1	1	
165	Cá Bống nhọn	*Oligolepis acutipennis* (Valenciennes, 1837)▲				1	
166	Cá Bống lác	*Ctenogobius gymnauchen* (Bleeker, 1860) ▲					
	Phân họ cá Bống kèo	***Oxudercinae***					
167	Cá Bống xệ	*Parapocryptes serperaster* (Richardson, 1846) ▲				1	
168	Cá Bống nác	*Boleophthalmus pectinirostris* (Linnaeus, 1758)▲				1	
169	Cá Thoi loi	*Periophthalmus cantonensis* (Osbeck, 1757) ▲				1	
	Phân họ cá Bống dài	***Amblyopinae***				1	
170	Cá Nhàm	*Odontamblyopus rubicundus* (Hamilton, 1822) ▲				1	
171	Cá Nhàm xám	*Taenioides eruptionis* (Bleeker, 1849) ▲				1	
172	Cá Đèn cầy	*Trypauchen vagina* (Bloch&Schneider, 1801) ▲					
E	**Phân bộ cá Đuôi gai**	ACANTHUROIDEI					
XI.21	**Họ cá Nầu**	**Scatophagidae**					
173	Cá Nầu	*Scatophagus argus* (Linnaeus, 1776) ▲				1	
XI.22	**Họ cá Đìa**	**Siganidae**					
174	Cá Đìa cam	*Siganus oramin* (Bloch&Schneider, 1801)▲				1	
175	Cá Đìa xám	*S. fuscescens* (Houttuyn, 1782)▲				1	
G	**Phân bộ cá Nhồng**	SPHYRAENOIDEI					
XI.23	**Họ cá Nhồng**	**Sphyraenidae**					
176	Cá Nhồng vằn	*Sphyraena jello* Cuvier&Valenciennes, 1829▲				1	
177	Cá Nhồng mắt to	*S. forsteri* Cuvier&Valen., 1829▲				1	
178	Cá Nhồng thường	*S. langsar* Bleeker, 1803▲				1	
H	**Phân bộ cá Thu ngừ**	SCOMBROIDEI					

XI.24	**Họ cá Thu**	**Scombridae**					
179	Cá Thu ẩu	*Scomberomorus commersoni* (Lacépède, 1800)▲				1	
XI.25	**Họ cá Hố**	**Trichiuridae**					
180	Cá Hố nhỏ	*Trichiurus muticus* Gray, 1831▲				1	
181	Cá Hố cát	*T. savala* (Cuvier&Valenciennes, 1831) ▲				1	
I	**Phân Bộ cá Rô**	ANABANTOIDEI					
XI.26	**Họ cá Rô đồng**	**Anabantidae**					
182	Cá Rô đồng	*Anabas testudineus* (Bloch, 1792)			1	1	
XI.27	**Họ cá Sặc**	**Belontidae**					
183	Cá Đuôi cờ	*Macropodus opercularis* Linnaeus, 1788	1	1	1	1	
184	Cá Sặc bướm	*Trichogaster trichopterus* (Gunther, 1861)			1	1	
K	**Phân bộ cá Chuối**	CHANNOIDEI					
XI.28	**Họ cá Chuối**	**Channidae**					
185	Cá Chuối	*Channa maculata* (Lacépède, 1802)				1	
186	Cá Quả	*C. striata* (Bloch, 1797)			1	1	
187	Cá Chuối suối	*C. orientalis* Bloch & Schneider, 1801	1	1	1		
XII	**BỘ CÁ BƠN**	**PLEURONECTIFORMES**					
XII.1	**Họ cá Bơn vỉ**	**Paralichthyidae**					
188	Cá Bơn vỉ	*Tephrinectes sinensis* (Lacépède, 1802)▲				1	
189	Cá Bơn vỉ chấm hoa	*Pseudorhombus cinnamoneus* (Tem.&Sch., 1846)▲					
XII.2	**Họ cá Bơn**	**Soleidae**					
190	Cá Bơn lưỡi mèo chấm	*Brachirus panoides* (Bleeker, 1851)▲					
191	Cá Bơn trứng	*Solea ovata* Richardson, 1846▲					
XII.3	**Họ cá Bơn cát**	**Cynoglossidae**					
192	Cá Bơn lưỡi trâu	*Paraplagusia bilineata* (Bloch, 1785)▲					
193	Cá Bơn lưỡi cát	*Cynoglossus arel* (Bloch & Schneider, 1801)▲					
194	Cá Bơn dẹp	*C. cynoglossus* (Hamilton, 1822)▲					
195	Cá Bơn điểm	*C. puncticeps* (Richardson, 1846)▲				1	
196	Cá Bơn cát	*C. trigrammus* Gunther, 1862▲				1	
197	Cá Bơn cát khảnh	*C. gracilis* Gunther, 1873▲					
XIII	**BỘ CÁ NÓC**	**TETRAODONTIFORMES**					
	Họ cá Nóc chày	**Lagocephalidae**					
198	Cá Nóc	*Takifugu ocellatus* (Osbeck,1757)▲				1	
Total			**49**	**55**	**75**	**110**	

(Source: Nguyen Huy Duc et al, 2008)

<u>Notes:</u>

1. In column 3:

No symbol: freshwater fish

▲ sea fish or brackish fish

Ξ imported fish

∴ aquaculture fish

Ξ∴ imported fish and aquaculture fish

2. In column 4: above retaining dam;

3. In column 5, 6, 7: below retaining dam

4. In column 8: EN, VU, CR are the level written in Vietnam Red Book (part I. Animal) 2007.

The regional fauna of Ma river has unique diversity with 13 orders, 57 families, 141 genera, 198 species. Specifically as follows:

- Order level: Of 13 orders and 57 families of fish, there are 28 families of *Perciformes* making up 49.1%, 7 families of *Siluriformes* (12.3%), 03 families per each of *Anguilliformes,Clupeiformes,Cypriniformes,Beloniformes*, and *Pleuronectiformes* (5.26%). Other orders have 1 or 2 families each.

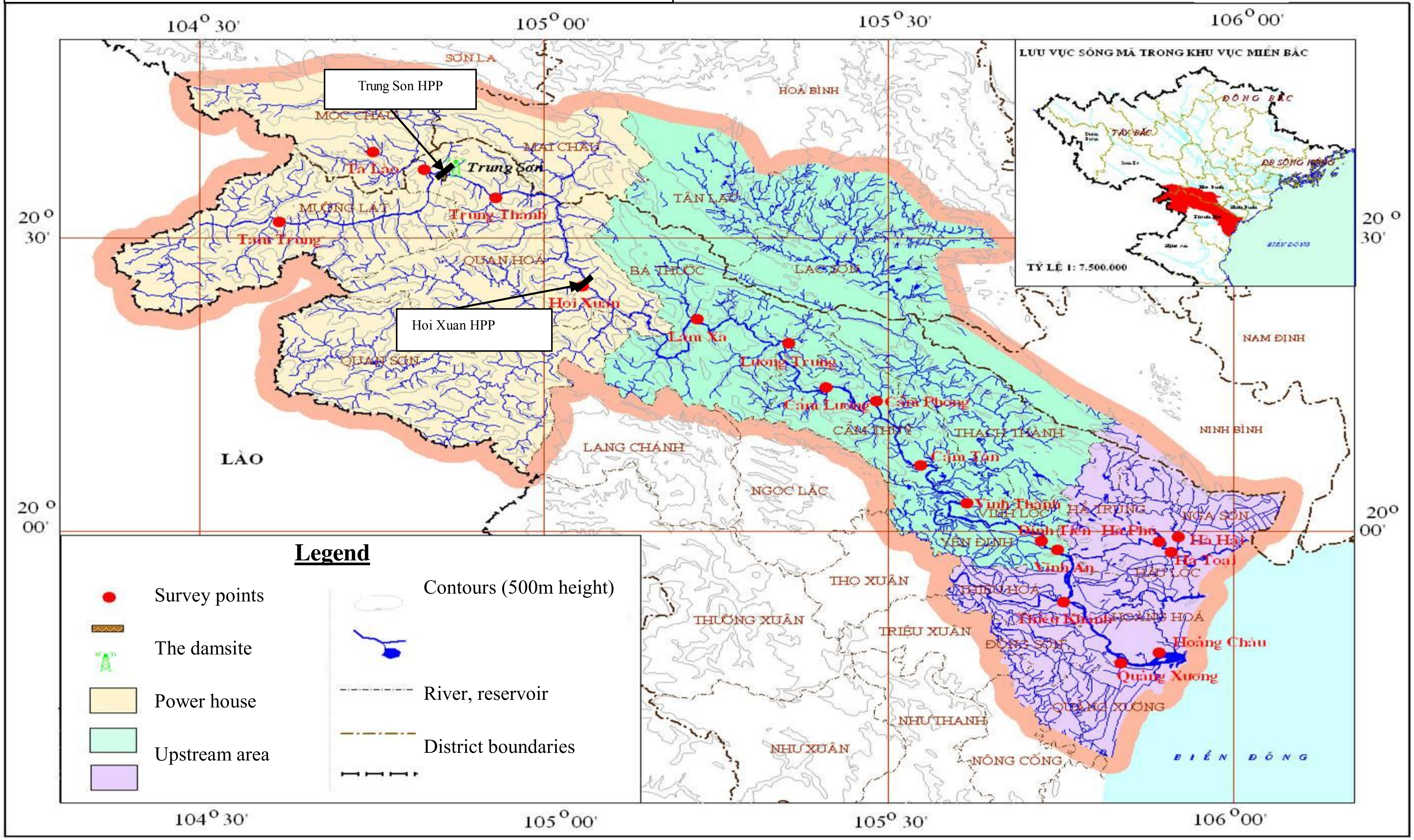
- Family level: Of 57 families of fish, there are 141 classes with *Cypriniformes* is the largest with 37 classes, making up 26.2%; Gobiidea – 14 classes (9.9%); Clupeidae - 6 classes (4.3%); Eleotridae – 5 classes (3.5%); Others have up to 4 classes (0.7%-2.8%)

- Class level: Of 141 classes, one class - *Cynoglossus* has 5 species, 2 classes with 4 species, 5 classes with 3 species, 37 classes with 2 species and 96 classes with only one species.

- Species level: Of 198 species, *Perciformes* has greatest number ofspecies: 82 species – 41.4%, *Cypriniformes* has 65 species making up 32.8%, *Siluriformes, Clupeiformes* – 12 species (6.0%), *Pleuronectiformes* has 10 species (5.1%). Others have up to 3 species (0.5%-2.0%).

FIGURE 6: MAP OF FISHES AND FISHERY IN Ma river BASIN

Rate 1: 600.000



(Reference source: Nguyen Huu Duc and the coworkers 2008)

Rare fish species:

Based on the research results of the status of fish in Ma river basin, 9 species among of 198 species on Ma river are listed in Vietnam Red data Book, 2007. These include one that is Critically Endangered, named *Bostrichthys sinensis;* one that is Endangered, *Clupanodon thrissa*; and seven that are Vulnerable, including *Konosirus punctatus, Tor (Folifer) brevifilis*; S*inilabeo lemassoni*; *Elopichthys bambusa; Bagarius rutilus*; *Hemibagrus guttatus* and *Anguilla marmorata*. The upstream area of Trung Son damsite has 4 VU species such as *Elopichhthys bambusa, Sinilabeo lemassoni, Hemibagrus guttatus,* and *Bagarius rutilus*. Hoi Xuan area and the downstream of Ma river appear all these 9 species. There is no species recorded in the *Red List of IUCN 2006*. However, none of those species are endemic to the project area because they are also distributed in different areas at rivers and streams in the North and North Central Vietnam as well as in the middle Central Vietnam.

Information related to endangered species within Ma river and the study area:

- *Bostrichthys sinensis* is a valuable species, good for exportation. At present, in the river estuary at Hoang Chau commune, there are nearly 400 ha semi-natural ponds of this fish species. This species' breeding season is between March and August. Their food is mainly crustacean and small fish. The habitats include river mouths, tidal flats, brackish-marshes with sandy or silt bed. Mature fish live in caves. They are found in Hoang Chau, Hoang Hoa District (Vietnam Red Data Book, part I – animal 2007)

- *Clupanodon thrissa*: this species is found in Cam Thuy, Vinh Loc and Quang Xuong. This species migrates from sea into river to spawn. In Ma river, during breeding season, this fish moves into river spawning flats in Huoi Cham, Ban Cong commune, Ba Thuoc district. They live in middle layer of the water column. Their food is mainly alga, small crustacean and residue. Their breeding season is between March and May, vigorously in April.

- *Konokirus punctatus is* found in Quang Xuong and nearly riversides on Ma river, and on the estuary in Gulf of Tonkin (Vietnam Red Data Book, part I – animal 2007). This species mainly live in upper and middle layers of the water column, in large shoals. Its food is mainly diatoms and copepoda. They migrate into rivers to spawn. There are two breeding seasons, from December to January and from March to May.

- *Anguilla marmorata*: Food is invertebrates and small fish. They live in fresh water, but migrate to sea to spawn. After metamorphosis, juveniles move into rivers following sea currents. Through interview, fishermen confirm the existence of this fish but they are rarely found. In 5 to 10 years, only a few individuals are found in Cam Thuy, Ba Thuoc, and Quan Hoa. Ma river is the northernmost river this species has ever been found in Vietnam. This investigation has only based on photographs of Prof. Dr. Nguyen Huu Duc et al, it, therefore, is not sured, but this species has very few individuals if the existence on Ma river of this fish is true. These experts did not collect any of this species during their survey of fish on Ma river from 1995 to 2006.

- *Sinilabeo lemassoni*: They are found in Muong Lat and Quan Hoa, as well as in Thai Nguyen, Tuyen Quang, Lao Cai, yen Bai, Nghe An Quang Nam, etc. (Vietnam Red Data Book, part I – animal 2007). This species lives on the stream bed and in sub-bed layers, particularly where there are stones, gravels and weeds. Their food is adhesive alga, organic detritus and small invertebrates. Breeding season is from December to February. Small fishes are grown in the cold water flows from mountain, which are underground rivers (e.g. Phu Le village)

- *Tor (Parator) brevifilis* is found in Cau Thuy and other places such as Lao Cai, Yen Bai, Tuyen Quang, Nghe An, Son La, etc. (Vietnam Red Data Book, part I – animal 2007). This species lives in middle layer of clean water with strong flows. Foods include mollusks, insects, worm, algae and organic detritus. Breeding season is from February to April or from May to June. They spawn in strong current with stones, gravels on bed.

Distribution:

- *Elopichthys bambusa* is found in Quan Hoa and large river system in midlands and highlands of the North and the North Central Vietnam. These fishes live in upper and middle layers of water column. This species is very fierce and eats other fish species, so they live alone or in small shoals. Breeding season is from April to July. Their spawning flats are in big rivers' midlands, and their spawns is floating type.

- *Bagarius rutilus:* this is typically fierce fish. Mature fishes eat small and average-sized fishes while little fishes eat insect larvas, shrimps and small fishes. Breeding season is from March to June usually in strong currents. This species spawns by digging caves, migrating to middle and highland with strong current, stones and gravels on bed and deep water to spawn. Their spawns go through the flow, hatching and becoming small fish, then come back against the currents to mature and spawn. They have broad distribution, with high abundance in Muong Lat, Quan Hoa, Ba Thuoc, Cam Thuy and Vinh Loc districts. Currently, some people have pilot growing in cages.

- *Hemibagrus guttatus:* this is typically fierce fish, lives in bed layer, and distributed in Muong Lat, Quan Hoa, Ba Thuoc, and Cam Thuy and in some big rivers in the North such as Red River, Thai Binh River, Ki Cung River, and Lam River, and Tra Khuc River (Quang Ngai in the Central). Juvenile fishes eat insect larvas. Mature fishes eat small fishes, shrimps, crabs, organic detritus. Breeding season is from April to June, sometimes extending to August. They migrate to upper and midland, with flow current, stones and gravels on bed to spawn.

In addition, basing on Doan Le Hoa and Pham Van Doan's list, the followings are also mentioned in Vietnam Red book, but were not found in this study or in other previous research: *Labeo tonkinensis* and *Semilabeo notabilis*. Both of them categorized as VU (Vulnerable).

Reproduction and migration behaviour of fishes:

According to the survey results, many fish spawning areas are reported along the river: In the highland spawning areas of *Cyprinus carpio*.are reported at Paxay village (Uon village), and in the midland at Vinh Hung, Vinh Ninh (Vinh Loc), Ban Cong (Ba Thuoc), and Bai Gian (Cam Thuy). In the lowland, spawning areas are reported in Thua Hop (Thieu Hoa) for *Cyprinus carpio* and *Silurus asotus*.

There are records of breeding season for 32% of downstream, 53% of midstream and 53% of upstream species. Reproduction time and behavior of some available fishes are presented as above.

For migration, there are records of the migration of 13% of downstream, 17% of midstream and 10% of upstream species.

- The migration of fishes from the sea to the river. According to our survey, there are 54 species of brackish and saltwater fishes that migrate into river, of which 42 species only penetrate into the downstream area (30 km far from river mouth); 12 species penetrating into the midstream area (over 30 km far from river mouth), with the species penetrating furthermost area being*Lates calcarifer* that penetrates up to 80 km from Ba Thuoc District. That none of the salt or brackish species of fish penetrates into upstream, which means that none of these migrate through the location of Hoi Xuan and Trung Son HPP at the upstream area.

- The migration of fishes from the river to the sea. According to the research, there are 4 species of fish, which are living in the river, have migrated to the sea such as *Anguilla marmorata, Lates calcarifer, Mugil cephalus andTherapon jarbua*. These 4 species have been allocated in Ma river downstream area, therefore, the dams of Hoi Xuan and Trung Son HPP are not a barrier of their migration and generation

Table 3.40: Migration features of fish species on Ma river

No.	**Science name**	**Migration features**							
		From sea to river							**From river to sea**
		<10km from the river mouth	***10 - 20km from the river mouth***	***20 - 30km from the river mouth***	***30 - 40km from the river mouth***	***40 - 50km from the river mouth***	***50 - 60km from the river mouth***	***>60km from the river mouth***	
1	Eleotris fusca							*X*	
2	Tridentiger trigonocephalus						*X*		
3	Clupanodon thrissa					*X*			
4	Coilia grayii				*X*				
5	Valamugil seheli				*X*				
6	Tephrinectes sinensis				*X*				
7	Taenioides eruptionis				*X*				
8	Leucosoma chinensis				*X*				
9	Hyporhamp hus				*X*				

No.	Science name	Migration features							
		From sea to river							From river to sea
		<10km from the river mouth	10 - 20km from the river mouth	20 - 30km from the river mouth	30 - 40km from the river mouth	40 - 50km from the river mouth	50 - 60km from the river mouth	>60km from the river mouth	
	limbatus								
10	Coilia mystus				X				
11	Sardinella zunasi				X				
12	Hyporhamthus sinensis			X					
13	Takifugu ocellatus			X					
14	Pisodonophis boro			X					
15	Gerres filamentosus			X					
16	Butis butis			X					
17	Salanx longianalis			X					
18/	Arius sinensis			X					
19	Liza carinatus			X					
20	Strongylura strongylura			X					
21	Acanthopagrus latus			X					
22	Liognathus equulus			X					
23	Sillago sihama			X					
24	Platycephalus indicus			X					
25	Salanx cuvieri			X					
26	Ctenogobius gymnauchen			X					
27	Stolephorus commersonii			X					
28	Cynoglossus trigrammus		X						
29	Periophthalmus cantonensis		X						
30	Boleophthalmus pectinirostris		X						
31	Parapocryptes serperaster		X						
32	Tridentiger barbatus		X						
33	Ambassis gymnocephalus		X						
34	Trichiurus savala	X							
35	Sphyraena langsar	X							
36	Sphyraena Jello	X							
37	Siganus oramin	X							
38	Chaeturichthys stigmatias	X							
39	Acentrogobius chlorotigmatoides	X							
40	Prionobutis koilomatodon	X							
41	Valamugil engeli	X							
42	Liza dussumieri	X							
43	Eleutheronema tetradactylum	X							
44	Johnius fasciatus	X							

No.	Science name	Migration features							
		From sea to river							From river to sea
		<10km from the river mouth	*10 - 20km from the river mouth*	*20 - 30km from the river mouth*	*30 - 40km from the river mouth*	*40 - 50km from the river mouth*	*50 - 60km from the river mouth*	*>60km from the river mouth*	
45	Boesemania microlepis	*X*							
46	Chrysophrys major	*X*							
47	Terapon theraps	*X*							
48	Amblygaster clupeoides	*X*							
49	Konosirus punctatus	*X*							
50	Pomadasys maculatus	*X*							
51	Stolephorus tri	*X*							
52	Chirocentrius dorab	*X*							
53	Muraenesox cinereus	*X*							
54	Cirrhimuraena chinensis	*X*							
55	Anguilla marmorata								*X*
56	Lates calcarifer								*X*
57	Mugil cephalus								*X*
58	Terapon jarbua								*X*

(Source: Nguyen Huu Duc et al, 2008)

<u>Fish resources and fishery:</u>

The study results show that there are 45 economic species on Ma river from Ten Tan section to the downstream, of which 11 species are in the upstream area, 17 species in the midstream and 29 species in the downstream.

In 45 economic species, only four common species (common carp, *Hemiculter leucisculus*, *Cranoglanis sinensis* and *Mastacembelidae*), with only 3 species in the upstream (*Hemibagrus guttatus*,*Spinibarbus denticulatus*, and *Cirrhinus*), 4 species in the midstream (*Clupanodon thrissa*, Sand goby *Glossogobius giuris*, *Spinibarbichthys Denticulatus*, *Bostrichthys aruensis*), 20 species in the downstream, including *Parachela oxygastroides, Mugil cephalus , Bartail Flathead, Cynoglossus puncticeps*, *Gerres filamentosus*, Scatophagus argus, *Silago sihama*, *Odontamblyopus rubicundus*, *Acanthopagrus latus*, *T. theraps*, *Plotosidae, Scombridae, Hemiramphidae*, *Pisodonophis*, *Serranidae*, *Bostrichthys sinensis*, *L. rivulatus*, *Argyrosomus macrophthamus*, *Bahaba taipingensis* and *Terapon jarbua*

Fish fauna in Ma river but rich in species composition but no species dominate production, fish stocks in general and in particular fisheries resources are not high and the rate of decline sharply by 75. 80% over the past 10 years, about 20-30% over the past 5 years. There are 9 species previously for high output, but this is very limited as fish Chat (Acrossocheilus krempfi), fish Nich (Sinilabeo lemassoni), river fish oil (Pseudohemiculter dispar), fish Lui (Osteochilus salsburyi), fish Bui (Liza carinata) fish Fire (Hilsha revesii) and fish Calendar (Pisodonophis boro), individuals considered (Liza seheli), sea bass (Lates calcarifer). There are 01 species not previously seen this fish is that UK arms (Semilabeo notabilis) (Nguyen Huu Duc et al, 2008). Most of the loss, including:

Despite of the plentifulness of species components, fish in Ma river have not any species with dominant output, beneficial potentiality of fish and fishery is not high and strongly reduces, about 75-80% down in comparison with that in the 10 years ago, and 20 – 30% compared with the 5 years ago. Nine (09) species used to have high output, but now it is still very low, these are *Acrossocheilus krempfi, Sinilabeo lemassoni, Pseudohemiculter dispar, Osteochilus salsburyi, Liza carinata, Hilsha revesii, Pisodonophis boro, Liza seheli, and Lates calcarifer*. *Semilabeo notabilis* used to appear in the area, but no longer existed (Nguyen Huu Duc et al, 2008). The reasons of the above problems are:

- The increase of fish catchers due to the population growth.

- The use of backward fishing gears such as nets, sweep-net.

- The use of unpermitted fishing means such as electricity, toxic chemicals, explosives.

- Fishing in breeding season, even in concentrated spawning grounds.

- The loss of watershed forests resulting in the increase of flooding frequency and intensity.

- The pollution on the river due to the use of plant protection chemicals, wastewater from enterprises (manufactories of paper, sugar, cassava powder, chopstick, etc.) along the two riversides without treatment, wastewater from industrial areas and domestic wastewater.

- The disturbance of the flow by sand and mineral mining.

Nearly 100% fish species on Ma river are catched for foods of people. A few species with non-deliviousness and cheap prices (2,000 – 3,000 VND/kg) are used for animal's food, they are *Oryzias latipes, Odontamblyopus rubicundus*. *Takifugu ocelatus* is a toxic species but it still is caught for people food. According to survey, interview from local people, protein from fish is an important nutrient of local people daily diet, about 50-60% of consumed protein.

According to statistic results (Thanh Hoa Department of Statistics, 2013), fishing output on Ma river of communes along the river only account for 4% of total aquacultural production. The fishing output has differences between the regions; it get the highest at the downstream, followed by that in the midstream and the lowest in the upstream. According to the survey results of Nguyen Huu Duc et al in 2008 on nearly 1,000 households, average fishing output per one household on Ma river from Muong Lat to the river mouth was

1.69kg/day/household, while this figure was 1.02kg/day/household of households in the upstream, 1.99kg/day/household of the midstream area and 3.33kg/day/household of the downstream area, 1.55kg/day/household in Trung Son HPP area and 1.77kg/day/household in Hoi Xuan HPP. According to the survey results of the PECC4's expert group (2014), average fishing production of 30 fishing households in Hoi Xuan HPP area is 40-50 kg/month.

Similarly with the fishing output, the rate of consumed protein and average income from fisheries in comparison their total gradually increases from the upstream to the midstream, and reaches the highest in the downstream. According to the survey results of Nguyen Huu Duc et al 2008, average income from fisheries accounted for about 30% of average total household income, particularly, 12% in the upstream, 35% in the midstream, and the downstream for about 65%, 15% in the Trung Son HPP area, approximately 20% in the Hoi Xuan HPP area. According to the survey results of the expert group (2014) at 30 fishing households in the project area ' income in Hoi Xuan HPP area, total average income from fishery is about 20-30%, only households who are specialized in fishery have income of 70 – 80%.

The vast majority of fish species (both juveniles and adults) are caught in the rainy season. Juveniles of 45% of species are recorded in the rainy season while juveniles and adults of 23% other species in the downstream and of 42% in the mid and upstream are caught in the same time.

The means and equipment for fishing include boats or motorboats with small capacity, sweep-net, net, multiple-layer net, fyke net, push net, tangle net, etc. These are the common means, but the most popular is is sweep-net. In the highland area, women usually use hand net to catch fish at small stream.

The vast majority of fishermen use fishing means inconsistent with the protection and maintenance of fish resources such as fishing nets with thick eyes, thick fyke net. Also, some dangerous means have been used, like blasting, toxic chemicals. As a result, fish resource is becoming exhausted. According to the survey, depending on the regions, there are from 12 to 23 species caught by electric shock.

The survey in local markets has recorded 52 fish species which are traded in the market, including 40 species caught in the natural rivers and 12 farmed fish species. These 12 species are *Hypophthalmichthys molitrix, Ctenopharyngodon idellus, Colossoma brachypomus, Cirrhina mrigala, Cirrhina molitorella, Channa striata, Cyprinius carpio, Monopterus albus, Mylopharyngodon piceus, Oreochromismossambicus, garius rutilus* (it varieties taken from Ma river), and *Spinibarbus sinensis* (its varieties taken from Ma river. The caugh fish size is from 23 to 650mm, *Eleotris fusca* has the smallest size (23mm) and *Monopterus albus* has the bigest size (650mm) In general the caught fishes have size smaller than the regulated size for fishing. Average rate of farmed fish sold at the market is more than 5.6 times compared with the caught fish from natural rivers/streams. This rate is lower in the upstream and increases in the middle and lower, 1.9 times higher than in the upstream; 2.8 times higher than in the midstream; and 12.2 times higher than in the downstream. In the wild fish species, *Glossogobius giuris* has the highest yields, *Hemibagrus guttatus* and *Bagarius rutilus* have also relatively high yields. *Ctenopharyngodon idellus* have the highest yields of farmed species.

Here are some pictures of the fish caught in the markets during the survey in the local markets.

	
Bagarius rutilus	*Sinilabeo lemassoni*

	
Hemibagrus guttatus	*Cirrhinus molitorella*
	
Hypophthalmichthys molitrix	*Cyprinius carpio*

The number of fishing days on average for households along Ma river is 170 days/year/household, the lowest in the upstream (110 day/year/household), higher in the mid and downstream (about 200 days/year/households), in Hoi Xuan HPP area about 110 days/ year/household.

Although the fishery resources have declined, the human resource in fisheries has increased with the insignificant rate from 2,211 people in 2001 to 2,365 people in 2008. The fishing means and methods are more and more versatile, therefore fishing yields are tend to increase with average rate of 1.3%/year (Thanh Hoa Statistics Department, 2008). According to statistic yearbook of Quan Hoa district (the directly affected communes of Hoi Xuan HPP), number of people in working age engaging in fighery has stably maintained from 2010 to 2013, about 1500 people.

In addition to catching wild fish, aquaculture activities in the study area are quite developed. The area, production and productivity of aquaculture in the province have fluctuated, but the trend is upward. The number of fish cages in the river is not many, with the highest in 2004 with 1,119 ones in the upstream, there are no any cages in the downstream. Output and productivity of farmed fish are also unstable, with average productivities at 0.25 tons/cage/year. According to statistic data of Thanh Hoa Statistic Bureau in 2012, the whole province’s aquacultural area is from 13,861ha in 2010 to 14,497ha in 2012. In which, the fresh aquacultural area is various and around 8,871ha in 2010 to 8,865ha in 2012. Total output of aquaculture is from 29,473 thousand tons in 2010 to 36,117 thousand tons in 2012. Fresh aquacultural output accounts for 68.37% of the whole province's output. The productivity of aquaculture is from 2.13 tons/ha/year in 2010 to 2.49 tons/ha/year in 2012.

In nearly 1,000 households surveyed by Nguyen Huu Duc et al in 2008, 30% of households engaged fisheries, the others were in agriculture associated with fishing. Educational level, and economic life of the fishermen were generally lower than the local average level. Most of them do not have houses on shore, they live on their boats. Therefore, their children have not enough chances to go to school, and the rate of literate people is only 10%-20% with the education level at class 1 or 3. Otherwise, this rate in agricultural households is at least 90%. This is the reason why it is difficult to make fishermen understand the guidelines and policies about aquaculture as well as how to change their career if fisheries get challenging. Furthermore, the decrease of fish resources and the high population of each fishermen household have caused more and more difficult in the life of fishermen household.

3.3.10.3. The affected natural protected areas

Under the project's design, Hoi Xuan HPP has the area of 14,975 km^2. The project area has four (04) natural reserves (NRs) which are able to be affected by the project. These are Xuan Nha natural reserve (in Son La province), Pu Hu and Pu Luong natural reserves (in Thanh Hoa province) and Hang Kia – Pa Co natural reserve (Hoa Binh province). Some information of the four natural reserves are summarized as the below table

Table 3.41: Main features of the natural reserves in Hoi Xuan HPP's area

Feature	**Xuan Nha NR**	**Pu Hu NR**	**Pu Luong NR**	**Hang Kia-Pa Co NR**
Geographical location	Moc Chau district, Son La province	Quan Hoa and Muong Lat districts, Thanh	Quan Hoa and Ba Thuoc districts, Thanh	Mai Chau district, Hoa Binh province

		Hoa province	Hoa province	
Geographical coordinates	N20^{0}34'45"- 20^{0}54'54" E 104^{0}28'42" - 104^{0}50'26"		N 20^o 21'00"- 20^{o}34'00" E 105^{o}02'00"- 105^o 20'00"	N20^{0}40'30''- 20^{0}45'30" E 105^{0}51' 20''- 105^{0}00'35''
Year of the NR's establishment	1986	1999	1999	1986
Year of NR's management board establishment	2002	1999	1999	2000
Management board	Xuan Nha NR Management board	Pu Hu NR Management board	Pu Luong NR Management board	Hang Kia – Pa Co NR Management board
Governing agency	Son La provincial Forest Protection Department (FPD)		Thanh Hoa provincial FPD	Hoa Binh provincial FPD
IUCN' ranking	Nature Reserve. IUCN Category Ib (Wilderness Area).	Nature Reserve. IUCN Category Ib (Wilderness Area).	Nature Reserve. IUCN Category Ib (Wilderness Area).	Nature Reserve. IUCN Category Ib (Wilderness Area).
The area of the NR's core area	16,316.8 ha	23,149.45 ha	17,662 ha	7,091 ha
The buffer area	87,336 ha.	27,306 ha	35,000 ha	8,135 ha
The major management objectives	- Conservation of tropical forest ecosystems and subtropical Northwest Vietnam - Conservation of precious species and threatened species - Protection of	- Conservation of tropical forest ecosystems and subtropical Northwest Vietnam - Conservation of precious species and threatened species - Protection of	- Conservation of limestone forest ecosystems in the Northwest Vietnam. - Conservation of precious species and threatened species	- Conservation of limestone forest ecosystems in the Northwest Vietnam. - Conservation of precious species and threatened species

	the watershed forest of Ma and Luong Rivers; environmental protection and assisting for the socio-economic development	the watershed forest of Ma and Luong Rivers; environmental protection and assisting for the socio-economic development	- Protection of the watershed forest of Ma river; environmental protection and assisting for the socio-economic development	environmental protection and assisting for the socio-economic development of mountainous communes

1. BIODIVERSITY VALUES OF XUAN NHA NR

a. Vegetation cover

Xuan Nha NR has three (03) main forest types such as tropical moist evergreen closed forests (distributed at elevations below 700 m), subtropical moist evergreen closed forest (distributed at elevations above 700 m) and subtropical moist evergreen closed forest mixed broadleaf and coniferous trees (at elevations above 800 m). However, the primary forest which has been not affected is currently about 45% of the NR's total area. The remaining parts of the forests are different alterable types of the above forest types due to logging or clearing for cultivation. These are secondary (second-growth) forest, shrubland and grassland (see in Map No.3). The tropical moist evergreen closed forests and subtropical moist evergreen closed forest are the typical types in the Northwest Vietnam.

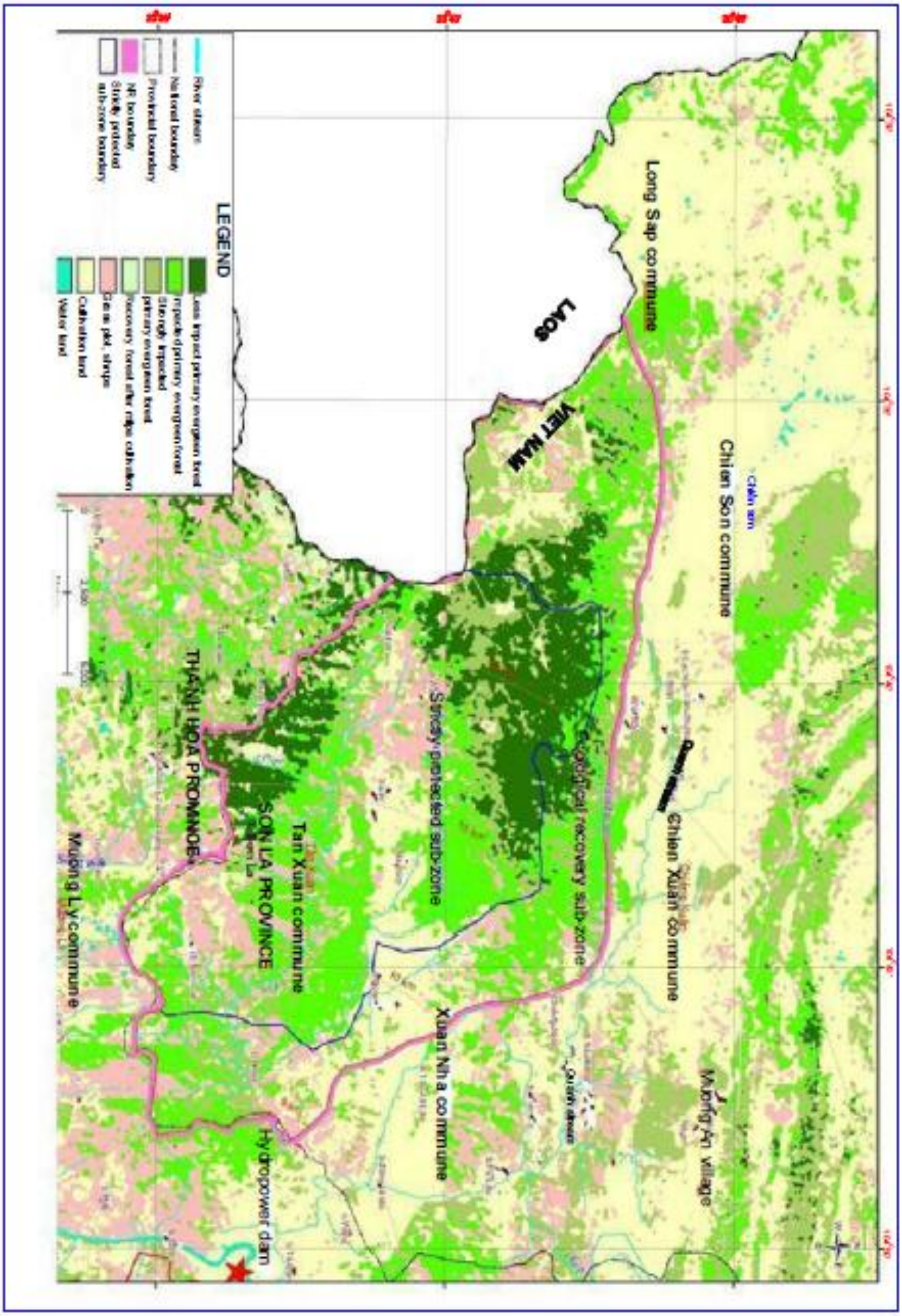


Figure 9. The vegetation cover of Xuan Nha NR

Tropical moist evergreen closed forests.

This forest kind occupies about 10-15% of total area of the land covered by forest (or total) and to be distributed at elevations below 700 m. Forest reserves is 300-400m^3/ha, with the structure of 5 layers, including three layers of timber trees. Dominant components in the timber-tree layer are *Dipterocarpus tonkinensis, Parashorea chinensis, Vatica fleuryana, Aglaia gigantea, Castanopssi sp., Pometia pinnata, Aphanamixis polystachya, Choerospondias axillaris*, etc. Some species of precious timber-tree are *Markhamia stipulata, Madhuca pasquieri, Vatica fleuryana, Chukrasia tabularis, Paramichelia baillonii, Michelia mediocris*, etc. Despite of the plentiful reserves, number of individuals of timber-tree species is not much, about 10-15 tree/ha. In case of the exploitation, the forest layer structure will be broken and result in the forest degradation.

On the limestonemountains, dominated species are Burretiodendron tonkinensis, Garcinia fagracoides, Dracontomelum duprreanum, Pomertia pinata, Annamocarya sinensis, Aglaia gigantea, Saraca dives, Bischofia javanica, Tacxotrophis macrophylla, Streblus macrophyllus, Diospyros rubra, Hydnocarpus sp., Celtis sp, etc.

Picture 1. Tropical moist evergreen closed forests in Xuan Nha NR

Subtropical moist evergreen closed forest

This forest kind occupies approximately 30% of total, mainly distributes on the strictly protected zones on elevation of 700m alt. This kind has been well developed and has average reserves (250-300m^3/ha). Timber-trees are *Castacopsis sp.,* Indian beech (*Castnopsis indica*), *Michelia balansaewith, M. mediocris, Camelia sp., Machilus sp. Some conifers such as Keteleeria evelyniana, Dacrydium elatum, Cunninghamia knonishii, Nageia fleuryii, Podocarpus pilgeri*. Coniferous species have small number of individuals, grow scatteredly, and sometimes they grow together in a small group and thinly distribute in the elevation of 800m.

On limestone mountains, the forest structure has 2 timber-tree layers. The timber-tree composition consists mainly of species in the genus *Lithocarpus, Quercus Fagaceae (Fabaceae), Machillus, Lauraceae, Ficus, Moraceae, Michelia, Magnoliaceae, Engelhartia Juglandaceae, Hydnocarpus Flacourtiaceae,* and *Diospyros Ebenaceae*.

Subtropical moist evergreen closed forest mixed broadleaf and coniferous trees

In this forest kind, the broadleaf tree component is relative similar to that mentioned above. This means that they consist of the genus *Lithocarpus, Quercus Fagaceae, Machillus, Phoebe Lauraceae, Ficus, Streblus Moraceae, Michelia, Magnolia Magnoliaceae, Engelhartia Juglandaceae, Hydnocarpus Flacourtiaceae,* and *Diospyros Ebenaceae*. Coniferous trees include *Keteleeria evelyniana, Dacrydium elatum, Cunninghamia knonishii, Nageia fleuryii, Dacrydium elatum, Pinus kwangtungensis*, and *Fokienia hodginsii*.

Post-extraction secondary forests

This forest kind occupies about 10% of total, distributed on the elevations of 800-900m or less. Most of forest is poor forest, low reserve with average of 40-50m^3/ha. The dominant species at the low elevation (below 700m) are *Saraca dives, Ormosia sp., Castacopsis sp., Gironniera subaequalis, Syzygium sp., Knema sp., Cinnamomum sp. Phoebe sp., Machilus sp., Elaeocarpus sp.* etc. The dominant species at the high elevation (above 700m) are Castacopsis *sp., Castnopsis indica, Ormosia sp., Schima wallichi, Camelia sp.,* species of the genus of *Machilus,* family of *Lauraceae*. Species on rocky mountains are *Tacxotrophis macrophylla, Streblus macrophyllus*), *Diospyros sp., Hydnocarpus sp.*, and *Garcinia obolongifolia*.

Swidden fallow secondary forests

This forest kind occupies about 25% of total. Most of the area is covered by young forest, thus, there is very low or no reserve (20-30m^3/ha). The forest has one timber-layer, the dominate species is *Trema angustifolia, Macranga denticulata, Styax tonkinensis, Mallotus paniculatus, Castanopsis, Engelhardtia roburghiana, E. spicata, Schima wallichii, Ormosia sp., phoebe sp., Gironiera subaequalis, Cratoxylon polyanthum, Wendlandia paniculata, Rhus rhetsoides,* etc.

Shrubland and grassland

This kind is distributed on elevations of 800m or lower. The dominant species are Cratoxylon polyanthum, C. prunìlirium, Aporosa sphaerosperma, A. serrata, Phyllanthus emblica, Phyllanthus reticulatus, species of Alchonea genus, Croton, Mallotus, Euphorbiaceae family, Flemingia, Desmodium Fabaceae family, Ardisia Myrisinaceae family, etc. This kind can be developed to secondary forest if it is protected. Otherwise, it will still be degraded and become bare hill if it is still affected.

Grassland occupies most of bare land and largely distributes on elevations of 1000m or lower. The dominant species are *Saccharum spontaneum, Thysanolaena maxima, Miscanthus japonica, Imperata cylindrical*.

b. Flora

Xuan Nha NR's flora has not been adequately studied. According to our preliminary survey results and previous studies of the Institute of Ecology and Biological Resources (IEBR, 2006) recorded that there are 851 species of vascular plants in this NR. Although this is an uncompleted list of plants of Xuan Nha, but it also shows a very high biodiversity of this NR.

Table 3.42: The diversity of classifiable flora components of Xuan Nha NR

Phylum	**Family**	**Genus**	**Species**
1. Psilotophyta	1	1	1
2. Lycopodiophyta	2	3	8
3. Equisetophyta	1	1	2
4. Polypodiophyta	17	27	45
5. Pinophyta	6	11	18
6. Magnoliophyta	117	415	777
- Magnoliopsida	100	367	714
- Liliopsida	17	48	63
Total	144	458	851

This flora has listed 81 endemic species (9.5% of total recorded species) and 61 threatened species (approximately 16%). Among Vietnam's 81 endemic species, there are 49 endemic species of the Northern Vietnam. The threatened species consist of 33 nationally threatened species (listed in Vietnam's Red Book, 2007) and 35 globally threatened species (listed in the IUCN Red List, 2008). Out of them, 15 species are very highly endangered (globally and/or nationally threatened at CR and EN).

Table 3.43: Number of threatened plant species in Xuan Nha NR

Threatened category	**VN RDB**	**IUCN RL**	**Very highly threatened species (Global: CR, EN & National: CR, EN)**
Critically Endangered (CR)		4	*Hopea chinensis; Hopea mollissimia; Podocarpus pilgeri, Vatica diospyroides,*
Endangered (EN)	8	4	
Vulnerable (VU)	25	10	*Amentotaxus yunnanensis, Burretiodendron tonkinensis, Cinnamomum balansae, Parashorea chinensis, Acanthopanax trifoliatus, Calocedrus macrolepis, Drynaria*
Near threatened (NT)		2	
Low Risk (LR)		12	
Data deficient (DD)		3	

Threatened category	VN RDB	IUCN RL	Very highly threatened species (Global: CR, EN & National: CR, EN)
Total	33	35	*fortunei, Fokienia hodginsii, Madhuca pasquieri, Pauldopia ghorta, Sindora tonkinensis*

Threatened categories are determined in both Vietnam Red Data Book and IUCN Red List as following:

- A taxon is Critically Endangered (CR) when facing an extremely high risk of extinction in the wild in near future.

- A taxon is Endangered (EN) when it is not Critically Endangered but is facing a very high risk of extinction in the wild in near future.

- A taxon is Vulnerable (VU) when it is not Critically Endangered or Endangered, but is facing a high risk of extinction in the wild.

- A taxon is Near Threatened (NT) or Low Risk (LR) when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

- A taxon is Data Deficient (DD) when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. Data Deficient is not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

c. Fauna

Fauna of Xuan Nha NR is poorly studied. Our preliminary investigation together with previous studies of Nguyen Van Sang et al. (2003) and IEBR (2006) have recorded 283 species of vertebrate animals including 69 mammal species, 147 bird species, 44 reptile species and 23 amphibian species.

Table 3.44: Taxa diversity of fauna in Xuan Nha NR

Phylas	Species	Families	Orders
Mammal	69	25	9
Birds	147	39	14
Reptiles	44	16	2
Amphibians	23	5	1
Total	283	85	26

This is obviously an uncompleted list of Xuan Nha NR. However, this already indicates high diversity of fauna in Xuan Nha NR. Moreover, the fauna contains 49 threatened species (about 17.3%) including 25 species of mammals, 2 species of birds, 21 species of reptiles and 1 species of amphibians. They are 43 nationally threatened species (24 species of mammals, 1 species of birds, 17 species of reptiles and 1 species of amphibians) and 29 globally threatened species (19 species of mammals, 1 species of birds, 8 species of reptiles and 1 species of amphibians). Out of them, 24 species are very highly threatened. Two endemic species herpeto fauna were recorded in Xuan Nha; they are Mabuya chapaensis and Paa verrucospinosa.

Table 3.45: Number of threatened animal species in Xuan Nha NR

Threatened category	**VN RDB**	**IUCN RL**	**Very highly threatened species (Globally: CR, EN & Nationally: CR, EN)**
Critically Endangered (CR)	4	3	*Cuora trifasciata, Panthera tigris, Cuon alpinus, Nomascus concolor, Platysternon megacephatum, Pyxidea mouhoti, Palea steindachneri, Panthera pardus, Python molurus, Ophiophagus hannah, Trachypithecus francoisi, Manis pentadactyla, Catopuma temminckii, Helarctos malayanus , Ursus thibetanus , Bos frontalis, Capricornis sumatraensis, Petaurista elegans, Varanus salvator, Ptyas korros, P. mucosus, Bungarus fasciatus, Naja atra, Cuora galbinifrons.*
Endangered (EN)	17	10	
Vulnerable (VU)	20	13	
Near threatened (NT)		6	
Low Risk (LR)	2		
Data deficient (DD)			
Total	43	29	

Specially, the species having great national and global conservation importance are *Primates* and *Testudinate*. Seven primate species were recorded in Xuan Nha NR are *Nycticebus bengalensis*, Pygmy Slow Loris *Nycticebus pygmaeus*, Stump-tailed Macaque *Macaca arctoides*, Assam Macaque *Macaca assamensis*, Rhesus Monkey *Macaca mulatta*, Grey Langur *Trachypithecus crepusculus*, Delacour's Langur *Trachypithecus francoisi*, Western Black-crested Gibbon *Nomascus concolor*. All of these species are globally and/or nationally threatened species. Western Black-crested Gibbon is distributed in very few areas of Northeast Vietnam and Quangxi, Yunnan (China). Therefore, the species receives a very high attention to the conservation. Unfortunately, in Xuan Nha NR, the species is only tentatively recorded through interview from local people.

Six testudineous species were recorded in Xuan Nha NR, five of them are very highly globally threatened including Big-headed Turtle *Platysternon megacephatum* (EN), Indochinese Box Turtle *Cuora galbinifrons* (CR), Keeled Box Turtle *Pyxidea mouhoti* (EN), Impressed Tortoise *Manouria impressa* (VU) and Wattle-necked Softshell Turtle *Palea steindachneri* (EN). The other species is Chinese Striped-neck turtle *Ocadia sinensis*.

2. BIODIVERSITY VALUES OF PU HU NR

a. Vegetation cover

Pu Hu NR has two (02) main forest types such as tropical moist evergreen closed forests (distributed at elevations below 700 m) and subtropical moist evergreen closed forest (distributed at elevations above 700 m). However, the primary forest which has been not affected is currently about 40% of the NR's total area. The remaining parts of the forests are different alterable types of the above forest types due to logging or clearing for cultivation. These are secondary forest, shrubland and grassland.

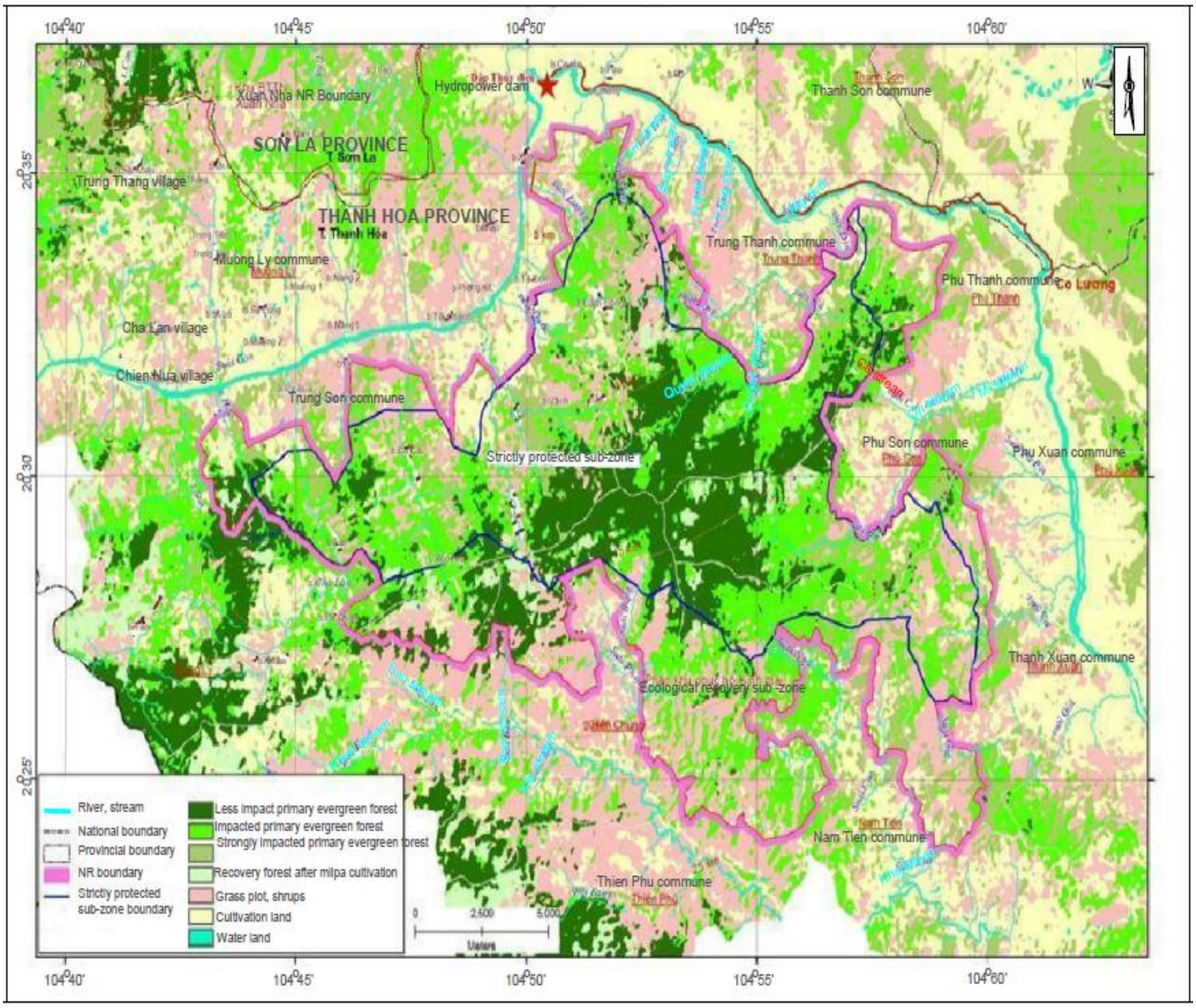


Figure 10. Vegetation cover in Pu Hu NR

Tropical moist evergreen closed forests

This forest type has an area of about 1,000 ha and occurs mainly in strict protection zones at elevations below 700m. This forest is still good, with the timber reserves of about 300-400m^3/ha, and five (05) layers including three timber-tree layers. The dominant species in the timber-tree layers are *Vatica fleuryana, Anamocarya sinensis, Parashorea chinensis, Nephelium melliferum, Pometia pinnata, Aglaia dasyclada, Chisocheton thorelli, Disoxylum tonkinensis*, etc.

Tropical moist evergreen closed secondary forest in Pu Hu NR

Sub-tropical monsoon dense evergreen moist forest

This forest has an area of about 3,000-3,500ha and occurs in strict protection zones at elevations of above 700m alt. The forest has average timber reserves about 250-300m^3/ha and two layers without emergent layer. The species component in the timber-tree layers consists of *Vatica fleuryana, Anamocarya sinensis, Paramichelia baillonii, Michelia mediocris, Diospyros apiculata, D. petelotii, Aglaia dasyclada, Dinocarpus fumatus, Nephelium melliferum, Pometia pinnata,* species of the genus of *Castanopsis, Lithocarpus, Quercus Fagaceae* family, *Beilschmiedia, Machilus, Cinnamomum Lauraceae* family, etc. There are some coniferous species such as *Nageia fleuryi, Podocarpus neriifolius,* and *Fokienia hodginsii*. Because of the thin distribution of these species, broadleaf mixed population cannot be created.

Post-extraction and swidden fallow secondary forests

This forest type has a large area accounting for about 40% of total area of the NR. It mainly distributes on ecological rehabilitated zones. It has low reserves, about of 50-80m^3/ha), belonging to poor forest type. The species composition is complicate with representatives of many families such as *Lauraceae, Myristicaceae, Fabaceae, Fagaceae, Judlandaceae, Theaceae, Ulmaceae, Euphorbiaceae,* etc.

Shrubland and Grassland

This is a degraded vegetation type due to shifting cultivation and excessive logging. This type is found at elevations below 900m. Dominated species are *Cratoxylon polyanthum,* *C. prunilirium, Aporosa sphaerosperma, A. serrata, Phyllanthus emblica, Phyllanthus reticulatus*, etc.

Grasslands are widely found in open lands at elevations below 1,000m. The dominant species are *Saccharum spontaneum, Thysanolaena maxima, Miscanthus japonica, Imperata cylindrica*, etc.

b. Flora

Pu Hu NR's flora has not been adequately studied. According to our preliminary survey results and previous studies of Do Tuoc and Le Trong Trai (1998) recorded that there are 753 species of higher vascular plants belonging to 6 phyla.

Table 3.46: Taxa diversity of flora in Pu Hu NR

Phylum	**Family**	**Genus**	**Species**
1. Psilotophyta	1	1	1
2. Lycopodiophyta	2	3	10
3. Equisetophyta	1	1	2
4. Polypodiophyta	13	19	29
5. Pinophyta	5	6	9
6. Magnoliophyta	108	338	702
- Magnoliopsida	93	297	644
- Liliopsida	15	41	58
Total	130	368	753

This list of flora in Pu Hu NR is un-completed, however, it shows very high species and taxa diversity of the flora. The flora contains 76 endemic species (10.1% of total species lists) and 49 threatened species (about 6.5 %). Among 76 endemic species to Vietnam, 40 species are endemic to the Northern Vietnam. Threatened species include 30 nationally threatened species and 41 globally threatened species, including 15 very highly threatened species

Table 3.47: Number of threatened plant species in Pu Hu NR

<table>
<tr><th>Threatened category</th><th>Vietnam RDB</th><th>IUCN RL</th><th>Very highly threatened species
(Globally: CR, EN & Nationally: CR, EN)</th></tr>
<tr><td>Critically Endangered (CR)</td><td>1</td><td>5</td><td rowspan="5">Aquilaria crassna, Diospyros mun, Hopea chinensis; Hopea mollissimia, Vatica diospyroides, Burretiodendron tonkinensis, Erythrophleum fordii, Parashorea chinensis Smilax petelotii, Acanthopanax trifoliatus, Sindora tonkinensis, Drynaria fortunei,</td></tr>
<tr><td>Endangered (EN)</td><td>9</td><td>4</td></tr>
<tr><td>Vulnerable (VU)</td><td>20</td><td>8</td></tr>
<tr><td>Near threatened (NT)</td><td></td><td>2</td></tr>
<tr><td>Low Risk (LR)</td><td></td><td>8</td></tr>
</table>

Threatened category	Vietnam RDB	IUCN RL	Very highly threatened species (Globally: CR, EN & Nationally: CR, EN)
Data deficient (DD)		4	Fokienia hodginsii, Madhuca pasquieri, Pauldopia ghorta
Total	30	41	

c. Fauna

The preliminary fauna list of Pu Hu NR, recorded during our survey and survey by Le Trong Trai et al. (1998), consists of 260 species of terrestrial vertebrate animals including 59 mammal species, 161 bird species, 27 reptile species and 13 amphibian species. The researched results show that Pu Hu NR's fauna is relative diversity in species component. Specially, there are two high conservative value orders with the maintenance of high number of species, which are 20 species of meat-eating order (*Carnivora*), 7 species of *Primates* order. However, this list already indicates high diversity of fauna of the NR.

Table 3.48: Taxa diversity of fauna in Pu Hu NR

Phyla	Species	Families	Orders
Mammal	59	23	8
Birds	161	37	11
Reptiles	27	14	3
Amphibians	13	4	1
Total	260	78	23

The fauna contains 44 threatened species (about 17.3%) including 26 species of mammals, 2 species of birds, 14 species of reptiles and 2 species of amphibians. They are 42 nationally threatened species (25 species of mammals, 2 species of birds, 13 species of reptiles and 2 species of amphibians) and 33 globally threatened species (23 species of mammals, 9 species of Reptiles and 1 species of Amphibians). 26 species are very highly threatened. There is only one endemic species recorded in Pu Hu NR as frog *Paa verrucospinosa* which is nationally threatened at VU (Vulnerable) level and globally threatened at NT (Near threatened) level.

Table 3.49: Number of threatened animal species in Pu Hu NR

Threatened category	Vietnam RDB	IUCN RL	Very highly threatened species (Globally: CR, EN & Nationally: CR, EN)
Critically Endangered (CR)	6	3	*Cuora trifasciata, Panthera tigris, Cuon alpinus, Platysternon megacephatum, Palea steindachneri, Panthera pardus, Belomys pearsonii, Python molurus, Ophiophagus hannah, Nomascus leucogenys, Trachypithecus francoisi, Manis pentadactyla, Catopuma temminckii, Neofelis nebulosa, Artictis binturong, Helarctos malayanus*
Endangered (EN)	15	9	
Vulnerable (VU)	19	14	
Near threatened (NT)		6	
Low Risk (LR)	2		
Data deficient (DD)		1	

Threatened category	Vietnam RDB	IUCN RL	Very highly threatened species (Globally: CR, EN & Nationally: CR, EN)
Total	42	33	*, Ursus thibetanus , Bos frontalis, Capricornis sumatraensis, Petaurista elegans, Varanus salvator, Ptyas korros, Ptyas mucosus, Bungarus fasciatus, Naja atra and Cuora galbinifrons.*

As similar to Xuan Nha NR, *Primates* and *testudinate* of the Pu Hu NR have also great national and global conservation importance. Seven primate species were recorded in Pu Hu NR, including Bengal Slow Loris *Nycticebus bengalensis*, Pygmy Slow Loris *Nycticebus pygmaeus*, Stump-tailed Macaque *Macaca arctoides*, Assam Macaque *Macaca assamensis*, Rhesus Monkey *Macaca mulatta*, Grey Langur *Trachypithecus crepusculus*, Delacour's Langur *Trachypithecus francoisi*, and White-cheeked Gibbon *Nomascus leucogenys*. All of them are globally and/or nationally threatened species.

Six testudineous species were recorded in Pu Hu NR, five of them are very highly globally threatened including Chinese three-striped Box Turtle *Cuora trifasciata* (CR), Big-headed Turtle *Platysternon megacephatum* (EN), Impressed Tortoise *Manouria impressa* (VU) and Chinese softshell Turtle *Pelodiscus sinensis* (VU). The other species is Black-breasted Leaf Turtle *Geoemyla spengleri*.

3. BIODIVERSITY VALUES OF PU LUONG NR

a. ***Vegetation cover***

Pu Luong NR has two (02) main forest types such as tropical moist evergreen closed forests (distributed at elevations below 700 m), subtropical moist evergreen closed forest (distributed at elevations above 700 m). However, the primary forest which has been not affected is currently about 30% of the NR's total area. The remaining parts of the forests are different alterable types of the above forest types due to logging or clearing for cultivation. These are secondary (second-growth) forest, shrubland and grassland.

<u>Tropical moist evergreen closed forests</u>.

This forest has an area of about 7,846ha, mainly distributes on elevations of 700m or lower and in all communes of the NR. The forest has the structure of five (05) layers, including emergent layer with average height of 35m, ecological dominant (Canopy layer) layer with average height of 20m, understory layer with average height of 12m, the 6m-high shrubland layer and the 2m-high grassland layer. Dominant species are *Poaceae* family, *Asteraceae* family, *Rubiaceae* family, and *Fabaceae* family. Density of forest is not high due to logging. In secondary forest, understory layer structure and tree species are simpler, with mainly as Lesser *Trema cannabina*, and *Litsea cubeba*.

Tropical moist evergreen closed decondary forest in Pu Luong NR

Subtropical moist evergreen closed forest

This forest type is located on elevations of 700m, on high mountains and especially on Pu Luong peak. This forest type has flora components with the *Fagaceae* family, *Moraceae* family and *Magnoliaceae* family. The forest's structure has 5 layers, including emergent layer (dominant species: *Magnoliaceae* and *Lauraceae* families, average height of 40m), canopy layer (*Fabaceae* family, 30m), understory layer (with 18m-high trees), scrub layer (7-8 m-high tree), and grass layer (with 1,5m-high grassland). This forest type is also distributed on rocky mountain with the smaller structure and lower canopy layer.

Artificial secondary forest subtype

Artificial secondary forest subtype is mixed with timber and Neohouzeaua, which has small area but scattered throughout soil mountains of the NR. The forest's structure have two main layers, including ecological dominant layer with 14 – 16 m height and the development of Fagaceae family, Moraceae family, Fabaceae family, Bambusaceae, *and understory layer withbanana*, *Phrynium placentarium*, and grass kinds.

Artificial secondary Neohouzeaua forest subtype is thinly distributed along river system because of humidity and good soil. This subtype is developed in groves with the two-layer structure. The main layer is neohouzeaua with average height of 9 – 10m while the understory layer is 1-2 m-high fresh cover with Bananito (Musa acuminate), *Phrynium placentarium*.

Artificial secondary woody bamboos subtype. This subtype is mainly grown by households on the lowland area because woody bamboos are easy to rot their root if they are grown on the highland communes like Thanh Son. In comparison between Pu Luong and Pu Hu NRs, the number of individual of this subtype in the former fewer than the later while tree's dimension and height is better. The forest's density depends on the planter, but it has reduced because of soil degradation and soil humidity decreases. The forest floor has 1m-high grass layer. Ecosystem features are very different with other mentioned forest types.

<u>*Shrubland and grassland*</u>

The ecosystem in the area are currently enriched by bare land covered with scrub, thinly grown trees, grassland, and natural pasture for animals

b. Flora

Pu Luong NR's flora belongs to the North Central Vietnam's flora with the influence of those in the West Northern Vietnam as well as in the Northern highland area. According to the preliminary survey, 552 flora species are recorded to belong to 413 genus, 138 family and 6 phyla.

Table 3.50: List of flora system under family, genus and species

No.	Phyla	Families	Genus	Species
1	Lycopodiophyta	3	2	3
2	Equisetophyta	1	1	1
3	Polypodiophyta	12	16	23
4	Pinophyta	4	5	7
5	Magnoliophyta	119	389	518
	Total	139	413	552

Regarding the protection of gene resources, Pu Luong NR has 39 precious tree species listed in Vietnam Red Book

c. Fauna

* Diversity of animal habitats

In each vegetation cover under zoologists's viewpoint, Pu Luong NR has habitats for various animals. Main habitats in the NR are described as follows.

- Tropical and subtropical moist evergreen boardleaf closed forests are habitats of monkey species, Gibbon (*Hylobatidae*), Gaur (*Bos gaurus*), tiger (*Panthera tigris*), Clouded leopard (*Neofelis nebulosa*) and Woodpecker (*Picidae*). Particularly, there is Delacour's langur (*Trachypithecus delacouri)* on rocky mountains which is endemic species in Vietnam and need to be protected.

- Bamboo forests are habitats of bear, wild boar, Hog badger (*Arctonyx collaris*), large bamboo rat (*Rhizomys sumatrensis),* Pangolin, mouse (*mus*), White-rumped shama (*Copsychus malabaricus).* This forest as well as evergreen forest is habitats of Parrotbill (*P.bakeri*)

- Shrubland and grassland are habitats of deer, barking dear (*Muntiacus)*, true owl (*Strigidae*) Red-whiskered bulbul (*Pycnonotus jocosus*), etc.

- Rivers, streams and lakes are habitats of fish species, Bony-headed toad (Ingerophrynus galeatus), *Duttaphrynus melanostictus,* frog, tree-frog, turtle, wagtail, White-throated kingfisher (*Halcyon smyrnensis), etc*.

* Number and species of animals

According to survey and researches, the NR's fauna is relative plentiful with some endemic species. The preliminary investigation showed that the area has not only species diversity but also high density.

Table 3.51: Components and number of animals in Pu Luong NR

Phyla	Species	Families	Orders
Mammal	59	22	8
Birds	169	41	13
Reptiles	25	13	2
Amphibians	12	4	1
Total	265	80	24

* Specious animal species listed in IUCN standard

This classification aims to identify specious animals in endangered situation in the NR area. According to the survey results in the NR, there are 36 species with 21 mammal species, 9 bird species, and 6 reptile species.

There are 44 threatened species (or 17.3%), including 26 mammal species, 2 bird species, 14 reptiles species, 2 amphibians species. Among them, there are 42 national threatened species (25 mammals species, 2 bird species, 13 reptiles species, 2 amphibians species and 33 globally threatened species (23 mammals species, 9 reptiles species, 1 amphibians species). There are 26 species in Critically Endangered (CR). There is only an endemic species as Paa verrucospinosa, and classified at nationally threatened level (VU) and globally threatened level (NT).

Table 3.52: Number of threatened fauna species recorded in Pu Luong NR

Phyla	E	V	R	T	Total
Mammal	8	10	2	1	21
Birds				6	6
Reptiles	1	3		2	6
Amphibians					
Total	9	13	2	9	33

Note: E - Endangered, V - Vulnerable, R - Rare, T - Threatened

Endangered species in Pu Luong NR are as follow:

1. Hylobates concolor

2. Cuon alpinus

3. Helarctos malayanus

4. Ursus thibetanus

5. panthera pardus

6. P. tigris

7. Bos gaurus

8. Cuora trifasciata

* Endemic species:

Trachypithecus f.delacouri

4. BIODIVERSITY VALUES OF HANG KIA – PA CO NR

a. Vegetation cover

Hang Kia – Pa Co NR has three (03) main forest types such as tropical moist evergreen closed forests (distributed at elevations below 700 m), subtropical moist evergreen closed forest on limestone mountains (distributed at elevations above 700 m) and subtropical moist evergreen closed forest mixed broadleaf and coniferous trees (at elevations above 800 m). However, the primary forest which has been not affected is currently about 40% of the NR's total area. The remaining parts of the forests are different alterable types of the above forest types due to logging or clearing for cultivation. These are secondary forest, shrubland and grassland.

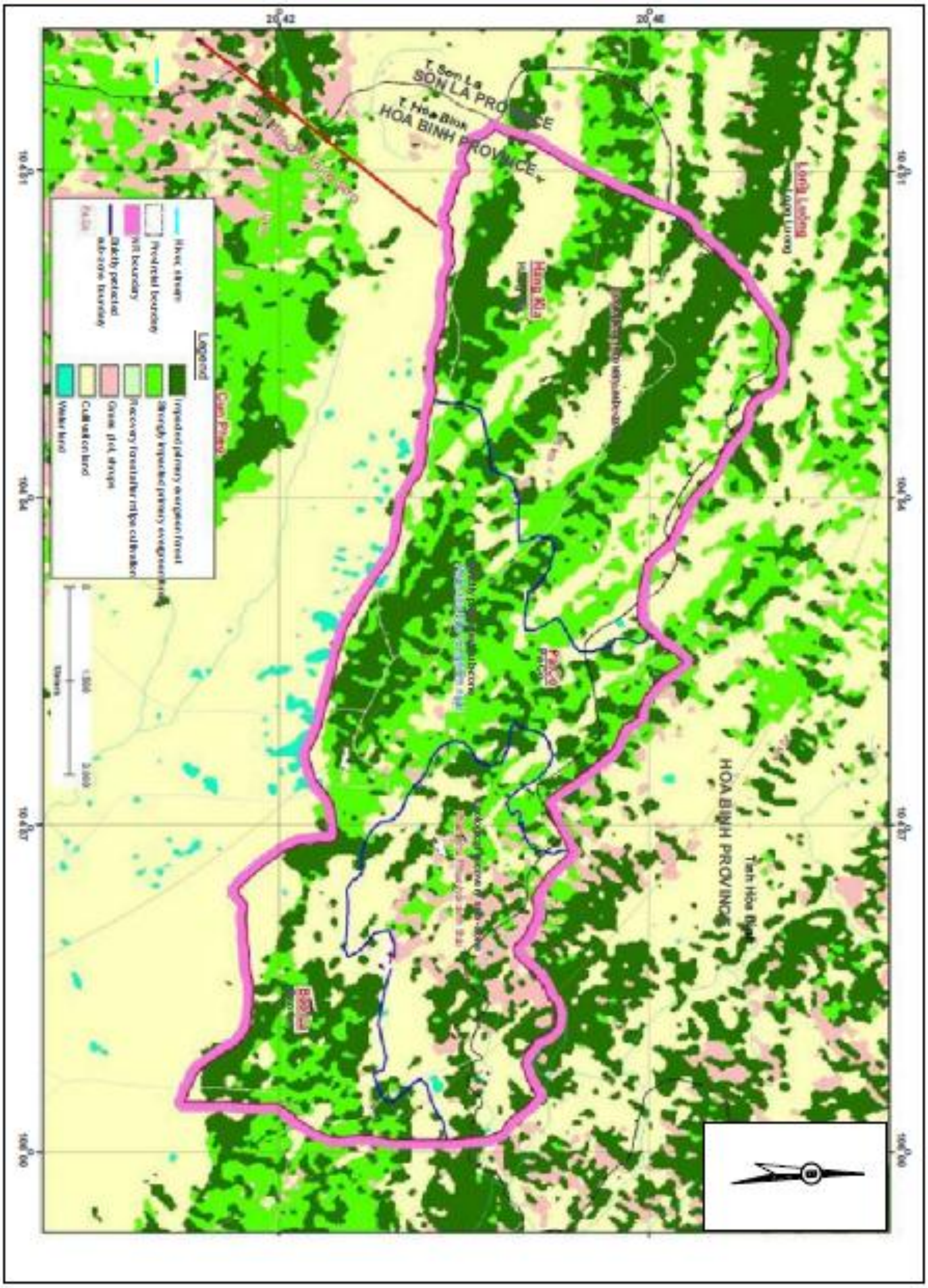


Figure 11. Vegetation cover of Hang Kia – Pa Co NR

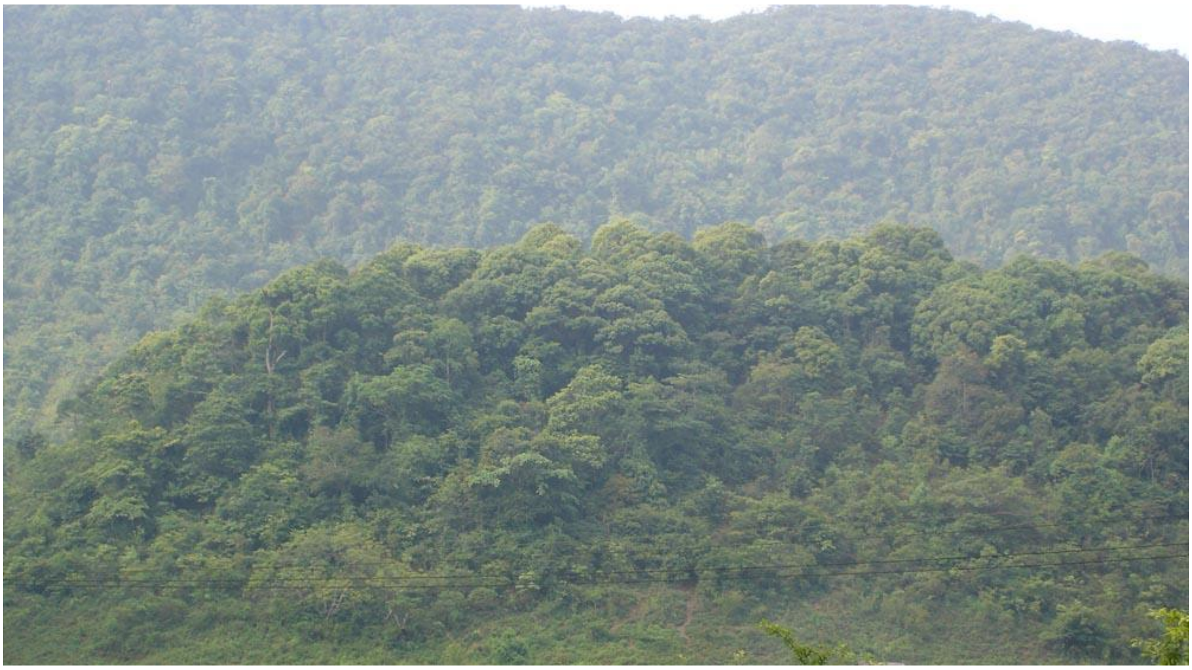
Tropical moist evergreen closed forests.

This forest kind occupies about 200ha on elevations below 700m in the south of Ba La and Pieng Ve communes and one part near to HW No. 6 of Pa Co commune. Forest reserves are 300-400m^3/ha which is rich forest, with the structure of 5 layers, including three layers of timber trees. The dominant components are *Vatica fleuryana, Dipterocarpus tonkinensis, Parashorea chinensis, Choerospondias axillaris, Castanopssi indica*, *Aglaia gigantea*, *Aphanamixis polystachya,* and *Annamocarya sinensis*.

On limestone mountain, forest has average reserve of (250-300m^3/ha). Home species of precious timber-tree are *Markhamia stipulata, Madhuca pasquieri, Vatica fleuryana, Chukrasia tabularis, Paramichelia baillonii, Michelia mediocris*, etc. Despite of the plentiful reserves, number of individuals of timber-tree species is not much, about 10-15 tree/ha. In case of the exploitation, the forest layer structure will be broken and result in the forest degradation.

In limestone mountains this forest type has medium timber volume about 250-300m^3/ha. In mountain foot, the forest has 2 layers without emergent layer. Dominated species are *Burretiodendron tonkinensis, Vatica fleuryana*, *Anogeissus acuminata*, *Garcinia*

Fagracoides, *Pomertia pinata*, *Annamocarya sinensis*, etc. In the mountain peak, the forest has only one timber-tree layer with domination species of *Tacxotrophis macrophylla*, *Streblus macrophyllus*, *Diospyros spp*., *Hydnocarpus sp*. and some genera of *Castanopsis, Lythocarpus, Magnolia,* etc.



Tropical moist evergreen closed forests in Hang Kia – Pa Co NR

Subtropical moist evergreen closed forests on limestone mountains

This forest has an area of about 2,000ha, which distributes at elevations above 700m alt. The forest has timber volume of about 250-300m^3/ha and 2 timber tree layer without emergent layer. Dominant species are from genera *Lithocarpus, Quercus (Fabaceae); Machillus, Phoebe, Cinnamomum (Lauraceae); Ficus, Streblus (Moraceae); Michelia,* *Magnolia (Magnoliaceae); Engelhartia (Juglandaceae), Hydnocarpus (Flacourtiaceae), Ormosia (Fabaceae), Diospyros (Ebenaceae).*

Subtropical moist evergreen closed forest mixed broadleaf and coniferous trees

This forest type occurs in kind of small formations distributed scatteredly in mountain slope at altitude above 800m alt. Broad leave species are from genera *Lithocarpus, Quercus (Fabaceae); Machillus, Phoebe, Cinnamomum (Lauraceae), Ficus, Streblus (Moraceae), Michelia, Magnolia (Magnoliaceae).* Coniferous species has the rate of 15%-20% in this forest type, including *Nageia fleuryi*i, *Pinus kwangtungensis*, *Podocarpus neriifolius*, *Taxus chinensis*.

Post-extraction secondary forest

This forest type occupies about 1,000ha, distributing on elevations below 800-900m alt., mainly at 300-900m alt. This type is formed from primary forest due to the excessive logging. It has low timber volume (about 50-80m^3/ha), with 2 timber-tree layers, however, most of large trees have been logged, remaining only small trees. Light-tolerant plants have the high percentage (25-30%) in this forest type. The forest can be rehabilitated if an effective protection is taken place

Swidden fallow secondary forests

This forest type has an area of about 1,200 ha, widely distributed at altitude 200-700m alt. This is recently regenerated forest with low timber volume (about 30-40m^3/ha). The forest has one tree layer with dominant species as *Engelhardtia roxburghiana, E. spicata*, *Mallotus paniculatus*, *Macaranga deticulata*, *Schima walichii*, *Castanopsis spp*., *Phoebe spp*., *etc*.

Shrubland and Grassland

Shrublands and grassland has an area of 1.800 ha in this NR, and distributes on most of elevations from 800-900m or lower. These types are formed after excessive deforestation for making field. Dominant species are *Rhodomyrtus tomentosa*, *Wendlandia paniculata*, *Psichotria montana*, *Aprosa mycrocalyx, Aporosa planchonania*, *Antidesma sp*., *Achornea rugosa, Achornea tiliaefolia*, *Cratoxylon polyanthum, C. prunifoliu, etc*.

Grasslands are found widely in open lands at elevations below 1,000m alt. Dominant species are *Saccharum spontaneum*, *Thysanolaena maxima*, *Miscanthus japonica*, *Imperata cylindrica*, *etc*.

b. Flora

Flora of Hang Kia – Pa Co NR is poorly studied. Preliminary investigation has recorded 589 species of high vascular plants belonging to to 339 genera, 125 families and 6 phyla. The species list shows high species diversity of the flora in Hang Kia – Pa Co NR.

Table 3.53: Taxa diversity of flora in Hang Kia – Pa Co NR

Phylum	Family	Genus	Species
1. Psilotophyta	1	1	1
2. Lycopodiophyta	2	3	8
3. Equisetophyta	1	1	2
4. Polypodiophyta	12	24	35
5. Pinophyta	6	12	14
6. Magnoliophyta	103	298	529
- Magnoliopsida	88	257	478
- Liliopsida	15	41	51
Total:	125	339	589

The flora contains 45 endemic species (7.6 % of total species lists) and 40 threatened species (about 6.8 %). There is no species which is endemic to Vietnam. Threatened species include 21 nationally threatened species and 27 globally threatened species. Among them, 10 species are very highly threatened (species which are globally and/or nationally threatened at CR and EN)

Table 3.54: Number of threatened plant species in Hang Kia – Pa Co NR

<table>
<tr><th>Threatened category</th><th>Vietnam RDB</th><th>IUCN
RL</th><th>Very highly threatened species
(Globally: CR, EN & Nationally: CR, EN)</th></tr>
<tr><td>Critically Endangered (CR)</td><td></td><td>2</td><td rowspan="7">Podocarpus pilgeri, Vatica diospyroides, Amentotaxus yunnanensis, Burretiodendron tonkinensis, Melodinus annamensis, Parashorea chinensis, Acanthopanax trifoliatus, Fokienia hodginsii, Madhuca pasquieri, Pauldopia ghorta</td></tr>
<tr><td>Endangered (EN)</td><td>5</td><td>4</td></tr>
<tr><td>Vulnerable (VU)</td><td>16</td><td>6</td></tr>
<tr><td>Near threatened (NT)</td><td></td><td>2</td></tr>
<tr><td>Low Risk (LR)</td><td></td><td>11</td></tr>
<tr><td>Data deficient (DD)</td><td></td><td>2</td></tr>
<tr><td>Total</td><td>21</td><td>27</td></tr>
</table>

c. Fauna

Preliminary studies have recorded 249 species of vertebrate animals including 44 mammal species, 142 bird species, 40 reptile species and 23 amphibian species. The list of

249 species indicates high diversity of fauna in Hang Kia – Pa Ko NR which the area of 7000 ha, this shows that the fauna in here is very diversified, but number of big animals is few due to the excessive hunting in the recent years.

Table 3.55: Taxa diversity of fauna in Hang Kia – Pa Co NR

Phylas	Species	Families	Orders
Mammal	44	20	8
Birds	142	38	14
Reptiles	40	12	2
Amphibians	23	6	2
Total	249	76	26

The fauna contains 37 threatened species (about 17.3%) including 14 species of mammals, 3 species of birds, 17 species of reptiles and 3 species of amphibians. They are 33 nationally threatened species (14 species of mammals, 3 species of birds, 13 species of reptiles and 3 species of amphibians) and 21 globally threatened species (12 species of mammals, 1 species of birds, 7 species of reptiles and 1 species of amphibians). Among them, 17 species are very highly threatened. Four endemic species herpetofauna were recorded; they are *Boiga multomaculata, Chaparana delacouri*, *Rana maosonensis* and *Paa verrucospinosa*.

Table 3.56: Number of threatened animal species in Hang Kia – Pa Co NR

Threatened category	**Vietnam RDB**	**IUCN RL**	**Very highly threatened species (Globally: CR, EN & Nationally: CR, EN)**
Critically Endangered (CR)	3	1	Cuora galbinifrons, Cuon alpinus, Pyxidea mouhoti, Sacalia quadriocellata, Indotestudo elongala, Palea steindachneri, Belomys pearsonii, Python molurus, Ophiophagus hannah, Manis pentadactyla, Catopuma temminckii, Ursus thibetanus, Capricornis sumatraensis, Ptyas korros, Ptyas mucosus, Bungarus fasciatus, Naja atra.
Endangered (EN)	12	6	
Vulnerable (VU)	16	8	
Near threatened (NT)		5	
Low Risk (LR)	3		
Data deficient (DD)		1	
Total	34	21	

3.4. Socio-economic conditions

According to the survey results, Hoi Xuan Hydropower Project will affect to the environments of 11 communes in two districts of the two provinces (Thanh Hoa and Hoa Binh). The communes affected to environment by the project are listed on the following table:

Table 3.57: The list on the affected communes

No	Affected area
A	**Quan Hoa Commune – Thanh Hoa Province**
1	Hoi Xuan Commune
2	Thanh Xuan Commune
3	Phu Xuan Commune
4	Phu Son Commune
5	Phu Le Commune
6	Phu Thanh Commune
7	Thanh Son Commune
8	Trung Thanh Commune
9	Trung Son Commune
B	**Mai Chau Commune – Hoa Binh Province**
1	Van Mai Commune
2	Mai Hich Commune

The socio-economic conditions of the affected area

3.4.1. Thanh Hoa Province

Thanh Hoa province, which is located in the middle of North Vietnam with geographical coordinates of 19º23' to 20º30' North latitude, 104º23' to 106º30' East longitude. The province is adjacent to three provinces: Ninh Binh, Hoa Binh and Son La Province to the North and Nghe An Province to the South. It owns a coastline of 102km to the East and share the border with the length of 192 km with Hua Phan province (in the Wester part of Lao PDR).

THANH HOA MAP

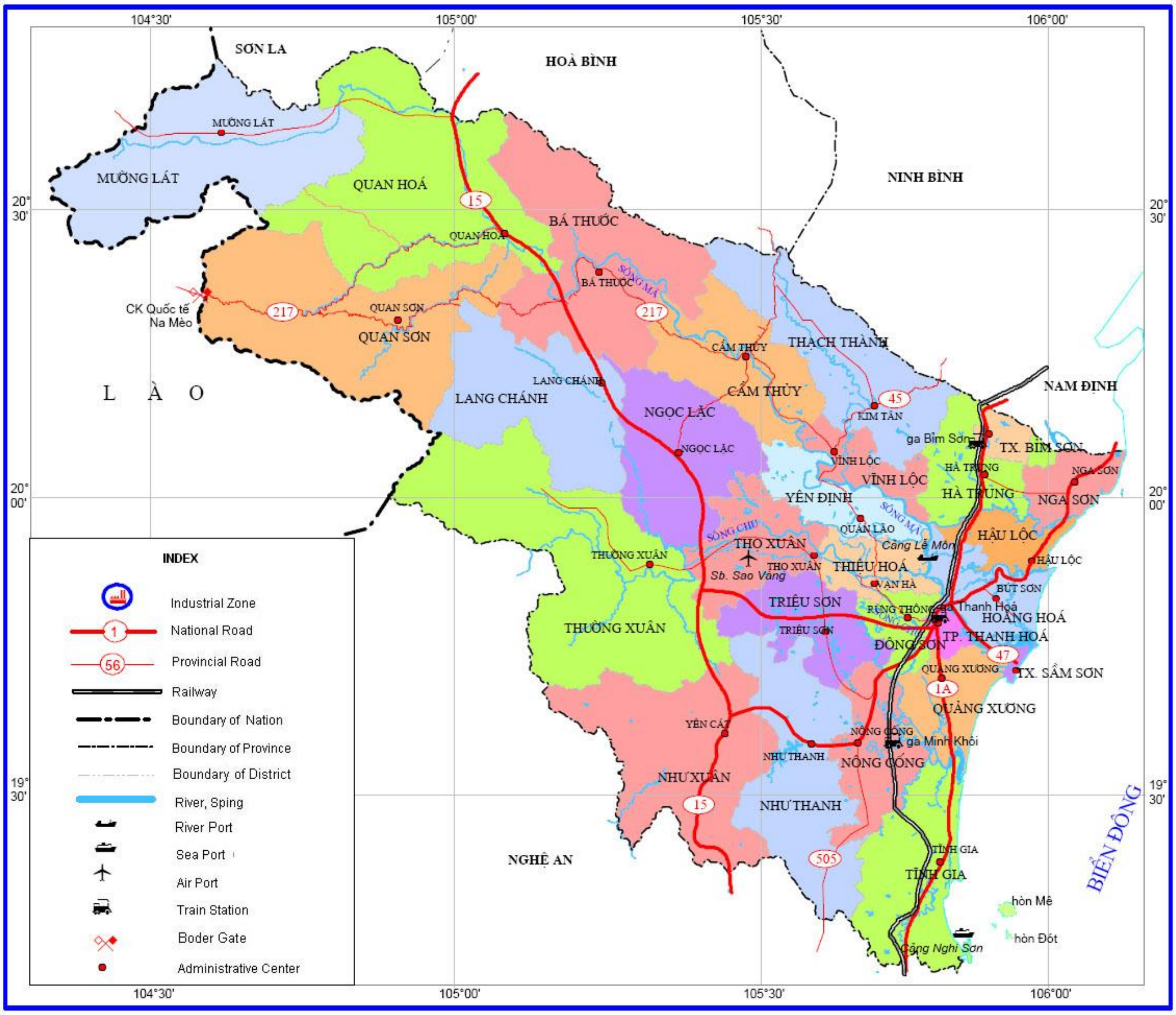


Figure 12: The location of Thanh Hoa Province

Thanh Hoa has 27 districts, towns and cities with a total natural area of 1,113,341.71 hectares, accounted for 3.37% of total natural area of the country. In which, over 70% of the land is mountain and forest. Total population of the province in 2013 was approximately 3,440,000 people, and average population density was estimated at 308.0 persons/km . The administrative center of the province is Thanh Hoa city, which is around 150 km away from Hanoi to the South.

a) Economic conditions

In 2013, economic growth reached 11.2% that exceeded the expected target, which was two times higher than the national average (5.4%). The economic structure is positively changing; proportion of agriculture, forestry and fisheries in GDP was accounted for 20%, decreased by 1.4% in comparison with 2012; industry and construction was accounted for 43.9%, increased by 1%; services was accounted for 36.1%, increased by 0.4% in comparison with the same period in the previous years. GDP per capita was estimated at $1,180.

• **Agriculture, forestry and fisheries:**

Agriculture, forestry and fisheries in 2013 of Thanh Hoa province developed relatively comprehensive, the value of production increased by 4.4% in comparison with the same period in the previous year, equal 100.2% of the plan, including: agricultural production increased by 2.9%, forestry increased by 14.7% and fishery increased by 6.6%. Food production achieved satisfactory results, annual productivity was estimated at 55.9 tons/ha, rice output reached 1.43 million tons; total food production was estimated at 1.65 million tonnes as expected. Implemented 221 production models, including a model of building effective rice paddies with high productivity, quality, efficiency... recover and develop livestock; cows increased by 0.5%, and that of pigs, poultry and meat production increased by 3.8%, 1.6%, and 3.8% respectively in comparison with the same period in the previous year.

Forest regeneration and protection was performed according to plan; 1,737 ha of artificial forest, increased by 7.4% over expected plan; forest coverage rate reached 51% that achieved objectives. Exploitation of forest products reaches the positive results (278,000 m) 3.7 times higher over the same period of the previous year, mostly bamboo trees.

Aquaculture production steadily grew, the production value was estimated at 1,171 billion VND, increased by 6.6% over the same period; the production is estimated at 124 thousand tons, increased by 6.5%, in which: Exploiting accounted for 4.5% (particularly offshore fishing increased 20%), cultivation rose by 11%.

• **Industry, handicraft:**

In 2013, industrial production remained at relatively high growth rate, the production value was estimated at 27,125 billion VND, increased 14.6% in comparison to 2012, equal to 99.7% the year’s plan, in which: the exploiting industry increased by 12.2%, processing industry increased by 13.5%, industrial production and distribution of electricity, gas and water increased by 51.2%, the production value of the enterprises located in the Nghi Son economic zone and industrial areas were accounted for about 43% of the industrial production value of the whole province. Production of some products increased significantly in comparison to the same period of previous year, such as: power generating increased 2.3 times, sneakers and clothing manufacturing rose by 40% and 31% respectively. Likewise, the production of stone for construction, sugar and cement also increased by 25%, 17%, and 13% respectively... Within this year, a number of industrial establishments were put into operation: Nghi Son 1 thermal power plant, Ba Thuoc 2 hydropower, Thanh Nam wood processing, Van Ha sewing…

Cottage industry was maintained and developed at the local level, the whole province has 155 traditional handicraft villages with around 36 traditional crafts are being practiced. In which, some of them are well developed, such as: sericultures, bronze casting, rattan, lanterns, embroidery, stitched ball ... which are creating jobs and increasing income for farmers.

• **Commercial services**

The service sector continued to grow at a steady pace. The production value was estimated at 16.081 billion VND, increased 12.8% over the same period. In fact, commercial activities were sufficient to meet the needs for production and consumption of local people; total retail value of goods and services were estimated at 49,330 billion VND that increased by 18% over the same period of the previous year. The ability to manage the market was enhanced, including: detailed inspection, market control, preventing the production and trafficking of imitations and trade fraud; the consumer price index in November 2013 increased by 0.4% and 11.22% over the previous months and the beginning of this year, respectively.

Exports continued to grow at high pace; export revenue was estimated at 920 million USD that exceeded 12% over the year's plan and increased by 25% over the same period of the previous year. In which, the direct export turnover reached 733 million USD that exceeded 14% of the year's plan and increased 28 % over the same period of the previous year. Imports amounted at 474 million USD, increased by 60% over the same period of the previous year.

The tourism industry attracted around 4.1 million visitors, increased by 10.5%, particularly international visitors increased by 41% over the same period of previous year. Around 38 million tons of cargo and 22 million passengers were transported, increased by 11.5% and 16% respectively in comparison with the same period of the previous year. The Tho Xuan airport was stably operated, that severed more than 60,000 passengers. Moreover, the flight frequency increased from 5 to 11 flights/week, the number of chair occupied reach 80% on average. Teledensity of mobile phone reached 67.5 units/100 people.

b) Social services

• Education:

In the school year of 2013-2014, 637/637 communes, wards and towns in the province were universal junior secondary education. As of June 2014, the province has 962 schools that meet national standards, increase by 7.9% (around 70 schools) over the same period of the previous year. In which, the number of new preschools, elementary schools, secondary and high schools are 27, 13, 28 and 2 respectively.

According to results of the exam for secondary education graduation, there were 40,549 students qualified, accounted for 98.96% of all students are examined, increased by 1.5% over the same period of the previous year. In the high school graduation examination for the school year 2013 - 2014, the regular group reached 99.86% (increased by 0.44% from the year 2012 to 2013); continuing education group reached 99.12% (10.75% increase compared to the school year 2012-2013).

• Health:

In 2013, the ratio of beds over ten thousand people in Thanh Hoa are 20.7 on average, the mortality rate for infants under 1 year age is 16‰, the rate of malnutrition of children under 5 year age was 18.7%.

According to the Preventive Medicine Center of Thanh Hoa province, as of June 2014, the province has recorded 282 cases of dysentery syndrome, 434 cases of HFMD disease, 962 cases of mealtes, and 4,527 cases of diarrhea.

In the first six months of 2014, the province has recorded 152 minor food poisoning cases and a serious food poisoning case on 15/5 at the Hong Fu Shoe Company, Hoang Long Industrial Zone, Thanh Hoa province. Accordingly, there are 735 patients were admitted to the hospital.

As reported by the HIV/AIDS Prevention Center, as of 31 May 2014, the province has recorded 6.991 positive-HIV patients, in which 4,079 people switched to AIDS stage. According to statistics, there were 306 people newly affected in the first 5 month of this year (increase by 136 people) and 152 AIDS cases, (increase by 52 cases) over the same period of the previous year.

• Clean water supply and sanitation:

Currently, Thanh Hoa province is implementing the program for clean water supply and rural sanitation during the period of 2013 – 2017 using the financial packet of 26.7 million USD from the World Bank. The project objective is to distribute clean water for 45,800 households in Thanh Hoa province and ensure 114,500 people can access to sustainable construction.

In 2013, within Thanh Hoa province, there are three districts: Hau Loc (7 communes), Nga Son (9 communes) and Hoang Hoa (8 communes) received the assistance of 21.5 million USD to implement the project. These are coastal communities had dense population and often submerged. The households living in this area were not supplied with enough water for domestic use as well as production. These communes were also supported to build 2,020 qualified restrooms. Accordingly, 33,680 people were benefited from this program. The project has also built 6 new clean water supply stations and new toilet for 6 schools. Likewise, water supply facilities and toilets in 17 schools and health centers were upgraded.

However, the proportion of rural population using clean water in the province in 2013 was still low (77%).

3.4.2. Hoa Binh Province

Hoa Binh is a mountainous province, the gateway to the Northwest, where the National Highway 6 run through. This is the main road linking the capital Hanoi and the lowland areas to the Northwest of the country. Hoa Binh province is located within the latitude and longitude of $20^{0}39'$ to $21^{0}08'$ N and $104^{o}48'$ to $104^{o}51'$ E. Accordingly, Hoa Binh city is the political, economic and social center of this privince which is 73 km away from the capital, Hanoi. The province is adjacent to Phu Tho province to the North and Ha Nam, Ninh Binh province to the South. This province share its eastern boundary with Hanoi and western boundary with Son La and Thanh Hoa province

Figure 13: Location of Hoa Binh province

Hoa Binh province has 11 administrative units, including the Hoa Binh city and 10 other districts with 210 communes.

The population of Hoa Binh is relatively sparse with low population density. Many district of this province are located in the remote areas. In 2012, the population of Hoa Binh province was 806,100 people. Average population density of the province was 175 people/km . The population is unevenly distributed, mostly concentrated in Hoa Binh cities and towns, while in some places the population density is very low, particularly Da Bac District having lowest population density. 80% of the local workforce is working in agricultural sector.

a) Economic conditions

In 2012, the economic growth of Hoa Binh reached 10.28%, average GDP was 1,189.59 USD/person/year, the proportion of poor households was 18.35%. 8,000ha of forests were newly planted, total coverage was estimated at 49.3%.

The GDP reached 20,055.8 billion VND. In which, total production value of the agriculture, forestry and fisheries was 8,404.76 billion VND, accounted for 26.17% GDP, the industry and construction reached 17,339.85 billion VND, accounted for 53.99 GDP, and the value of service sector was 6,373.98 billion VND, equivalent to 19.85% GDP. According to the economic structure of Hoa Binh province, the industry and construction play the important role in the GDP.

Agriculture, forestry and fisheries:

- Agriculture: In 2012, total value of agricultural production reached 7,301.98 billion VND, in which cultivation was estimated at 5,292.031 billion VND, accounted for 72.52%; livestock reached 1,952.842 billion VND; services and other activities to reach 54.103 billion VND, accounted for 0.74%. Accordingly, concerning the structure of agriculture, farming played an important role.

- Forestry: total forest area of Hoa Binh province was 239,933 hectares. In which, the area of natural forests was 134,960 ha of and artificial forests was 104,973 ha. Total production value of the forestry sector reached 883.28 billion VND, of which planting and tending reached 109.76 billion VND, accounted for 12.43% of total value of forestry production. The exploitation of timber and other forest products reached 709.25 billion VND, accounted for 80.3% of the forestry production. Non-wood forest products and other forest products collecting was estimated at 47.33 billion VND, accounted for 5.36% of total value of forestry production; Forest Service reached 16.94 billion VND, accounted for 1.92% of the value of forestry production.

- Fisheries: Total area for aquaculture was 2,180 ha. Total value of fisheries production reached 219.505 billion VND, of which the mining industry reached 73.264 billion VND, accounted for 33.4%; aquaculture industry reached 146.241 billion VND, accounted for 66.6%, the service sector reached 3.715 billion VND accounted for 1.7%.

• Industry and small scale industry:

Total value added of industries - construction was 15,274.85 billion VND in 2013. In particular, the industry contributed 11,869.25 billion VND, while that of construction industry was 3,405.62 billion VND. The growth rate of the industry - construction continued to increase and reached an average growth rate of 20.7% per year.

- Industrial production value in the area continued to increase over the years that reached 11,869.25 billion VND in 2013. Regarding the structure of the internal industrial production value, the manufacturing and distribution industry of electricity and gas always occupies a large proportion in the structure of the industry. In particular, the Hoa Binh hydropower plant with the capacity of 1,920 MW plays an important role in the country's electricity production; followed by the processing industry accounted for 18% and the rest are other industries.

Small scale industries are diversely developing, besides the traditional industries (Brocade, wine marking) there are the appearance of the embroidery, high grade furniture (Hoa Binh city), rattan (Lac Thuy), etc.

• Commercial services

Total retail sales in 2012 of the province was 5,809 billion VND, of which food was estimated at 2,295 billion VND, garments was 431 billion VND, utensils and tools - equipment reached 677 billion VND, cultural and education articles reached 62 billion VND, timber and construction materials reached 652 billion VND; automotive and transportation reached 586 billion VND; the repairing services for cars, motorcycles and other motor vehicles reached 193 billion VND, and other goods reached 602 billion VND.

- Hoa Binh tourism has started to exploit the strengths of its diverse culture, especially the culture and traditions of ethnic minorities living here, including Thai, H'mong, Muong ... Some ecotourism project has been implemented in the province such as the Da lake Resort, Kim Boi, Kim Boi Resort, Bac Waterfall (Kim Boi), Thang Thien Waterfall (Ky Son), Lac Village (Mai Chau)... revenue from accommodation and food services reached 1,039.2 billion VND in 2012. In which, the revenue from accommodation services reached 84.2 billion VND, and that of food service was 955 billion VND.

b) The social services

• Education:

Hoa Binh province has achieved universal secondary education in 2003 and continues to strengthen universal results and prevents illiteracy. Currently, the province has two districts successfully universalized high school education. 100% of communes, wards and towns in the province have school or kindergarten, elementary, secondary and high schools. All the 11 districts and cities have high schools (at least 02 school districts), Hoa Binh city has 05 schools.

• Health Care:

Hoa Binh province has three provincial hospitals, including: Provincial Hospital; Traditional Medicine Hospital of the province; Hospital Mai Chau area. In addition, there are 10 general district hospitals and 24 regional clinics.

The province has a total of 1,640 beds, an average of 20.6 hospital beds per 10,000 population. The proportion of commune having health stations reaches 98.6%. The number of communal health centers (CHCs) that meet national standards is still low.

100% of CHCs have midwife or obstetric nurses, 65.2% of CHCs have doctors. Number of health centers without doctors mainly locates in remote communes. At this moment, 100% of villages have medical staff.

In 2013, the mortality rate of infants under 1 year of age was 17.6 ‰, the malnutrition rate among children under 5 years old is 21.5%. Percentage of children under 1 year old are fully vaccinated is 96%.

• Providing clean water and sanitation:

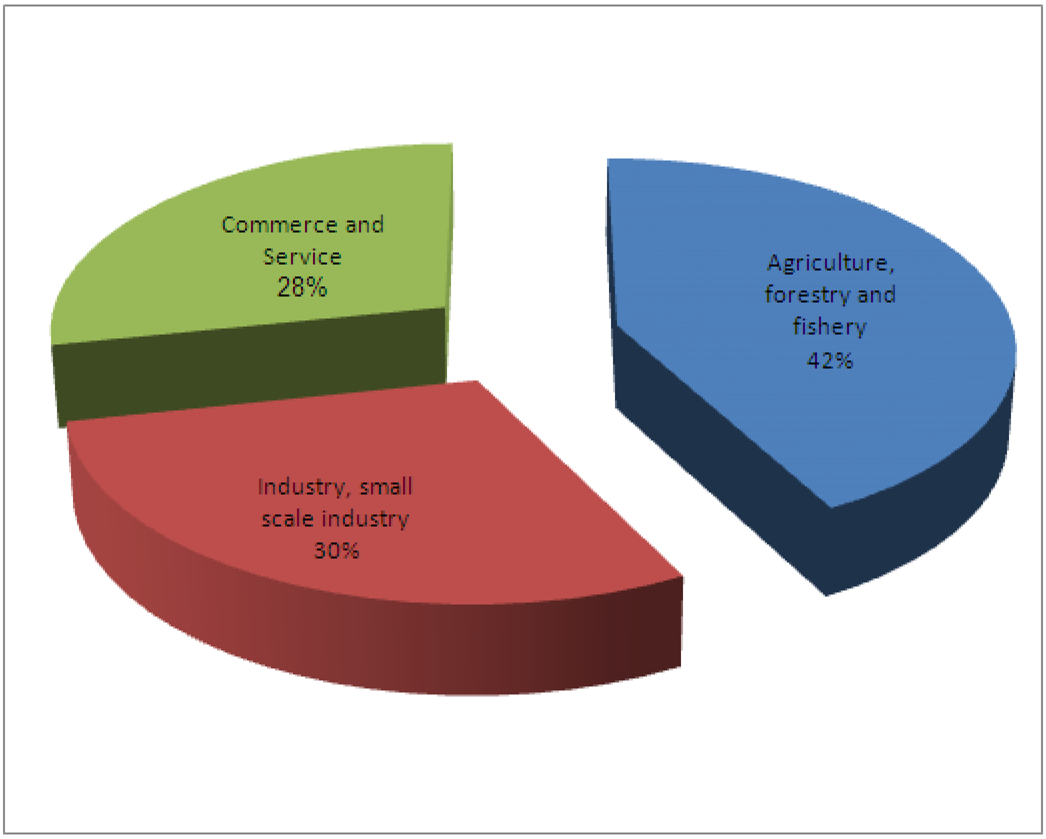
Potable water supply system was invested by the State budget, ODA (ADB, World Bank, South Korea), many drinking water projects have been completed and put into operation, such as water supply system in Chi Ne town, Thuy Yen, Mai Chau (budget from ADB), water supply projects 3 in Kim Boi district, Tan Lac and Lac Son (ADB), Luong Son, Cao Feng (aid from South Korea). The proportion of the rural population that can access to hygienic drinking water increased from 58% in 2005 and reached 80% in 2013.

3.4.3. Quan Hoa district

The Quan Hoa district is located on the West of Thanh Hoa Province with the multiform and complicated terrain. Its total natural area is about 990.13 square kilometers. It has 17 communes and one town (Quan Hoa town) with total population of about 47,015 people in 2013, of which total number of population in age of work was 29,675 people, the population density was 47.5 people per square kilometer and the rate of natural population growth was 1.0%. The income per capita in Quan Hoa district reached 9 million VND per person per year and its poverty rate was 33.16%. That was the reason why it was classified into the list of 62 extremely poor districts which had been received special support of the State through the Program of supporting for rapid and sustainable poverty reduction stated at the Resolution No. 30a/ND-CP of the Government dated December 27th 2008.

a. Economic condition

The proportion of economic sectors in GDP of the district is shown as bellow:



Economic structure of the Quan Hoa district in 2013

- **Sectors of agriculture, forestry and fishery:**

- The cultivation sector: in 2013, total cultivated area of the district was 7,518.09 hectares reaching 108% of the plan, as 103% in comparison with the same period in 2012. The cultivated area of rice was 2,240.9 hectares; the cultivated area of crops in the winter harvest was 110 hectares. Of which, the cultivated area of hybrid rice accounted for 58.46% with productivity averaged 53.7 quintals per hectare, an increase of 3.4 quintals per hectare as compared to the same period in 2012. The cultivated area of maize was 2,697.1 hectares, reached 110.8% of the plan; an increase of 11% in comparison with the same period in 2012 with productivity averaged 39.6 quintals per hectare, an increase of 0.6 quintals per hectare as compared to the same period in 2012. The cultivated area of cassava was 2,045 hectares, reached 113.6% of the plan, as 95% in comparison with the same period in 2012 with the productivity averaged 128 quintals per hectare, an increase of 0.5 quintals per hectare as compared to the same period in 2012. The cultivated area of vegetables, beans all kinds was 316 hectares. The area, productivity and production of major crops in Quan Hoa district in 2013 are shown in the following table:

Table 3.58: The annual cultivated area of crops in Quan Hoa district, in 2013

Indicators	Area (hectare)	Productivity (quintal per hectare)	Production (ton)
Total	**7,518.1**		
1. Staple-food crops	4,938.0		
Rice (whole year)	2,240.9	47.4	12,033
Other staple-food crops	2,697.1		
Maize	2,697.1	39.6	10,680
2. Starch crops	2,143.0		
Cassava	2,045.0	128	26,176
Other starch crops	98.0		
3. Vegetables and beans all kinds	340.6		
Vegetables all kinds	315.0		
Beans all kinds	25.6		
4. Perennial industrial crops	100.0		
Soybeans	36.0	16	57.6
Peanut	28.0	9	25.2
Sugar-cane	36.0	65	234

- The breeding sector: The animals such as buffaloes, cows, pigs, poultry and goats are the popular domestic animals in the locality. There were 8552 buffaloes reaching 100.7% of the plan; 17,144 cows reaching 100.5% of the plan; 25,200 pigs reaching 100.7% of the plan; 144,280 poultry reaching 106% of the plan and 2,095 goats reaching 30% of the plan.

Table 3.59: total livestock and poultry in Quan Hoa in 2013

Indicators	Quantity
The number of buffaloes	8,552.0
The number of cows	17,144.0
Of which total dairy cow:	
The number of cross-bred cows	45.0
The number of pigs	25,200.0
total poultry (*1000 units)*	144.2
The live weight of meat *(ton)*	2,755.0
Of which: live weight of pigs *(ton)*	1,540.0

- The forestry sector: in 2013, there was 4,320 hectares of forest to be regenerated, 13,504 hectares of forest to be protected and 6,400 hectares of forest to be well cared. The exploited production of Dendrocalamus Membranaceus Munro was 9 million trees, more than 1,800 cubic meters of wood and 510 tons of Neohouzeaua Dullooa (also known as dullooa bamboo).

- Aquaculture and fishery: in 2013, the exploited and cultivated values in aquaculture sector in Quan Hoa district estimated at 110 tons, the exploited production estimated at 20 tons and cultivated production estimated at 90 tons.

- **The industry and small scale industry sectors:**

total production value of industry and small scale industry sectors in 2013 reached more than 127.266 billion VND reaching 105% of the plan, as 116% in comparison with the same period in 2012. In the district, there were 26 companies, cooperatives and complexes operating in forest product processing; 24 companies, cooperatives and complexes operating business in exploiting rock, sand, gravel and building materials (of which, there were 2 companies which had stopped operation including the Phat Tai import-export and trading limited liability company and the Dong Bac Investment & Construction Development Company). The main business products were mainly building materials such as brick, stone all kinds, sand, gravel, sawn timber, bed, wardrobe, table, chair, chopstick, votive paper and pulp, etc.

- **The sectors of commercial service and tourism**

Total retail sales of goods and turnover from commercial services estimated at 122.250 billion VND, an increase of 43% compared to the same period in 2013. In which, the sales of Quan Hoa Commercial Branch was 51.5 billion VND reaching 111% of the plan, as 123.8% compared to the same period in 2012. The main commodities are mainly fertilizer, iodized salt, rice, cement, gasoline, oil, agricultural and consumer products, etc.

b. The social services

- **The education:**

There were 36 schools in total in the whole district, including 18 elementary schools, 17 junior high schools and one senior high school. There were 18 communes and towns which were invested in construction permanent elementary school. Total number of classrooms is 691 rooms, including 656 permanent classrooms and 35 semi-permanent classrooms. The education indices of Quan Hoa district are listed in the following table.

Table 3.60: The education indices in Quan Hoa district, in 2013

Indices	Unit	Quantity
1. The number of institutions, of which	school	36
The number of elementary schools	school	18
The number of junior high schools	school	17
The number of senior high schools	school	1
2. The number of classes	Class	401
The number of elementary classes	Class	270
The number of junior high classes	Class	101
The number of senior high classes	Class	30
3. Preschool education		
The number of preschool institutions	school	18
The number of preschool classes	Class	184
4. The number of teachers	People	636
Of which: The elementary school teachers	People	326
The junior high teachers	People	233
The senior high teachers	People	77
5. Number of students	Student	7.367
The elementary school students	student	3.872
The junior high students	student	2.203
The senior high students	student	1.292
6. The number of communes, wards and towns have been eliminated literacy and universalized elementary education	unit	18

In 2013, there were 17 of 18 preschool institutions finishing universalizing education for 5 year old children; firmly maintaining on universalizing elementary and junior education. In the school year 2013-2014, there were 410 students who graduating from junior high school are mobilized to continue to take the secondary education, accounted for 76% in proportion.

- **Heath facility:**

The facilities of health department in the district basically meet the requirements of health care for local people. All communes and towns in the district were invested in construction of clinic and three Public health facilities with 215 medical staffs including 203 doctors and physicians and 12 pharmacists. Total number of hospital beds was 227 beds. In 2013, total number of examinations at the general hospital was 27,294 visits. Total number of inpatient and outpatient patients was 5,467 and 18,933 people respectively.

Table 3.61: The medical indices of Quan Hoa district, in 2013

Indices	Unit	Quantity
1. The number of health facilities	Unit	*21*
- The State health facilities	Unit	3
- The clinics at communes, wards and towns	Unit	18
- The private health facilities (with registration certificate)	Unit	
2. The number of medical staffs	People	*215*
In medicine	People	203
Of which, number of doctors and physicians	People	133
In pharmacy	People	12
3. The number of hospital beds	unit	*227*
Of which, number of public hospital beds	unit	227
4. Current status of health facilities at communes, wards and towns		
- Number of communes and towns which is invested in construction of health care facilities as well as arranged with medical staffs	unit	18

In 2013, some main diseases occurred as bellows:

- Number of malaria (including parasite) sufferers: 04 people.

- Number of clinical malaria sufferers: 121 people, an increase of 31 people compared to the same period and up 25% compared to 2012; there was no fatality from malaria.

- Number of diarrhea sufferers: 655 people.

- Number of flu sufferers: 1467 people.

- Number of mumps sufferers: 76 people.

- The hand, foot and mouth disease (HFMD) sufferers: 62 people.

The Quan Hoa district is also the trouble-spot for HIV/AIDS. In 2013, thirty six people affected by HIV virus were discovered. That raised total number of HIV sufferers touching 633 people.

- **Water supply, sanitation**

The proportion of the rural population using hygienic water is 76% reaching 89% of the plan. There are 67 constructions of domestic water supply on the whole district. Currently, a number of works have been damaged, together with lacking funds for repair, the rural households using hygienic water decrease all the more. The populations therefore mainly use water from wells and river for their domestic activities.

c. The basic infrastructure

- **The power supply facility**

The national power grids in the district include the 35 kV transmission lines 29.182 kilometers in length, 0.4 kV transmission lines 43.6 kilometers in length, 21 substations with total capacity of the step-down station is 1.575kVA. Currently, there are 623 households using power from the other sources, which are mainly the small-scale hydropower located at the streams. For this type, it will be proved it energy output only in the rainy season but in the dry season.

In the whole district, there were 11 of 18 communes and town being supplied power from the national power grid. However, the current status is that the transmission lines has just been constructed to central of several communes, commune groups and several surrounding villages. Therefore, most of the remote villages are still not supplied the power leading to the difficulties in people's lives. By 2010, the percentage of households using power from the national power grid reached 85%.

- **The irrigation system**

- There are two irrigation reservoirs in Quan Hoa district that are Trung Lap and Pha Day reservoirs.

+ The Trung Lap reservoir located in Phu Xuan commune built in 1980 by the budget reserved for small irrigation works. Its task is to irrigate the cultivated area in the Cung village with total area of 18 hectares.

+ The Pha Day reservoir located in Nam Xuan commune. It was built in 1981 with the task of irrigating for 45 hectares.

- In the district, there are 40 small-scale dam built to create the water head in order to irrigate for 600 hectares.

- For the irrigation channel: the Quan Hoa district has been invested in construction of channel systems 152 kilometers in length; of which 75 kilometers of channel was strengthened; and 217 irrigation dams.

- **The traffic system**

- In the Quan Hoa district, 16 of 18 communes and town have roads built to the center; the two remaining are Trung Thanh and Phu Son communes.

- The national road: Highway 15A goes through the district with the length of 43 kilometers. It is classified as grade V and VI road with asphalt pavement. It is currently being upgraded by the Ministry of Transportation.

- The provincial road: the provincial roads pass through the district with a total length of 74 kilometers e.g the provincial road 520 (from Hoi Xuan to Ten Tan district) 50 kilometers in length has medium quality with asphalt pavement and provincial road from Van Mai to Trung Son (24 kilometers in length) has average quality with asphalt pavement.

- The Tay Thanh Hoa street: 33 kilometers in length and it is currently being upgraded.

- The district road: 10 routes with total length of 91.5 kilometers. They all are currently classified as type of a rural road with its bad quality earth surface.

- The inter-commune road: there are 122.5 kilometers of inter-commune and inter-village roads; of which, 10 kilometers of roads with aggregate surface and the rest are earth roads which should be invested to upgrade.

- **The water traffic**

The water traffic in the Quan Hoa district is under undeveloped status although Ma river flows through its territory. The operation of water traffic is mainly to transport the bamboo *(Dendrocalamus membranaceus Munro)* following closely to the two riverbanks from the upstream to the downstream collection point.

- **The historical, cultural and archaeological monuments**

There are three historic and cultural monuments which are recognized, including:

- Phi Cave historical and cultural monument located in Hoi Xuan and Nam Xuan communes.

- Bia Ky Kham Ban historical and cultural monument located in Kham village of Hoi Xuan commune.

- Co Phuong Cave historical and cultural monument located in Sai village of Phu Le commune.

3.4.4. Mai Chau district

Mai Chau is a mountainous district, located in the West of Hoa Binh province. It is away from Hoa Binh City about 65 kilometers, with coordinates of from 20º24' to 20º45' North latitude and 104º31' to 105º16' East longitude; it has the borders with the following administrative units:

- Bordering the Da Bac and Tan Lac districts on the East;

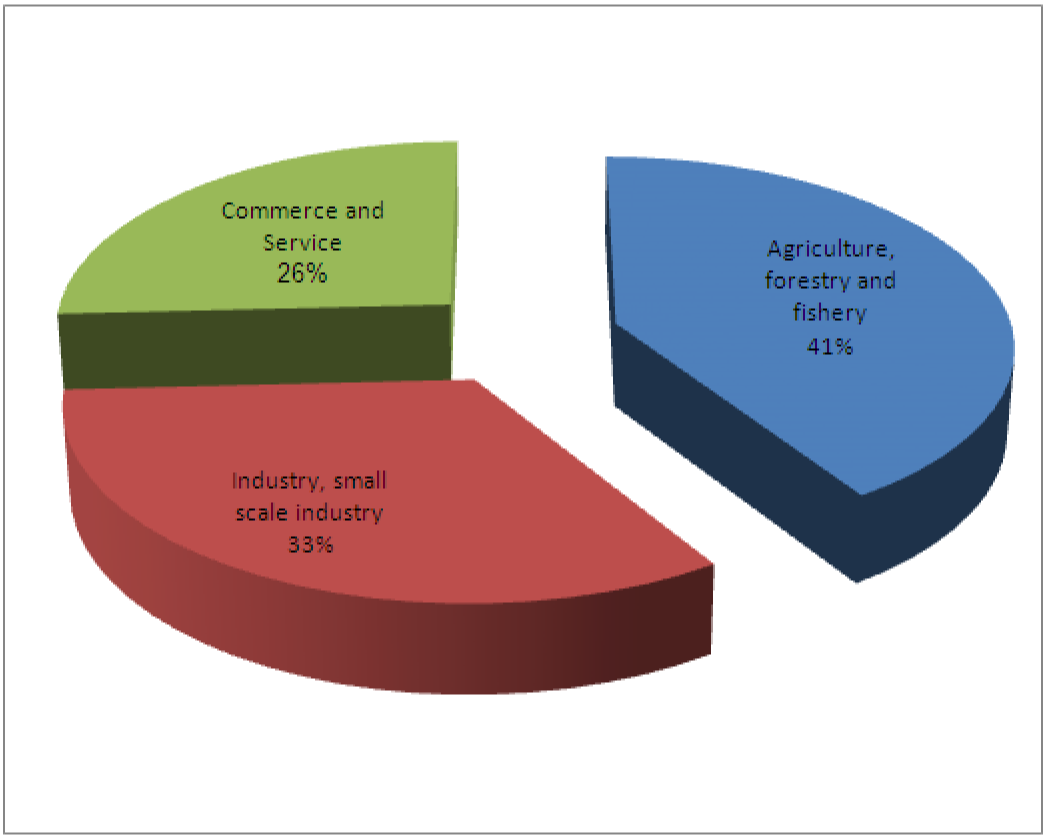
- Bordering the Quan Hoa district of Thanh Hoa province on the West and South;

- Bordering the Moc Chau district of Son La province on the North.

Total natural area of the district is about 571.28 square kilometers. There are 22 communes and one town (Mai Chau town) with total population of 53,315 people in 2013, of which total number of population in age of work was 25,067 people, the population density was 93.3 people per square kilometer and the rate of natural population growth was 1.0%. The income per capita in Mai Chau district reached 13.067 million VND per person per year and its poverty rate was 23.1%.

a. Economic condition

The proportion of economic sectors in GDP of the district is shown as below:



The structure of economic sectors of the Mai Chau district in 2013

- **The sectors of agriculture, forestry and fishery:**

The agriculture is still an important sector in the overall economic structure of the Mai Chau district. In 2013, the production value of the agriculture sector reached 442.4 billion VND, accounting for 40.9% of GDP of the district.

- The cultivation sector:

The main crops include: rice, maize, upland rice, sweet potatoes, taro, cassava, arrowroot (also known as Maranta arundinacea in Latin), etc. Total cultivated area was 11,361.9 hectares with value of production reached 210 billion VND, accounting for 47.5% of agriculture its value of production. The area, productivity and production of main crops of Mai Chau district in 2013 are listed in the following table:

Table 3.62: The cultivated area of crops in Mai Chau district, in 2013

Indicators	**Area** (hectare)	**Productivity** (quintal per hectare)	**Production** (ton)
1. Staple-food crops			
Rice (whole year)	2081.1	52.03	10.828
Other staple-food crops			

Indicators	Area (hectare)	Productivity (quintal per hectare)	Production (ton)
Maize	5,441.7	30	16,325
Upland rice	283.6	13	369
2. Starch crops			
Sweet potatoes (whole year)	132.8	45	598
Taro	49.3	68	335
Cassava	1,540.3	88	13,555
Arrowroot	508	97	4,928
3. Industrial crops	100.0		
Soybeans	326	14.5	473
Sugar-cane	7.1	270	192
Ginger	40	37	148
4. Vegetables and beans all kinds			
Vegetables all kinds	565.8	46	2,603
Beans all kinds	36.2	6.5	24
5. Perennial industrial crops			
Tea	250	23	575

- The breeding sector:

The animals such as buffalo, cows, pigs and poultry are the popular domestic animals in the locality. There were 6,200 buffaloes; 8,542 cows; 27,581 pigs and 190,500 poultry (chicken, duck). Total value of production reached 110 billion VND, accounting for 10.2% of agriculture its production value. Total livestock and poultry in Mai Chau district in 2013 are shown in the table below:

Table 3.63: total livestock and poultry in Mai Chau in 2013

Indicators	Quantity
The number of buffaloes	6,200
The number of cows	8,542
The number of pigs	27,581
total poultry	190,500
The live weight of meat *(ton)*	
The live weight of buffaloes (t*on)*	82

Indicators	Quantity
The live weight of cows *(ton)*	183
The live weight of pigs *(ton)*	1,320
The live weight of poultry *(ton)*	206

- The forestry sector:

The production value estimated at 115.6 billion VND, accounting for 10.7% of agriculture its production value, an increase of 34.98% compared to the same period. In 2013, there were 203.3 hectares of new-planted forest including 174.5 hectares of forest planted concentratively and 28.8 hectares planted dispersedly. Well perform the care, regeneration and protection of forest to ensure the proportion of forest cover is stable at 63%.

- Aquaculture and fishery:

The natural aquaculture operation was relatively stable, total area of aquaculture was 55.4 hectares with 314 fish cages, and aquaculture production estimated at 189.5 tons. The main aquatic species were primarily carp, red tilapia and Africa carp. The cultivated value in aquaculture sector estimated at 3.8 billion VND, of which the fishing value reached 3.8 billion VND, accounting for 0.6% of the agriculture its production value.

- **The industry and small scale industry sectors:**

Total production value of the industry, small scale industry and construction sectors in 2013 reached 360 billion VND, accounting for 33.3% of GDP. The products of the industry and small scale industry sectors were mainly building materials such as brick, stone all kinds and pulp; the agricultural processing and brocade spin were the fast-growing branches. However, the small scale industry sector was under small-scale, scattered and spontaneous status with low efficiency and less abundant types. The growth rate of production value reached 18.75%, in which the production value of the industry and small scale industry, and the construction sector rose 36.29% and 8.59% respectively.

- **The sectors of commercial service and tourism**

Total production value of these sectors reached 280 billion VND, accounting for 25.8% of the district its GDP, the growth rate of production value reached 10.52%. Total retail sales of goods and turnover from commercial services estimated at 132 billion VND, an increase of 3.2% compared to the same period in 2012.

b. The social services

- **The education:**

There were 45 schools in total in the whole district, including 20 elementary schools, 23 junior high schools and two senior high schools. There were 11 schools meeting the national standard.

Table 3.64: The education indices in Mai Chau district, in 2013

Indices	Unit	Quantity
1. The number of institutions, of which:	school	45.0
The number of elementary schools	school	20.0
The number of junior high schools	school	23.0
The number of senior high schools	school	2.0
2. The number of classes	Class	433.0
The number of elementary classes	Class	270.0
The number of junior high classes	Class	131.0
The number of senior high classes	Class	32.0
3. Preschool education		
The number of preschool institutions	school	23.0
The number of preschool classes	Class	141.0
4. The number of teachers	People	747.0
The elementary school teachers	People	397.0
The junior high teachers	People	278.0
The senior high teachers	People	72.0
5. Number of students	Student	8,156.0
The elementary school students	student	4,162.0
The junior high students	student	2,872.0
The senior high students	student	1,122.0
6. The number of communes, wards and towns have been eliminated literacy and universalized elementary education	unit	23.0

In 2013, there were 23 of 23 communes and town in the district finishing universalizing elementary education at the right age and for literacy. There were 66 students achieving the title of good performance student in provincial level, 238 qualified teachers in district level, 21 qualified teachers in provincial level and 03 qualified preschool principals in provincial level.

- **The heath facility:**

In 2013, 23 of 23 communes and town were invested in construction of clinics and two general hospital and surgery. There were 29 doctors, 83 physicians and 29 midwives. There were 232 hospital beds in total.

Table 3.65: The medical indices of Mai Chau district, in 2013

Indices	Unit	Quantity
1. The number of health facilities	Unit	*25.0*
- The general hospital and surgery	Unit	2.0
- The clinics at communes, wards and towns	Unit	23.0
2. The number of medical staffs	People	*192.0*
- Doctor and doctor with higher academic title	People	29.0
- Physician	People	83.0
- Nurses	People	51.0
- Midwives	People	29.0
3. The number of hospital beds	unit	*232.0*
- In the general hospital and surgery	unit	140.0
- In the clinics at communes, wards and towns	unit	92.0
4. Total number of medical visits	People	99,223.0
5. Total number of patients treated	People	39,792.0
- Number of impatient patients	People	8,539.0
- Number of outpatient patients	People	31,253.0

In 2013, some main diseases occurred as bellows:

The hand, foot and mouth disease (HFMD) sufferers (first ten months): 61 people;

Number of diarrhea sufferers: 413 people;

Number of flu sufferers: 731 people;

Number of chickenpox sufferers: 05 people;

In addition, the Mai Chau district is also the trouble-spot for HIV/AIDS. In 2013, one hundred and three people affected by HIV/AIDS were discovered. Of which, the number patients living with the community was 65 people; and the number of patients living in treatment camps or other places was 38 people. The number of patients with the virus developing to AIDS was 21 people. The number of patients being treated to provide against infection was 27 people.

- **Water supply, sanitation**

- 12,826 households in the district used water from the various sources as follows:

+ Use water from well: 3675 households.

+ Use water from drilling well: 159 households.

+ Use water from gutter: 7369 households.

+ Use rain-water: 766 households.

+ Use tap-water: 847 households.

- Number of households using hygienic restroom was 4,728 households accounting for 36.8% of total 12,826 households.

c. The basic infrastructure

- **The power supply facility**

The national power grids in the district include 74 kilometers of 35 kV transmission lines running in parallel with Highway 6 with 2 intermediate substations; and 0.4 kV transmission lines 45 kilometers in length with 33 substations to supply power to the communes in the district.

Currently, all communes are being supplied power from the national power grid. The proportion of households using power is 95%. Number of villages without electricity is mainly in the remote area.

- **The irrigation system**

The irrigation system in Mai Chau district ensures to actively irrigate for over 2,000 hectares of rice yearly and supply a part of water source for domestic activities of local people.

- There are 11 irrigation reservoirs including Mo Luong, Mo Bin, Kha, Tong Dau, Reservoir 3-2, Na Phat, Sam Tang, Pieng Nhung, Noong Nien, Denh and Long San.

- There are 18 irrigation dams including Muong Pung, Hu, Buoc, Te, Tan Tien Long, Muong Mai Hich, Luong, Na Lan, Khan, It, Lau, Pheo, Ta, Ly, Hao, Phat and Hung.

- **The traffic system**

There are two national highways running through the district that are Highway 15 and Highway 6. Highway 6 segment which runs through the district with the length of 38 kilometers, has been upgraded and expanded to meet demand for traffic and goods transportation from Mai Chau district center to the Hoa Binh city. Highway 15 segment which runs through the district from Tong Dau to Van Mai with the length of 20 kilometers, has been upgraded with asphalt pavement. It is the main road accessing the construction site of the Trung Son and Hoi Xuan hydropower projects.

The internal road system includes 3 main roads together with the inter-commune and rural road system, rural roads. The internal road system in district has length of 50 kilometers in total, including:

The route Van Mai - Cun Pheo is 26 kilometers long with asphalt pavement.

The route Dong Bang - So Lo is 13 kilometers long with asphalt pavement.

The route Mai Chau - Pu Pin 14.2 kilometers long with asphalt pavement.

The route Thung Khe - Noong Luong is the new-built road 17 kilometers in length.

The route from Highway 6 to Hang Kia commune is 15 kilometers long with asphalt concrete pavement.

The inter-commune and rural road system is 90 kilometers long, most of their pavement is made from cement concrete. Some sections have been upgraded with asphalt pavement. The road section at the position where its slope is quite steep, has been renovated to reduce the slope such as the route Pa Co - Hang Kia. There are also several routes which have been upgraded such as the routes of Mai House - Van Mai, Xam Khoe - Pieng Ve, Pieng Ve – Cum Pheo, Pa Co - Hang Kia and Ba Khan - Phuc San.

In addition, the district its central bus station is at the center of Mai Chau town and 4 positions for taking passengers including Cun Peo, Bao La, Xam Khoe and Co Luong.

- **The water traffic**

Mai Chau district has the border with the reservoir of the Hoa Binh hydropower, the traffic between communes in the reservoir area and Hoa Binh city as well as neighboring localities is relatively convenient. The communes in the reservoir area were supported with motorboats under the 472 projects to develop water transportation.

- **The historical, cultural and archaeological monuments**

There are 16 historic, cultural and archaeological monuments and landscape on the Mai Chau district. Of which, 5 relics were ranked as the national monument. The list of 16 monuments is listed in the following table.

Table 3.66: The list of historical, cultural and archaeological monuments and landscape in Mai Chau district

No.	Monument	Location	Type	Ranked as national monument	people's Committee issued the Decision for the protection	Unclassified
1	Khoai Cave	Sum village, Sam Khoe commune	archaeological	X	X	
2	Lang Cave	Lac village, Chieng Chau Commune	archaeological	X	X	
3	Dan Dua rock slope	Mo village, Chieng Chau Commune	archaeological		X	X
4	Hang Khau Puc	Lac village, Chieng Chau Commune	archaeological		X	X
5	The Thai I sepulcher	Van village, Mai Chau district	archaeological		X	X
6	The Thai III sepulcher	Mo village, Chieng Chau Commune	archaeological		X	X
7	Chieu Cave	Mai Chau district	landscape	X	X	
8	Mai Chau Valley	Mai Chau district	landscape		X	X
9	Ancient forest at Route K54	Xa Linh village, Pa Co Commune	landscape		X	X
10	MO Luong Cave	Mo village, Chieng Chau Commune	landscape	X		
11	Van Village	Mai Chau district	historical and cultural		X	X
12	Lac Village	Chieng Chau Commune	historical and cultural		X	X
13	The Mong people's Village	Xa Linh village, Pa Co Commune	historical and cultural		X	X
14	Pieng Kem Cave	Chieng Chau village, Chieng Chau Commune	landscape	X		
15	Goc Cay Thi	Mo village, Chieng Chau Commune	historical		X	X
16	Nuoc Cave	Mo village, Chieng Chau Commune	landscape		X	X

3.4.5. Economic-social conditions of 11 environental affected communes

a) The area, population, ethnics

Of 11 communities affected to the environments by the project, Trung Thanh commune has the largest area with an area of 80.2km^2, the smallest area is Van Mai commune with an area of 36.48 km , the most of communes has from 5 to 6 hamlets, villages, in which Trung Thanh commune has most hamlets with 10 hamlets, Phu Le have least hamlets with 4 hamlets. Distribution of population density of the affected communes is quite sparse, Mai Hich commune has the largest population density with 94.48 people/km ; Trung Thanh commune has the lowest population density with 34.96 people/km ; average population density of 11 communes is 55.23 persons/km . The size of households in an average is 4.3 persons/ household; the details of area, number of households, number of people affected by the communal are shown in the table as follows:

Table 3.67: Summary of area, number of households, number of people of the affected communes

No	**Commune name**	**Area** (km)	**Number of hamlets**	**Number of household**	**Number of people**	**Size of household** (number of people/number of household)	**Population density** (people/km)
1	Hoi Xuan	68.93	7	841	3,364	4.00	48.80
2	Mai Hich	42.24	7	913	3,991	4.37	94.48
3	Phu Le	43.47	4	400	1,801	4.50	41.43
4	Phu Son	63.87	5	538	2,507	4.66	39.25
5	Phu Thanh	32.33	6	437	1,761	4.03	54.47
6	Phu Xuan	24.31	5	431	1,886	4.38	77.58
7	Thanh Son	55.49	8	562	2,419	4.30	43.59
8	Thanh Xuan	78.30	6	635	2,868	4.52	36.63
9	Trung Son	76.95	6	742	3,100	4.18	40.29
10	Trung Thanh	80.27	10	617	2,806	4.55	34.96
11	Van Mai	36.48	7	730	3,020	4.14	82.79

In the affected communes, the Thai ethnic is mainly with 72.80%, followed by Muong people account for 20.66%. Kinh people account for 4.85%. H'Mong people account for 1.34% and Hoa people account for 0. 34%. The number of people are classified according to the ethnic composition of the affected communes as the following table:

Table 3.68: Summary of number of people of the affected communes according to the ethnic composition

No.	Communes	Population	Kinh	Thai	Muong	H'Mong	Hoa	Kho Mu
1	Hoi Xuan	3,364	336	2,691	236		101	
2	Mai Hich	3,991	31	3,412	548			
3	Phu Le	1,801	19	1,764	18			
4	Phu Son	2,507	16	1,802	315	374		
5	Phu Thanh	1,761	67	1,688	6			
6	Phu Xuan	1,886	5	1,179	702			
7	Thanh Son	2,419	41	1,664	712	1		1
8	Thanh Xuan	2,868	25	1,460	1,383			
9	Trung Son	3,100	43	2,114	943			
10	Trung Thanh	2,806	3	1,670	1,112	21		
11	Van Mai	3,020	846	2,050	124			
Total		**29,523**	**1,432**	**21,494**	**6,099**	**396**	**101**	**1**
Percentage (%)		**100**	**4.85**	**72.80**	**20.66**	**1.34**	**0.34**	**0.00**

b) The main economic branches in 11 environmental affected communes

In 11 communities affected to the environments by the project, the majority of households work in agriculture and forestry with 81.79% of population, a few households sell the daily consumer goods such as clothing, electronics, motorcycle repair with 2.29% of population. A small number of people small industry with 1.55% of population, and the limited number of people in other jobs such as state employees and officials, soldiers, etc… are account for 2.50% of population.The main economic sectors in the affected communes are shown in the following table:

Table 3.69: Main economic sectors of the households in 11 environmental affected communes

No	Commune name	Total of households	Agriculture, forestry	Tradeservices	Agriculture - services	Small industry	Others
1	Hoi Xuan	841	788	9	11	6	27
2	Mai Hich	913	755	18	73	46	21
3	Phu Le	400	322	3	42	21	12
4	Phu Son	540	439	7	85	3	6
5	Phu Thanh	437	223	12	166	15	21
6	Phu Xuan	431	371	4	42		14
7	Thanh Son	562	492	8	21		41
8	Thanh Xuan	635	523	11	95		6

9	Trung Son	742	619	16	84	10	13
10	Trung Thanh	617	490	24	99		4
11	Van Mai	730	579	45	95	5	6
Total		**6,848**	**5,601**	**157**	**813**	**106**	**171**
Percent (%)		**100**	**81.79**	**2.29**	**11.87**	**1.55**	**2.50**

b) Social services

- **Education**

All communes in the project area had the solidly primary school, secondary school. Number of pupils in 11 communes in the studied area are such as the following table:

Table 3.70: Education indicators of communes in the studied area in 2015

No.	Commune name		Hoi Xuan	Thanh Xuan	Phu Xuan	Phu Thanh	Phu Le	Phu Son	Van Mai	Mai Hich	Trung Thanh	Thanh Son
1	Temporary classrooms	Area (m^2)		260				105			350	
		Number of room (room)		13				5			14	
2	Preschool semi-permanent classrooms	Area (m^2)		325	35	200	40	240	180		350	180
		Number of room (room)		13	2	4	2	4	6		12	9
3	Preschool permanent classrooms	Area (m^2)								700		
		Number of room (room)								20		
4	Primary temporary classrooms	Area (m^2)		390				55			350	
		Number of room (room)		13				3			12	
5	Primary semi-permanent classrooms	Area (m^2)			40	350	40	460	90		550	1600
		Number of room (room)			2	7	2	14	3		18	11
6	Primary permanent classrooms	Area (m^2)		870						650		800
		Number		29						25		26

No.	Commune name		Hoi Xuan	Thanh Xuan	Phu Xuan	Phu Thanh	Phu Le	Phu Son	Van Mai	Mai Hich	Trung Thanh	Thanh Son
		of room (room)										
7	Secondary semi-permanent classrooms	Area (m^2)				350	40	350	120		420	
		Number of room (room)				6	2	12	4		14	
8	Secondary permanent classrooms	Area (m^2)		300	40			150		410		800
		Number of room (room)		10	2			5		13		27
9	Preschool teacher	Total (people)		20	10	12	17	12	43	37	18	17
		Ethnic minority people (people)		19		12		12				16
10	Primary teacher	Total (people)		23	12	12	14	18	24	28	27	20
		Ethnic minority people (people)		3		5		14				16
11	Secondary teacher	Total (people)		15	18	11	10	10	19	17	10	10
		Ethnic minority people (people)		1		2		3				1
12	Preschool Pupils	Total (people)		182	100	105	125	153	236	216	200	201
		Ethnic minority people (people)		182				153				201
13	Primary school	Total (people)		234	100	122	172	233	168	213	320	252
		Ethnic minority people (people)		234		122		233				246
14	Secondary school	Total (people)		121	100	75	52	139	128	124	165	89
		Ethnic		121		75		139				89

No.	Commune name		Hoi Xuan	Thanh Xuan	Phu Xuan	Phu Thanh	Phu Le	Phu Son	Van Mai	Mai Hich	Trung Thanh	Thanh Son
		minority people (people)										

Some pictures of the current state of facilities for the education of the communes in the project area are shown as follows:

Picture: Hoi Xuan primary school

Picture: Khu Phe primary school – Phu Xuan commune

• Health:

In all 11 communes in the studied area have invested the commune health stations from semi-permanent to permanent, basically meet the requirements of health care in the region. In case of serious illness, people can go to general hospitals at Quan Hoa district or Mai Chau district, where have sufficient the facilities, equipment to treat for people. The maximum distance from people to the general hospital of Quan Hoa district or Mai Chau district is 20 km. Current status of facilities for health of 11 communes of project areas are as the following table.

Table 3.71: Current status of the health facilities at 11 communes in the studied area

No	Commune name	Area (m^2)	Number of rooms	Number of beds (beds)	Number of nurses and doctors (people)	Structure
1	Hoi Xuan	250				Permanent
2	Mai Hich	400	6	5	3	Permanent
3	Phu Le	250	3	12	5	Semi-permanent
4	Phu Son	230	9	10	6	Permanent
5	Phu Thanh	566.4	7	4	6	Semi-permanent
6	Phu Xuan	180	3	12	5	Permanent
7	Thanh Son	200	6	10	8	Permanent
8	Thanh Xuan	420	7	4	4	Permanent
9	Trung Son	150				Semi-permanent
10	Trung Thanh	180	3	6	6	Permanent
11	Van Mai	200	2	4	7	Permanent

Picture: Health station of Phu Le commune

Picture: Health station of Phu Xuan commune

- **Clean water supply and environmental sanitation:**

In 11 communities affected to the environments by the project, most people use spring water for domestic use, only Phu Thanh commune have invested the clean water supply work concentrated in the center of town. In addition, some households have better economic conditions, which have made wells, water purification systems for use in daily life. All communal project area is not systematically collecting and burying the solid waste concentratively. People dig holes at the home area for burying garbage.

Table 3.72: Current use of water in 11 environmental affected communes, 2015

Index	Hoi Xuan	Thanh Xuan	Phu Xuan	Phu Thanh	Phu Le	Phu Son	Van Mai	Mai Hich	Trung Thanh	Thanh Son
Tap water (%)										
Borehole (%)		1.6					1.1	1		
Dug wells, deep wells and groundwells (%)					70		38.4			
River and lakes (%)							53.7			
Rain water (%)					10		6.8			
Waterravine (%)		67.7		73.5	20	100		99	100	100
Buy water tanks from dealers (%)				26.5						
Other (%)		30.7								

3.4.6. Socio-economic conditions of the households in the affected area

According to a random survey of 200 households in areas affected by the project, average age of the household head is 44.1 years. Number of male heads is 175 households, accounting for 87.5% of total households, and number of female heads is 25 households, accounting for 12.5% of total households. Divided by the ethnic composition. Thai ethnic people are majority with 150 households, accounting for 75% of total households; Kinh people have 33 households, accounting for 16.5% of total households. Muong ethnic people have 16 households, accounting for 8%; Native ethnic people are only one household, accounting for 0.5% of total households. However, in the project area, the ethnics live sociably with each other. There are no ethnic conflicts.

Table 3.73: Sociological statistic of households in the affected area of the project

Commune	Average age of household head	Male head	Female head	Ethnicity			
				Thai	Kinh	Muong	Tho
Hoi Xuan	42.3	6		6			
Mai Hich	45.8	22	3	25			
Phu Le	48.3	35	4	31	8		
Phu Son	42.7	23		22		1	

Phu Thanh	36.0	17	3	12	6	2	
Phu Xuan	41.6	9	1	8		1	1
Thanh Son	42.5	16	4	10	1	9	
Thanh Xuan	44.4	11	4	13		2	
Trung Son	45.7	36	6	23	18	1	
Total		175	25	150	33	16	1
Percent (%)		**87.5**	**12.5**	**75.0**	**16.5**	**8.0**	**0.5**

a) Occupation of the households

In 200 surveyed households has 136 households in agriculture, accounting for 68%; 4 households in livestock, accounting for 2%; 19 households in sales, accounting for 9.5%; 2 households in eating sales, accounting for 1%; 24 households in State officers, employees, accounting for 12%, 4 households are workers, accounting for 2%, 2 households are drivers, accounting for 1%; 3 households in transportation sector, accounting for 1.5%, 2 households are in other jobs, accounting for 1%. Thus, the heads of households in the project area are mainly in agriculture and small number of state employees and do some other jobs.

Table 3.74: Occupation of the heads of the households

Commune	**Agriculture**	**Livestock**	**Sales**	**Restaurant. food shop**	**Factory worker**	**State officials. employees**	**Work for private company**	**Driver**	**Work in transportation sectors**	**Other**
Hoi Xuan	6									
Mai Hich	20	1	2		1	1				
Phu Le	22	3	4	1	1	7	1			
Phu Son	16		2			5				
Phu Thanh	8		6		1	3				2
Phu Xuan	8					2				
Thanh Son	17		3							
Thanh Xuan	10					5				
Trung Son	29		2	1	1	1	3	2	3	
Total	**136**	**4**	**19**	**2**	**4**	**24**	**4**	**2**	**3**	**2**
Percent (%)	**68.0**	**2.0**	**9.5**	**1.0**	**2.0**	**12.0**	**2.0**	**1.0**	**1.5**	**1.0**

b) Income of the households

Average income of affected households is 25.55 million dong/person/year; in 200 surveyed households have 5 households in poverty, accounting for 2.5%.

c) The main assets of the households

The houses and land for production are the most important assets of households and the households in areas affected by the project also purchase motorcycles, television, refrigerator, and gas stove service for daily activities. There are 185 households with motorcycles, accounting for 92.5% of the surveyed households; 195 households have television, accounting for 97.5% of all households; 78 households have gas stoves, accounting for 39% of all households; 31 households have refrigerator, accounting for 15.5% of all households, In addition, two households have the trucks serve transporting raw materials for local people.

Table 3.75: Main assets of the households in the affected area

Commune	**Number of households have**			
	Motorcycle	Television	Gas stove	Refrigerator
Hoi Xuan	6	6	4	1
Mai Hich	21	24	8	3
Phu Le	39	38	16	8
Phu Son	23	22	8	2
Phu Thanh	19	20	11	
Phu Xuan	9	10	3	1
Thanh Son	13	19	2	2
Thanh Xuan	15	15	7	5
Trung Son	40	41	19	9
Total	**185**	**195**	**78**	**31**
Percent (%)	**92.5**	**97.5**	**39**	**15.5**

d) Access to social services

- All of the areas affected by the project have the primary school, so the children of local people are facilitated to school, in addition each pupil going to school is also supported rice by the Government.

- People’s health in the affected areas are been taken care, the medical officers of villages, hamlets will advise and support them when they are sick.

- All hamlets have the department stores, where people can buy items of daily necessities such as rice, clothing, personal hygiene items such as washcloths, toothpaste, shampoo, etc…

- At all Communal People’s Committees in the project area that have the branches of Bank for Social Policies, this is bank for the poor, the difficulties households, ethnic minorities, they are loaned the capital with the low interest rate for economic development, improving their life.

- In addition, in the affected communes that also have the cultural house where people can concentrate, be consulted on major issues related to the daily life and the traditional culture of their ethnicity.

Picture: Department store at En hamlet, Thanh Xuan commune, Quan Hoa district

Picture: Cultural house of Thanh Xuan commune

Picture: Branch of Bank for Social Policies at People's committee of Trung Thanh commune

3.4.7. The culture of the ethnic minorities and indigenous social organization

a) Thai people

Thai ethnic has the longstanding origin sticking with the homeland of Thanh Hoa; With 223,316 inhabitants at present. Thai people have the population of about 35.6% of total the ethnic minorities of Thanh Hoa province. Tay dam (Black Thai). Tay Do (White Thai) are two main branches of the Thai of Thanh Hoa province, people in the white Thai groups (Tay Do) mainly reside in Thuong Xuan district (48,142 people) and a few of the mountainous communes of Nhu Xuan Trieu Son districts. The majority of the Black Thai ethnic groups lives in the mountainous regions such as Quan Hoa and Ba Thuoc, Quan Son, Muong Lat, Lang Chanh.

- *Social Organization:*

In community relations. the Thai people organizes into hamlets. The hamlet is the social units with neighboring households including many families and the various families. The large families of Thai people are: Ha family, Pham family, Lang family, Lo family, Vi family, etc... Thai houses are usually built on flat ground or at mountain sides with low slope, beside streams and wet rice fields. This is the traditional form of hamlet establishment of Thai people.

• *Livelihoods of Thai:*

Since ancient times. Thai people have experienced on establishing the mountain villages, hamlets along the rivers and streams favorable for the agriculture development "Tay kim nam" or "o loc co noong xoong hun co ban" (kinds of traditional occupation) Meaning: The Thai lives along the water flow; a small puddle can be seen as a pond, two households as a hamlet. Associated with the experiences of establishing hamlet, which are the valuable experiences of the Thai people, such as: backfilling channel, making water-engine to take water into production farm, for the daily activities of people. This proves that they are the agricultural residents of wet rice cultivation for a long time. However, glutinous rice is the main staple in the daily meals of Thai ethnic people. Out of rice cultivation, and Thai people also grow corns, potatoes, cassava and vegetables, etc ... And forestry and handmade textile are also create important life source for the Thai people. Handicraft of the Thai people, Thai Women subtle, ornate in traditional brocade weaving works; Thai man delicate in bamboo and rattan basketry, carpentry. Particularly, dovetail dugout canoes carry goods white-water rafting, river, which reflect quite unique distinctions of Thai people – where are the upstream of rivers in general.

- *Rituals, legends, poetry:*

Like many other areas, the Thai people at Thanh Hoa province belongs to Tay-Thai language group. The traditions of ancestor worship: worshiping the heaven and earth, mountain village, hamlet and some rituals such as praying for rain, pray for season, phan tra festival, Muong Ca da, Muong Xia, etc ... Usually organized during the beginning of a new year. Because the conception of death is to live in the afterlife; so the burial custom of the Thai people is "the ceremony" farewell to the dead to "Muong Troi" (heaven).

Their writing has very early, so the Thai in Thanh Hoa province (in particular) has been stored the cultural treasures including many stories of myths, tales, legends, poems, which are plentiful such as: “Xong tru xon xao”; “Khun lu”; “Nang ua”; “Kham panh”, “Dua Phase love story”, ect... Especially in the spiritual life of Thai river wherever is also indispensable: “Hat khap”, “khua luong”, “nem con” the unique culture of the Thai in Thanh Hoa province up to now remains basically to be stored, promoted in many village areas, the uplands of Quan Hoa and Quan Son, Ba Que, etc…

- *Houses:*

Houses, costumes are the distinctions of Black Thai and White Thai group, General the same – spacious firmly house on stilts. Houses of the Black Thai people – the roof has turtle shape; the roof top is made with different styles. On the floor of the house is divided into 2 parts: a part for sleeping of family members; the other part is for guests and kitchen works.

Picture: House on silts of Thai people in the project area of Hoi Xuan HPP

- *Costumes:*

Thai costumes are very different from each relationship such as: daily clothing, clothing of labor, in daily life activities, festivals; and the distinction between branches of Black Thai and White Thai are women's clothes. Men swear are simple - short blouses with cut chest, crotch split pants. Thai White women usually wear light-colored short blouses, V-shaped collar, and the black dress is not decorated. Black Thai women wear daily clothing of “Ao Khom” (a traditional shirt) with the dark color and round neck, pullovers, buttoned towards the shoulders; while White Thai women button the silver button with butterfly shape, ticks, bees, etc... The bun method of Black Thai and White Thai is alike. A single woman is bun in nape; if she is married, the bun will be on the top of her head.

Traditional clothes of Thai people in traditional festival

3.4.8. Gender status

a) In Vietnam, the Law on Gender Equality was issued on November 29th, 2006 and entered into force on July 1st, 2007. The goals of gender equality law are eliminating gender discrimination, creating the equal opportunities for men and women in economic–social development and human resource development, proceeding to the actual gender equality between men and women; and establishing, strengthening the cooperative relations and support between men and women in all fields of social life and family.

Vietnam's policy on gender equality:

- Ensuring the gender equality in all fields of politics, economics, culture, society and family; supporting and creating the conditions for men and women that improve their ability, have the equal opportunities to participate in the development process and receive the benefits of development;

- Protect and support the mother during pregnancy, childbirth and raising small children; create the conditions for men and women share household chores;

- Applying the appropriate measures to eliminate the outdated customs and practices that hinder the implementation of gender equality objectives;

- Encouraging the agencies, organizations, families and individuals participate in activities to promote gender equality;

- Support for gender equality activities in remote areas and ethnic minority areas and the area have economic-social conditions especially difficulties; support the necessary conditions to improve the gender development index for sectors, branches and localities, where the development index is lower than the national average.

b) In Vietnam, level of the State has Vietnam Women's Union, level of province has Vietnam Women's Union of provinces. at the district level has Vietnam Women's Union of districts and level of communes has Vietnam Women's Union of communes. The missions of the Vietnam Women's Union are supporting the women to improve their ability and qualifications, to build a happy family; take care, improve the material, spiritual life of woman.

c) For women in the project area: In all communes of the project area have invested the communal medical stations to health care for people, including women. Also, in each commune that also has midwives; the mission of midwives is to support, advice and care of pregnant mothers. In 2013, at Quan Hoa district 1,174 pregnant women were examined, the examined women with 3 times/period reached 92.9%; in Mai Chau, 911 pregnant women were examined, the examined women with 3 times/period reached 82.25%.

In addition, the poor women are granted free medical insurance and loaned capital for production development with preferential interest rates.

3.5. The investments in the surrounding areas of the project

According to the survey results, the investments in the surrounding areas of Hoi Xuan HPP being invested and constructed currently include: the Trung Son HPP, Ba Thuoc I HPP, Ba Thuoc II HPP and Improvement Project of National Highway 15 running through Thanh Hoa province.

Table 3.76: Some main parameters of investments at the surrounding areas of the project

No.	Project name	Main parameters					Note
		Position	**Location**	**Full supply level (m)**	**Installed capacity (MW)**	**Length. grade of road (km)**	
1	**Project**						
	- Hoi Xuan hydropower project	On main flow of Ma river. downstream of Trung Son HPP	Damsite located on territory of Hoi Xuan commune. Thanh Hoa province	80	102		Under construction
2	**Investments in the surrounding areas**						
	- Ba Thuoc I hydropower	On main flow of Ma river,	Damsite located on	54	60		Under construction

No.	Project name	Main parameters					Note
		downstream of Hoi Xuan HPP	territory of Thiet Ke commune, Ba Thuoc district, Thanh Hoa province				
	- Ba Thuoc II hydropower	On main flow of Ma rive, downstream of Ba Thuoc I hydropower	Damsite located on territory of Dien Lu commune, Ba Thuoc district, Thanh Hoa province	41	80		Operating
	- Improvement Project of National Highway 15					the length is 23.5km, the mountainous road of grade III (from Phu Le commune to Hoi Xuan commune, Quan Hoa district, Thanh Hoa province	

Some main characteristics of these investment projects are as follows:

3.5.1. Trung Son Hydropower Project

Trung Son Hydropower Plant is far about 38.5km from Hoi Xuan Hydropower Plant in the upstream of Ma river.

Trung Son HPP will be constructed on Ma river in the upstream of Hoi Xuan, it belongs to Trung Son commune, Quan Hoa district, Thanh Hoa province. This project will provide low-cost power sources to continue supporting the economic development of Vietnam and improve the living standards through the development of hydropower resources, have the social responsibility and sustainable development on environment. The project will support EVN for developing one of the projects of medium-scale hydropower development in Vietnam. The purpose is to provide a case of "best practices" on sustainable hydropower development in this central part of Vietnam's electronic engineering.

Trung Son hydropower project with an installed capacity of 260MW and an average power output of 1,065 GWh is a multi-purpose project that provides the benefits both power generation and flood control. Hoi Xuan damsite is far about 40km from Laos boundary in the downstream and the reservoir tail is about 10km from the boundary. A roller compacted concrete dam will be built with a height of 88m and a crest length is 353m. Full supply water level is 160m, total reservoir capacity is about 348.50 million m^3 including flood prevention capacity of about 112 million m^3. The reservoir will cover an area of about 13.175km , flooding of mixed forest and agricultural land.

Construction items includes of the main dam and spillway, intake, penstock, powerhouse and tailrace channel. A distribution station at the damsite and a 220 kV transmission line for about 61km will transmit power from the plant and connection to the existing 220kV transmission line at Tan Lac district, Hoa Binh province. A 35kV transmission line of about 35km will transmit power from Mai Chau to provide the power to the construction site during construction progress. A 22km long road into damsite connects with a trail of local people at Co Luong and 13km of construction road in the construction site will be built. Four turbines and generators, control devices and other equipment will be installed as well as mechanical equipment including intakes.

Total project cost is estimated at 380 million dollars, of which approximately 2.25 million dollars will be spent for environmental management and 24.2 million dollars will be spent for resettlement and recovery of people's livelihoods. Vietnam Electricity Group (EVN) has formally proposed the World Bank for loan of 330 million dollars.

The project is expected to be completed in the second quarter of 2017.

3.5.2. Ba Thuoc I Hydropower Project

- Ba Thuoc I hydropower project is located on main flow of Ma river and in the downstream of Ma river, it belongs to the territory of Thiet Ke commune, Ba Thuoc district, Thanh Hoa province, about 25km from Hoi Xuan damsite. The designed capacity of the plant is 60 MW with 4 units, each unit of 15 MW, the full supply level is 54 m .Total investment cost is 1,441 billion VND.

- The project owner is Hoang Anh Joint Stock Company in Thanh Hoa.

- Construction time is 35 months, from October 2013 to the end of August 2016 that will generate electricity all 4 units.

3.5.3. Ba Thuoc II Hydropower Project

- Ba Thuoc II HPP is located on main flow of Ma river and in the downstream of Ba Thuoc I HPP, it belongs to the territory of Dien Lu commune, Ba Thuoc district, Thanh Hoa province, about 53 km from Hoi Xuan HPP in the downstream of Ma river.

The designed capacity of the plant is 80MW, full supply level is 41 m, with a total investment cost of 1,497 billion. The construction was put into operation all four units on May 24, 2013.

- The project owner is Hoang Anh Joint Stock Company in Thanh Hoa.

3.5.4. Improvement Project of National Highway 15 through Thanh Hoa province

The project has a total length of 23.5 km from Phu Le commune to Hoi Xuan commune, Quan Hoa district, Thanh Hoa Province, with total investment cost of 992 billion VND, according to size the mountainous road of grade III the width of road base is 9m, the width of road surface is 8m, the road surface is designed with two-layers of asphalt concrete synchronous with the drainage system, signage system of traffic safety.

National highway 15 which was expanded and modernized has very important significance in connection of the Northwest Provinceswith National Highway 217. Ho Chi Minh road, National Highway 6, etc... creating a complete traffic system and synchronization. This is the shortest road connecting the Northwest Provinces to seaport, creating the conditions of exchange on culture and economics between the locals in the region, promoting the integration of the western region of Thanh Hoa and the whole Northwest region.

3.6. Socioeconomic development plant of the project area

3.6.1. Socioeconomic development plan of Thanh Hoa Province, with the vision to 2020

3.6.1.1. Development orientation

Promote the highest potential and advantages of the province on basis of effective use of all resources for socio-economic development, accelerate economic growth, narrow gap with other provinces in region and nationwide. Construct Thanh Hoa province soon become one of an economic exchange center between North Vietnam and North Central region and one of an economic, social–culture center of the country.

Improve quality of economic growth with reasonable structure, construct highly competitive economy, efficient use of natural resources; develop quality industry, services and travel; develop agriculture towards production of goods.

Concentrate investment resources to build economic driving force and main products groups; give priorities in investment to quickly develop Nghi Son Economic Zone, creating breakthrough growth and economic restructure.

Gradually adjust to create harmonious and reasonable development between provinces in the region; develop strongly coastal and sea economic; enlist maximum support and investment of the State and economic sectors. Develop midland, the west and mountainous regions to soon get out of underdevelopment.

Combine economic development with gradual progress and social justice, Promote implementation of policies of socialization in fields of education, training, health, environment ...; ensure high quality human resources to meet requirements of rapid development; focus on hunger and poverty reduction, health care, social stability, and strengthening unity among ethnic groups in the province.

Consider development of science - technology as a key stage in improving quality of goods and services; promote economic growth, increased competitiveness of the economy.

Combine economic development with strengthening national defense and security; hold firmly borders and islands sovereign; maintain friendly relations with provinces and neighboring border areas of Vietnam – Laos, security and political order and social safety.

3.6.1.2. Development objectives

a) Overall objective

Rapid, sufficient and sustainable socioeconomic development: strive forward to make fundamental changes in growth quality and competitiveness of the economy, Strive to 2015, Thanh Hoa province reaches average level of the country and by 2020, Thanh Hoa become an industrial province with reasonable economic structure (socio-economic infrastructure is comprehensively developed and modernized to become one of the political, economic, cultural and scientific centers of the North Central region and the country, strengthening security and political stability, great national unity.

b) The specific objectives:

• Economic objectives

- Average growth rate during the period 2011 - 2015 reach 17-18% and over 19% during the period of 2016 – 2020. In 2015, the GDP per capita hits the national average and exceeds average level of the country after 2015;

- Restructure the economy towards industrialization and modernization; the economic structure in 2015: Agriculture – industry, construction – services are 15.5% - 47.6% - 36.8 %, respectively and in 2020 are 10.1% - 51.9% - 38%, respectively;

- In 2015, strive to hit export turnover of 800-850 million USD, in 2020 reaches over 2 billion USD, export growth rate reaches 19-20% per year;

- The State budget revenues account for about 6-7% of GDP in 2015 and over 7% in 2020.

Social objectives

- Limit speed of population growth, natural birth rate of population increase 0.65% in 2015 and about 0.5% in 2020;

- Increase the rate of trained labor to 45% in 2015 and 55-60% in 2020;

- Employ about 50,000 workers per year. Rate of urban unemployment below 3%, rate of employment in rural areas below 3.5% in 2020;

- Reduce poverty rate (current standard) each year to 3-5%;

- Improve healthcare network; strive to 85% of commune clinics have doctors before 2015; By 2015, there are 23 beds/10,000 people and 25 beds/10,000 people in 2020; reduces rate of malnourished children under 5 years old down to 18-20% in 2015 and less than 10% in 2020;

- By 2015 all provincial roads, district roads, roads to commune centers are asphalted or concrete, 100% of households can access to electricity and television.

- Objective of environmental protection

- Increase rate of forest coverage to 53-54% in 2015 and over 60% in 2020. Protect the environment of the groundwater, surface water, coastal and marine areas;

- In 2015 collect and treat waste in all urban areas, 100% of new production facilities construct concentrated waste treatment to ensure environmental standards or application of clean technologies; number of production facilities meet environmental standards in 2015 reaches over 80% and 90% in 2020;

- By 2015, all households in urban are supplied clean water and 90% of rural households used hygienic water and 100% in 2020.

- Defense and security objectives

Ensure national defense and security, maintaining sovereign borders, islands, political stability; inhibit increase, then proceed to gradually reduce crime and other social evils.

3.6.1.3. Development orientation for sectors

a) Industry

- Rapidly and steadily develop industry whose role as the foundation for the rapid growth and economic restructuring of the province. Comprehensively combine industrial development with infrastructure development, gradually form new industrial clusters and industrial zones; Quickly deploy projects located within Nghi Son Economic Zone and form some other dynamic economic zones to foster the economic growth;

- Maintain industry - construction growth rate at over 21.5% per year (in which the period 2011-2015 is expected to reach 21.4% and 21.6% during the period of 2016-2020);

- Reform the internal structure of the industry toward increasing, enhancing and improving the basic industries as well as processing industry. In 2020, Thanh Hoa fundamentally becomes an industrial province with a modern structure;

- Develop the following major industries:

+ Oil refinery industry: Complete construction of complex of Nghi Son oil refinery with a capacity in phase I of 10 million tones/year and come into operation before 2013, while investment in phase II with a capacity of 10 million tons per years; develop other industries such as polypropylene, synthetic fibers, plastics, synthetic fertilizers, synthetic detergents and other products;

+ The production of construction materials industry: speeding up the production line installation for the Nghi Son, Bim Son, and Cong Thanh cement plant; implement the project to construct Thanh Son cement plant with the capacity of 1.4 million tons per year and strive to reach 18-20 million tons in 2015;

Deploy new material manufacturing facilities for construction in Nghi Son Economic Zone and other industrial areas, such as: factories of asphalt concrete, ready mixed concrete, precast concrete and roofing production.

By 2020 commercial electricity output reaches over 20 billion KWh. Invest in construction of Nghi Son thermal power plant, forming large thermal power center of north Central region. Nghi Son thermal power plant will complete soon phase I with a capacity of 600 MW in operation; phase II of investment to increase capacity to 1,800 MW in 2015. Deploy several constructions: Trung Son hydropower (260 MW). Hoi Xuan hydropower (92 MW) and a number of other small and medium hydropower projects such as: Ba Thuoc 1 and 2; Cam Thuy 1 and 2; Lo River; Luong River ...

+ Mechanic and manufacturing industries

Speed up the construction of the POMIDO steel plant with a capacity of 650,000 tons per year. Nghi Son steel plant with capacity 750,000 tons per year. Attract more manufacturing project of sheet steel, shaped steel, high-grade steel in Nghi Son Economic Zone with a capacity of about 6 million tons per year; produce steel for the defense industry.

Develop industry of mechanical, manufacturing: assemble heavy equipment, transport means and equipment; manufacturing equipment for industry of building materials and agricultural products processing; electrical equipment, electronic components, information technology, automobile assembly, production of locomotives, wagons, equipment and rail accessories. ...

Complete phase I marine shipyard Nghi Son with a capacity of building 50,000 DWT vessels in 2010, phase II of investment in 2015 to building 50,000 DWT ship and repairing ships over 100,000 DWT.

+ Processing industry (agriculture, forestry and fisheries): Renovate, upgrade, promote maximum production capacity of existing facilities; while building new facilities of processing agricultural, forestry and fisheries associating with construction of concentrated material area. Expanding capacity of rubber processing plants in Xuan Thanh, Cam Thuy; upgrade vegetable processing plant in Thach Thanh, build new vegetable processing plants, in Bim Son and some conditional locations such as Hau Loc, Hoang Hoa; food processing factories in industrial parks of Thach Quang (Thach Thanh) and coastal plain districts;

Innovate technology and improve production capacity of aquatic product processing factories of Hoang Truong, Le Mon, Lach Bang, Hoi Lach, Lach Truong, construct concentrated processing plants for animal feed in districts of Nong Cong, Trieu Son, Thieu Hoa, Ngoc Lac. ...

Construct Chau Loc paper mills with the capacity of 60 thousand tons of paper, 5 thousand tons of pulp per year; invest in processing wood panels for export with the capacity of 5,000 tons per year.

+ Continue to develop other industries: mining, consumer goods manufacturing, textiles, packaging, footwear, tourism, and sports. Gradually developed a number of high-tech industries. Restore and develop traditional craft villages such as sedge, embroidery, silk, brocade, bamboo and rattan, fine arts, jewelry stone.

- Develop industrial clusters and zones:

Continue to invest and expand and develop existing industrial parks; form a number of other industrial parks in city of Thanh Hoa and Bim Son town and districts of Ngoc Lac, Hau Loc, Quang Xuong, Hoang Hoa, Nhu Xuan, and Thach Thanh. By 2015 construct uniform and gradually modernize infrastructure of industrial zones having been established, promoting investment to improve to meet industrial parks in the area.

- Develop industrial clusters, small and medium sized traditional villages in districts and towns in the province. Strive to 2020 all communes and about 50% of communes in mountainous villages have industrial clusters.

b) Services

Rapidly develop and diversify of the types of services to offer more jobs and contribute significantly to the economic growth.

Average growth rate of service in the period of 2011 - 2020 reaches 18.5% per year; increase proportion of services in GDP to 36.8% in 2015 and over 38% in 2020. Export value of goods and services to reach 800-850 million USD in 2015 and over 2 billion USD in 2020.

Development orientation for major services:

- Trading: Develop synchronous trading system that make Thanh Hoa become one of the point of convergence of goods transport North - South and circulation of goods between northwest and northern provinces of Laos through Nghi Son port and mountainous areas in the country;

Invest in building a modern commercial center in city of Thanh Hoa, Nghi Son Economic Zone in association with free tax zones; construct Na Meo border gate economic zone to trade goods between Thanh Hoa province and Laos, especially northern Lao province and surrounding regions, construct a commercial center in Bim Son and Ngoc Lac and some other towns.

- Tourism: quickly and sustainably develop tourism to become an important economic sector that significantly contributes to the economy. The main focus is to develop a number of major tourist destinations and attractions, create diversified tourism products with high quality. Gradually make Thanh Hoa to become one of the major tourist centers of the country as well as a major tourist destination in the national tourism system. Striving to attract about 3 million visitors/year in 2015 (international visitors accounted at 30%) and 5 million passengers/year in 2020 (international visitors accounted at 40%);

Focus on building comprehensive tourism infrastructure for Sam Son that make it to become a major tourism city, Ham Rong resort, Ho stronghold, Cam Luong Fish Stream, Lam Kinh, Nga Son, Hai Hoa, Hai Tien, to build Cua Dat Lake eco-tourism, the Nghi Son ecotourism and some other tourist areas after 2010.

- Transportation: developing diverse types of transport, combine transport development of railway and waterway to exploit strengths of Nghi Son deep-water port and river port system to expand maritime transport and inland waterway transport. Develop passenger transportation, combine with tourism development; forms of transportation to tourist areas; focus on developing passenger transport in city of Thanh Hoa, towns and business centers the province.

- Finance and banking: encourage domestic and foreign banks, especially large financial regional and international institutions to open branches or representative offices in the province; gradually establish financial market to meet increasing demand for capital of economic sectors;

- Promote the development of telecommunications and information technologies that positively contribute to socioeconomic development, ensuring national defense and security;

- Rapidly develop other types of services such as training services, consulting services, technology transferring.

c) Agriculture, forestry and fisheries

- Develop the agriculture in a comprehensive manner, towards forming high-tech and clean agriculture that facilitate export, quickly increase income per unit area. Simultaneously, gradually improve the infrastructure to foster the agricultural development; actively effectively respond to natural disasters;

- Growth rate of agriculture, forestry and fishery products is projected to reach 5%/year during the period of 2011-2015 and 5.1% in the period of 2016-2020; the proportion of agriculture, forestry and fisheries in GDP is expected to be reduced from 31.6% in 2005 to 15.5% in 2015 and 10.1% in 2020;

- Develop a stable area of food crops by 2020 from 270,000-280,000ha; area of paddy is around 220,000-230,000 ha, about 50-60,000 ha of maize; food production in 2020 is 1.7 million tones, ensuring food security and big commodity food. Increase area of trees of high economic value from about 30% of total cultivated area in 2010 to over 50% in 2020;

- Development of other crops: Rubber plants in 2015 reaches 25,000 ha; stabilize sugar cane area in 2020 about 26,000 to 28,000 ha; peanut tree 22,000-23,000 ha in 2020; stable vegetation area from 3,000 – 3,500 ha associating with processing industry.

- Stably and strongly develop the livestock, both in scale and quality of cattle and poultry that raise the proportion of animal husbandry in agricultural production value up to 45% in 2015 and 50% in 2020;

- Develop towards forest protection, develop and rational exploit forest resources to ensure protection features, environmental protection and raising contribution to the economy; strives to 2020 raising forest coverage rate to 53% - 54% in 2015 and over 60% in 2020. Construct of forest as flow of materials, paper materials, wood ... associating with the processing industry;

- Comprehensively develop fisheries (both fishing and aquaculture) to improve the production efficiency and protect the environment, creating a stable source of raw materials for export and processing industry. Step up the development of aquaculture using freshwater, brackish water, and salt water. By 2015, aquaculture area is projected to reach 19,000-20,000 ha and over 30,000 ha in 2020. On the basic of the harmonious combination between investment to increase capacity offshore fishing and rational exploit of near-shore areas.

- Expand the types of services for agriculture, forestry and fisheries.

d) Social sector

Develop education and training towards standardization and improve quality of teachers and education managers, building a learning society; promote socialization of education and training to mobilize all sources in development of education - training. By 2015, 100% teachers meet national standard. Enhance facilities for teaching and learning, complete solidify of schools and classrooms in the province before 2015; Maintain and strengthen achievements of lower secondary school and implementing universal of lower secondary school, striving to complete lower secondary school universal by 2020.

- Diversify of types of vocational training; pay attention to vocational training for rural workers; improve rate of trained workers to 45% in 2015 and 60% in 2020. Continue construction of University of Hong Duc to become quality training center. Construct plans for development and expansion of facilities of training of human resources, in accordance with the plan of the country.

• Health Care

Develop community medical and health care system in direction of developing preventive medicine stations, ensuring all citizens are examined, and initial treatment and provide basic health services.

Promote socialization, improve investment facilities, equipment and medical staff from the provincial to grassroots level to improve the quality of medical treatment and activities of population - family planning; in 2015 to 85% of commune health stations have doctors and meet national standards on health, rate of hospital beds reaches 23 beds / 10,000 people and 25 beds / 10,000 people in 2020. Complete upgrade and modernization of provincial hospital, increase equipment and expand a number of health specialist; complete construction children's hospital, hospital of Ngoc Lac and some district hospitals. Strengthen specialty hospitals to meet level 2 or higher.

Implement effective national programs on health care, Rate of malnutrition children under 5 to below 20% in 2015 and less than 10% in 2020; mortality rate of infants under 1 year to less than 15‰ in 2020 reduce annual birth rate 0.5‰ to reduce rate of natural population growth to 0.5% in 2020.

• Science and Technology

Promote the research, development and application of technology that is modern, environmentally friendly and suitable for the economic development. Focus on building a science and technology center in the province to encourage and create favorable conditions for companies to invest in research, development and application of science - technology.

• Broadcasting - Television

The network of digital television is planning to be quickly and broadly developed; infrastructure to receive technical information from Vinasat-1 is being built that help to extend the coverage to remote areas and increase the number of radio programs in ethnic languages. By 2010, ratio of radio coverage reached 100% and TV coverage ratio reached 100% by 2015.

• Culture - sports

Improve quality of cultural activities, information and entertainment facilities, meeting needs of cultural spirit of people. Continue to invest in conservation and creation, promoting value of historical, cultural relics. Complete Lam Kinh project, building heritage of Ho dynasty citadel, Ba Trieu monument ... upgrade and restore historic cultural relics. Strive to 2020 reaches 100% of villages having places for cultural and entertainment, spots activities, radio systems, law bookcases.

Develop movement exercise, sports facilities and promote sport socialization. Invest in construction of sports training center; develop high achievement sport, strive to bring Thanh Hoa province into group of 10 the country's leading in exercise and sport.

• Labor, employment and poverty reduction

Improve and enhance people's lives; strive to reduce the poverty rate to 3-5% each year. The main goal is to properly implement social security policies in the area, 4-5 thousand jobs will be create every year; promote labor exports and reduce the unemployment rate in urban and rural areas; focus on human resources training and development to meet the requirements of socioeconomic development.

e) Infrastructure development

• Transportation

- Road:

Develop synchronous transport system to ensure uninterrupted, link between the locality and province; connect major economic centers of the country; focuses on opening roads connect to the Northwest, Laos, Thailand, Myanmar; Building modern transport system in key areas: Nghi Son General Economic Zone, Thanh Hoa city, town of Bim Son, Sam Son. ... build new roads having an important role in economic development, security and defense, especially roads connecting with main axis as:

- National Highway 1A: Upgrade national highway 1A to delta road level III. Construct intersections between railway and a large traffic road, moving homes of household living in industrial zones.

- Ho Chi Minh road: implement second phase. Invest in building horizontal roads connecting Ho Chi Minh road with National Highway 1A (Thach Quang - Bim Son) standard level III.
- North - South Highway through Thanh Hoa province 100 km long.
- Nghi Son - Bai Tranh (length 53 km) linking port of Nghi Son with Ho Chi Minh road.
- Yen Cat - Ben Sung - Chuong – Tan Dan.

Other highway: upgrade highway 47 to level III, highway 10, 45, 15A, 217 to level IV. Expand highway 10 from But Son connect to national highway 1A (But Son – Do Dai - Moi – Nui Chet), extend highway 45 to Nghe An connect with highway 48 (Yen Cat - Thanh Quan). Highway 47 through Kheo gate into Laos (along provincial road Xuan Thuong – Bat Mot) before 2010. Proceed to upgrade entire highway in the province to reach level III, several importance roads meets grade II. Extend highway 217 to highway 10; construct highway 217 become trans-Asia road.

Provincial road system: in a period of 2011 - 2020 continues to upgrade provincial road system to meet plain standard level III, level IV and mountainous level III, IV, V, Construct traffic intersects with others in large traffic. Upgrade important highways.

The system consists of horizontal lines: Van Mai - Muong Lat 70 km long, Lang Chanh - Yen Khuong - 44 km long, Hoi Xuan – Tan Moi - Muong Chanh length 139 km;

Urban roads (some main projects)

City of Thanh Hoa: Build highway 1A to avoid city of Thanh Hoa; expand Le Loi boulevard; ring road in western of the city; highway 47 in Thanh Hoa City in 2010. Conduct renovation and new construction of Lai Thanh bridge, Cao bridge, Duong bridge...

Other urban areas: construct system of urban roads in towns of Sam Son, Bim Son, and new urban Nghi Son - Ngoc Lac. By 2020, all big towns in the province complete modern transportation network.

Coastal roads: building coastal roads (length about 100 km from Dien Ho, Nga Son to Nghi Son, Tinh Gia district).

Rural transport systems: By 2010, 100% of communes have roads to commune centers. By 2020 fundamentally stabilize transportation infrastructure and create conditions for social economic development.

Complete building a number of brides on major rivers before 2015 such as bridges of Tham (Nga Son district), Chuc Son (Hoang Hoa district), Khanh Chung, Khanh Hoang (Hoang Hoa), Van Cam (Cam Thuy), Nam Tien bridge (Quan Hoa), Kim Tan (Thach Thanh) and suspension bridge system in mountainous districts.

- Waterway:

Complete construction of Nghi Son port group with the capacity to receive ships up to 30,000 tons, preparing conditions for expanding the port with capacity to 50 million tons per year before 2015. Research deep-water transshipment port in island of Me. Expand ports and construct a specialized service complex of oil refinery, thermal power plants, steel and cement plants.

+ Upgrade and expand river ports: Le Mon port, Len port (1.6 - 2.5 million tons/year). Lach Hoi port, Ham Rong tourism port, Develop port of Quang Chau after 2010 with scale of 5 wharves for ships with 1,000 DWT and capacity of 1.5 million tons per year.

Develop waterway traffic going to the northeastern provinces (Quang Ninh, Hai Phong, Thai Binh ...).

- Railway:

Develop railway network in the province to connect most of economic zones especially in Nghi Son Economic Zone. After 2010, upgrade existing rail systems and build North – South high speed railway. Invest in building a bridge over railway and some important provincial roads.

- By Air:

Strive to implement construction of civil airport in Quang Thuong commune - Quang Xuong district before 2020.

Aquaculture - irrigation infrastructure

- Focus on investment in irrigation, upgrading irrigation systems of Hoang Khanh, Dai Xa. Complete water supply system for Nghi Son Economic Zone, pumping stations. Invest in complete sea dyke system (including estuaries issue) before 2012.

- Develop fishery project combining with farm of freshwater aquaculture.

- Development of power supply

- Invest newly and upgrade to gradually modernize entire system of transmission and distribution to ensure stable power supply with high quality and meet requirements of socioeconomic development in the province.

- Focus on construction of small hydropower plants and supply electricity to high, deep and remote areas. Ensure 100% of the population in the province can access to electricity before 2015 with a total consumed capacity up to 5-6 billion KWh.

Water Supply

Construct water supply systems for cities, towns, economic zones and industrial parks; upgrade, expand and build new water supply systems for towns, concentrated residential areas. Give priority to build water plant for Thanh Hoa City, Bim Son Town, Sam Son, Nghi Son Economic Zone and district centers, ensuring clean and qualified water supply in big urban areas with an average rate of 180-200 liters / person /day in 2020.

By 2015, construct drainage system and collection system of waste water for Thanh Hoa City and other towns, townships, industrial parks, economic zones. For concentrated industrial zones, focus on building systems and wastewater treatment station for each area, ensuring all wastewater shall be treated before discharging into environment.

- Post and telecommunications

Develop wide -postal network to every region in the province. Focus on developing telecommunications infrastructure with modern technology, coverage across geographical areas with large capacity, high speed and high quality, good service. Meet communications requirements of the Party committee, government, business and people, contributing positively to social economic development, national security and defense, flood and storm prevention, mitigation of natural disasters.

3.6.2. Socioeconomic development master plan of Hoa Binh Province in 2020

3.6.2.1. Viewpoints of the development

Socio-economic development of Hoa Binh province is put in the overall context of the development of the midlands and mountainous areas of the North Vietnam, the capital – Hanoi, in the context that the country is integrating to the international economy.

Mobilize the highest internal resources, combined with the advantage of external resources for development with rapid growth rate, improve the quality of growth, promote economic restructuring towards reducing the proportion agriculture, increase the share of industry and services in both GDP and labor structure.

Mount economic development with social development, poverty alleviation, job creation and improving the quality of human resources, narrow the gap in term of social development among regions, raising living standards of people.

Economic development must incorporate with reasonable exploitation of natural resources and environment protection, ensuring sustainable development and landscape environment protection for tourism development.

Mount economic development with development of urban areas and modernization of urban infrastructure system.

Combine economic development with national defense – security, political stability and political security and social order and safety.

3.6.2.2. Objectives for Development

a) Overall objective

Striving for rapid and stable develop economy that helps this province to reach an average level of the whole country. Gradually modernize socio-economy infrastructure. Urban systems are relatively developed. Living standards of people is improved. Environment is maintained. Cultural characters of ethnic groups are preserved and promoted. National defense and security is guaranteed.

b) Specific objectives:

- Economic objectives:

- Average growth rate of GDP during the period 2014 - 2015 reach 13%/year and over 12% during the period of 2016 – 2020.

Take into account added value of the Hoa Binh hydropower plant, the GDP growth rate is expected at 8.9%/year in the period 2013 - 2015 and reach 9.6%/year in the period 2016-2020;

- Economic structure in 2015: Agriculture, forestry and fisheries: 23.6%; industry - construction: 39.7%; Services: 36.7%. The economic structure in 2020: Agriculture, forestry and fisheries: 16.4%; Industry - construction: 45%; Services. 38.6%;

Taking the Hoa Binh hydropower plant into consideration, the economic structure in 2015: Agriculture, forestry and fisheries: 19.5%; Industry - construction: 50%; Services: 30.5%. The economic structure in 2020: Agriculture, forestry and fisheries: 15.8%; Industry - construction: 46.8%; Services: 37.4%;

- Income per capita is expected to reach 28-29 million VND/year in 2015, approximately 60-61 million VND/year in 2020 (take into account contribution of hydropower plants, income per capita is expected at about 34-35 million VND/year in 2015 and approximately 63-64 million VND/year in 2020);

- In 2015, strive to hit export turnover of 100 million USD, and reach 230 million USD in 2020.

- Total state revenues in 2015 reach 2,200 billion VND and reaches 4,000 billion VND in 2020;

- Food production output in 2015 is expected to reach 36,000 tons, 37,000 – 37,500 tons in 2020.

- Social objectives

- Reduce the natural population growth rate about 0.88% in 2015 and 0.84% in 2020. The population size is expected at 832,360 people in 2015 and 870,500 people in 2020.

- Employ about 15,000 – 20,000 workers per year in the period of 2013 – 2015 and 22,000 in the period 2016 – 2020.

- Strive to increase the rate of trained labor to 45% in 2015 and 55-60% in 2020;

- Reduce poverty rate to below 12% in 2015 and below 4% in 2020 (new standard on poverty).

- The number of households can access to electricity from the national grid reaches 97% in 2015 and 99% in 2020, respectively;

- The number of doctors per 10,000 people reaches 7.57 in 2015 and 8.5 in 2020. Strive to achieve 100% of communal clinics have doctors before 2015

- Environmental objectives

- Maintain forest coverage at 46%;

- The proportion of production facility equipped with proper, qualified waste disposal system is expected to reach 80-85% in 2015 and 100% in 2020.

- 100% city, town has garbage collection system. In 2015, 95% solid waste and about 77% of hazardous waste is collected and processed; and by 2020, 100% of the waste is collected and processed;

- 90% of rural households are provided clean water in 2015 and 100% population is provided clean water in 2020.

- National defense - security:

- Mounting socio-economic development with enhancing defense security, political stability and social order in the new period;

- Continue to build and strengthen the national defense posture and people's security, establish a solid defensive area to meet the requirements of the new situation.

3.6.2.3. Development objectives of economic sectors

a) Agriculture, forestry, fishery

Develop agriculture towards building a sustainably and highly intensive agriculture; improve the quality, value and competitiveness of agricultural commodities. The main goal is to achieve high-tech agriculture after 2015. The growth rate of agriculture, forestry and fisheries in the period 2013 - 2015 is expected at about 4.2% per year and about 3.8% per year in the period 2016 - 2020.

Strengthen of science and technique application to manufacture, research to create a new variety by cross-breeding, convert some cultivation area with low effect, unstable one-crop paddy area to plants with higher economic value which have a wide consumption market in order to increase income for farmers. Expand sugarcane area and grow newly tea, specially *Camellia Sinensis O.Ktze*. Invest in new breeding for peanuts, soybeans, Develop decorative plants, types of flower and aromatic plants serving urban and industrial areas.

Gradually limit small scale, dispersed animal husbandry, develop livestock towards industrial, semi-industrial model and disease-free. Focus on improving and enhancing the quality of breeding herd, apply advanced production process to increase productivity, quality and efficiency. Extend the small and medium farming models.

Properly conduct sustainable forestry protection and development program. Attract and facilitate investors on plantation of material forest and ecological forest.

Comprehensively develop fisheries, enlist the highest potential of the water surface area and apply modern technologies to increase productivity, quality and effectiveness.

b) Industry, construction

Mobilize all the possible resources, advantages to accelerate the industrial growth rate with high effective, develop industry towards modernization, while protect the environment. Prior to develop high-tech industry having competitive advantages that need large number of labor.

Develop industry to create breakthrough regarding growth and restructuring of the provincial economy by increasing the proportion of industry and services. Ensure sustainable development and increase state revenues. Strive for increasing growth rate of industry and construction to reach 18% per year in the period 2013 - 2015 and about 15% per year in the period 2016-2020.

Mobilize all resources to develop key industries having advantages (construction materials production industry, agricultural - forestry - fisheries processing industry), the industry has the advantage of labor, market (adjacent to the capital, Hanoi), including: electronics, apparel, automotive components assembly, motorcycle, beverage ... and high-tech industry. In addition, develop the pharmaceutical industry, small scale hydropower (ensure environmental requirements), handicraft, etc.

Quickly invest, improve infrastructure for the industrial areas/zones. Build appropriate mechanism, incentive policies to attract investment in production and in the industrial parks that create favorable conditions and environment for investors to approach and invest to the area.

Prepare trained labor to facilitate industrial development, attract highly skilled workers – individual to work in the province.

c) Services

Develop service sector in order to meet the needs of socio-economic development, become a lever for the development of other sectors.

Gradually raise the proportion of services in GDP, ensure the harmonious development of the manufacturing sector and the service sector, and positively contribute to the economic restructuring.

Develop the service sector of Hoa Binh province in the correspondence to the potential and maximize the strengths of the sub-regions within the province. Identify the types of services and commodities that the province has competitive advantages to invest and develop.

Strive to achieve growth rate of services at 14.5% per year in the period 2011 - 2015 and about 12.2% per year in the period 2016-2020.

Complete infrastructure system and engineering facilities to facilitate the commercial development in province, combine commercial development in urban areas to rural market development, creating favorable conditions for development of supermarkets and commercial centers in the Hoa Binh city, district centers, and towns ... and have plan to upgrade the rural market system.

Set up trade - services clusters with favorable conditions that can connect to the concentrated agricultural production areas or industrial clusters. There are mechanisms and policies to develop export and import, create conditions for exporting enterprises to expand their markets.

Promote and develop the tourism industry of the province to become an important economic sector. Prioritize the development of cultural tourism, eco-tourism to promote the potential advantages of the province. Mount tourism development to preserving, conserving and promoting the nation's cultural identity.

Create favorable conditions for the development of transport services, financial – banking, healthcare, education, and services for industrial complexes, urban areas.

d) Social sectors

• Education

- Develop education in accordance to the task of the socio-economic development. Increase the number of trained workers and improving the quality of human resources to meet the requirements of the socio-economic development in the next stage;

- Consolidate and maintain the results of primary education at the right age, towards universal secondary education;

- Maintain and strengthen achievements of universal primary education and implement universal of lower secondary school.

- Continue to build schools that meet national standards. By 2020, over 70% of kindergartens, 100%, primary schools, 70% secondary school, 75% high school meet national standards;

- Focus on investing, upgrading facilities and equipment for schools, secondary schools, colleges and vocational training centers, to encourage all economic sectors to invest on education and vocational training;

- Improve the quality and qualifications of teaching staff, connect with universities and research institutes in training and scientific research. Promulgate policies to attract high skilled scientists and technicians to work in the province.

• Health Care

- Gradually modernize and comprehensively develop the health care systems of Hoa Binh province, from provincial to grassroots level. Provide good services for people in the province and neighboring provinces;

- Keep investing to improve facilities, medical equipment for hospitals; and to build more specialty hospitals. Encourage socialization on health care, develop non-public medical facilities. Enhance and improve the skill of nurses and doctors, have satisfactory support and allowance for medical staff, especially in remote areas that are difficult to attract doctors. Effectively conduct national programs on health care.

- Culture - sports

Conserve and develop traditional ethnic culture. Integrate cultural development with every political - economic - social activity, and people’s life, Increase the ability to access information for ethnic minorities. Perform the movement "unite to build cultural life". Strive to maintain 80% of families, 75% of villages and residential areas reaching cultural standards in 2015.

In 2015, 28% of the population practice sport regularly, 18% of households are qualified sporting family, and that of in 2020 is 35% and 25% respectively;

Prioritize to invest on cultural institutions to serve the community, such as: museums, libraries, cinemas, art monuments, recreation parks. Implement prioritizing policy for building cultural life in disadvantaged and remote areas. Invest in research, and collect cultural elite of 5 ethnic minorities: Muong, Thai, Tay, Dao, H'Mong.

Keep investment on facilities for physical activities, sports to hold regional, national and international professional tournaments. Mobilize resources for the socialization of physical activity, sports; develop sporting infrastructures at district and communal level, strive to achieve 100% of districts and cities having stadium.

• Science - Technology:

- Develop science - technology to motivate the industrialization and modernization. Promote the application of scientific - technologies advances to improve productivity, quality and competitiveness of products;

- Socialize research and application of science and technology, implement policies to attract and encourage the non-state sector to participate on science and technology development;

- Implement mechanisms and policies to attract talented people to take part in scientific research, advanced training for qualified staff in the scientific research units in the province;

- Promote the application of advanced scientific and technological progress, in every industry and sector. Invest on informational technology infrastructure; gradually integrate information technology into the management and administration.

• Poverty reduction:

Exploit the potential. maximum mobilize resources for socio-economic development; manage, and effectively capital on building infrastructure, production support, stabilize the living of people, especially poor communes in the province; successfully implement supportive policies and incentives on health care, education, social security for the poor households.

e) Infrastructure

Improve and modernize infrastructure to serve socio-economic development. Focus on investment and development of the region, city, town, dynamic areas, and other areas according to the program from the State government.

Upgrade Highway 6 to grade-III road, section of Xuan Mai - Hoa Binh to grade II road as planned (4 lanes); construct Hoa Lac – Hoa Binh highway with 4-6 lane, highways and some provincial roads to III - IV grade road. Some new roads, new bridges are being built that meet traffic demand on the locality.

Invest on upgrading the power grid, ensure uninterrupted power supply for manufacturing and living of people. Focus on develop power supply network for industrial complexes, urban areas, tourist areas ... rehabilitation and upgrading of rural power supply system.

Universalize access to basic telecommunications services, prioritize rapid development of new services, value-added services. Deploy the application of information technology in 100% of the state management agencies, 100% of communes, wards and towns have broadband internet access point.

Upgrade and construct of irrigation works. Ensure a stable water source for 92% of crop area, well perform floods and flooding prevention. By 2020, basically 100% of the population can access to clean water sources.

Construct and upgrade rainwater and wastewater drainage systems in Hoa Binh, Luong Son City and other urban areas in the province. Industrial, hospital waste water is treated on site before releasing to the general system. Gradually separate rain water and waste water collecting system and construct domestic waste water station in urban area, pay attention to develop drainage system and wastewater treatment for rural areas, especially traditional handicraft villages, densely populated areas, etc.

Exploit and rational use water, mineral resources. Develop and implement programs and specific measures to limit the negative impacts caused by flash floods, erosion, cracks, landslides, especially plan to move people out of the areas with high risle of landslides. Strengthen the capacity of environmental management systems at all levels. The investment project must strictly implement the provisions of environmental impact assessment, environmental commitment. Promote the inspection and certification of works, environmental protection measures before the project fully goes into operation operated in accordance with the provisions of law.

f) Combine socio-economic development with defense - security

Ensure national security – defense, maintain political stability, social order and safety. Keep strengthening and improving facilities and infrastructure for safety area (Construction 229). Properly execute local military tasks, promote movement to protect national security in the new situation. Perform the movement for prevention of crime, traffic accidents prevention.

3.6.3. Master plan for socio-economic development of Quan Hoa district in 2020

3.6.3.1. Development viewpoints

The development viewpoints of the Mater Plan include:

Promote the potential advantages of the district, effective using of resources for socio-economic development; increasing the quality of products and the competitiveness of the economy.

Develop the agriculture in orientation of making safety and sustainable products on the basis of the strong development at specialized farming areas and the development of household and farming economy.

Implement educational and training socialization, health, environment, etc.; develop and improve the quality of human resources, solve jobs, effective implement poverty alleviation, gradually raise the residential living, community health, social stability.

3.6.3.2. Development targets

a) Economy

- Annual economic growth rate in GDP in the period 2011 to 2020 is expected to increase 19.0%. Particularly, agri-forestry-fishery products will increase 6.8% while this figure of industry – construction and services will be 32.4% 23.2% respectively.

+ 2011-2015 period: Economic growth in GDP (compared with prices in 1994) has an annual average of 21.0%, with 6.6% of agriculture, forestry and fisheries. 29.2% of industry – construction, 25.6% of services.

+ 2016-2020 period: Economic growth in GDP (compared with prices in 1994) has an average annual of 21.0%, with 7.0% of agriculture, forestry and fisheries, 29.2 % of industry – construction.

- Economic structure	2015	2020
Agri-forestry-fishery	41%	22%
Industry – construction	36%	51%
Services	23%	27%

- Total value of goods and services for export in 2015 will be 3.0 million USD, and rise to 10.0 million USD in 2020. Average annual increase in the period 2011 - 2020 is 25%.

- The budget of province will reach 55.0 billion VND by 2015 and 80.0 billion VND by 2020. The annual average increase rate is 7-8%.

- Total food production will be 16.6 thousand tons in 2015, 19.4 thousand tons in 2020. Amount of food per capita will be 354kg/person/year in 2015 and 399kg/person/year in 2020.

b) Society

- The poverty rate will be 20.0% in 2015, and drop to 8% in 2020.

- The rate of malnutrition children below 5 years old will decline to 18% in 2015 and 10% in 2020.

- By 2020, 100% of communes and towns are expected to meet national standards for health care, 85% health stations having adequate staffs structure with intermediate education level or above, 100% of commune's health stations having doctors; 100% of villages having nursing staff.

- The percentage of firm classrooms will reach 100% in 2020.

- Developing schools with national standards at primary school will reach 45% in 2015 and 80% in 2020 while this at secondary school will rise to 40% in 2015 and 70% by 2020.

- The percentage of trained workers will be 40% by 2015 and 50% in 2020.

- By 2020, 100% villages will be covered by broadcast wave.

c) Environment

- The rate of forest coverage will increase to 80% in 2015 and 85% in 2020.

- Better controlling industrial waste, medical and domestic waste.

- 100% of new-constructed manufacturing facilities must be applied clean technology or equipped with devices reducing environmental pollution. By 2020, 90% of business and manufacturing facilities are expected to meet environmental standards.

- Rate of households using clean water will reach 90% by 2015 and 100% by 2020.

c) National Defense and Security

The entire civil power is mobilized to fulfill the tasks of national defense – security, ensure political stability, sovereignty of border, and minimize the social ills.

3.6.3.3. Development planning in economic sectors

a) Agriculture - Forestry - Fisheries

- Agriculture and forestry is oriented to develop with qualified commodity production efficient productivity. The focused commodity production areas (the paper material, the soybean, beef cargo area, etc.) are projected to form. The development of rural industries will be promoted to generate income outside agriculture for rural residents.

- Production value of Agriculture - Forestry - Fisheries is forecasted to be 250.8 billion in 2015, with 7.8% as an average growth rate of the period 2011-2015; total grain output in 2015 will reach to 16.6 thousand tons. By 2020, total output value will reach 356.6 billion and an average growth rate of the period 2016-2020 will be 7.3%.

- Agriculture:

Technological advances are oriented to put into the production to increase productivity, crop yields, and improve product quality. Some other plans are to promote the development of animal husbandry, increase livestock density within this sector, focus on the development of intensive farming areas, crop areas of raw materials for the processing industry; put priority for favorable areas of food cultivation conditions, and reach to the target of balance food for people in the district. Agricultural production value (price comparison 94) is expected to get 107.8 billion VND in 2015, with average rate of annual increase in 2011-2015 of 5.9%; 142.6 billion VND in 2020, with average annual increase rate in the period 2016 to 2020 of 5.76%. The proportion of agriculture in this sector will account for 43.0% in 2015 and 40% in 2020.

- Cultivation:

+ Rice: in 2015, planted area will reach 2,470 hectares a year (720 hectares of winter-spring crop).average productivity of 40 quintals/ha, 9.88 tons of rice a year. In 2020, planted area will be 2,540 hectares (740 hectares of winter-spring crop), average productivity of 45 quintals/ha, yields of 11.43 tones.

+ Maize: Stabilizing the cultivated area at 1,600 ha; average productivity will be 45 quintals/ha with yield of 6,750 tons in 2015 while average productivity will be 50 quintals/ha with yield of 8,000 tons in 2020.

+ Cassava: Stabilizing the cultivated area at 2,000 ha until 2015 with the yield of 30 thousand tons of production and 36 thousand tons in 2020.

+ Peanut: the cultivated area will be 15ha in 2015 with the productivity of 12 quintals/ha, and yield of 18 tons; these figure will be 20 ha, 15 quintals/ha, and 30 tons, respectively in 2020.

+ Soybean is focused to farm in communes along Ma river. The cultivated area, productivity and yield will be 450 ha, 20 quintals ha, 900 tons, respectively in 2015, and 600 ha, 22 quintals/ha, 1,320 tons in 2020.

+ Medicinal trees: 15 ha in 2015 and 20ha in 2020; focusing the development of rare medicinal herbs such as *Fisch ex Hoffan, Artemisia annua*, etc.

- Livestock:

+ Strongly develop in scale livestock and poultry quality in orientation of commodity production, raise livestock density in agricultural production value up 40% in 2015 and 45% in 2020.

+ By 2015, livestock will reach 45,000 number of buffalo, cows with 30,000 cows; 250 thousand poultry; total meat output will reach 2,647.7 tons. By 2020, livestock will 60,000 buffaloes and cows with 40,000 cows, 45,000 pigs, 300 thousand poultry, 20,000 goats; total output of meat will reached 3,233.9 tons.

- Forestry:

+ Forestry Development towards ensuring watershed protection functions, environmental protection, reasonably serving for industrial processing, minimizing the impact of hydropower development for the area of forest land. By 2015, the district will have 43,984.66 ha of production forests, 16,943.58 ha protection forests and 23,253.99 ha special used forest; these figures in 2020 will respectively be 44,120 ha. 17,423 and 23,153; increasing the forest cover to 80% in 2015 and 85% in 2020.

+ In 2015, output value will reach 137.96 billion VND, accounting for 55%. speed development period from 2011 to 2015 to reach 9.41%; in 2020 production value will reach 203.2 billion VND, accounted for 57% of the sector, the growth rate of the period 2016-2020 to reach 8.01%.

- Fisheries

Maximum exploiting the water surface in the district to develop the fisheries sector; apply appropriate measures to aquaculture in the hydropower reservoir area; 2015 aquaculture area will be 150 hectares with an output of 500 tons; 2020 area of 200 hectares with an output of 800 tons. Striving to 2015, the production value will be 5 billion VND; in 2020 of 14.5 billion VND with the proportion in local agriculture - forestry - fishery of 2% and 3%, respectively.

- New rural development

Developing synchronously rural socio-economic infrastructure in accordance with spatial planning and building villages and the overall planning of the district social development; combination of state support to develop the internal resources of rural communities; 2015, 20% of rural communes will meet new standards according to the criteria of the Ministry of Agriculture and Rural Development and 70% in 2020.

b) Industrial - Construction

• Industry

Focus on developing hydropower and processing industries, exploiting the maximum conditions of district resources; construction of industrial complexes, rehabilitation and development of traditional industries. In 2020, Quan Hoa will basically develop with reasonable industry management structure.

The industrial production value will reach 520.3 billion VND in 2015 and rise to 1,896.5 billion VND in 2020 with annual growth in the planning period of 2011-2020 of 32.4%; in which 35.8% for the period 2011 - 2015 and 29.2% for the period 2016-2020

- Hydropower Industry: In 2015 power output will reach 1.2 billion kWh/year; 2.0 billion kWh/year in 2020, in 2015 production value will reach 320.0 billion, accounting for 80% of total production value of the industry.

+ Trung Son hydropower project on Ma river, at the Co Me village. Trung Son commune (Prime Minister has agreed to approve the dispatch list of this project at letter No. 1532/TTg – IR, dated 16 Sep 2008); capacity of 260 MW, the stable operation of Trung Son HPP will provide an average power output of 1.05 billion kWh/year.

+ Hoi Xuan Hydropower project in Hoi Xuan Commune, 102 MW in capacity, stable operation of Hoi Xuan HPP will provide an average of 410 million kWh/year.

Industrial production of building materials: in 2015, the production value will reach 20 billion VND, accounting for 5% of the industrial share; in 2020, this figure will rise to 205 billion VND, accounting for 15% of the industrial share.

Build an adobe bricks manufactory with a capacity of 20 million bricks per year. Invest to quarry at some points in the district; the output will be approximately 150,000 m per year in 2020, providing stone for the construction of road boundary, roads to the commune center, etc.

Sand mining for construction shall comply with the master plan of survey, exploration, exploitation and use of natural resources on rivers in Thanh Hoa province until 2015. This master plan was approved by Thanh Hoa PPC at Decision No. 3360/2007/QD-PPC date 05 Nov 2007. In 2015 the output is expected to reach 30,000 m gravel and 50,000 m in 2020.

- Mining industry: mining of iron ore will be concentrated at not village-Nam Dong commune with reserves of 32,000 tons; iron ore at Co Village - Hoi Xuan commune with 112,000 tons. Bau village – Nam Dong with 6,800 tons, and Sa Lang – Thanh Xuan with reserves of 7,200 tons of additives during 2016 – 2020. The production value will be 12 billion VND in 2015 and 137 billion VND in 2020; accounted for 3% and 10%, respectively.

- Processing industry: By 2015, production value will reach 40 billion VND. or 10%; by 2020 production value will reach 342 billion VND, accounting for 25%.

Development of wood processing plants, plank manufactures with capacity of 15,000 m /year; bamboo plank artificial plant with capacity of 16,000 m /year; cement processing plant of 3,000 tons/year; constructing 01 pharmaceutical processing facilities.

Food production capacity of milling facilities is oriented to maximally improve upgrade; some factories are expected to construct, including 20,000-tons/year livestock-food processing plant, clean and microbial fertilizer for agriculture with a capacity of 10,000 tons/year, etc.

- Developing industrial parks in the project area: Xuan Phu Industrial Complex - Xuan Phu commune, with land area of 25 hectares. It has been agreed to invest in building and entitling assistance policies by the PPC at Decision No. 27/2008/QD-TTg date 5 Feb 2008 of Prime Minister (letter No. 2841/UBND - CN date 23 Jun 2008).

Phu Thanh Industrial Complex - Phu Thanh commune, with the area of 10 hectares, specializing to develop building materials industry, mechanical engineering, wood processing industry, arts and crafts, etc.

- Development of handicrafts:

Consolidating, restoring and developing traditional handicraft villages as well as the introduction of new trades such as weaving in Quan Hoa town, weaving in the town of Quan Hoa, Hoi Xuan Commune, furniture manufacturing in Quan Hoa district.

Introducing new jobs such as aquaculture in cages; searching market to promote traditional career with large-scale.

• The construction industry

In the period 2011 - 2020 the district's economy will attract a number of investment capitals. More than 70% of them are for basic construction. As a result, the industry will have an important role to significantly increase the production capacity of the economic sectors and contributing speed of industrialization and modernization. By 2020, the system infrastructure will be built synchronously and the production facilities, social and cultural projects will commission so that meeting the social and economic development during the planning period of this district.

c) Development of service sector

Development of services with high speed and diverse services gradually become an important sector with major contributions to the economic growth of the district. By 2015 this sector's production value is expected to reach to 150 billion VND, with an annual growth speed from 2011 to 2015 of 20.9%. By 2020, the production value will reach 484.5 billion VND and 25.6% as the annual growth in 2016 -2020 period. Therefore, average growth rate of the period 2011 - 2020 is forecasted to be 23.2%.

• Commercial services

Total value from retail sales of goods and services in 2015 will reach 250 billion VND and to 650 billion VND in 2020. Annual average growth rate is 20%. Value of exports of goods and services in the area in 2015 and 2020 will be 3 million USD and over 10 million USD, respectively. Growth rate of annual export will reach 25-27%.

• Travel services

Coordinate closely with local tourism programs to attract investors for infrastructure construction; exploit the strengths of diverse resources to develop tourism products in the province.

Focus on developing key tourist spots, creating tours, diversifying tourism products. The target of tourism revenue in 2015 and 2020 is expected to reach 15 billion VND with 150,000 visitors and 40 billion VND with 200,000 visitors, respectively.

• Transportation services

Develop diverse forms of transport with the development of passenger transport services, combined with tourism development; forming the transport route to the tourist areas and major economic center of the center of province, which will facilitate economic sectors to participate in the provision of transport services. It is expected that by 2015 the volume of freight in the district will be about 0.4-0.5 million tons, and 0.8-1 million tones by 2020. Transportation need to be combined with routes of key tourist areas like ecotourism destinations such as Hu Pu, Pu Luong NR, Phi cave, Muong Ca Da tourist complex, etc.

• Financial and banking services

It is necessary to closely manage revenues and expenditures; use the budget in the right purpose, and efficiency savings. The revenue in the district is forecasted to be 55 billion VND in 2015 and to 80 billion VND in 2020, with 7-8% at an increase of the annual average growth rate.

• Information and communication

By 2020, number of telephones will be over 55 machines/100 inhabitants; 100% of the Party agencies and local government, unions from communal level upward will be networked with the Internet by high-speed links, broadband. Other target is publishing over 1 million newspapers, books.

d) Social Culture

• Population, labor, employment and poverty alleviation

The district's population will reach 48,640 people in 2020, the population growth rate on average during the period 2011-2015 of 0.9%; 0.75% in period 2016 - 2020. The poverty rate is reduced to 20% in 2015 and 8% in 2020.

Percentage of employees trained will be over 40% in 2015, more than 50% in 2020, to boost labor export, reduce the rate of unemployed workers in rural areas. Labour structure is oriented to transfer in the direction of reducing the proportion of agricultural labor and increasing labor in industrial, construction and services.

• Education and training

Annually, 100% of children go to primary school at the correct age; 98% of students are graduated from elementary, 95% from junior high school, and 75% from high schools. It is necessary to enhance professional competencies for teachers at all levels in the district.

The construction of the national standards in primary education will be 45% in 2015, and 80% in 2020; at junior high level reach 40% in 2015 and 70% in 2020. The development and expansion of private school system is being in the direction of socialization. It is oriented to train qualified human resources, enhance facilities for vocational training establishments in the area.

• Health

Until 2020, 100% of communes and towns will meet national standards for health care, 85% have adequate health centers and medical staffs with intermediate levels or above. 100% of commune health centers with doctors, 100% of the villages have nurse. There are total of 6-7 physicians, 1.5 to 2 pharmacists/10 thousand people, 40-45 beds/10 thousand people.

• Culture

By 2020, 100% of villages; 100% offices, schools, cultural construction units, with more than 75% of the families in the district will meet cultural standard, 100% of communes will have bookcases with legal books, and others relate to popular techniques of agriculture, forestry and fisheries, 100% of communes have postal, 60% of people regular exercise sports. By 2020, the district will have 60% of people participating into gym regularly.

e) Develop infrastructure

• Transportation:

- Highway:

Period 2011 – 2020. Highway 15A is projected to upgrade to IV grade of mountainous area, widen some sections going through towns commune centers. Build bridges to replace some major upgrading sections have large traffic flow level III; performing solidify flood stage, sliding, soft soil, etc. Western roads of Thanh Hoa will meet level IV of mountainous area; routes to reach rural roads Grade A, extended some important stages to grade IV.

- Provincial roads:

Upgrade Canh Nang (Ba Thuoc) - Phu Le (Quan Hoa) at section with 8 km long through the district to become a provincial road; road No. 520 will meet mountain grade standard; Van Mai – Trung Son road with 24 km long will expand the importation section to become grade IV.

- District roads:

Period of 2011 – 2020, district roads will be upgraded to become grade IV and to be asphalted at all, ensure traffic from the district to the town center.

- Rural roads

Refresh and upgrade the routes from villages to the town center; from production areas to the district roads and provincial roads to facilitate socio-economic exchanges.

- Waterways, docks

According to the master plan of domestic or inland waterway transport of Thanh Hoa Province in 2020 (Decision No. 69 dated 07 Jan 2004 of Thanh Hoa PPC), inland waterway in Ma river will be developed and constructed 01 pier at Quan Hoa town with a capacity of 150,000 tons/year, and developing transportation in hydropower reservoirs.

- Bridges, culverts, bus stations:

From now to 2020, with the demand on the national highways, provincial highways, it is necessary to upgrade Nam Tien and Trung Thanh bridges (Thanh Son – Trung Thanh), Coc bridge, Han bridge (Pheo Yen), Pau Not, etc, and build 03 bus stations in the area, including one at the town, others at Phu Le and Hien Kien ranked Class VI (implementing Decision No. 1059/QD-UBND dated 10 April 2009 of Thanh Hoa PPC).

• Irrigation

Period 2011 – 2015, it is newly construction of 17 dams, reservoirs replacing temporary buildings, mainly in the regions I and III to ensure enough water for development near the service area of 1,050 hectares of two-crop rice. Increasing the area of two-crop rice up to 2.375 ha, and ensuring water supply to the town for 6,500 people in the commune centers. Period 2016 – 2020, it will ensure stability for 4.12 ha irrigated rice and crops, and stable water supply for people.

• Electricity

From now to 2020, it is focused to the investment of national power lines to 7 remaining communes without electricity, building 66 power substations (50 - 100kVA), constructing 35kV lines with a length of 167.0 km and low voltage lines (including improvement of 3 phase and 1-phase lines, construction of new 3-phase lines, etc,).

• Development of social infrastructure

Invest to upgrade and procure equipment for communal health facilities, health centers, district hospitals; improve health care, disease treatment and examination ability for all health facilities in the province.

It was strengthen 140 classrooms, 185 public service buildings, 52 buildings for school headquarters, 14 day-broader buildings, boarding ethnic schools and other auxiliary works, construct 01 high school located in the area where is contiguous to Thien Phu commune and Nam Dong commune (along Luong river) with the area of 12,000m^2....

Stadiums having enough conditions for competition at district level will be built in the commune centers. Build culture - sports sites in 2 locations: at Thien Phu commune (along Luong River); Phu Thanh commune (Ma river).

Upgrade facilities of television broadcast stations of district, each station will be installed 2 -3 television transmitter with 150W - 300W or more.

3.6.4. Socio-economic development Master plan to 2020 of Mai Chau district

3.6.4.1. Overall objectives

Promote Mai Chau district to become one district developing at average level of the province. Economic development of district mainly depends on key tourism and services sectors. Agricultural sector has been invested concentratively, formed areas of production to supply agricultural products for markets. Handicraft production has been associated with new rural development which is friendly with environment. In the district, people's life has been improved, ethnic groups' cultural character has been preserved and promoted. Relationships with localities in the province and neighboring districts have been consolidated and strengthened (about economic development. goods and commodities exchange, cultural exchange....).

In the district, infrastructure structure such as system of transport, irrigation, power supply, water drainage and supply, telecommunications, health, education, sports, culture are gradually modernized. Market economy has been gradually formed and effectively operated in all sectors. Socio-economic development has been closely combined with national defense and security in order to protect social order and security.

3.6.4.2. Detail targets

a) Economic development

- The growth rate of GDP is forecasted to reach 12-13% in period 2011 -2015 and 10-11% in the period 2016-2020. The proportion of agriculture-forestry-fishery, industry – construction, services in the economic structure of the district is forecasted to be respectively 39%. 22.9%. 38.1% in 2015 and 37.7%. 23.7%. 38.5% in 2020.

- The state budget revenues of the district will reach 23.5 billion VND in 2015 and 30 billion VND in 2020.

- GDP per person will reach 13-14 million VND in 2015 and 18-20 million VND in 2020 (replacement cost).

b) Social development

- Rate of natural population growth is expected to be less than 1%.

- No more hunger and poverty rate reduction of 2-3% per year.

- By 2020, the district will have 50% of national standard schools.

- Reduce the rate of malnutrition children to 14% in 2015 and less than 5% in 2020.

- By 2015, 70% of commune health stations in the district will have doctors, 70% or more to achieve national standards of health care. In 2020, 100% of communes meet national standards and 100% of health centers with doctors. The number of doctors per ten thousand people will be 8 in 2015 and 10 doctors in 2020.

- Labour trained will be 28% in 2015 and 35% in 2020.

c) Environmental protection

- The target will be achieving 95% of the population using clean water.

- Well implement the management, protection and development of forests, expanding areas of woody bamboo, bamboo in order to ensure coverage of forest vegetation on 70%.

- Build landfills for collecting domestic waste in densely populated areas, especially in the towns, commune centers.

- The percentage of households using clean water in 2015 will be 95%. Building water supply systems in towns and townships for 2020, 100% of the urban population uses hygienic drinking water.

- Planning and constructing of infrastructure under the planning in 2015 with two communes meeting new rural standards, and in 2020 with 5 communes.

3.6.4.3. Development orientation of economic sectors

***a)* Agriculture - Forestry - Fisheries**

- Perspective:

Keeping the stability in food production, increase food production based on intensive investment, ensure food security in place; using advantages to form focus cultivation areas with appropriate scale; planning focused livestock areas, livestock development in concentrative and industrial manner to improve productivity, quality, efficiency and ensure environmental hygiene; exploitation associated with management and protection aquatic resources of Da River reservoir; development of a number of economic forests (paper material) to supply raw materials for the processing industry.

- Objectives and solutions:

- Strive to increase the speed of production value (in 2010 constant prices) to get averaged level at 5 -7%/year; the proportion of 39% in 2015 and 37.7% in 2020.

- Continuing to change the structure of crop and livestock in orientation of good production. Using varieties with high productivity, quality and efficiency. New rice varieties will be seeded at 80% of land area for cultivation with average productivity over 55 kg/ha/crop. Cross-bred corn varieties will be seeded on over 80% of the planted land area for corn with average productivity of 30-35 quintals/ha/crop; formation of the specialty corn area (local varieties. high quality) in the highlands such as Thung Khe, Tan Son, Pu Pin, Noong Luong, Ba Khan.

- Forming the area cultivating crops for production such as soybeans (about 450 ha) at communes Mai Ha, Xam Khoe, Mai Hich, Pieng Ve, etc.; snow tea growing region (approximately 450 ha) in the Pa Co, Ba Khan, and Tan Son communes.

- Application of advanced breeding techniques, bringing livestock into the main producing sectors, to enrich farmers, building livestock areas centralized at a scale of farms. Livestock Development to 2015 will have 25,000 cattle heads and 30,000 pigs. and 31,000 cattle 40,000 pigs in 2030.

- Well protect and manage existing forests, extend bamboo forest area, increase vegetation cover of forests and provide raw materials for processing.

- Intensive aquaculture with mostly as carp, grass carp, common carp, etc; project communes in reservoir foundation can be develop fish cages and natural fishing, and join into protecting spawning grounds of fish such as Anh Vu fish, black carp, grass carp, etc.

b) Development of industry and handicraft industry

- The development perspective

- Industrial, small and medium-scale industrial development are the most important. Also considering handicraft cluster, and agricultural and forestry product processing are as a basis for development.

- Focus on technological improvement, new equipment investment for production bases. For industrial production bases that are being prepared for construction, it should be applied advanced technology and modern equipment.

- Handicraft: introducing and developing handicraft industries, traditional handicraft, embroidery, weaving, knitting to produce commodities for tourists is essential. Encouraging innovative technologies, in accordance with the level of human resources in place, attracting many workers

- Ensure the environmental standards for sustainable development

- Objectives and solutions:

Average growth in period 2011-2020 is 12-13%/year; proportion of construction- industry sector increase to 22.9% in 2015 (in which industry, handicraft accounting for 13.7%), 23.7% in 2020 (in which industry. handicraft account for 15.2%).

Development of traditional handicrafts and products serving tourists create consuming channels and attract more visitors. The main industries are embroidery, weaving of rugs, cushions, wicker. ... Developing living tools manufacturing facilities, agricultural handy tools with traditional technique of steel making of Hmong, Thai ethnics. In the tourist villages, besides introducing and selling products, organizing the production process on the spot to attract tourists exploring taste.

Agricultural and forestry product processing:

+ The main sectors: processing soybeans, tea, cannaceae starch, paper materials. The process, which based on traditional manual methods, need to focus on products such as vermicelli, bread, dried fruit, jam and other vegetables.

+ Development of processing facilities along with the concentrating material areas such as Tuyet tea in Pa Co, Tan Son; paper material in Dong Bang, Van Mai, Phuc San; cannaceae starch in Xam Khoe, Van Mai, Mai Hich, Tong Dau, etc. In addition to the focused processing facility of Shan Tuyet tea, encouraging the development of manual process (sao, say) based on experience.

+ Production of construction materials: The main sectors are mining stone, gravel, bricks production, tiles, lime. Investing on production line of new Tuynel material in Mai Ha, Chien Chau; developing the manufacturing of new materials such as roofing, adobe brick, light aggregate concrete blocks, cheap materials.

c) Development of services – tourism sector

- Development perspective:

Develop tourism into a spearhead economic sector of the district; maintain and develop new community tourist attractions, making Mai Chau district become a community tourist destination, and creating an important step in the development of quality services, efficiently serving the economic-social development, satisfy the needs of people.

- Objectives and solutions:

Average growth in 2011 - 2020 period is 15%/year. Proportion in the economic structure in 2015 is 33.6%, and 33.56% in 2020.

Commercial activities:

+ In addition to 9 current regional markets, it continues to invest on building new gathering markets, facilitating the exchange of goods for production and daily life of people.

+ Continue to strengthen and develop the commerce units system of the State.

+ Complete the wholesale market in district center, construct type 3 markets in the communes, construct permanent or semi-permanent markets, and remove temporary markets.

+ Establish priority policies for commercial services to support agricultural production, material supply, seeds, quality-assured livestock, protection service for plant and veterinary, etc, and handicraft industry production.

- Tourism activities:

+ Continue to review and complete tourism planning: invest on tourism spots in well-known places on the tourist map. Develop traveling tour, Hoa Binh lake tour.

+ Exploiting archaeological sites in Mo Luong, Khoai caves to serve tourists. Organizing eco tours to explore the nature reservation in Hang Kia - Pa Co, Pu Luong. Establishing and maintaining self-managed cultural art groups in villages, serving the needs of visitors such as to eating, resting, recreation and information.

Other service sectors:

+ Financial services: quickly expand other forms and increase the quality of service in a direction of diversifying the form of capital raising.

+ Bank: increase the professional skills, scope of activities to ensure self-controlled and self-responsibility of these banks in business.

3.6.4.4. Development of social sector

a) Development of education and training field

- <u>Development perspective:</u>

Considering education and training is the most important task in order to improve people's intellectual, develop and improve the quality of human resources in a fastest way to meet the requirements of economic - society development towards industrialization and modernization in the new stage of development.

- <u>Objectives and solutions:</u>

- Continue to invest on school facilities to remove 100% of temporary classrooms in 2015, and there will not be any semi-permanent classrooms in 2020. Attracting 100% of school-aged children at all levels, satisfying the standard of preschool education universalization for children 5 years old. Consolidating the results of education universalization, maintaining communes that achieved education' standards, completing universalization of middle-school education in Hang Kia commune.

- Investing 100% on community learning centers of communes and towns with enough equipment and efficient operation. Continuing to recruit students to study in regular schools to create resource of officers. Prioritizing in recruiting local students graduated from professional schools to serve the local communities.

b) Development of community healthcare

- <u>Development perspective:</u>

Strengthen the diagnosis and cure ability for each medical facility level to ensure normal medical care for people in time, efficiently, reduce the pressure for the upper level healthcare. Actively preventing diseases timely, essentially eliminating infectious diseases, implementing population and birth control well to regulate the growth rate of natural population towards stablization, to ensure its reasonable population size and enhance longevity, and improving the living environment in urban and rural areas in a sustainable way.

- <u>Objectives and solutions:</u>

- Maintain a 0.01% sub-replacement fertility to achieve the planned development of population goals. In 2015, the mortality percentage of children under 5 will decrease to 0.06% and the rate of malnutrition will decrease to 10%. By 2015, 16 communes and towns will have doctors; and be above the national standard of healthcare. By 2020, 100% of communes meet national standards of healthcare and 100% of health centers have doctors.

- Maintain, strengthen and improve the professional qualifications of healthcare village staff, to ensure healthcare for the local population.

- Increase training human resources, and material resources for disease prevention.

- Combine modern medicine and traditional medicine, promote precious medicine of ethnic minorities. Linking military medical and civil medical in the area to work effectively on healthcare for people.

c) Development of culture. Communication, fitness, sport

- Complete cultural institutions, build cultural house in the communes and commune groups in order to by 2015, over 85% of communes have a cultural house, create a healthy cultural environment, resolutely handle cases of depraved culture and newspapers propaganda.

- Continue to promote the campaign “people unite to build a cultural life"; striving for over 45% of cultural village in 2015; over 85% of households are cultural families; 100% people have radio and television. By 2020, there will be 70% cultural villages. 95% cultural families, 100% agencies achieve culture criteria. Accelerate the campaign of building cultural families associated with the propagation of moral lifestyle behavior in family and society, implement law of domestic violence prevention.

- Complete invests on conservation, restoration and renovation of historical and cultural sites. Organize festival "Xen Muong" and other traditional festivals. Organize the folk art groups in the villages, especially the tourist villages.

- Allocate land for a stadium center for each village that have a sports field. Construct playground and entertainment complexes at residential areas, combined with exercise place for people.

- Maintain football teams, sports clubs in residential areas, organize amateur tournaments, maintain and ensure sufficient forces to participate in tournaments organized by the higher-ups. Coming up with plans to exploit and preserve the ethnic sports and folk games.

- Population, labor, employment.

- In 2015, the district will be expected to have a population of 55.3 thousand to 26.5 thousand employees, and, about 57.8 thousand people with 28 thousand employees in 2020.

- Training and attracting talented people back to the rural areas; raising the proportion of professional civil servants up to 80% in 2015 and 100% by 2020, which is currently at 43.7% with college education level.

- Continue to implement the vocational training, job orientations to employees so that trained employees percentage versus total workforce rises by 30% in 2015 and 50% in 2020. There are 2 ways to resolve the job issue: on the spot and exporting, in which resolving job issue on the spot is more essential.

3.6.4.5. Development of technical infrastructure

a) Transport infrastructure

- <u>Road transport network</u>

- Highways: Upgrade Highway 6 section from on Dong Bang to Moc Chau section; continue to upgrade and expand Highway 15.

- Provincial/district roads: Raising the road standard to mountainous grade IV and V, with 100% asphalted road. The main roads consist of 6 routes with 109 km long.

- Route of Dong Bang–Tan Dam (Provincial Road 432) is upgraded for traffic through. Firstly, crossing Da river by ferry, then prepare to construct a bridge.

- Rural roads are constructed in accordance to standards of type A and type B rural roads. Continue to upgrade and renew some short-line routes in Mai Chau town and other communes such as Tong Dau, Na Phon, Chieng Chau for tourism, of handicraft villages development purposes. By 2020, 85% type A roads are concreted, and asphalted.

- <u>Bus station and parking spot</u>

- Center bus station will be used for other purposes, so new bus station will be constructed at Mo village. Construct bus sub-station at important positions such as communes of Co Luong, Xam Khoe, Bao La, Cun Pheo, etc.

- On Highway 6 route at Tong Dau commune, Dong Bang commune will build resting areas for visitors, each area with approximately 300m .

- River transportation

It continues to invest on the items construction of Bai Sang port to increase the capacity of receiving and exchanging goods for economic - social development.

b) Irrigation system and water supply planning

- Completing the irrigation system

- Focus on managing and exploiting to ensure actively support for production; detailed planning for irrigation development, combine irrigation with in-field traffic.

- Complete upgrading the reservoirs to ensure the water supply. Construct the water circulation pump station, electric pump station.

- Research a plan to use water from the small hydropower plants in the area (2 plants) for production in neighboring areas.

- Continue to solidify and upgrade the canal route to oversee water losses for improving service performance of structures.

- Maintaining, repairing, upgrading small dam system (with over 110 dams).

- Water supply

Planning to build 25 water supply projects focused in areas that have water sources, and are eligible for construction such as Mai Hich, Van Mai, Mai Ha, Na Phon, Tong Dau, Dong Bang communes. Wells construction for water supply, 325 wells are expected to apply to the regions that have low terrain, high groundwater level, primarily in Chieng Chau commune, with some distributed Na Phon, Tong Dau, Dong Bang communes.

c) Development of rural postal, telecommunications and communications

- Expand, upgrade the existing service places and develop more new service places in the area. Maintain and equip more tools, books and newspapers to the culturalpost office.

- Expand and install switching systems in some key areas. Develop high technology transmission system, optical fiber to some communes with good conditions. Universalization of telecommunications services communications, strive for bringing internet service to most of the commune centers in 2015.

- Encourage the mobile networks to expand their coverage, facilitate for people's use of mobile devices, with 35 machines / 100 people in 2015. Continue to expand the service area of the landline telephone network to reach 10 devices / 100 People.

d) Power system planning

- Continue to review the electricity network, additional planning suitable with to suit the new situation. According to the plan of Hoa Binh Electricity, a 110/35/22 kV intermediate substation will be built at Tong Dau Commune in the planning phase.

- Take advantage of the capacity of the existing lines stations. Construct new substations and transmission lines when the load increases and at the regions without national power grid. In each village, there should be 1 to 2 small substations (capacity from 50 to 100kVA).

- Regions that have a greatly increasing power demand in peak hours especially in the industrial area, need to construct additional stations and lines in the early stages to attract more investment. Encouraging to construct small hydropower plants to protect the environment.

e) Drainage and sanitation planning

- Rainwater drainage: Water can be basically drained along the natural terrain with all due respect to the nature. Water flows in to gutters along roads, from the gutters to converging waterway, stream, river…

- Waste water drainage: waste water is collected into manholes for processing and deposit, and then is moved into the public drainage ditch or used for watering gardens. In urban areas, renovate and construct new drains to collect waste water. Construct small scale stations of water treatment before water can flow into rivers and streams.

- Industrial waste water: construct synchronized infrastructure in the industry area, including water treatment system to ensure the water standards before releasing it into the environment.

- Construct focusing waste treatment site: research position at Thung Khe or Chieng Chau commune.

- New rural construction: accelerate the planning and construction of infrastructure, develop production based on the planning so that there will be 2 communes achieving new rural standards in 2015, and 5 communes in 2020.

CHAPTER 4. IMPACTS ON THE NATURAL AND SOCIAL ENVIRONMENT

This chapter describes the impacts and measures to mitigate these impact caused by the construction of the components of Hoi Xuan Hydropower Plant, the connecting line and resettlement area. The impacts were evaluated in accordance with each phase of the project, including the impacts on environment, biology and economy - society, as follows:

4.1. Impacts and mitigation measures in the area of Hoi Xuan HPP's main components

The area of Hoi Xuan HPP's main components include items such as damsite, reservoir, waterway, powerhouse, OPY switchyard, construction – operation road, water and electric supply system, workers' camps, other auxiliary works and a sand mine.

4.1.1. Impacts. mitigation measures for bio-physical environment

4.1.1.1. Topography, geomorphology and landscape

1. Pre-construction and construction phase

In pre-construction and construction phase, the project will implement the activities such as salvaging and cleaning vegetation cover, clearance in the residential area. Leveling, removal of the top soil. Excavation and constructing main and auxiliary works. These activities will lose vegetation cover and result in the landscape change due to the disturbance of terrain with some places leveled (such as auxiliary works site: worker's camps, construction-operation road, etc.), some places excavated (like the area of main works, sand mine), some others filled by spoils (like the disposal areas, material and sand storage places). The land disturbance will easy to cause erosion, landslide, subsidence. In the headwork area, the proposed items are concentratively distributed within 55.862ha while sand mine is located in Ma river's foundation in Kham village. Hoi Xuan commune, far from the Powerhouse about 10km to the upstream direction. This sand mine has the area of 4,2170ha with 90m in width, 1,200m in length and 1.2m in depth; the reserve is about 49,339m^3, which is supplemented by sediment after 5 years with volume of 59,207m^3; the exploitation capacity is 12,000m^3/year.

In order to mitigate impacts the PO has to implement the following measures:

- Only salvaging and cleaning vegetation cover within the acquired land for the project, not allow to exceed the around areas.

- Collecting all spoils, cut-trees and disposing to the regulated areas, then treating or dumping, and tightly compacting these wastes. After finishing the construction, the temporary acquired area have to be cleaned, leveled and recovered by trees.

- Planting trees around the powerhouse, shift-operating house, construction-operation road in order to increase vegetation cover, enhance environmental quality and avoid soil erosion.

- According to evaluation, the sand mine ensure the quantity and quality for the project construction. However, the exploitation have to implement evenly throughout the permitted area, not digging in one positions in order to avoid causing river flow change and creating whirl water which dangerous for ships, boats and people. Avoid causing erosion of riversides and the subsidence of river bed at the exploitation area.

During the sand exploitation, if the PO identify the reserves of this mine is not ensure to continuous exploitation, the exploration of another mine will be necessary to implement. It needs to avoid overexploitation which can change the river bed terrain, accelerate the process of erosion damage and danger to other objects.

2. Operation phase

a. Topography, geomorphology

In the phase, topography and geomorphology will be changed due to the reservoir sedimentation and the erosion of the reservoir and river banks in the downstream area due to the project operation.

- Topography, geomorphology in the reservoir foundation:

When the reservoir is stored up water, the wetland terrain type will be extended (corresponding to the FSL 80m, the reservoir area of 6.19km^2), and erosion processes, reservoir’s bank regeneration and the bed sedimentation will frequently occur, which results in the morphological shoreline and lake bottom elevation change.

- The process of erosion and regeneration of reservoir banks

+ The process of the reservoir landslide and regeneration will be caused by wave, wind, flow, slope of the reservoir edge, etc. This process will create alluvium causing the reservoir sedimentation.

The ability of the reservoir edge landslide and regeneration was studied according to a method of dynamic geologic activity assessment of Khositasvilli, in which 17 factors are considered such as topography, geomorphology, geology, tectonics, geology of construction and hydrology. These factors are combined with other factors as follows:

Height of wave: This depends on wind direction, length and width of reservoir. In general, height of wave is not big. Also, the proposed Hoi Xuan HPP's reservoir foundation is small (6.19km^2), its width is as approximate as the width of the current river, the reservoir's foundation will coincide with the river bed along the valley (about 29km in length). This will be distributed on the surface of the current river's bed sedimentation. Therefore, impacts of this factor will be insignificant.

Slope of reservoir edge: This is small, about of 5 - 30^o and covered by trees while the slope of 20-40^o is rarely appeared.

Useful volume of reservoir: Hoi xuan HPP's FSL is 80m. MSL 78.5m, the useful volume of reservoir. Therefore, is 1.5m which will not easy to cause the reservoir edge regeneration.

Character of soil and stone of reservoir edge: Some positions of the reservoir wall appears medium-hardness bedrocks covered with clay, clay mixed small grit which is sheared strength at zone edQ: φ=15^o and C = 0.270kG/cm^2; zone IA$_1$:φ=16^o and C = 0.291kG/cm^2. The reservoir foundation is mainly on Ma river with 29km in length and some small tributaries which have the length from tens meter to hundreds meter, the maximum depth of 30m. There is, therefore, not big problem on the reservoir wall regeneration.

The assessment method of Khositasvilli which is based on the above mentioned factors demonstrates that indicates of dynamic geology activity of the reservoir wall is average level.

Table 4.1: Prediction of recreation level on sections of reservoir edge

No	Typical factor	Section			
		I	II	III	IV
1	Character of petrology cross-section of sloping side	2	2	2	2
2	Tectonic destroying level	1	2	2	2
3	Earthquake level	3	3	3	3
4	Watery level of sloping side	2	2	2	2
5	Stone dip direction compared to sloping side	2	4	1	2
6	Sloping angle of stone	2	4	4	4
7	Decomposition level	3	3	3	2
8	Splitting level	3	3	3	3
9	Stone erosion according to erosion constant kx	2	3	3	2
10	Destruction due to sliding	2	2	2	2

No	Typical factor	Section			
		I	II	III	IV
11	Depth of sliding block of sloping side	2	2	2	2
12	Development stage of sliding block	3	3	3	3
13	Deposition of sludge. sand in reservoir	3	3	3	3
14	Height of sloping side compared to river water level	3	3	3	3
15	Average slope of sloping side	2	2	2	3
16	Character of cross section of sloping side	3	3	3	4
17	Appearance of deposition shelf	2	2	2	4
S (total mark)		40	46	43	46
Value according to recreation level		0.56	0.68	0.63	0.65
Assessment on recreation level of reservoir edge section		**Average**	**Average**	**Average**	**Average**

*Note: S = ni/(A * 4); ni: value according to level of factors; A: number of factors in assessment*

According to method of Zolotariep, scale and volume of sliding zone following recreation periods is predicted as below:

Table 4.2: Calculation results of projection of sliding of Hoi Xuan reservoir

Direction	Slope of side	Recreation length (m)	Recreation after 10 years (beginning period)		Recreation after 100 years (last period)	
			Average area of cross section (m^2)	Volume of sliding zone (m^3)	Average area of cross section (m^2)	Volume of sliding zone (m^3)
RW	$<10^0$	2,000	482.0	964,000	471.5	943,000
LW		2,000	400.4	800,800	637.4	1,274,800
S		3,000	553.6	1,660,800	672.8	2,018,400
E		2,000	361.1	722,200	587.9	1,175,800
Total				**4,147,800**		**5,142,000**

Results show that sliding volume after 100 years is about 5,142,000 m^3, equal to 9.24% of dead volume of reservoir.

To summarize, considering both quality and quantity assessment, it can be seen that edge line of Hoi Xuan reservoir is fairly stable and in operation period of reservoir, it is foreseen that only small sling blocks happen within zone of water level fluctuation, creating a marginal impact on volume and working condition of reservoir.

- Sedimentation of the reservoir bed

Sedimentation of the reservoir bed is mainly from alluvium from river flow.

According to the above analysis, the process of reservoir recreation will happen at average level. This is proposed to be an unregulated reservoir. Trung Son Hydropower Plant is on the upstream area (most of sediment from the upstream is kept in Trung Son HPP's reservoir before flowing to Hoi Xuan reservoir). Therefore, amount of sediment to the reservoir will be small, about of 0.01 milion m^3/year, mainly moving sediment. This amount is very small compared to the dead storage of the reservoir, accounting for only 0.2% of the dead volume. Therefore, this will not affect the safety of the project operation and the reservoir.

Sedimentation of the reservoir bed is mainly from alluvium from river flow and erosion.

Because of Trung Son hydropower on the upstream, volume of sand and sludge to Hoi Xuan's reservoir will be significantly reduced because most sand and sludge are from middle section between Trung Son dam and Hoi Xuan dam and the volume runs through turbines of Trung Son hydropower plant. According to calculation, volume of sand, sludge to the reservoir is expected about 0.417 million m^3 per year and the deposited volume is proposed about 0.159 million m^3 accounting for 0.25% of the dead volume of the reservoir.

The volume of sediment eroded from the reservoir edge will be 0.05142 million m^3.

Total deposited alluvium in reservoir bed is 0.21042 million m^3/year, 21.042 106m^3 after 100 years, equal to 37.8% of dead volume of the reservoir. In the fact, the project's life cycle is proposed about 40 years, therefore the sediment volume will not affect the project's expectation life.

- Topography, geomorphology of edge line and riverbed in downstream area

+ Impact due to lacking alluvium

A large amount of sludge, sand is kept at upper cascades. When Hoi Xuan reservoir is constructed, another amount of sludge and sand will be kept in the reservoir (about 37%). This makes the flow increase its ability to carry sludge and sand, leading to erosion and changing form of edge line and riverbed in the downstream area.

Mitigation measures:

Mitigation measures of impacts on topography and geomorphology processes are as follows.

(i) Mitigation measures for erosion. regeneration of river side; sedimentation in reservoir bed

- The PO will conduct tree planting in the area of the vacant and temporarily acquired land along the reservoir area, associating with the protection of vegetation cover around the reservoir. Especially, in flooded areas there are some species preferring water such as bamboo. Neohouzeaua, reed, etc., there for the project owner need to protect, manage and develop these species.

- The PO has to coordinate with local government to inform the prohibition of deforestation in the edge of reservoir and nearby areas.

- Prohibiting all activities affecting the reservoir edge line, especially not to exploit for cultivation, sand exploitation or others in the inundated and semi-inundated areas.

- In order to ensure the safety during the project and reservoir operation.the project owner, who represented by the management board of plant, will inspect monitor the scour of reservoir border twice a year, active implement effective measures for banking up to prevent erosion, especially in areas likely to be erode near residential areas and other facilities to ensure the safety of lives and property of people around the reservoir border. Coordinate with local government to invest, encourage inhabitants who have land around the reservoir to plant trees.

- The PO have to seriously implement the monitoring of reservoir sedimentation, and carry out to dredge if necessary in order to ensure the useful storage for the reservoir.

(ii)Mitigation measures for bank and bottom erosion of the river behind the plant area

To minimize the erosion of riverside behind the plant, a drainage system was designed to reduce the kinetic energy water flow, and the flow rate after the discharge channel of plant, water flow after the drainage system return to the state of natural river flows.

Carry out closely monitoring the erosion of downstream area behind the dam site, especially the part of Ma river from dam site to Quan Hoa town so that there is measure treating timely such as bank up, responding incidents caused by erosion.

b. Dynamic geology

The construction of dam and reservoir can cause excitation earthquakes and activate operation of tectonic faults such as the dam movement, loss of the reservoir water, Dam failure, etc.

The analysis of possibility of excitation earthquakes and activate operation of tectonic faults due to Hoi Xuan HPP is presented below.

- Excitation earthquakes

According to researches on excitation earthquakes at large reservoirs in the world of UNESCO organization, reservoirs can cause excitation earthquakes are those have over 90m in depth and the reservoir's volume of more than 1 billion m^3, in the condition that stone, soil in reservoir area and the surrounding are divided by tectonic faults. The highest water level of Hoi Xuan reservoir corresponding to FSL is about 30m; design volume is 63.65 million m^3, therefore ability to have excitation earthquakes is very much small. Moreover, reservoir bed area has not any deep faults and operating faults, so in operation period of reservoir, it is impossible to appear excitation earthquakes.

However, according to Vietnamese standard TCXDVN 375:2006, earthquakes are divided into three types:

Strong earthquakes have ground acceleration $a_g \geq 0.08g$, it is necessary to calculate structures for seismic resistance.

Weak earthquakes have ground acceleration $0.04g \leq a_g < 0.08g$. This only need to apply measures of mitigated seismic resistance.

Very weak earthquakes have $a_g < 0.04g$, this is not need to seismic resistance.

The project are has a_g=0.12-0.24g which belong to the strong earthquake area with background earthquakes on level VIII of MSK-64 scale. Therefore, it is necessary to consider the possibility of causing excitation earthquakes earthquakes when constructing the reservoir. In this phase, the PO needs to sign contract with Geological Institute for the detailed assessment the hazard of earthquake.

- Activating operation of tectonic faults

Although study area of the project is laid in between two deep faults (fault level I) of Ma river and Son La, known as quake creating faults, these faults are far from dam site (more than 4km). In addition, according to the study results, the project area only develops faults level IV and V in NW-SE, NE-SW, sub-longitude, and sub-latitude directions. They are internal zone faults and cannot create quakes. Hence, the construction of reservoir and dam will not activate operation of these faults.

Mitigation measures:

According to the above analysis, the possibility of excitation earthquakes and activate operation of tectonic faults due to Hoi Xuan HPP construction is at low level. However, in order to prevent, avoid and intermediate mitigate the impact, the PO need to have the following measures.

- Before constructing the project, the geological exploration and drilling for detection and evaluation of tectonic faults and seismic activity in the area have to be implemented in order to to take remedial measures to minimize Impacts which may occur due to earthquake excitation.

- During operation phase, the Plant Management Board will have to closely monitoring the movement of dam, seepage loss of water reservoirs, prepare prevention and mitigation measures for the impact of dam failure.

c. Landscape

After storing up water into the reservoir and commissioning the project, the following landscapes will be formed.

+ Landscape of reservoirs. Currently, Trung Son hydropower is under construction on Ma river. When appearing the reservoir of Hoi Xuan hydropower project, this will create a landscape of pan-reservoirs.

+ Landscape of rural population around the plant area.

This is the inevitable impact, no mitigation measures.

4.1.1.2. Ambient air

1. Pre-construction and construction phase

The ambient are during this period is mainly affected by dust and exhaust gases (SO_2, CO, NO_2....) arisen from the construction activities. In addition, odor from garbage and wastewater will contaminate the ambient air if they are not collected and treated.

a. Impacts of dust emissions

- Due to mine blasting for the construction of foundation pits

In addition to the above activities, material processing will also generate dust and exhaust gases, and its main influenced areas are the concrete crushing area, and the mixing concrete plants. Moreover, the concrete crushing and mixing work will be often equipped with modern technology and production line to reduce labor. The number of workers required to operate equipment will be only 1 to 2 people/shift and they will be fully equipped with appropriate protective equipment to reduce the level of impact.

The following results are calculation of emitted dust and exhaust gases from some main sources of emissions:

Activities of vehicles, machines, and equipment in the construction site during site clearance, soil excavation and filling back, etc.

- Exhaust gases:

Based on the document of NATZ on toxic exhaust gases when using a ton of oil for internal combustion engines, amount of exhaust emission from operations of machines, equipment and vehicles can be predicted as follows:

Table 4.3: Amount of exhaust emission arising from operations of machines, equipment and vehicles during construction phase

Emission coefficient (kg/ ton of oil)			**Amount of oil use in per shift (tons)**	**Amount of emission (mg/s)**		
SO_2	NO_2	CO		SO_2	NO_2	CO
2.8	12.3	0.05	22.572	2,194.5	9,640.125	39.188

- *Dust:*

+ According to US Environment Protection Agency (USEPA), pollution coefficient (kg/1,000km)) and World Health Organization (WHO), dust generated from vehicles with 3.5 – 16 tons load capacity is 0.9 kg/1000km.

With approximately 105 12T-type trucks operating in peak time, average length of transportation at 60km/vehicles/day, 2 shifts operation, the maximum amount of dust emissions is 98.44 (mg/s).

+ According to the EIA guidelines of the World Bank (Environmental assessment sourcebook. Volume II, sector guidelines. Environment, World Bank, Washington DC

8/1991), the coefficient of dust pollution during soil's leveling, excavation and backfilling procedure is calculated as follows:

$$E = k \times 0,0016 \times (U/2,2)^{1,4} / (M/2)^{1,3}$$

In which:

E: Pollution coefficient (kg/tons);

k: grain pattern with average value is 0.35;

U: average wind speed;

M: average humidity of material is 20%.

According to the calculation result.average coefficient of pollution in the area is 0.00654 kg / tons. With amount of exploitation, excavation of soil during peak time at 5.918 m^3/day/2 shifts, equivalent to 10534.04 tons/day/2 shifts, amount of dust released into the ambient air is about 68.893kg/day/2 shifts.

The report used Pasquill model which is improved by Gifford to calculate the spread of dust, exhaust pollutant generated by operation of the machines, equipment and transport activities in the atmosphere:

$$C_{x,0,0} = \frac{Q}{\pi(\sigma_y^2 + \sigma_y^2 o)^{1/2} \sigma_z \bar{u}} \qquad (1)$$

In Which:

$C_{x.0.0}$: Terrestrial concentration of dust or exhaust < 20 μg at a distance x to the source downwind (mg/m^3);

Q: flow rate of dust or exhaust emission (μg/s);

$\sigma_{y:}$ horizontal diffusion factor;

$\sigma_{z:}$ vertical diffusion factor;

$\bar{u}$: Average wind speed (m/s); $\sigma_y o$ is ¼ emissions width of source or line source that coincides with the wind direction (m)

The calculated result is as follow:

Table 4.4: The emissions of dust, exhaust gasses from the operation of machines, equipment and vehicles

Sources	Scope	Parameters	Distance to sources (m)	Concentration (mg/m^3)	Industrial exhaust standard - TCVN 5939-2005	Ambient air quality standard- TCVN 5937:2005
1. Exhaust gases from internal combustion engine of machines. equipment and vehicles	- Construction site - Disposal area - Along the material transporting roads	CO	0.5	906.87	1,400	30
			4	21.478		
		SO_2	0.5	50,522.1	700	0.35
			5	605.949		
			250	0.276		
		NO_2	0.5	221,936.27	812	0.2
			10	673.166		
			650	0.166		
2. Dust from traffic activities		Dust	0.5	2.266.464	280	0.3
			2	164.166		
			100	0.246		
3. Dust from activities of leveling. excavating soil		Dust	0.5	27.536.03	280	0.3
			7	169.85		
			400	0.229		

Note: the forecasted concentration of dust and gases includes amount of gas or dust in the natural environment - the primitive environment

❖ Mine blasting for foundation pit construction:

+ When blasting 1 m^3 of stone 0.4 kg of dust will be generated. According to the design, amount of stone exploited and dug for foundation pit is 860.05 * 103 m^3; and amount of dust emission is 344.02 tons.

The report used Gauss condensation trail model to calculate the spread of pollutants in the atmosphere. However, because the emission source are blasting activities. Gauss condensation trail model has the form:

$$C_{x,y,0} = \frac{Q}{\pi\sigma_y\sigma_z u} \exp\left[-\left(\frac{y^2}{2\sigma_y^2}\right)\right] \quad (2)$$

With the digging capacity in peak time is 2.281m^3/shift.amount of dust emissions exceed the permitted levels of industrial dust emission in a position with 120m away from the blasting point (TCVN 5939-2005).

Table 4.5: The emissions of dust due to mine blasting

Sources	Scope	Parameters (mg/s)	Distance to sources (m)	Concentration (mg/m^3)	Industrial exhausted gas standard - TCVN 5939-2005	Ambient air quality standard TCVN 5937:2005
Mine blasting for foundation pit construction	- Foundation pit construction site	Dust/253444.44	0.5	11,.210,667.9	280	0.3
			120	195.965		
			5,500	0.291		

(Notes: the time of mine blasting usually takes place in a very short time. and mine blasting works are carried out when other activities are paused from 11h30 to 12h and from 17h30 to 18h)

+ Amount of exhaust gases generated by mine blasting (SO_2, P_2O_5) is also very large. However, the specialist team (PECC4) has not found any published research documents that calculate and study volume of exhaust gases from mine blasting.

The above forecasted results are calculated at the maximum emission capacity (in terms of maximum construction intensity). However, the emission capacity not only depends on the workload and intensity of construction at each point during the construction phase, but also depends on the temperature, humidity, wind condition, obstructions (vegetation cover, terrain, etc.) conditions, so the possibility of dust concentration that causes air pollution in the dry season is greater than that of rainy season; in the rainy season, this concentration is much smaller than the calculated results. Furthermore, the project site is expected to locate in areas that have lower terrain than the surroundings, covered with vegetation. So the impact scale and radius are smaller than the prediction.

The calculated results demonstrate that some positions having concentration of gases, dust beyond the permitted level of ambient air TCVN5937: 2005 are at position with 650m away from the construction site, and the farthest position with 5,500m (due to mine blasting).

Due to the spreading and dilution ability of the atmosphere; the activities will only take place during the pre-construction and construction time (4 years); even though the blasting activity has a wide radius of influence, it will take a very short time about one hour per day (from 11h30 to 12h and from 17h30 to 18h); particles that generated by blasting has a large size so it can be easily settled and fell. Therefore, the impact of exhaust gases and dust to the environment atmosphere is assessed as moderate.

Dust, exhaust gases arising from the construction activities not only increase the level of environmental contaminants, but they also directly impact on the respiratory of workers. Therefore, their health will be affected as well.

Mitigation measures:

Measures to mitigate Impacts on the ambient air during the construction phase as follows:

- The transport vehicles and machinery equipment (included in the list of vehicles having to register environmental standards and safety specifications of Registry Department) must meet the requirement standards for technical safety and environment of Registry Department when operating.

- Having periodical maintenance of machinery and construction equipment.

- Watering 2 times/day during leveling operations, transporting road, especially in sunny and windy days in the dry season, increasing number of watering times on roads which are constructed near the area of workers' camps and residential areas.

- Watering in excavating areas where generate lots of dust

- Spraying water in the material processing sites which generate lots of dust. The cost for this work has been included in the construction costs which are paid by contractors.

- The material transporting vehicles that are both inside and outside of construction site have to carry at the designed loading capacity; trucks' body must be covered to avoid spillage of construction materials during transportation process.

- Organizing a cleaning team to clean roads passing through densely populated areas.

- Arranging working time and vehicle regulations appropriately.

Applicable standards:

- QCVN 05:2013/BTNMT

- QCVN 04:2009/BGTVT

- QCVN 05:2009/BGTVT

2. Operational phase

- The operation phase of the power plant will not generate dust

-The exhaust gases generated during the period will be mainly from the decomposition of biomass which is flooded when the lake stores up water.

Biomass flooded at the reservoir's foundation will be decomposed in anaerobic condition and release CO_2, H_2S, CH_4, NH_3, and a small amount of N_2O (nitrogenous oxide) that create unpleasant stench, contaminate environmental atmosphere, affect the health of workers and residents around the reservoir area.

The reservoir will be cleaned before storing up water. Also, inundated biomass at the proposed reservoir's foundation only includes roots, regenerative grass, organism, animal's corpses and organic matter in the soil, which have little masses. Therefore, amount of exhaust gases generated by decomposing biomass will be relatively small and mainly occur in the first few years of storing up water.

-Activities of the operators: The plant will be built a wastewater collection system and put garbage cans for daily collection so that no amount of stench can be generated.

- The operation phase of the power plant will not generate dust

- The exhaust gases generated during the period will be mainly from the decomposition of biomass which is flooded when the lake stores up water.

- Biomass flooded at the reservoir's foundation will be decomposed in anaerobic condition and release CO_2, H_2S, CH_4, NH_3, and a small amount of N_2O (nitrogenous oxide) that create unpleasant stench, contaminate environmental atmosphere, affect the health of workers and residents around the reservoir area.

The reservoir will be cleaned before storing up water. Also, inundated biomass at the proposed reservoir's foundation only includes roots, regenerative grass, organism, animal's corpses and organic matter in the soil, which have little masses. Therefore.amount of exhaust gases generated by decomposing biomass will be relatively small and mainly occur in the first few years of storing up water.

- Activities of the operators: The plant will be built a wastewater collection system and put garbage cans for daily collection so that no amount of stench can be generated.

Mitigation Measures:

- Complying with the cleaning procedure for the reservoir before storing up water to decrease inundated biomass, therefore, exhaust gases arising from the decomposition of biomass will be mitigated.

Applicable standards:

- QCVN 05:2013/BTNMT

4.1.1.3. Noise

Environment of the project area is affected by the noise, which is caused the mine exploding activities of foundation pit (range of influence: blasting area for executing the foundation pit) and the operation of transportation means (range of influence: along the roads of execution and operation), due to the operation of the equipment, construction machinery (the range of influence is mainly in the construction area: dam site, water way, power house. distribution stations and the construction area of auxiliary works. In addition, due to the voices of construction workers.

The noise, the vibration are caused be the mine exploding of foundation pit

The mine exploding causes the noise, the vibration and large concussion from the execution area of foundation pit. Instantaneous intensity of the noise due to mine exploding can be up to 95 – 100dB, even over 115 dB. However, time of the mine exploding is short. the time of mine exploding activities is usually implemented from 11h30 to 12h and 17h30 to 18h (in this time, the other activities stop working). In addition, the range of blasting in the areas of damsite, powerhouse, waterway, etc... which are far from the concentrated population areas, so Impacts are greatly reduced.

The noise from the transportation means, the machinery, equipment (excavators, bulldozers, concrete mixers, rollers, drilling machines....) on the construction site:

Table 4.6: Noise level from a number of machines. main means expected to be used during construction process at a distance of 15m

Type of machine	**Noise (dB)**	**Type of machine**	**Noise (dB)**
Heavy truck	70-96	Sawing machine	80-82
Bulldozer	77-95	Drilling machine	76-99
Compressor roller	72-88	Concrete mixers	71-85
Diesel air compressor	75-80	Motorized concrete breaker	80-85
Excavator	72-83	Crane	75-95
Pump	70	Electric generator	70-82

Source: From FHA (USA))

Actually, the construction area has a lot of resources and activities cause the different noise, they resonate with each other. So the noise in reality will be greater. According to the documents “Environmental impact assessment – Method and application” of Le Trinh, then the largest noise level due to resonance is 3dB. Then the noise of transportation means, machines on construction site with the largest resonance as follows:

Table 4.7: Noise level of transportation means, machines with the largest resonance at a distance of 15m

Type of machine	**Noise (dB)**	**Type of machine**	**Noise (dB)**
Heavy truck	73-99	Sawing machine	83-85
Bulldozer	80-98	Drilling machine	79-102
Roller	75-91	Concrete mixers	74-88
Diesel air compressor	78-83	Concrete press	83-88
Excavator	75-86	Crane	78-98

Pump	73	Electric generator	73-85

Based on the forested results in the table above can forecast the noise when there is the noise in the largest resonance level in some areas as follows: the largest noise in the dam site execution area is 102dB, 99dB in the areas along the road of execution, operation, 88dB in the area of concrete mixed station, etc … It can be based on the type of operating machines to determine the noise level when having the greatest resonance in each region, based on the contact standard to have the measures of organization, work arrangement, working time reasonably to ensure the health of workers.

Table 4.8: Noise exposure standard TCVN 3985-1999

The max allowable noise exposure time	**Allowable noise level (dB)**
24 hours	70
8 hours	85
4 hours	90
2 hours	95
1 hours	100
30 minutes	105
15 minutes	110
	Max level: 115

Thus, the noise is generated by the operation of means, machines and equipment during the construction process, which is measured at the distance of 15m from the noise source over 70dB; it causes the pollution of air environment. According to the allowable noise exposure standards, in this range, the workers are not allowed to work continuously for 24 hours.

In order to calculate the impact radius of the noise due to the mine exploding, due to the operation of machines, equipment, the formula is applied as follows (U.S department of transportation, 1972):

$$M1 - M2 = 20\log (R2/R1)$$

In which:

M1: The noise level at location 1; M2: The noise level at location 2; R1: Distance from the noise source to location 1; R2: Distance from the noise source to location 2;

Table 4.9: Noise level of blasting and machines, equipment according to the distance from noise source

Type of machine	**Distance (m)**							
	15	*30*	*60*	*120*	*240*	*450*	600	*3000*

Type of machine	Distance (m)							
	15	*30*	*60*	*120*	*240*	*450*	600	*3000*
Heavy truck	73-99	93.0	87.0	80.9	74.9	69.5		
Bulldozer	80-98	92.0	86.0	79.9	73.9	68.5		
Roller	75-91	85.0	79.0	72.9	66.9	61.5		
Concrete mixers	74-88	82.0	76.0	69.9	63.9	58.5		
Concrete press	80-85	79.0	73.0	66.9	60.9	55.5		
Excavator	75-99	93.0	87.0	80.9	74.9	69.5		
Diesel air compressor	72-89	83.0	77.0	70.9	64.9	59.5		
Crane	78-98	92.0	86.0	79.9	73.9	68.5		
Drilling machine	79-102	96.0	90.0	83.9	77.9	72.5	69.3	
Sawing machine	83-85	79.0	73.0	66.9	60.9	55.5		
Electric generator	73-85	79.0	73.0	66.9	60.9	55.5		
Pump	73	67.0	61.0	54.9	48.9	43.5		
Mine exploding	95-115	109.0	103.0	96.9	90.9	85.5	78.5	69.0

The results in the table show that when the distance doubles, the noises will degree about 6dB. Thus, in the radius of 450m from the noise source, the noise is generated by all machines, equipment less than 70 dB. The mine exploding activity has the affecting radius of 3km.

Thus, according to the calculation above, with the arrangement of camps, the auxiliary works and the current population distribution, then the noise as well as the dust and the exhausted gas do not affect to the concentrated population areas, only affect to the workers and some households around the construction during the execution period.

The distance from dam site – concentration location of construction activities to the boundary of Pu Hu natural protection area is 5.5 km, 6km distance to Pu Luong natural protection area, 26.7km distance to Hang Kia – Pa Co natural protection area and 30km distance to Xuan Nha natural protection area. Compared with the largest impacting radius (3km) can confirm the noise will not affect to the wildlife in these natural protection areas.

Impact mitigation measures:

- The transportation means and the machines, equipment (included in the catalog. they must be registered the achievement the standards on environment and technical safety of the Registry Department), when putting into operation, they must be achieved the standards of the Registry Department on technical safety and environment.

- Arranging the appropriate working time

- Regulatory regime of means, machines, equipment accordingly.

Applicable standard:

- QCVN 26:2010/BTNMT

2. Operation phase

The noise and the vibration in the operation stage are generated from the sources:

- Due to the operation of machines, equipment in the power plant: Turbine. Generators, ventilators, etc …

- Due to the voice of the operation workers of power plant

The power plant will be installed the advanced machines, equipment and the walls will be installed the sound proof devices, so the generating noise will just affect within the scope of power plant. The operation workers are arranged according the working shifts and equipped the protective clothing, so impacts reduce significantly.

4.1.1.4. Climate

Regional climatic conditions around Hoi Xuan HPP will have the change according to a positive direction. However, Hoi Xuan reservoir is small, narrow, extending about 29km along river, so the formation of Hoi Xuan reservoir has the insignificant impacts on the climatic regime on the basin, the impact scope is small (micro climate). It can forecast the change of some main climatic characteristics as follows:

- The heat regime: When Hoi Xuan reservoir stores full water and starts operation, fluctuation of temperature during day and year will decrease in the surrounding area of reservoir. Specifically, the maximum value will be reduced, while the minimum value will be decreased.

- The relative humidity: The lowest absolute humidity will increase in all months of the year. The mean humidity is almost unchanged, increases about 1% in the hottest dry months.

If considered separately, the climate conditions are improved in the small area, but considered on the hydropower cascades of Ma river (Hoi Xuan HPP and Trung Son HPP); the improvement scope of climatic conditions is larger.

4.1.1.5. Hydrology

a. Impacts on hydrological regime of surface water

The reservoir filling and the operation regime of Hoi Xuan project will change large the flow regime of Ma river from damsite of Hoi Xuan HPP to the downstream. In this river section, two different flow regimes will be appeared and their boundary is the damsite of Hoi Xuan HPP.

- ➢ hydrological regime of surface water in the normal operation regime

The upstream of damsite (reservoir area)

The reservoir is built in the river section with the length of 29km in the upstream, it creates a reservoir, and the flow regime of river is replaced by hydrological regime of reservoir. Flow velocity into reservoir is decreased suddenly; the ability of carrying sediment reduces significantly, a part of sediment is deposited in the reservoir, reducing the operation capacity of reservoir and reducing amount of sediment down the downstream. This is the impact occurring to any hydropower, irrigation projects and reservoirs.

Due to Trung Son HPP in the upstream of Hoi Xuan HPP, so the sediment into Hoi Xuan reservoir reduces significantly, it is mainly the sediment from the between region of Trung Son, Hoi Xuan dam sites and the sediment via turbine of Trung Son powerplant. According to the calculated data, the annual sediment into reservoir is about 0.417 million m^3, amount of sediment deposited in reservoir is 0.159 million m^3, which accounts for 0.25% of dead volume. The economic life of project is 40 years, so this is less influence to the active volume of reservoir and the benefits of the project.

Hoi Xuan HPP is the last cascade on Ma river system, the generator is mainly used the discharge from Trung Son powerplant and the flow of the between region, so the water level and hydrological regime in the reservoir not only depend on the operation regime of Hoi Xuan powerplant, the rainfall, the regulation of vegetation coverage, but also depend on the regulation of Trung Son powerplant.

The downstream of damsite

- Ma river section from the tailrace channel of powerplant to the confluence location with Luong river:

+ When without Hoi Xuan hydropower, Trung Son hydropower has the generation regime for covering the peak of the load diagram, so the flow regime of Ma river in the downstream of Trung Son hydropower is also consistent with this operation regime: many water in the operated hours (7h/days, 10h -12h and 18h-21h). less water in the non operated hours (the rest hours in day). Impacts on environmental flow are large.

+ When building Hoi Xuan hydropower: Hoi Xuan hydropower will use the flow discharged from Trung Son hydropower to generate power, it is operated according to the daily regulation regime, power generation during 24/24h with the discharge flow of 70.56m^3/s(dry season). The flow regime of Ma river from Hoi Xuan hydropower to the confluence location with Luong river is also similar to the flow regime in the downstream of Hoi Xuan hydropower, the flow regime is equable and stabilize with the flow of 71.16m^3/sin dry season (including the discharge flow from Hoi Xuan powerplant: 70.56m^3/s and the flow of the between region from Hoi Xuan damsite to the confluence with Luong river 0.6m^3/s), which reaches about 29.15% of the natural flow calculated to Hoi Xuan damsite ($Q_{0Hoi\ Xuan}$

$_{damsite}$ = 244.1m^3/s), this flow maintains at good level for ecology (according to Tennant method).

- Ma river section from the confluence location with Luong river to the downstream

In the downstream, Luong river is located relatively close to Hoi Xuan hydropower, the distance is 5km. Luong river provides for Ma river a significant amount of water with the flow of 13.4m^3/s. Along with the steady flow discharged from Hoi Xuan hydropower (24/24h) is 70.56m^3/s and the flow of the between region is about 0.6m^3/s, total flow of Ma river at the confluence with Luong river is 84.56 m^3/s. the flow reaches up 34.64% of the natural flow calculated to Hoi Xuan damsite ($Q_{0\ Hoi\ Xuan\ damsite}$ = 244.1m^3/s), this flow maintains at good level for ecology (according to Tennant method).

Thus, Hoi Xuan HPP is built to reduce Impacts due to the generation regime of covering peak demand of Trung Son hydropower on the flow regime of Ma river in the downstream area, and ensure the environmental flow in the downstream area.

❖ Hydrological regime in the operation conditions during flood season

Flood flow on Ma river in the downstream of Hoi Xuan hydropower is regulated according to Hoi Xuan reservoir operation schedule, which was approved by the Ministry of Industry and Trade.

Mitigation measures:

In order to minimize Impacts due to the reservoir operation during flood season. The project owner will implement the following measures:

For Hoi Xuan hydropower reservoir:

Flood flow regulation complies with the reservoir operation schedule:

the project owner shall commit the strict adherence the reservoir regulation schedule, the current regulations on the water discharge, flood discharge and always timely information to the local authorities, the management boards of adjacent hydropowers (Trung Son hydropower is directly), etc … in the areas of the project and the downstream, in order to minimize the damages of life and property of people caused by the process of water discharge, flood discharge.

- For the downstream of Hoi Xuan hydropower: the project owner shall commit the strict adherence the reservoir regulation schedule.

In order to ensure the safety for the downstream works, the life and property of people in the downstream. The project owner will widely publicize the regulation regime of reservoir, the operation regime of powerplant for people, local authorities, the related agencies. The management board of the hydropowers on the same cascade system and the other economic organizations, which are known.

The other hand, in the process of operation, the project owner often coordinates with the local authorities in the monitoring activities of the flow (observation of flow, water level) and bank erosion, in order to provide the reasonable mitigation measures.

- The damages (trees. crops or facilities) are caused by the water discharge; flood discharge of the project, the unit of management, operation of Hoi Xuan HPP is responsible for compensation, support, overcoming the damage.

b. Groundwater

When the reservoir stores water, it will create a number of ground water table in the shallow layer, especially in below the lowlands of reservoir area, increasing the groundwater level and the humidity of soil, which creates the favorable conditions for the development of plants prefer moisture, but also contribute to promote the lakeshore erosion process. However, the reservoir area is small (6.19km^2); the water level is irregular at full supply level, so the level and scope of impacts are not large.

4.1.1.6. Land and land resources

1. Stage of preparation and construction

a. Impacts of solid waste

Generating sources of solid waste at this stage including:

+ The solid wastes due to the construction of work items including: waste soil, construction materials are spilled, removed.

Excess materials, spillage, removed during the construction progress including: brick, crushed stone, mortar, concrete, wood, pieces of iron and steel, parking, sawdust, wood chips, car rags, broken machines, ect, (It is mainly in the construction area and auxiliary area). Volume of this waste can not be determined precisely, but these are not the biodegradable ability, easy to be washed with the flow so these are collected, treated reasonably when flood flow occurs.

+ The trees is cut down during the process of site clearance for building the construction items (dam site, powerplant, distribution stations, roads of construction – operation, construction areas of electric and water system, camp area, yards and other auxiliary areas) and the reservoir area.

+ Domestic waste of construction workers (mainly in the camp area): excess food, the damaged clothes and footwear, empty bottles, etc.

The solid waste is generated by the construction activities, which will occupy the land for dumps (rock, soil waste dumps, and rubbish dump). In addition, the water from the rubbish dump will leach into the ground cause the land pollution, if the rubbish dump is not built and treated according to the process and ensure environmental sanitation. Rags for machines with oil are the hazardous waste if not collected; they will also cause the pollution of the environment of soil, water.

+ In addition, there are also the wastes when cleaning up the residential area, graves.

❖ Acquired land for waste dumps of soil. rock:

Volume of rock, soil from the foundation pits of main construction sites such as damsite, powerplant, distribution station are about 3,110,733 m^3. In addition, the volume of rock, soil of removing vegetation coverage, ground leveling, execution of construction-operation roads is also quite large, the specific data will be determined in the next stages.

The entire amount of waste rock, soil is arranged in five waste dumps: three right bank waste dumps (total area is about 8.88ha) are arranged near the service road TC2 and two left bank waste dumps (total area is about 9.46ha) are arranged along the National Highway 15A. Total acquired land for soil, rock dumps is 18.94ha.

The exploitation in sand mine will also generate waste sand volume (including fine-grained sand and clay), an average volume of about 600m^3/year but this sand is utilized for leveling work and for local people to take advantage of leveling up. It is not necessary to arrange disposal area.

❖ Acquired land for the domestic solid dumps

During the construction progress, a number of workers will range from 1,500 to 3,200 people. With the volume of domestic waste averages 0.5kg/person/day and the density of solid waste is 500 kg/m^3, so the daily waste at construction area is from 1.5 m^3 to 3.2 m^3. Thus after 4 years of construction, it is estimated to generate approximately 3,730.665 m^3 of domestic waste.

Table 4.10: Volume of domestic waste during the construction process of the project

No	Progress	Numbers of people	Daily domestic waste (*m^3/day*)	Annual domestic waste (*m^3/year*)
1	1st construction year	1,565	1.565	571.225
2	2nd construction year	2,355	2.355	859.575
3	3rd construction year	3,261	3.261	1,190.265
4	4th construction year	3,040	3.040	1,109.600
Total volume of waste (*m^3/4 years*)				**3,730.665**

The composition of domestic waste is mainly the organic substances: removed vegetable, fruit peel, rise, soup and excess food.

The inorganic substances including: plastic bags, cans (beer cans, cans of canned meat), etc… There are also: clothes, footwears, hats, removed papers, etc… There substances are difficulty or inability to decompose and needed the treatment measures.

Compared with the soil, rock waste the domestic waste is not large, but the main component is the organic substances, which is the environment for the development of micro-organisms, especially the micro-organisms can cause the harmful for people and can affect to soil environment, water surface sources of Ma river, groundwater in the dump areas. Thus, it should have the measures to collect and treat the domestic waste effectively.

❖ For fallen trees:

Vegetation coverage in the acquired land area for the hydropower construction is mainly the planted forests (Dendrocalamus barbatus, Sapele, Ebony, etc …) (account for 26.58% of total acquired land for constructing the Hoi Xuan HPP) and a few rice, which are harvested before the acquired land, thus volume of the felled trees is not large.

❖ For the waste when clearing the residential areas, graves:

- The waste when clearing the residential areas: Imperata cylindrical, bamboo, brick walls, furniture, clothes, etc… which are left by people when moving out of the areas of reservoir and head works.

- The waste when clearing the graves: coffins, clothes, etc…

Mitigation measures

- The domestic wastes will be collected, transported to the dumps and treatment and burial according to rules, in order to prevent the pollution of soil, water in the dump areas and surroundings, specifically:

+ The contractors and the construction unit must implement according to the regulations on the general sanitation of the construction area, the public waste bins will be arranged on construction area to collect and transport the garbage to the designated places.

+ Building a sanitary landfill of domestic waste according to regulation standards on environmental sanitation.

In order to store amount of domestic waste above, a sanitary landfill needs to be built with the height of 5m and the wastes are pressed to the specific weight of 700 kg/m^3 and 4 times of ground cover with the height of 10cm, so the scope of the sanitary landfill is:

Volume of landfill: $3,730.665 * (5/7) = 2,664.761\ m^3$

Plot area of landfill: 2,664.761: (5-0.4) = 579.295 m^2

Landfill surface area: 579.295: 0.75 = 772.394 $m^2 \approx$ 0.0772 *ha*

Including the entrance road, duty house, yard, etc… so the scope of landfill is 0.1ha.

Construction location: the burial pits are arranged according to the regulations: the landfill is located outside the reservoir area; the area is not flooded and is not affected by flood discharge.

Treatment methods of domestic waste: the landfill pit must be built according to the sanitary regulation. The landfill is arranged near the water source, so the base of landfill must be designed waterproof, ensures the permeability of the pit base of 10^{-7} cm/s and does not pollute the groundwater. The wastes are pressed and sprinkled lime before covering the soil. Groin systems are built to prevent the rainy water flows to landfill pits.

+ The waste in bins will be collected to landfill every day

+ After each day of collection must be covered with a thick layer of 10cm soil to minimize the odor and activities of insects.

+ After completion of construction, this landfill will be buried, bulldozed and compacted according to the process of treatment and tree planting.

- Spending the maximum volume of soil, rock excavation of foundation pits to make the paving stones, concrete gravel, and backfill soil, in order to minimize amount of waste rock, reducing the acquired land area for making the landfill.

The rest waste rock, soil will be collected to the private landfills for preventing the environmental problems such as erosion, landslides, flash floods, etc … during flood season.

The waste dumps are arranged in the favorable location for the construction process and ensure the environmental issues including five waste dumps (18.94ha): three right bank waste dumps (total area is about 8.88ha) are arranged near the service road TC2 (figure 3) and two left bank waste dumps (total area is about 9.46ha) are arranged along the National Highway 15A (figure 3).

A landfill along HW 15

(landfill is a low-lying location along roads, spoils will be leveled, compacted to create spaces, that will not affect the operation of traffic and limit soil erosion)

The construction units, the contractors will transport the removed soil, rock to the landfills, which were planned above. In order to stabilize the edge of waste rock, soil mass; preventing the erosion the wastes into rivers, reservoir; minimizing the pollution of water resources; landscape protection, etc… in the surroundings of the landfills. It expects to embank the retaining dike and will dig the ditch around the landfill to collect the rain water carries the suspended solid and deposited before flowing into rivers. When pouring the waste, conducting large-sized stone backfill in surrounding areas, loose soil, rock in the middle, the bulldozing compaction in layers to create the density, limiting the washout according to the flow, increase the water turbidity. After the completion of construction, these landfills will be bulldozed; compacted tightly and planted trees to make the beautiful scenery area, increasing the surface vegetation coverage, ensuring the soil, rock in the landfills are not landslided, eroded according to the flow into rivers. The costs for construction of the waste dumps, bulldozing, compaction, and treatment according to the disposal process are paid by the contractor. Due to the right bank landfill and the left bank landfill of Ma river are located near the river, so the project owner and contractors will perform closely supervision on the disposal activities and the treatment methods.

- For the furniture, common items, construction materials, which are spilled, removed: Classification of the waste materials can reused such as covers of cement, cardboard, cans, bottles, damaged clothes, shaving cover, etc... will be used to sell for scrap, making fuels, cleaning the machines (damaged clothes), etc ... The materials can not be reused, which will be collected to burn or dump into the landfills and bury with the garbage. The oily rags will be collected for treating according to the regulations to prevent the pollution of soil and water.

Before acquiring the land for the project, people will harvest all the agricultural products on their land: using trees, branches as fuels to reduce the volume of waste. The rest wastes will be cleaned and burned a controlled manner or dumped into the landfills to bury with the garbage.

- For the wastes due to clearing the residential areas, graves: After the households move their homes and graves to a new location, the project owner will proceed to collect the construction materials, which are left by local people and the waste of graves. All the waste will be burned a controlled manner to prevent the forest fire.

Applicable standard

- QCVN 25:2009/BTNMT

b. Impacts due to erosion

The construction activities of the work items will make friable soil, rock to accelerate the process of erosion, wash away of soil nutrients.

In addition, the operation of vehicles, machines and equipment can change the soil physical properties (the density, grain structure, etc...) or cause the soil pollution due to the oil leakage in the maintenance process.

Mitigation measures:

- Planting trees in the temporarily occupied areas:

After completion of construction, the contractors and construction units will clear, bulldoze the site plan of the temporarily occupied areas (worker camps, garbage dumps, waste rock dumps, yards, the areas of material exploitation, etc...). Then the plants will be planted for greening these areas. The planted area is equal to the the area of temporarily occupied land during the time of the project implementation. This area will be determined accurately after cadastral survey to give the land area for the project construction.

- Implementing the periodic maintenance of machines, construction equipment to ensure non-leakage of oil into environment, polluting the soil and water.

2. Operation stage

- Impacts due to the domestic waste:

According to the design, the plant operation workers are about 88 people, the workers work according to shifts. Therefore.amount of domestic waste of workers is very small compared with the waste in the construction stage (about 44kg/day, nearly $0.01m^3$). In addition, the powerplant is full designed the sanitation system according to the civil design standards, so the wastes will not dump directly into the natural environment, so the wastes generated by the activities of operation workers have less impact on the environment and people. Powerhouse operation management board will contract with the agency which implements waste collection in the locality to collect and transport the project's domestic waste in accordance with the local conditions.

- Land resources will be flooded when the reservoir stores water. When the reservoir stores water, 678.27ha of land will convert to the water surface area, in which 282.5ha all kind of lands (account for 41.65% total flooded area of reservoir area), the rest part is the land of rivers, streams (395.77ha. account for 58.35%).

The flooded lands include most of the land in the basin, but mainly the red-brown soil on limestone and yellow red soil on metamorphic clay rock; a little alluvial soil, scope land distributed along the river valley. In general, the land here is rich in nutrients, the thickness of soil layer reaches over 50cm, mechanical components from moderate to severe, suitable for many kinds of plants, which were exploited by local people to plant (woody bamboo) and rice.

After the soils are sunk about 3-6 months, the plants, the dead body of organisms living in the soils (worms, crickets, etc...) will be decomposed, and the soils in the bottom of reservoir will be broken the structure, lost the coherence of soils and pasty, etc... forming the mud deposit in the bottom of reservoir. According to the direction of flow, the bottom mud will tend to move to the bottom zone off main dam and they are often trained according flow when discharging water, flood.

- The land zones near banks are flooded, increased the humidity, the erosion, creating the mud deposit in the reservoir bottom.

- When the reservoir stores water and starts operating, then the moisture of soils around the reservoir will increase (estimated 10-15%).

Mitigation measures:

- In the study process for establishing the investment project has selected the optimal alternative, less impact on the soils, which have the ability of agricultural production, residential land and public work lands. In the area of lands will be converted to the water surface area of the project, land of rivers, streams accounts for 58.35%.

- Strictly forbid any activities that adversely affect the reservoir shoreline structures, especially not exploit the frequent wetlands, submerged area (exploitation of land, sand, etc...)

- Protecting the development of plants prefer moist and the aquatic vegetation along the shore: reeds, bamboo....

4.1.1.7. Mineral resources and building materials

❖ Thereservoir area

According tothe conclusion of theDepartment of Geology& Minerals of Vietnam (at the Correspondence No. 49/DCKS-DC dated January 9th 2008), inthe reservoir area of Hoi Xuan hydropower project it has not discovered any other valuablemineralsfor industry yet besides the common minerals used as buildingmaterials.

Common building materials in the studied area are mainly sand used for construction. There are not any companies licensed for exploitation of sand borrows on Ma river besides the VNECO Hoi Xuan Investment and Electricity Construction Joint Stock Company. This sand borrow is located in Kham village. Hoi Xuan commune away from the powerhouse about 10 kilometers. There are also a few exploitation areas where local people exploit sand material for construction of their private house.

On the other hand, the reservoir has the Normal Water Level of 80 meters and extends along the rivers with the length of about 29 kilometers. The reservoir's surface area is around 6.19 square kilometers, of which the area of rivers and streams accounts for 63.9% so it can be said that most of reservoir area is located entirely in the riverbed. The submerged area has a small area distributed around the reservoir. Therefore, the impounding water for the reservoir will almost not cause the loss of mineral resources as well as effect on the discovery and exploitation of mineral resources.

❖ Construction site of work items (out of the reservoir area)

According to the mineral map 1:100,000 in scale of Quan Hoa district, in the studied area near the reservoir area and dam site of Hoi Xuan hydropower project, there are two iron mines. One is located in Phu Xuan commune and one located at the downstream in Hoi Xuan town. These two mines have not been researched, investigated and evaluated indetails as well as licensed for exploitation yet. Their locations are out of the range of land recovery for the project.

The common building materials are mainly sand and stone used for construction. Currently, there are not any companies licensed for exploitation of these quarries besides few exploitation areas where local people exploit sand material for construction of their private house.

Thus, the construction of Hoi Xuan hydropower project in assessment will not effect on the mineralresourcesin the project area.

4.1.1.8. Water quality

1. In the stage of preparation and construction

a. Impacts ofdomestic wastewater produced by the staffs and workers on the construction site

The domestic wastewater will be generatedduring the activitiesof workers on the construction sites of dam, powerhouse, outside power yard (OPY) station, construction-operation roads, system of power and watersupply for construction, camps, warehouseandother auxiliary facilities.

The water demand and quantity of wastewater generated by staffs and workers on the construction site are forecasted as the following:

Table 4.11: The water demand and quantity of wastewater generated by staffs and workers on the construction site

Construction year	Number of works (people)	Water demand (m^3/day)	Water demand f other activities (infirmary, etc)	Total	Total amount including unequal factor of water use $K_{day.max}$ = 1.2-1.4	Accrued wastewater quantity (m^3/day)
1st construction year	1,565	187.8	20.57	208.37	291.72	233.37
2nd construction year	2,355	282.6	20.57	303.17	424.44	339.55
3rd construction year	3,261	391.32	20.57	411.89	576.65	461.32
4th construction year	3,040	364.8	20.57	385.55	539.77	431.82

The wastewater compositions include organic matter, total suspended solid (TSS), detergents and microorganisms, etc. When the wastewater drained into Ma river and other rivers and streams. The content of these compositions will increase causing the pollution of water resource and effect on aquatic organisms.

According to the analysis results, by Tran Duc Ha, major in sewerage of the Engineering University, the compositions of domestic wastewater are as follows:

Table 4.12: The compositions and quality of domestic wastewater

No.	Analyzed indicators	Unit	Wastewater in public sewer	Wastewater in private sewer
1	pH		7.0 - 7.8	7.2 - 7.8
2	TDS	mg/l	100 - 250	150 - 350
3	DO	mg/l	0.5 - 2.0	0 - 1.5
4	BOD_5	mg/l	80 - 250	150 - 350
5	COD	mg/l	120 - 400	180 - 600
6	Total N%	mg/l	5 - 30	8 - 35
7	Total P%	mg/l	1.5 - 3.5	1.5 - 4.5
8	Coliform	MNP/100ml	10^4 - 10^7	10^5 - 10^7

(Source: Tran Duc Ha, Engineering University)

Thus, the content of compositions included in the wastewater produced by the workers on site is forecasted as follows:

Table 4.13: The content of compositions included in the wastewater produced by the workers on site (in the 3rd construction year of the most crowded workers)

Parameters	Content (kg/day)	Parameters	Content (kg/day)
Suspended solid	46.132 - 115.33	Total N%	3.46 – 20.74
BOD_5	36.906 - 115.33	Total P%	1.04 – 2.42
COD	43.36 - 276.53	Coliform	$691.32.10^8$ – $691.32.10^{11}$

With the wastewater volume of 461.32 cubic meters per day (i.e. 168,381.8 cubic meters per year) and the maximum amount of suspended solids drainedintothe river will be 42,095.45 kilograms per year, average concentration of suspended solidsin the wastewater after being drained into the river will be 0.0053 milligrams per liter. This means that the concentration of suspended solids in the water of Ma river will increase 0.0053 milligrams per liter more-a minor increase.

So, it can be seen that the wastewater produced by domestic activities of workers is fairly high but when discharged to source which having high regular exchange volume (7,947.072 cubic meters) like Ma river, the concentration of substances in the wastewater is significantly diluted. River water after receiving wastewater does not change much as compared with the natural water. On the contrary, the domestic liquid waste will be collected and treated before discharging to the river (mentioned in mitigation measures), so water quality is not substantially affected.

Mitigation measures:

During the construction process, the domestic wastewater will be generated primarily from the daily activities of human such as products of excreta, taking a bath, washing clothes, sanitation, etc. The substances in domestic wastewater exist under various forms such as suspended matter (scrap paper, plastic, nylon bags, etc), or solid matters (in colloid or solution) and malignant bacterium. Therefore, the following mitigation measures are needed:

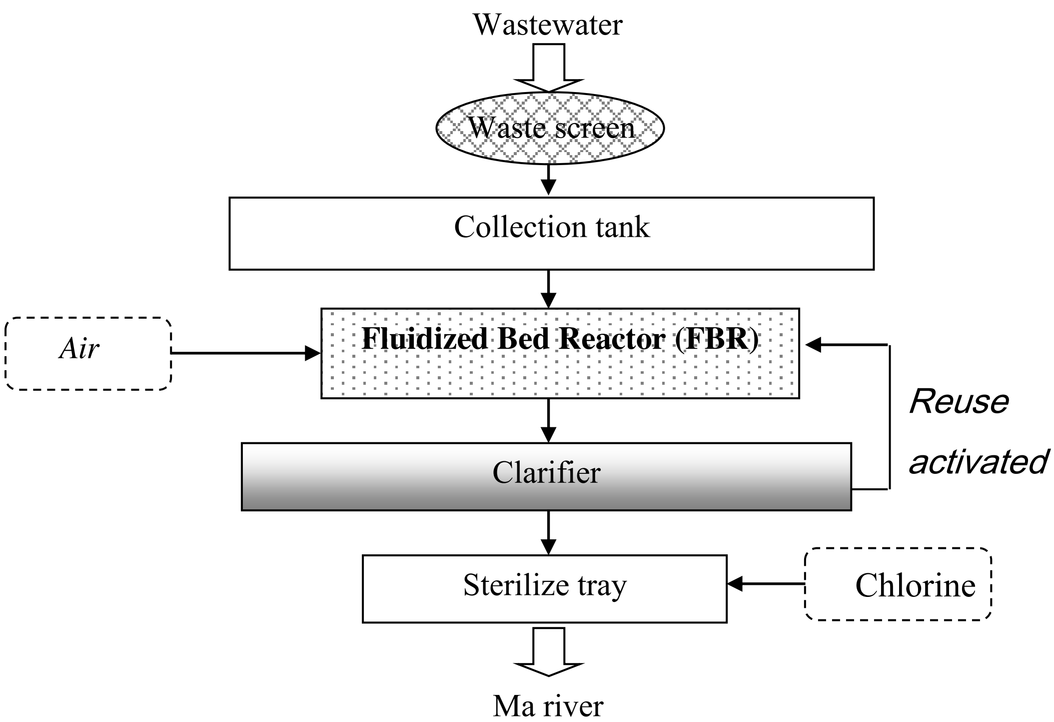
- Build the septic tankin thecamps for workers and the domestic house area for the management staffs;

- Total gray wastewater from toilets must be collected into septic tank for anaerobic treatment;

- For the common wastewater (from cooking. washing dishes, cleaning floor, bathing and washing clothes…) will be collected and treated in order to meet the environmental standard before discharging into Ma river.

For favorable use in the operation period of the project, the wastewater treatment system should be arranged closely to working zone of the Project Owner and the Contractor (figure 3). All of wastewater from residential area andcamps for worker must be collected into public treatment area.

Common domestic wastewaterwill be collected.treated anddischargedin accordance withthefollowing process:



Principle ofoperation:

The domestic wastewater will be collected following the public pipeline, through the waste screen and then entering the collection tank. From the collection tank, the wastewater will be entered the Liquidized Bed Reactor FBR (permanent stuff kind). At there, the wastewater will be continuously bubbled; the aerobic microorganism adheres on stuff material's surface will decompose organic substances in the wastewater. Then the wastewater will be transferred into clarifier for sludge deposition, the activated sludge will be returned to the FBR for being retreated. The wastewater will be entered the sterilize tray to be treated with chlorine, and then drained into Ma river following the pipeline. The treated wastewater must meet the level II in accordance with Vietnamese standard TCVN 6772-2000.

Applicable standard

- QCVN 08:2008/BTNMT

b. Impacts ofconstructional wastewater

The constructional wastewater will be generated from the processing operations of building materials (washing sand and stone, mixing concrete, etc); and from other operations such as maintaining concrete, cleaning vehicles, exchanging engine oil, maintaining machinery and vehicles, etc.

According to the design, amount of water used during the construction will be around 1,497.74 cubic meters per day.

Table 4.14: Water demand for construction operations

No.	Work items	Water demand (m^3/day)
1	Water for concreting work (including the unequal factor in month from 1.1 to 1.4); the number of days for concreting work in month are 25 days.	185.76
2	Water for maintaining concrete (including the unequal factor in month from 1.1 to 1.4), the number of days for concreting work in month are 25 days.	301.24
3	Water for cleaning the concrete aggregate (including the unequal factor in month from 1.1 to 1.4); the number of days for concreting work in month are 25 days. Of which.	
	For cleaning crushed stone	90.37
	For cleaning sand	45.19

No.	Work items	Water demand (m^3/day)
4	Watering for construction road to reduce dust (watering 2times per day)	78.00
5	Water for washing machinery	56.00
6	Water for firefighting (calculated for 2-3 hours)	216.00
	Total (1+2+3+4+5+6)	972.56
	Provision for other demands (10% of (1+2+3+4+5+6))	97.26
	Total	1,069.82
	Total water demand (including the unequal factors in water use) $K_{day.max}$ = 1.2-1.4	1,497.74

The constructional wastewater containsoil and grease, many suspended solid substances and not excluding the possibility of containing some heavy metals.

Among construction activities, the construction and maintenance of concrete are the most in water demand, but the activities of maintaining concrete, cleaning building materials and vehicles will generate the largest volume of wastewater, which is considered as approximately much as the water used. The wastewater from the firefighting operation is infrequent, it will be only produced in the event of fire occurs. The watering for construction roads to reduce dust and the concreting works will almost not generate the wastewater. Thus, the constructional wastewater from some main sources can be forecasted as follows:

+ The wastewater from concrete maintenance activities: 301.24cubic meters per day

+ The wastewater from aggregate cleaning station, of which:

For cleaning crushed stone: 90.37 cubic meters per day

For cleaning sand: 45.19 cubic meters per day

+ The wastewater from cleaning the machinery 56.0 cubic meters per day

The wastewater contains many suspended solids. Just for the wastewater from cleaning machinery contain engine oil and grease must be treated with appropriate measures. If not, it may cause the pollution of water in Ma river, the underground water as well as surrounding land surfaces in case of it spread far and wide on the surface.

- The waste engine oilduring the repair and maintenance of machinery and equipment:

Amount ofused engine oil averages 18 liters per time per vehicle, and average number of oil replacement times is 4 times per vehicle per year. The number of vehicles concentrated in the peak period is around 105 units. Therefore, during 4 years construction of the project (including a year of preparation) the maximum amount of waste engine oil will be about 30,240 liters.

This is the type of hazardous liquid waste discharged from the machinery operating on site (trucks, excavators, bulldozers, rollers, etc). It has a major impact on quality of surface water, groundwater and soil environment. Therefore, total amount of engine oil after exchanging will be thoroughly collected at the maintenance and repair stations.

Mitigation measures:

- Engine oil will be collected at the maintenance and repair stations to be handled and itis not allowed to drain directly into the environment orany other water sources. The Project Owner will sign a contract with the agencies that take the task of transporting engine oilto the area of treatment, re-use or used as fuel for other production processes.

- Wastewater from cleaning vehicle activity will be collected intoa tank to deposit, and then passed through sand filter tank for creating suspension and oilscum before being drained into the environment.

- Wastewater from cleaning material activity will be collected into a tank to deposit sediment then drained into the public pipeline.

- Just for wastewater from activity of dam concrete maintenance: currently inVietnam, there arenot any effective measures to collect wastewater from activity of dam concrete maintenance. According to calculation in addition, the water demand for concrete maintenance for the entire projectis 301.24 cubic meters per day, of which asmall part will penetrate into the concrete and the rest will be returned to the river. Amount of wastewater flowing into the river after the operation of concrete maintenance is not significant as compared with the annual natural flow of Ma river of about 244.1 cubic meters per second (i.e. 21,090,240 cubic meters per day-a large flow exchange). According to this, it almost does not impact on water quality.

c. Impacts of rain-water spreading far and wide on the construction site.

With the annual layer of flow of about 584.56 millimeter, amount of rain-water flowing on the surface of the construction area (approximately 67 hectares) is about 391,665.2 cubic meters per year.

In general, the rain-water flowing through this area is not large but the runoff will sweep away many substances, loose rock and soils, the mineral salts on the surface, leakage engine oil. This will increase the concentration of suspended solids, organic matter, and turbidity and also increase the content of oil, etc in the water.

Just for the disposal sites where the waste rock and soil exist in loose form (in rock/soil disposal areas), which contains many organic matters and microorganisms especially the harmful microorganisms (landfill). So, the water flowing out from the waste soil and rock sites and landfill contains many suspended solids, organic matters and bacteria. There should be the proper mitigation measures and strict monitoring-if not, the water environment of rivers and streams in the project, the groundwater and the soil environment (mostly in landfill) are likely to pollute. In particular, the material storage and disposal areas (Figure 3) are arranged in the areas along Ma riverbanks so they are likely to slide; and the loose material suffering from being washed away is possible. These cause the pollution of water environment in the reservoir and at the downstream.

Mitigation measures:

- The rain-water spreading far and wide on the surface of auxiliary facility, camp and rock/soil disposal areas will be collected into the ditch system. which equipped with trash rack to deposit sediment and solids washed way from surface before flowing into the rivers and streams. Just for the areas of powerhouse, dam site… the rain-water and leakage water will be collected into the foundation pit to deposit sediment before pumping into the river.

- The rainwater flowing through the landfill will be collected and treated to ensure environmental requirements as specified.

d. Impacts ofsolid waste

The domestic waste, constructional waste, the waste produced by people as moving to a new location left and the waste of graves being moved to another location must be collected. If not, these will increase the turbidity, suspended solids and organic matter…. which are washed away from surface; and cause the pollution of water environment as well as effect on aquatic life. The subjects that suffer from the impact are Ma river, the tributaries of spring surrounding the construction site of work items and disposal sites.

In addition, the groundwater strata under the landfill areas can also be contaminated by the leakage water if the landfills are not built and handled properly in accordance with the process and environmental requirements

Mitigation measures:

Mitigation measures against Impacts caused by the domestic waste:

- The construction contractors and agencies must arrange the public waste bins to collect garbage.

- Build one landfill for domestic waste (area of 0.1 hectare) that meets the standards of environmental sanitation. Arrange the collection and treatment *systems* of leakage water (water leaking out from the landfill and rain-water flowing through the landfill) to prevent the water environment *surrounding* the project area from pollution.

- The landfill location must be arranged out of the submerged area caused by the reservoir.

- The garbage in the bins will be collected and transported to the landfill every day.

- Landfill must be covered by a soil layer 10 centimeters in thickness after each day to minimize odor and activity of insects.

- After finishing the construction, this landfill will be buried, leveled and compacted in accordance with the processes of garbage disposal, on which the green trees will be planted.

Mitigation measures against impacts caused by cutting down trees:

- Collect thoroughly the vegetable matter.

- Allow local people to thoroughly harvest their crops before the clearance for construction of the auxiliary facilities.

- Collect thoroughly those trees to be used as firing. Their branches and leaves will be collected and burnt in monitoring, or transported to the landfill to be buried to prevent the water pollution caused by erosion or washout.

Mitigation measures against impacts caused by constructional waste such as disposal rock and soil, scattered and discarded materials (bags. shavings. etc):

- Utilize the excavated soil and rock for using as paving stones. crushed stone for concrete and soil fill material. The excavated rock/soil will be transported to the planned disposal sites. When implementing disposal. The large-size rocks will be poured near the boundary of the disposal site while the loose rocks in the middle. Then it will be leveled and compacted into layers to create the density for preventing from the increase of water turbidity caused by erosion and washout. After finishing the construction, this landfill will be used to plant trees.

- Collecting the furniture, tools and discarded materials: bags, shavings, pieces of steel, thick broken sandals, discarded hats and clothes, firewood, broken chairs ... to use for cleaning machinery, do the cooking or being recycled.

- Collecting the discarded materials that can not be reused to burn (in monitoring) or transported to the landfill to be buried together with domestic garbage in accordance with the disposal process.

Mitigation measures against impacts caused by waste left by local people or graves as moving to another place:

- Sprinkling lime to sterilize, disinfect and clean the breeding facility area, toilets and graveyards which have been moved to another location.

- Collect the furniture, tools and materials left by local people as moving to another place to burn in monitoring or *transport* to the landfill to be buried together with the domestic garbage.

- Collect the sarcophagi (coffins), clothes of the deceased… to burn in monitoring or transport to the landfill to be buried together with the domestic garbage.

e. Impacts of toxic chemical OB survived from the war

- If poison survived in earth's womb from the war is submerged. it will cause water pollution, effect on aquatic life and other objects at the downstream as well as surrounding the reservoir area. It will effect on people health if they use fish and other foods contaminated with OB. The wide scope of impact (from the reservoir to the downstream areas), together with being long-lived in the water, it will effect on humans over the generations. Therefore, investigating and treating it before impounding water for the reservoir are needed.

Mitigation measures:

- To ensure water quality and health of people in all aspects and in the long term. the Project Owner has been submitted in written to the military authorities to ask whether the toxic chemical OB still be survived from the war in the reservoir area or not.

- If these authorities confirm the existence of the toxic chemical OB in the reservoir area. The Project Owner must be responsible for hiring the military its specialized units to reconnoiter, detect and treat it before the impounding water for the reservoir with the purpose of preventing the poison from being widespread.

f. Impacts of sand exploitation serving for construction of the project

Sand exploitation at the sand borrow serving for construction of the project will not only change the terrain of sand borrow but also change the flow regime in this area. This will increase the erosion and landslide of riverbanks as well as the turbidity of the river water, and effect on the aquatic life.

Mitigation measures:

Comply with the exploitation procedure and give out a sensible exploitation plan to avoid changing the river its flow regime. During the sand exploitation in this area, if occurring abnormal phenomena or not enough volume for construction. The Owner should stop exploiting to avoid deeply digging and excessively exploiting the riverbed; and carry out surveying and finding the new sand borrows.

2. In the operation phase

a. Impacts of domestic wastewater

The number of workers and staffs in the stage of operation will be about 88 people; amount of wastewater generated is therefore not significant as compared with as much as approximately 8.448 cubic meters in the construction stage. Moreover, whole sanitary system of the powerhouse is designed in accordance with the civil design standard; the wastewater will be therefore not drained directly into the natural environment.

b. Impacts of engine oil during the operation process

For the turbines of the hydropower, they will be the advanced type of devices which do not result in leakage of oil during operation. The engine oil produced from the maintenance operation will not be drained directly into rivers and streams due to the collection and storage system included in the design. This waste oil then will be sucked out of the storage tank and transported to the treatment position as specified.

c. Impacts of submerged mass of living organisms

As impounding water for the reservoir, the organic matters (lifeless bodies), vegetable all kinds, small mammals and insects living in and out the soil, which are not likely to move out of the submerged area, will be disintegrated. This will cause pollution of water in the reservoir and at the downstream area, effect on aquatic life and health of people and other objects using water. The degree of impact depends on the clearance work of reservoir foundation.

The land located in the reservoir foundation is mostly the river land with area of 395.77 hectares (accounting for 58.35% of the whole area). The vegetation cover is mainly artificial forest (accounting for 21.8%); and only a few fruit trees and agricultural crops (10.3%). the remaining is land used frequently. So before impounding water for the reservoir, the agricultural products and artificial forest should be thoroughly harvested. Thus, the mass of living organisms remaining in the reservoir area is mainly grassland, shrub, tree roots and leaves left by local people.

The mass of living organisms remaining in the reservoir area, as being decomposed, will change water quality of the reservoir and downstream area through the transformation of nutrients and organic matters such as the decrease in oxygen concentration and the increase in concentration of BOD, N, and P.

According to the calculation, total amount of the mass of living organisms submerged in the reservoir area is about 3.046.45 tons including small braches and leaves, and tree roots and regenerated grass. Amount of oxygen required for the decomposition of this mass of living organisms as well as the organic matter in the soil will be about 72.1 tons (of which, amount of oxygen required for decomposition of the two things mentioned is 53.54 and 18.56 tons respectively).

If taking the concentration of dissolved oxygen as 6.31 milligrams per liter included in the flow to the reservoir, with a total annual flow averaging about 7,947 million cubic meters, amount of oxygen in the reservoir will be about 50,146.02 tons. According to this, amount of oxygen remaining in the reservoir will be 50,073.92 tons corresponding with the oxygen concentration of 6.3 milligrams per liter.

Thus as we see, the small amount of the mass of living organisms and organic matter in soil submerged in the reservoir will lead to the small amount of oxygen required for the decomposition, amount of oxygen in the reservoir will therefore decrease insignificantly in comparison with the natural water.

The change in some indicators of water quality such as BOD_5, N and P as the mass of living organisms decomposed is shown in the table below:

Table 4.15: Forecast for concentration of BOD_5, N, P included in water after impounding water for the reservoir

	BOD_5	**N**	**P**
The volume of the mass of living organisms (tons)	2.284837	14.62296	2.741804
The increased concentration as compared with the natural water as the mass of living organisms decomposed (milligrams per liter)	0.287507	0.00184	0.000345

Note: volumes of BOD_5, N and P account for 75%, 0.48% and 0.09% of mass of living organisms in the reservoir respectively.

In conclusion, the mass of living organisms submerged in the reservoir area will not affect significantly on water quality of the reservoir and downstream areas.

In summary, results mentioned above show that vegetable matters in the reservoir area are mostly artificial forest and agricultural crops; not any natural forests because they has been thoroughly collected by local people before impounding water for the reservoir. The mass of living organisms submerged in the reservoir area, with small volume, is primarily small branches and leaves, tree roots and regenerated grass, water quality will be therefore changed insignificantly as compared with the natural water. Thus in principle, the vegetable matter should not be cleared, this together with agricultural products and artificial forest will be thoroughly collected by local people as required by the Project Owner to ensure water quality. However, also to ensure water quality in the reservoir and downstream areas of Ma river as well as requirement of hydraulic regimes and the beauty of construction, the Project Owner should thoroughly collect and clean up the reservoir foundation. According to this, the valuable trees will be thoroughly harvested, and the small branches and leaves, scrub, and grass will be collected to burn in monitoring or transport to the landfill to be buried before impounding water for the reservoir. The remaining organic matters submerged in the reservoir area will be mainly the tree roots, humus layer, organic matters and organisms in soil.

Mitigation measures:

To ensure water quality, hydraulic requirements and the beauty of works and increase of firing for local people surrounding the project area, after the Feasibility Study approved, the Project Owner should coordinate with the authorities which relevant to thoroughly collect and clear all vegetable matter before impounding water for the reservoir. In order to mitigate Impacts caused by the clearance, this procedure should be carried out as follows:

- Before recovering the land for the project and impounding water for the reservoir, the agricultural products will be thoroughly harvested by local people required by the Project Owner. The valuable trees and their branches will be collected to be used as firing.

- The Project Owner is responsible for collecting all of the remaining mass of living organisms for burning in monitoring or transporting to landfills to be buried in order to prevent from the stench of decomposition.

- In the process of cleaning up the reservoir area, the clearance and collection will be carried out within the range of land recovery for the project. The collection out of the range of land recovery for the project will be forbidden strictly. The works of collection and clearance should be managed closely to prevent from illegal activities in the surrounding areas.

Applicable standards:

- QCVN 08:2008/BTNMT

d. Impacts of waste generated during clearance of residential area and graveyard

The cleaning up of solid waste, sprinkling lime, disinfecting water closet areas and breeding facilities should be done for the residential areas and graveyards in the reservoir area before impounding water.

- Cleaning up the graveyards: with area of 2,750.6 square meters with about 150 graves located in Ba and Mo villages in Phu Xuan commune.

- Cleaning up residential areas: with 496 households.

e. Impacts of impounding water for the reservoir and operating project

- As impounding water for the reservoir, the soil layer in the reservoir will become flabby and easily swept away by the flow as discharging flood through bottom culvert. This will impact on water quality in the reservoir and river at the downstream.

- As impounding water for the reservoir, the temperature regimes, the mineralization and nutrients… included in the water of reservoir and river at the downstream will be also changed due to the change in water levels in the reservoir and tailrace as compared with before the construction formed.

- The reservoir has the length of about 29 kilometers with the surface area of 6.19 square kilometers and total volume of 63.65 million cubic meters. The reservoir is not deep with the deepest position is about 30 meters. It has the daily regulation regime, so the stratification in temperature is insignificant; and there is not large change in nutrient as well as mineralization in comparison with the water resource discharged from Trung Son hydropower project at the upstream.

- Before the reservoir of Hoi Xuan hydropower project formed, the fluctuation amplitude of water levels in the river is 3.2 meters within a day and the erosion status along Ma riverbanks occurs strongly. These will increase the suspended solids and water turbidity. As the Hoi Xuan HPP built, the flow and tailrace water levels will become stable. These will reduce erosion of riverbanks caused by the Trung Son HPP as well as impacts on water quality.

- After the reservoir of Hoi Xuan hydropower project formed, together with Trung Son hydropower project at the upstream, the sediment included in the flow will be deposited in the reservoirs. This will decrease amount of sediment flowing to the downstream area.

4.1.1.9. Aquatic ecosystem, fish and fisheries

1. Pre-construction and construction phases

a. Due to dam and reservoir construction of Hoi Xuan HPP:

Normally, the river fill for construction (dam line) will prevent movement between upstream and downstream of aquatic organisms, especially fish species having migratory behavior for spawning and feeding.

For Hoi Xuan HPP, the impact has been assessed as follows:

- For fish species have migration behavior from the sea to the river and vice versa to spawning and feeding:

According to the survey result of the consultant group and the inheritance of study results from authors Ho Thanh Hai, Phan Van Mach, Nguyen Huu Duc et al, in Ma river has been discovered 58 migratory species, including 54 species migrating from the sea to the river for spawning and feeding and 4 species migrating vice versa. The study results show that the formers (54 species) migrate not too far away from the estuary, with the main distance of most species of 10 - 40km from the estuary. Particularly, the *Eleotris fusca* species which migrates into the farthest into the river just moves to < 80km from the estuary. The other 4 fish species live in the downstream area and move to the sea (see the section of environmental biology in chapter 3). Thus, the dams of Hoi Xuan or Trung Son HPP will not be barrier to their migration route for spawning and feeding.

- For species with migratory behavior along the river for feeding and spawning:

For fish species having migratory behavior along the river for feeding and spawning are still remained and developed although the environmental flow at the downstream behind the dam is dropped compared with pre-project. Specifically, the flow at Hoi Xuan HPP's dam downstream to the confluence with Luong river is designed to be 29.15% of the natural river flow ($Q_{0\ Hoi\ Xuan\ Damsite}$ = 244.1 m^3/s), and its from the Luong river confluence to the downstream is about 34.64% of the natural river flow. The flow ensures to well maintain ecosystem (Tenant method), including fish and other aquatic organisms.

b. Due to waste water, rubbish and eroded soil washed away with the flow

From the above analysis, the concentration of pollutants in domestic wastewater does not significantly affect the river water quality, but it still has certain impacts on the live of aquatic fauna and aquatic resources. Specifically, wastewater contains organic ingredients which are an important food source for aquatic creatures. The impact is assessed at a low level.

Mitigation measure:

- The project owner has to strictly implement measures to collect and treat wastewater, solid waste and to minimize soil erosion which have been proposed.

2. Operation phase

a. Reservoir foundation

- Reservoir's typical aquatic ecosystem will be formed to replace river flow ecosystem. Living place of aquatic system will be enlarged. Number of species and individuals, and reserve of aquatic organisms will increase, in which importantly, an increase in number of fish species, prawns, crabs and other species due to cultivation of human.

Groups of indicator organisms for reservoirs in Vietnam such as *Microcystis, Melosira; Bosmina, Diaphanasoma, Mongolodiaptomus, Vietodiaptomus, Microcyclops, Mesocyclops, Thermocyclops, Conchostraca* will appear with dominant density and quantity in floating organisms of reservoir.

Fish species eating plants and organic matters, living in unchanging water bodies, develop both quantity of species and individuals; fish species ling in changing water bodies will decrease. During the beginning time, exploitation output of natural fish is high, many individuals with big size appear like carps, hypophthalmichthys, major carps, etc.

- During water storage time of 3-6 months, soil in reservoir bed breaks structure, being soft and settled as sediment in reservoir bed. In this period, bottom animals especially invertebrates reduce number of species and also number of individuals because foundation of reservoir bed is not stable.

After several years, when dead bodies of organisms are properly decomposed, nutrition content reduces, foundation of reservoir bed is relatively stable, density and biomass of plankton will reduce and invertebrate species will increase.

- Larger surface area of reservoir will be an ideal condition for development of fish, resulting in fish cultivation in the region.

In using process, most reservoirs will undergo four periods. Each period is represented by structure, component and aquatic organisms under direct impact of factors of water environment. Ecologic process of reservoir is as follows

+ Disorder period: happens right after formation of reservoir, can last for 10 years. This period includes two continuous sub-periods which are high nutrition sub-period (beginning of water storage-about 5 years) and nutrition reducing sub-period.

+ Stable period

+ Eutrophication period

+ Bogginess period: last period of reservoir, start when volume of sludge reaches dead water level.

To summarize, changing from flowing water ecosystem to reservoir ecosystem will increase quantity of species and individuals of aquatic organisms appropriate with this state. Also the appearance of new species due to fish cultivation of human contributes to increasing biodiversity of aquatic ecosystem, increasing exploitation output, increasing nutrition for inhabitants.

Biodiversity of aquatic ecosystem of reservoir changes according to periods of reservoir. Specifically, species component, quantity of aquatic organisms are high in the high nutrition period and gradually reduced in the nutrition reducing period, stable in the stable period and steadily increased in the eutrophication period, steadily reduced in the bogginess period.

b. Dam’s downstream area

Aquatic organisms, flora and fauna in downstream riverside are affected due to change of flow regime when construction Hoi Xuan HPP, in particular:

- From the downstream area of Trung Son HPP’s dam to the confluence with Luong River:

When there is only Trung Son HPP without Hoi Xuan HPP. Trung Son HPP will generate power for peak load hour supply. That means the plant only generate power in 7 hours a day and does not generation in the other 17 hours. Therefore, during 17 hours, downstream area loses additional water source from upstream area. At that time, additional water for downstream area only includes flow from Trung Son to Luong river. This is a small amount of about 4.8 m^3/s (average flow in dry time in Ma river from Trung Son dam to Hoi Xuan dam is 4.2 m^3/s. from Hoi Xuan dam to Luong river it is 0.6 m^3/s). This discharge is only about 2.04% of the natural flow on the upstream of Trung Son dam ($Q_{o\ Trung\ Sơn}$ = 235.0m^3/s). Thus this impact on ecosystem will be severe, especially for aquatic organisms, and water using objects in downstream areas (including fishery).

When there are both Trung Son and Hoi Xuan HPP. Hoi Xuan hydropower will generate power in all hours a day with regular flow of 70.56 m^3/s. equal to 27.42% of the natural flow on Hoi Xuan's upstream area ($Q_{o\ Hoi\ Xuan}$ = 244.1m^3/s), and the flow to Luong confluence reaches 34.64% $Q_{o\ Hoi\ Xuan}$. This will maintain ecosystem as well.

- From the confluence with Luong river to the downstream area:

When there is no Hoi Xuan hydropower, only Trung Son hydropower. At the off-peak hours without power generation, water flow of the river section to the downstream will be supplemented by Luong river around 13.4m^3/s. Then the flow of Ma river at the confluence with the Luong river will be 14.0m^3, equaling to 5.96% flow of natural rivers. This flow rate will be severe recession.

When there is the reservoir of Hoi Xuan HPP, flow at the confluence with Luong river will be 84.56m^3/s, nearly 34.64% of the natural river flow at the Hoi Xuan dam site. This flow rate will be very good for the ecology, aquatic organisms, fish and fisheries.

(More detailed in the section of cumulative impact assessment)

Thus, from the above assessments, the construction of Hoi Xuan HPP will be very important to the ecological environment, aquatic organisms, fish and fisheries at Ma river area which is from behind the dam of Trung Son hydropower to the downstream.

In order to exploit and use in a reasonable and sustainable manner of fishery resources, aquatic organisms at the reservoir area and the upstream-downstream of dam site, the following measures are proposed:

- Management board of Hoi Xuan hydropower has to strictly manage fishing in the reservoir area under their management; ban the use of fishing methods having destructive nature such as electric shocks or nets with small mesh sizes. It is possible to diversify and increase the number of species by means of adding fish species into the reservoir with division in water layers. The selected fish species are prefer to live in the quite water environment with biological features consistent with the nature of water layers. This help to take advantage of the reservoir potential such as *Hypophthalmichthys. Labeo rohita, Mylopharyngodon piceus, Cyprinidae, Mytusnemurus, Bagarius, etc*.

- In addition, the PO has to coordinate with local authorities to carry out propaganda and popularization of fishing methods in scientific ways for local people. Methods are: do not use nets with too small mesh size for fishing; do not use fishing methods which will be destructive nature such as electric shocks; not overexploit the river basins (sand mining); not destroying habitats and spawning behavior of aquatic species, ensuring the reproduction of fish species. For migratory species for food, only use the means of catching big fish species. The exploitation can reduce natural fish output. Therefore, to meet fish consumption, it can be developped fish farming on Ma river or Hoi Xuan reservoir and the other hydropower reservoirs on Ma river system.

4.1.1.10. Terrestrial ecosystems and national parks nearby the project area

1. Pre-construction and construction phases

a. Impact of cutting and clearing trees to ecological environment

- Impact on vegetation and flora:

Impacts on the ecological environment in these periods mainly come from clearance of crops and trees during the project construction (including items such as dam site, waterway, powerhouse, OPY, and auxiliary work items such as worker camps, warehouses, material storage sites, disposal site, construction - operation roads. power supply system and water supply system, etc.) and cleaning the reservoir area. These activities will reduce the area, separate habitats and obstacle movement of terrestrial animals.

According to the survey result, the acquired land area for the project is mainly covered by rocks and water land (55.13%). The vegetation cover in this area is only about 35.86%, mainly the artificial forest (bamboo), some rice plants and vegetables. Affected people will be allowed to harvest their cultivated products before the land acquisition for the project. Although there are some rare plants namely *chukrasia tabularis A.Juss, parashera stellate, three-leaf clover* and *false ginseng,* all of them are popularly planted in the region and not to be natural rare plant species. Moreover, these are species with large ecological range and distributed with high population in the non-flooded area, especially in the conversation areas, as well as these species have a large number of individuals. Therefore, impacts on vegetation, flora and landscapes will be insignificant, and the biological diversity and gene source are not affected. Except the permanent acquired land area (in the headworks and reservoir areas), the temporary acquired land area (such as workers' camps, material storages) will be recovered, replanted with trees, so ecological environment will be rehabilitated.

- Impact on fauna:

Trees are cut down, cleaning in the reservoir area, the construction area of the head works (dam site, waterway, powerhouse, OPY, etc.) and the landfills will lose habitats of animals, separate living spaces and chase them away from the surrounding area. This is the inevitable impact of most infrastructure projects.

Animals are mostly domestic. Some species of wild animals live near people such as bird, mice, snake.*peccary, Muntiacus muntjak*. *Tragulidae*. *Atherurus macrourus*. *Varanus bitatawa*... But there are not rare wild animals in need of protection. So cutting down the trees do not affect the animal's living space. Moreover the project area has the conservation areas such as the Pu Luong Nature Reserve (about 3.5 km from the dam line). the Pu Hu Nature Reserve (about 6 km from the construction site). the Hang Kia - Pa Co Nature Reserve (about 26 km from the construction site). the Xuan Nha Nature Reserve (about 30 km from the construction site). The project surrounding area is covered by the artificial forest cover (bamboo) with conditions similar to the project area. These areas should be very good habitat for the animals to live when the reservoir is storage of water.

When reservoir stores water, small animals, birds, reptiles, etc. in reservoir bed will move to the surrounding area and near conservation areas like Pu Hu, Pu Luong. Species moving to the surrounding area belong to groups living on the earth surface. Due to geologic condition and other barriers, species moving to nature reserve belong to flyable groups (most birds). For species relating to water such as birds (heron. kingfishers. etc), iguanas, water snakes, water turtles, frogs only move to edge side to live. Most small mammals cannot move far, thus they will die in water. This loss has less impact on local animal system as these species distribute largely, live in many regions and breed quickly. The left population will continue to develop new generations.

Since Pu Luong Nature Reserve, Pu Hu Nature Reserve, Hang Kia-Pa Co Nature Reserve are pretty close to the construction site, some species (mainly birds) from inundated area will move to these areas to live, increasing number of individuals, affecting ecologic balance in this region. However, under the rules of survival, the ecological balance will be restored soon.

Mitigation measures:

- Clearance of vegetation cover.

+ Before land acquisition and clearance for construction work items, reservoir bed area, households are allowed to collect agricultural products on their land.

+ The remaining foliage is collected, safely burned or dumped into landfill; leveling after clearance.

- Only proceed with recovery and clearance of vegetation cover in the project area; prohibiting recovery of surrounding area.

Following regulation, the project owner has to combine with the relevant agencies to implement afforestation with acquired forest area. Replant area is equivalent with appropriated forest area (Including permanent and temporary area). This area will be accurately determined after cadastral survey for project land.

- Planting trees in temporary appropriated land area: worker camps, garbage dumps, disposal site, material storages, etc. after the completion of construction.

b. Impact due to noise, dust and exhaust

Exhaust, dust and noise is not only impact on air environment and people's health but also impact on the lives of animals and plants, particularly animal species is sensitive to noise. However, the project area doesn’t have rare animal species. The wild species distribute in the area living near people such as sparrow, house mice, field mice, rat snake, water snake, barracuda, etc. Domestic animals species such as bovine, chicken, etc. have adapted to the noise. So they should be less affected by noise caused by the project.

Dust due to construction activities which stays on leaves will reduce its photosynthesis and water evaporation. The impact is at low level.

Nature reserve areas are the storage and living of many rare plant and animal species. While the distance from dam site – gathered construction activities area to the boundary of Pu Hu Nature Reserve is 6km; to Pu Luong Nature Reserve is 3.5km; to Hang Kia – Pa Co Nature Reserve is 26km; to Xuan Nha is 30km. Compared with the largest radius of noise is 3km. It can affirm the noise will be not impact on these wild animal species.

c. Impact due to concentration of workers on construction site

Demand of workers on fuel, food will increase exploitation, hunting, storage and trading of illegal firewood, wildlife animals, having bad effects on animals and plants in the surrounding area and nature reserves. In addition, the concentration of a large number of workers on construction site and free migrants cause difficulties in local management work and create condition for operation of forest destroyers.

The possibility to have effects on Pu Hu Nature Reserve and Pu Luong Nature Reserve is high because the project area is close to these two places. Specifically Hang Kia – Pa Co Nature Reserve is far from the project area, respectively 26 km and 30 km and limited geographically. There is no possibility of physical access of workers to the conservation areas. But demand for forestal produce of workers can promote illegal activities for these conservation areas. Therefore, it is needed to have active measures to prevent violation of workers, free migrants and local residents to the nature reserves when the project is implemented.

Mitigation measures:

- Project owner and construction contractors need to have measures to closely manage the construction workers, prohibit illegal activities harming the forest resources and especially protect the conservation areas. Violators will be severely dealt with according to law.

- The project owners combine with local authorities and forestal management units (Board of management of natural reserve) to manage and protect forest, propagate to staffs, free immigrants in the project region and local people in forestal protection awareness.

- Can take advantage of firewood and timber during site clearance and fuel reservoirs for cooking or building.

d. Impact of relocation and resettlement of affected households

When Hoi Xuan hydropower project is under construction, households living in the construction site and reservoir area lose residential land and a part of production land, and have to relocate to new locations.

The relocation will result in the transfer of land between the resettled households and local residents. Also, it also makes the resettled households and local residents to reduce productive land leading to reduce their income. Surrounding the project area is mainly forest so that people have the ability to encroach into the forest for hunting, illegal logging, reclaiming for production. These issues will affect forest resources of the surrounding areas, including the neighborhood natural reserves.

Mitigation measures:

- In addition to compensation, adequate support for people as regulations to quickly stabilize their life and production, the PO have to take measures to support the recovery of people's income to ensure the APs' income and living standards at or better than pre-project level. Vulnerable households and woman head households (such as women headed households. ethnic minority households. elderly households. etc.) are given priority consideration.

Through surveys, interviews of the affected people's expectations and local government representatives' comments, in coordination with the local authorities, the PO has considered to implement measures the assistance methods such as:

+ The local government considers to allocate more forest to households for management, care and protection of forest under land allocation program if communes have still forests (5%land under communal management);

+ Support for people to extend handicraft sector such as pre-processing, processing bamboo to create jobs for local workers and increase production value of bamboo trees instead of just selling raw as present.

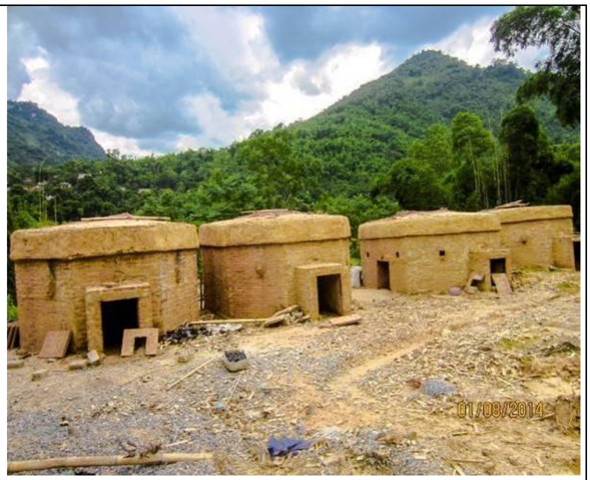
Through the survey, the current project area, along Ma river, from Luong river confluence to Co Luong area, there are 10 bamboo processing units (including 01 factory and 01 cooperative and 08 small-scale facilities), there are also 01 specialized production facility of activated coal with the utilization raw material from bamboo joint disposal from toothpick and chopsticks processing facilities. But most of the production facilities are small, roughly processed products without refinement, so export value is still low. However, this also creates a significant income for local labour and takes advantage of idle labour force in the area.

According to the survey results at a production facility of Mr. Nguyen Van Hung at Eo village, Thanh Xuan commune, the facility use daily average about 10 tons of bamboo to produce 3.5 – 4 tons of products (mainly as toothpick and chopsticks). The subproducts and waste are sold for recycling (bamboo joint sold for activated coal. chips should for paper pulp facility. only sawdust disposed to the environment). His facilities alone sawdust is discharged into the environment). His facility has 30 workers with average income about 3.5 million VND/person/month.

Thus, the expansion of cottage industries such as bamboo processing is entirely feasible.

Some pictures of the harvest and processing bamboos in the project area.

	
Harvesting bamboo	Harvesting bamboo
	
Bamboo processing cooperative	Small-scale facility of bamboo processing

	
Semi-processing bamboo (chopsticks)	Activated coal ovens

+ Recruit local workers for the project construction;

+ Support for training and hiring local workers to work long-term when Hoi Xuan Hydropower Plant commission;

+ Support people improve their production efficiently on the remaining area of productive land.

Support to create jobs for local workers will help to stabilize and increase household's income and contribute to restrict encroaching into the forest.

The measures and programs of income restoration for the AHs are mentioned in more detail in the resettlement plan report, income restoration and development of ethnic minorities.

- Local authorities and natural reserves management boards have to well implement the management and protection of forests, preventing from land reclamation, hunting, illegal logging; propagating to improve local people's awareness of protecting forests, rare plants and animals.

- The local government will allocate more forestland to people for management, care and protection under the program of allocation for local people to raise awareness of forest protection. This will avoid encroaching forest.

- The local government of communes receiving resettled households by the project will implement management measures to stabilize social order and security in the area.

- In order that the resettled households have sufficient land to ensure production life, the PO shall corporate with local governments to balance production land in the area to allocate for the affected households. This helps to reduce pressure on forest resources due to land reclamation activities by unauthorized people.

2. Operation Phase

- For the forest and fauna: as mentioned above (actual state of biological environment. chapter 2), the concentration of operators will less impact on the natural resources.

- After completion of construction works, the temporary acquired land area will be replant trees, and barren land areas are reforested, which help to improve environmental ecosystem.

- Storing up water will help to expand water surface (6.19km^2 corresponding to FSL 80m) and increase levels of surface water and groundwater; improve the climate of the surrounding area. This will have a positive impact on the growth and development of plant around the reservoir, especially during in dry season. The creation of reservoir is usually accompanied by an increase in number of species and number of birds.

4.1.2. Impacts on socio-economic and cultural environment. mitigation measures

4.1.2.1. Impacts on land, production, economy, income, life, living activities of local people

a. Impacts of land acquisition and clearance for the project construction

Land acquisition and clearance for the project construction mainly cause impacts on land use and socio-economics. Specifically as follows:

Acquisition of land for the project in the field work (auxiliary facilities, dam site. Waterway, Powerhouse, OPY, reservoir, sand mining area) will not only reduce land and loss of land for other purposes, but also damage to houses, buildings and other assets on the ground, affecting to the economy, income, life, living, studying, producing of people and the project area.

❖ Impacts on land use

When the project is implemented, there are about 7,644,509.2 m^2 land acquired for the main components of the project, including 7,517,112.3 m^2 of permanent acquired land and 127,356.9 m^2 of temporary affected land for the construction.

Table 4.16: Area of the acquired land for the hydropower plant

No	Work items	Area (m^2)
I	**Permanent acquired land**	***7,517,112.3***
1	Headworks	680,681.7
2	Reservoir	6,825,369.4
3	Rebuilding area of public works	11,061.2
II	**Temporary acquired or leased land**	**127,396.9**
1	Auxiliary works	31,734.4
2	Sand mining area for project construction (lease of land for quarry)	95,662.5
	Total	**7,644,509.2**

Table 4.17a: Types of affected land in the hydropower plant (Land use of individual and household)

No.	Location	Total (m^2)	Classification of land (m^2)							
			Land use of individual and household							
			ONT	Garden	NHK	LHK	LUC	TSN	RST	SKC
I	**Head works area**	**536,489**	**22,332**	**13,444**	**1,225**	**253**	**15,734**	**3,755**	**479,746**	
1	Hoi Xuan commune	204,117							204,117	
2	Thanh Xuan commune	332,372	22,332	13,444	1,225	253	15,734	3,755	275,629	
II	**Reservoir bed area**	**2,659,345**	**333,128**	**27,093**	**104,067**	**47,184**	**468,716**	**11,321**	**1,665,051**	**2,785**
II.1	**Quan Hoa district. Thanh Hoa province**	**2,455,976**	**302,480**	**27,093**	**89,216**	**36,629**	**465,379**	**11,321**	**1,521,073**	**2,785**
1	Thanh Xuan commune	595,175	44,771	27,093	13,886		36,687	851	471,887	
2	Phu Xuan commune	775,221	123,892		11,855	7,220	169,259	4,091	458,904	
3	Phu Le commune	351,771	42,348		16,410	17,410	125,568	5,495	144,540	
4	Phu Son commune	300,553	30,374		5,054	11,999	115,876		137,250	
5	Phu Thanh commune	379,117	48,648		40,867		17,989	884	267,944	2,785
6	Trung Thanh commune	19,530	7,480		1,049				11,001	
7	Thanh Son commune	34,609	4,967		95				29,547	
II.2	**Mai Chau district. Hoa Binh province**	**203,369**	**30,648**		**14,851**	**10,555**	**3,337**		**143,978**	
1	Van Mai commune	180,864	30,648		9,823	10,555	3,337		126,501	
2	Mai Hich commune	22,505			5,028				17,477	
III	**Rebuilding area of public works**	**11,061**	**900**	**4**					**10,157**	
1	Thanh Xuan commune	11,061	900	4					10,157	
IV	**Sand quarry area for project construction**	**0.00**								
1	Hoi Xuan commune	0.00								
	Total	**3,206,896**	**356,360**	**40,541**	**105,292**	**47,437**	**484,450**	**15,076**	**2,154,955**	**2,785**

(Source: By the result of survey was carried by PECC4, August - September, 2015)

Table 4.17b: Types of affected land in the hydropower plant (Land use of Commune People's Committee and other oraganizations)

No.	Location	Total (m^2)	Classification of land (m^2)														
			Land use of Commune People's Committee and other oraganizations														
			BCS	**DBV**	**DCH**	**DGD**	**DGT**	**DNL**	**DTL**	**DTT**	**DVH**	**DYT**	**NTD**	**SKC**	**SON**	**TSC**	**MNC**
I	**Head works area**	**144,192**					**24,092**								**120,100**		
1	Hoi Xuan commune	43,471					11,518								31,953		
2	Thanh Xuan commune	100,721					12,574								88,147		
II	**Reservoir bed area**	**4,166,024**	**72,002**	**217**	**568**	**10,156**	**190,232**	**113**	**9,610**	**11,981**	**377**	**3,871**	**2,751**	**3,757**	**3,856,347**	**3,672**	**372**
II.1	**Quan Hoa district. Thanh Hoa province**	**3,755,833**	**70,583**	**217**	**568**	**9,923**	**186,597**	**113**	**9,406**	**11,981**	**265**	**3,871**	**2,751**	**2,785**	**3,452,729**	**3,672**	**372**
1	Thanh Xuan commune	755,686				3,106	66,730	9		211		1,088			682,466	2,076	
2	Phu Xuan commune	593,582	435			4,374	59,424	83	3,274	2,018	265		2,751		520,927		32
3	Phu Son village	309,287	666			637	8,825		1,752	3,212		1,425			292,430		340
4	Phu Le village	296,700	2,774	217	568	1,565	34,951	20	4,380	3,888		1,358			245,688	1,290	
5	Phu Thanh village	1,175,952	107			242	16,666			2,619				2,785	1,153,226	306	
6	Thanh Son commune	257,613													257,613		
7	Trung Thanh village	367,014	66,602							33					300,379		
II.2	**Mai Chau district. Hoa Binh province**	**410,191**	**1,419**			**232**	**3,634**		**204**		**112**			**972**	**403,618**		
1	Van Mai commune	320,824	1,419			232	3,634		204		112			972	314,251		
2	Mai Hich commune	89,367													89,367		
III	**Rebuilding area of public works**	0															
1	Thanh Xuan commune	0															
IV	**Sand quarry area for project construction**	**95,623**													**95,623**		
1	Hoi Xuan commune	95,623													95,623		
	Total	**4,405,839**	**72,002**	**217**	**568**	**10,156**	**214,324**	**113**	**9,610**	**11,981**	**377**	**3,871**	**2,751**	**3,757**	**4,072,069**	**3,672**	**372**

(Source: By the result of survey was carried by PECC4, August - September, 2015)

SYMBOLS OF LAND CLASSIFICATION BASED ON LAND USE SITUATION

Agriculture land			
LUC	Specialized wet paddy land	RPN	Land with protective natural forest
LUK	Remaining wet paddy land	RPT	Land with protective artificial forest
LUN	Land for upland paddy	RPK	Land for zoning off for protective forest regeneration and restoration
COC	Grass for husbandry livestock	RPM	Land for protective afforestation
BHK	Flat land for other annual trees	RDN	Land with special-purpose natural forest
NHK	Milpa for other annual trees	RDT	Land with special-purpose artificial forest
LNC	Land for perennial industrial trees	RDK	Land for zoning off for special-purpose forest regeneration and restoration
LNQ	Land for perennial fruit trees	RDM	Land for special-purpose afforestation
LNK	Land for other perennial trees	TSL	Land for salt water and brackish water aquaculture
RSN	Land with productive natural forest	TSN	Specialized land for fresh water aquaculture
RST	Land with productive artificial forest	LMU	Land for salt production
RSK	Land for zoning off for productive forest regeneration and restoration	NKH	Other agricultural land
RSM	Land for productive afforestation		
Non-agricultural land			
ONT	Rural residential land	DYT	Land for health bases
ODT	Urban residential land	DGD	For education bases
TSC	Land used by offices, headquarters and non-profit agencies	DTT	Land for sports and gyms
TSK	Land used by other offices, headquarters and non-profit agencies	DKH	Land for science research bases

CQP	Defense land	DXH	Land for socio-services
CKS	Land for business and production bases	DVH	Land for non-profit cultural works
CSK	Land for mineral activities	DCH	Market land assigned without payment
CAN	Security land	DDT	Land with heritages and landscapes
SKK	Land for industrial area	DRA	Land for disposal sites and wastes treatment
SKC	Land for business and production bases	TON	Religious land
SKS	Land for mineral activity	TIN	Faith land
SKX	Land for producing materials and ceramics	NTD	Cemetery land
DGT	Land for non-profit traffic	SON	River, canal
DTL	Land for non-profit irrigation	MNC	Land for special-purpose water bodies
DNL	Land for energy works	PNK	Other non-agricultural land
DBV	Land for post and telecommunication works		
Unused land			
BCS	Unused flat land	DCS	Unused mountainous land
NCS	Mountainous land without trees		

The acquired land area is containing rivers, streams land and stone sites, about 4,072,069.0 m^2 (54.17%); artificial forest land, about 2,154,955.0m^2 (28.67%); rice land, about 4984,450.0m^2 (6.44%); vegetable land, about 105,292.0m^2 (1.40%), others.

The acquired vegetable land area is small, but it is important source of food for local people. Particularly the bamboo forest, it is now an important source of income for local people. So the land acquisition for the project will affect income and living of resident.

According to a survey of Consultants in August and September 2015, because agricultural land area of communes has almost been exploited and used up (no vacant land to be reclaimed), total area of owned land by households is almost stable. Therefore, presently impact level of the project on land use of households is similar to the damage survey done by the Consultant in 2007.

According to the results of the survey conducted in August and September 2015 by PECC4, households still have much land outsideinundated area; forest area as well as paddy and crops acquired is small in comparison with total own production land area. Most of it accounts less than 10% of total area of owned land. Some village of the affected households with relatively large area belong to villages of Pang, Chiang, Phe, Sa Lang, Gia, and Co Luong, in which the households of Chieng village – Phu Son commune is affected the most, average 26.55% of the area. This village has 131 affected households/ total of 2,150 affected households.

According to the survey results and information gathered by PECC4, Quan Hoa district, about 25,000ha of bamboo, with about 12,000 households, on average, each household has about 2.1ha bamboo. Medium income of a household one year from bamboo is around 50 million VND/household/year; income from other sectors (such as fishing, working for bamboo processing firms, small businesses, cultivating rice, cops, etc.) is about 25 million VND/year. Average household income total is about 75 million VND/household/year.

According to the survey results of PECC4 in feasibility study phase (2007), average production area of households affected by the project is 3.7ha, of which about 2.9ha of forest bamboo plantation.

According density and current prices.average income of affected households are as follows: 1ha of bamboo having 300-350 clumps/ha, about 8 trees/clump (large clumps can have 10 trees); each clump every year is about 4-5 harvest trees; each tree weights 15 - 20kg, price approximately 900 VND/kg. Therefore.average income per hectare per year is about 20-25 million VND/ha/year. With an average area of about 2.9ha, total income of a household from bamboo plantation is around 60-75 million VND/year, not including other sources of income. Currently, small business such as selling and repairing motorcycles well develop, especially processing facilities. In project communes, there are about 12 processing and recycling facilities, in which one company, one cooperative, 8 production facilities and 01 small-scale facility to recycle waste from bamboo of processing units. Through a survey in 01 bamboo processing facility with 30 workers, average income is about 3.5million VND/person/month. Thus other sources of income are also significant.

The affected production land for the project is mostly accounted for <10% of total landholding of AHs, which is not a major source of income. Moreover, during project implementation, the project conducts fair compensation to people and has appropriate measures to support households to stabilize their life and restoration work income. Therefore, the impact can be mitigated.

Table 4.18: The affected rate on productive land of the AHs

No.	Locality	Average affected agricultural land (ha/1HH)	Average landholding (ha/1HH)	Average Remaining land area (ha/1HH)	Percentage of affected land (%)	Percentage% of remaininglan d (%)
I	**Quan Hoa district**					
1	Thanh Son commune					
	Son Thanh village	0.02	1.16	1.14	1.72	98.28
	Tan Huong village	0.09	1.63	1.54	5.52	94.48
2	Trung Thanh commune					
	Phai village	0.03	2.65	2.62	1.13	98.87
	Chieng village	0.05	2.13	2.08	2.35	97.65
3	Phu Thanh commune					
	Uon village	0.09	3.34	3.25	2.69	97.31
	En village	0.06	1.19	1.13	5.04	94.96
	Do village	0.08	0.35	0.27	22.86	77.14
	Chang village	0.2	2.23	2.03	8.97	91.03
	Pang village	0.14	1.14	1.00	12.28	87.72
4	Phu Le commune					
	Sai village	0.2	0.81	0.61	24.69	75.31
5	Phu Son commune					
	Chieng village	0.21	0.78	0.57	26.92	73.08
6	Phu Xuan commune					
	Ba village	0.23	2.82	2.59	8.16	91.84
	Phe village	0.26	1.62	1.36	16.05	83.95
	Pan village	0.16	2.41	2.25	6.64	93.36
	Mo village	0.25	2.4	2.15	10.42	89.58

No.	Locality	Average affected agricultural land (ha/1HH)	Average landholding (ha/1HH)	Average Remaining land area (ha/1HH)	Percentage of affected land (%)	Percentage% of remaininglan d (%)
7	Thanh Xuan commune					
	Sa Lang village	1.74	11.42	9.68	15.24	84.76
	Tan Son village	0.58	6.99	6.41	8.30	91.70
	Eo village	0.3	5.73	5.43	5.24	94.76
	Vui village	0.35	3.42	3.07	10.23	89.77
	Thu Dong village	0.08	2.46	2.38	3.25	96.75
	Gia village	3.34	13.28	9.94	25.15	74.85
8	Hoi Xuan commune					
	Muop village	0.36				
II	**Mai Chau district**					
1	Mai Hich commune					
	Choi village	0.2	1.99	1.79	10.05	89.95
2	Van Mai commune					
	Don village	0.12	1.09	0.97	11.01	88.99
	Khan village	0.1	2.12	2.02	4.72	95.28
	Nam Dien village	0.08	1.29	1.21	6.20	93.80
	Thanh Mai village	0.17	2.38	2.21	7.14	92.86

(Source: By the result of survey was carried by PECC4 in August - September, 2015)

Table 4.19: The impact level of agricultural land of affected households

No	Regions	Number of affected households	Total area of agricultural land (ha)	Total area of affected agricultural land (ha)	Total rest area of agricultural land (ha)	Average area of land (ha/ household)	Remaining land area (ha/ household)
I	**Quan Hoa district**						
1	Thanh Son commune						
	Son Thanh village	29	33.63	0.70	32.93	1.16	0.02
	Tan Huong village	24	39.02	2.27	36.75	1.63	0.09

No	Regions	Number of affected households	Total area of agricultural land (ha)	Total area of affected agricultural land (ha)	Total rest area of agricultural land (ha)	Average area of land (ha/ household)	Remaining land area (ha/ household)
2	Trung Thanh commune						
	Phai village	6	15.90	0.20	15.70	2.65	0.03
	Chieng village	19	11.26	1.01	10.25	2.13	0.05
3	Phu Thanh commune						
	Uon village	26	86.72	2.30	84.42	3.34	0.09
	En village	76	90.35	4.81	85.54	1.19	0.06
	Do village	98	34.51	7.90	26.61	0.35	0.08
	Chang village	37	82.64	7.57	75.07	2.23	0.2
	Pang village	69	78.55	9.66	68.89	1.14	0.14
4	Phu Le commune						
	Sai village	153	124.36	30.94	93.42	0.81	0.2
5	Phu Son commune						
	Chieng village	130	101.76	27.02	74.74	0.78	0.21
6	Phu Xuan commune						
	Ba village	55	155.35	12.86	142.49	2.82	0.23
	Phe village	85	138.07	21.87	116.20	1.62	0.26
	Pan village	56	134.91	8.91	126.00	2.41	0.16
	Mo village	87	209.05	21.49	187.56	2.4	0.25
7	Thanh Xuan commune						
	Sa Lang village	42	166.32	25.65	140.67	11.42	1.74
	Tan Son village	13	90.97	7.56	83.41	6.99	0.58
	Eo village	79	452.74	23.75	428.99	5.73	0.3
	Vui village	35	123.47	12.06	111.41	3.42	0.35
	Thu Dong village	25	44.46	7.08	37.38	2.46	0.08
	Gia village	19	252.43	63.48	188.95	13.28	3.34
8	Hoi Xuan commune						

No	Regions	Number of affected households	Total area of agricultural land (ha)	Total area of affected agricultural land (ha)	Total rest area of agricultural land (ha)	Average area of land (ha/ household)	Remaining land area (ha/ household)
	Muop village	32		11.64			0.36
II	**Mai Chau district**						
1	Mai Hich commune						
	Choi village	11	21.92	2.25	19.67	1.99	0.2
2	Van Mai commune						
	Don village	32	35.00	3.92	31.08	1.09	0.12
	Khan village	28	59.40	2.73	56.67	2.12	0.1
	Nam Dien village	5	6.43	0.41	6.02	1.29	0.08
	Thanh Mai village	46	109.63	7.96	101.67	2.38	0.17

(Source: By the result of survey was carried by PECC4 in August - September, 2015)

Note: Sign "-": There is no information on the owned area of households which cannot calculate the % of affected area.

❖ Damage to trees and vegetables

Table 4.20: Damage to trees and vegetables in the hydropower plant

No	Affected trees and vegetables	Type/Unit	Number	
			Thanh Hoa province	Hoa Binh province
1	**Annual plants**			
1.1	*Sechium edule, Lagernaria siceraria (Molina) Standl, Telosma cordata (Burm. F) Merr, Cucumis Sativus L, Momordica, Lablab purpureus, etc.*	A (m^2)	43	-
		B (m^2)	1,156	248.0
1.2	*Pachyrhizus erosus. Pueraria thomsoni Benth. Pachyrhizus erosus, Languas officinarump, Colocasia esculenta, Zingiber officinale Rose, Curcuma longa L,*	A (m^2)	484	671.0
		B (m^2)	6,592	310.0
1.3	*Saccharum*	A (m^2)	-	-
		B (m^2)	1,048	619.0
1.4	*Citrullus lanatus. Cucumis melo L, Cucumis sativus, etc.*	A (m^2)	21	
		B (m^2)	20	

No	Affected trees and vegetables	Type/Unit	Number	
			Thanh Hoa province	Hoa Binh province
1.5	*Arachis hypogaea, Scientific classification. Panicum miliaceum,Scientific classification, Vigna radiate, Lablab purpureus, Vigna angularis, etc.*	A (m^2)	-	
		B (m^2)	27	
1.6	*Ipomoea batatas*	A (m^2)	32	
		B (m^2)	1,424	
1.7	*Solanaceae, Zea mays L. ssp., mays*	A (m^2)	4,000	92.0
		B (m^2)	11,052	3,310.0
1.8	*Ipomoea aquatic, Neptunia oleracea Lour*	A (m^2)	60	-
		B (m^2)	998	148.0
1.9	*Solanum macrocarpon.Melongena, Lycopesium esculentum*	A (m^2)	74	-
		B (m^2)	297	1,819.0
1.10	*Phaseolus vulgaris. Pisum sativum L, Vigna sesquipedalis Fruwirth Vigna sinensis spp., Psophocarpus tetragonolobus*	A (m^2)	-	-
		B (m^2)	171	9.0
1.11	*Alium fistulosum L Allium sativum L Capsium frutescens L Colocasia gigantean, staurogyne repens (Cymbopogon citratus. Eryngium foetidum, Coriandrum sativum, Anethum graveolens. Perilla ocymoides L, etc.)*	A (m^2)	90	
		B (m^2)	4,481	4,194.0
2	**Perennial plants**			
2.1	*Artocarpus heterophyllus*	A (tree)	165	
		B (tree)	376	17.0
		C (tree)	321	87.0
		D (tree)	240	
		E (tree)	49	
2.2	*Citrus grandis (L.) Osbeck, Citrus × sinensis,Aurantifolia, Citrus reticulate, Syzygium campanulatum, Citrus medica var, sarcodactylis*	A (tree)	199	19.0
		B (tree)	727	61.0
		C (tree)	657	244.0
		D (tree)	267	
		E (tree)	20	
2.3	*Prunus salicina Lindley, Prunus persica, Prunus mume, Baccaurea sapida, Psidium guajava, steel hook, Magnoliaceae, Lygodium sp*	A (tree)	137	17.0
		B (tree)	609	169.0
		C (tree)	1,028	
		D (tree)	387	
		E (tree)	133	

No	Affected trees and vegetables	Type/Unit	Number	
			Thanh Hoa province	Hoa Binh province
2.4	*Dimocarpus longan Lour, Litchisinensis, Nephelium lappaceum L, Phyllanthus reticulatus Poir*	A (tree)	327	44.0
		B (tree)	650	2,333.0
		C (tree)	1,256	
		D (tree)	883	
		E (tree)	106	
2.5	*Ziziphus mauritiana, Chrysophyllum cainino, Achras sapota*	A (tree)	5	24.0
		B (tree)	68	136.0
		C (tree)	94	
		D (tree)	32	
		E (tree)	6	
2.6	*Annonaceae, Pyrus, Punica granatum L. Pouteria lucuma, Hylocereus undatus, Billardiera longiflora, Clausena lansium (Lour.) Skeels [Clausena wampi (Blanco) Oliv.*	A (tree)	66	17.0
		B (tree)	330	60.0
		C (tree)	289	492.0
		D (tree)	256	
		E (tree)	13	
2.7	*Garcinia oblongifolia Champ, Ex Benth*	A (tree)	7	
		B (tree)	21	
		C (tree)	7	
		D (tree)	19	
2.8	*Diospyros, Mangifera reba, Mangifera*	A (tree)	386	-
		B (tree)	599	26.0
		C (tree)	600	199.0
		D (tree)	404	
		E (tree)	56	
2.9	*Artocarpus tonkinensis A chev, Dracontomelon duperreanum, Averrhoa carambola L, Elaeagnuas latifolia L, Tamarindus indica L, Phyllanthus reticulatus Poir*	A (tree)	17	
		B (tree)	101	15.0
		C (tree)	149	47.0
		D (tree)	94	
		E (tree)	22	
2.10	*Aleurites montana (Lour) Wils. camellia sasanqua thumb, Tamarindus indica*	A (tree)	7	
		B (tree)	16	
		C (tree)	48	
		D (tree)	16	
		E (tree)		
2.11	*Cocos nucifera*	A (tree)	63	
		B (tree)	159	13.0
		C (tree)	142	

No	Affected trees and vegetables	Type/Unit	Number	
			Thanh Hoa province	Hoa Binh province
		D (tree)	106	
		E (tree)		
2.12	*Fructus Gleditschiae*	B (tree)	45	
		C (tree)		
		D (tree)		
		E (tree)	20	
2.13	*Areca catechu L*	A (tree)	265	60.0
		B (tree)	848	
		C (tree)	775	25.0
		D (tree)	512	
		E (tree)	142	
2.14	*Ananas comosus*	A (tree)	747	80.0
		B (tree)	7,173	4,680.0
2.15	*Momordica cochinchinensis (Lour) Spreng*	A (tree)	22	
		B (tree)	164	
2.16	*Musa*	A (tree)	995	110.0
		B (tree)	12,713	1,811.0
2.17	*Carica papaya*	A (tree)	1,051	147.0
		B (tree)	921	98.0
2.18	*Coffea robusta, Theobroma cacao*	B (tree)	23	
		C (tree)		
		D (tree)		
2.19	*Camellia sinensis*	B (cluster)	4,264	
		C (cluster)	707	
2.20	*Pipe siriboa L*	Truss	36	
	Piper betle L<4m^2	Truss	659	
2.21	*Morus alba L, Fragaria*	B (tree)		16.0
		C (tree)		
2.22	*Saccharum officinarum L,*	A (tree)	1,673	
		B (tree)		
2.23	*Eucalyptus sp.*	B (tree)	4	
2.24	Acacia auriculiformis	A (tree)	399	
		B (tree)	171	
2.25	*Alstonia, Delonix regia Muntingia calabura*	A (tree)	111	
		B (tree)	190	22.0
2.26	*Erythrina variegata L, Bombax ceiba, Ficus benjamina L, Elaeis*	A (tree)	12	-
		B (tree)	78	23.0

No	Affected trees and vegetables	Type/Unit	Number	
			Thanh Hoa province	Hoa Binh province
2.27	*Magnoliaceae, M.glauca, Parashorea chinensis Wang Hsie, Dillenia indica L, Dalbergia tonkinensis Prain*	A (tree)	58	-
		B (tree)	54	
2.28	*Peltophorum pterocarpum, Chukrasia tabularis A. Juss, Nageia fleuryi, Senna siamea (Lam.) H.S.Irwin & Barneby*	A (tree)	1,868	53.0
		B (tree)	820	55.0
2.29	*Melia azedarach*	A (tree)	5,149	5,187.0
		B (tree)	1,624	4,178.0
2.30	*Nymphaea. Bombax ceiba. Ficus elastica Roxb. Dracontomelon duperreanum, Terminalia catappa*	A (tree)	80	
		B (tree)	280	18.0
2.31	*Bismarckia nobilis. Sabal palmetto*	A (tree)	52,324	9,752.0
		B (tree)	274	-
		C (tree)	250	-
2.32	*Dendrocalamus membranaceus Munro. Arthrostylidiinae. Acidosasa*	A (tree)		24,239.0
		B (tree)	726,381	24,239.0
2.33	*Cinnamomum cassia Nees & Eberth, Ricinus communis L*	B (tree)	13	

(Source: By the result of survey was carried by PECC4 in August - September, 2015)

The survey results show that damaged crop plants is relatively diverse at the project area, but most significantly it is bamboo species. The current average price of bamboo is 900 VND/kg; an average tree weighs 15 - 20kg; about 300-350 clumps/ha; average eight trees per clump (including three mature trees. three growing trees and two bamboo shoots); annual average harvest is 4-5 harvests/1 clump/year; so the plants are the main income source of people. Therefore, the land acquisition for the project will lose this income, affecting the economic life of people. However, the affected land area is small (less than 10% of total land ownership) and income from other sources is relatively large. In addition to compensation for damage, the project also has support measures for affected households to stabilize life and production and recovery of income, thus reducing the impact.

Note: Quarry is located on Ma river bed, and sand stockpile is located along the river on which there are not trees, crops, houses and affected buildings. The PO shall have exploitable license and land lease of local authority during project implementation.

❖ Damage to houses and buildings

Table 4.21: Summarizing affected houses/ buildings of the hydropower plant

No	Thanh Hoa province			No	Hoa Binh province		
	Types of affected houses and buildings	**Unit**	**Number**		**Types of affected houses and buildings**	**Unit**	**Number**
I	**Buildings and attached architectural objects of households**			**I**	**Buildings and attached architectural objects of households**		
1	***Housing***			***1***	***Housing***		
1.1	Temporary bamboo hut	m^2	1,299.6		House with three-floor or higher, having water and electricity, closed toilet		
1.2	Hut without masonry wall. roof pro and cement floor	m^2	5,732.5	1.1	House with three-floor, close toilet, 110-wall, wood door, tiled floor 300x300, metal roof, water and electricity.	m^2	72.0
1.3	Bamboo house with sand cement floor or terra cotta, tile floor	m^2	1,761.5		House with two-floor or higher, having water and electricity, closed toilet		
1.4	Wooden house with cement wall, sand cement or tile floor and electric lighting installation			1.2	House with two-floor, close toilet. 110-wall, wood door, tiled floor 300*300, metal roof, water and electricity.	m^2	118.8
	- Thatched roof and tar paper	m^2	188.8	1.3	House with two-floor, close toilet. 110-wall, wood door, tiled floor 300*300, metal roof, water and electricity.	m^2	24.8
	- Tiled roof	m^2	4,563.0		House with one-floor (height the foundation is <=1.2 m)		
1.5	House with 110 cm wall thickness, concrete column, plastered wall, white washing, XMH tiled floor and electric lighting installation			1.4	House with one-floor, close toilet, 110-wall, wood door, tiled floor 300*300, metal roof, water and electricity, height ≤3.6 m	m^2	165.5
	- Thatched roof and tar paper	m^2	580.8	1.5	House with one-floor, close toilet, 220-wall, wood door, tiled floor 300*300, tiled roof, water and electricity, height ≥3.6 m, without toilet	m^2	537.6
	- Tiled roof	m^2	2,925.7	1.6	House with one-floor, 110-wall, fibro metal roof, N3 wood door, tiled floor 200*200, electricity, without toilet, height ≥3.6 m.	m^2	
	- Reinforced concrete roof	m^2	96.4	1.7	House with one-floor, 110-wall, fibro metal roof, N3 wood door, tiled floor 200*200, electricity, without toilet, height ≥3.6 m.	m^2	
1.6	House with 220 wall thickness, plastered wall, whitewashing, XMH tiled floor and electric lighting installation			1.8	House with one-floor. 110-wall, fibro metal roof, N3 wood door, tiled floor	m^2	

No	Thanh Hoa province			No	Hoa Binh province		
	Types of affected houses and buildings	Unit	Number		Types of affected houses and buildings	Unit	Number
	- Thatched roof and tar paper	m^2	122.5	***2***	***Other structures***		
	- Tiled roof	m^2	1,327.3	2.1	Stone wall, thickness of <= 60cm, height >2m, 100 cement mortar	m^3	175.8
	- Reinforced concrete roof	m^2	337.4	2.2	Stone wall, thickness of > 60cm, 50 cement mortar	m^3	360.0
1.7	House with 110 thickness wall, reinforced concrete frames, reinforced concrete foundation, plastered-wall, whitewashing, XMH tiled floor and electric lighting installation			2.3	Stone wall, thickness of <= 60cm, 75 cement mortar	m^3	52.5
	- Tiled roof	m^2	1,596.5	2.4	Houses with 6.5*10.5*22 wall, with foundation >33cm, 50 cement mortar	m^3	12.0
	- Reinforced concrete roof	m^2	50.4	2.5	Houses with 6.5*10.5*22 wall, with foundation <=33cm, 50 cement mortar	m^3	48.6
1.8	House with 220 thickness wall, reinforced concrete frames, reinforced concrete foundation, plastered wall, whitewashing, XMH tiled floor and electric lighting installation			2.6	Houses with 6.5*10.5*22 wall, with foundation's width <=33cm, 75 cement mortar	m^3	238.2
	- Tiled roof	m^2		2.7	Houses with 6.5*10.5*22 wall, with foundation <=60cm, 50 cement mortar	m^3	57.0
	- Reinforced concrete roof	m^2	1,047.0	2.8	Houses with 6.5*10.5*22 wall, with foundation >60cm, 75 cement mortar	m^3	42.8
1.9	House with combination of 220 and 100 wall thickness, reinforced concrete frames, combination of reinforced concrete foundation and plastered wall construction.whitewashing, glazed wall tile for bathroom, nonslip CERAMIC tile 300*300mm for floor, wooden door (group III), iron window, smooth granite stairs. Electricity, lightning protection power and water supply (in-wall wiring, fan installation, sanitary ware, roof water tank, septic tanks), fully completed			2.9	75 cement mortar	m^2	2,470.9
	- Reinforced concrete roof	m^2	366.6	2.10	Concreted, 200 cement mortar	m^3	
1.10	Unbaked brick house with plastered wall, whitewashing, smooth crushed-concrete floor, cement sand mortar or tile and electric lighting installation			2.11	Concreted, 200 cement mortar	m^3	
	- Thatched roof and tar paper	m^2	70.8	2.12	Concreted, 200 cement mortar	m^3	83.8
	- Tiled roof	m^2	308.0	2.13	Plastic ceiling	m^2	334.2
1.11	Stilt house with thatched roof, wooden	m^2	118.8	2.14	Tiled floor with 20*20 cement	m^2	

No	Thanh Hoa province			No	Hoa Binh province		
	Types of affected houses and buildings	Unit	Number		Types of affected houses and buildings	Unit	Number
	frame and column (wooden group I, II). Column diameter <25cm, floor and wall with rosewood or bamboo, buried column.				mortar 75#		
1.12	Stilt house with thatched roof, wooden frame and column (wooden group I, II). Column diameter <25cm, floor and wall with rosewood or bamboo, pedestaled column.	m^2	877.5	2.15	cement mortar 75# floor	m^2	990.8
1.13	Stilt house with thatched roof, wooden frame and column (wooden group I, II). Column diameter >25cm, floor and wall with rosewood or bamboo, pedestaled column.	m^2	616.1	2.16	Titled roof 22 one/m^2.	$100m^2$	42.1
1.14	Stilt house with thatched roof, wooden frame and column (wooden group III-VI). Column diameter <25cm, floor and wall with rosewood or bamboo, buried column.	m^2	2,130.0	2.17	Metal roof	$100m^2$	3.3
1.15	Stilt house with thatched roof, wooden frame and column (wooden group III-VI). Column diameter <25cm, floor and wall with rosewood or bamboo, pedestaled column.	m^2	12,737.2	2.18	Panel grass door	m^2	29.8
1.16	Stilt house with thatched roof, wooden frame and column (wooden group I, II). Column diameter >25cm, floor and wall with rosewood or bamboo, pedestaled column.	m^2	857.3	2.19	Panel grass door	m^2	
1.17	Wooden House (wooden group I, II) with sand cement floor or terra cotta tile floor, wall foundation surrounding house with brick and stone. wall with rosewood or bamboo and column diameter <25cm			2.20	Panel grass door group 4	m^2	
	- Pedestaled column. Tiled roof	m^2	857.3	2.21	Iron door 2-3mm without steel	m^2	36.0
1.18	Wooden House (wooden group III-VI) with sand cement floor or terra cotta tile floor, wall foundation surrounding house with brick and stone, wall with rosewood or bamboo and column diameter <25cm			2.22	Water tank	one	
	- Buried column, thatched roof and tar paper	m^2	42.0	2.23	Squat toilet (including installation)	set	
	- Buried column. Tiled roof	m^2	466.1	2.24	Pedestal lavatory (including installation)	set	22.0
	- Pedestaled column. Tiled roof	m^2	1,078.9	2.25	Digging wells, swept the solid brick VXM 100 8 to 10 m deep. Diameter 1200	piece	1.0
1.19	Wooden House (wooden group I, II) with sand cement floor or terra cotta tile floor, wall foundation surrounding house with brick and stone, wall with rosewood or			2.26	Digging wells, tile drains book features 100 deep VXM> 10m diameter 1200	piece	1.0

No	Thanh Hoa province			No	Hoa Binh province		
	Types of affected houses and buildings	Unit	Number		Types of affected houses and buildings	Unit	Number
	bamboo and column diameter <25cm						
	- Buried column. Tiled roof	m^2		2.27	Drill well with deep pump <30m, diameter 100	well	2.0
1.20	Wooden House (wooden group I. II) with sand cement floor or terra cotta tile floor, wall with rosewood or bamboo and column diameter >25cm			2.28	Non reinforced Concrete Foundation 150 #	m^3	247.8
	- Buried column. Thatched roof and tar paper	m^2	44.1	2.29	Paving bricks	m^2	66.9
1.21	Wooden House (wooden group III-VI) with sand cement floor or terra cotta tile floor, wall with rosewood or bamboo and column diameter >25cm			2.30	Wire mesh fence B40. V3	m^2	55.6
	- Buried column. Thatched roof and tar paper	m^2	101.5	2.31	Barbed Wire Fence V3	m^2	20.0
	- Buried column. Tiled roof	m^2	72.0				
	- Pedestaled column. Tiled roof	m^2	474.9				
1.22	Wooden House (wooden group III-VI) with sand cement floor or terra cotta tile floor, wall with rosewood or bamboo and column diameter >25cm						
	- Pedestaled column. Tiled roof	m^2	162.9				
1.23	Wooden House (wooden group III-VI) with sand cement floor or terra cotta tile floor, wall foundation surrounding house with brick and stone. wall with rosewood or bamboo and column diameter <25cm						
	- Pedestaled column. Tiled roof	m^2	363.6				
1.24	Wooden House (wooden group I. II) with sand cement floor or terra cotta tile floor, wall foundation surrounding house with brick and stone, wall with rosewood or bamboo and column diameter >25cm						
	- Pedestaled column. Tiled roof	m^2	25.6				
1.25	Wooden House (wooden group I, II) with sand cement floor or terra cotta tile floor, wall with rosewood or bamboo and column diameter <25cm			2.51			
	- Buried column. Tiled roof	m^2	24.0				
	- Pedestaled column. Tiled roof	m^2	56.3				
1.26	Wooden House (wooden group III-VI) with sand cement floor or terra cotta tile floor, wall with rosewood or bamboo and column diameter <25cm			2.61			
	- Buried column. Tiled roof	m^2	277.2				
	- Pedestaled column. Tiled roof	m^2	133.8				
1.27	House with bamboo and wood column,	m^2	595.8				

No	Thanh Hoa province			No	Hoa Binh province		
	Types of affected houses and buildings	Unit	Number		Types of affected houses and buildings	Unit	Number
	bamboo wall, ground floor or sand cement floor, wood gate, thatched roof and tar paper.						
1.28	Loft is calculated based on the actual cost of materials for loft	m^2	80.8				
1.29	Stairs (outdoors)						
	- Stairs with combination of concrete and brick-stone	m					
1.30	Heat resistant roof on roof						
	- Tin roof and beam with galvanized steel pipe	m^2	488.9				
	- Tiled roof	m^2	85.3				
2	***Auxiliary works within the land of households***						
2.1	Kitchen (independent. not within the scope of house)						
	The structure of bamboo	m^2	2,881.5				
	Baked brick wall and reinforced concrete roof	m^2	18.4				
	Baked brick wall and tiled roof	m^2	662.7				
	Unbaked brick walls and tiled roof	m^2	428.7				
2.2	Barn						
	Bamboo roofing	m^2	2,348.9				
	Bamboo-Fibro-cement roofing	m^2	326.0				
	Baked brick wall D = 110, cement plastering. XMH tiled floor. Thatched roof and tar paper	m^2	373.4				
	Baked brick wall D = 110, cement plastering. XMH tiled floor, tiled roof, metal sheet and Fibro-cement.	m^2	497.9				
	Unbaked brick wall D = 110, cement plastering. XMH tiled floor. Thatched roof and tar paper	m^2	179.2				
	Unbaked brick wall D = 110, cement plastering, smooth crushed-concrete floor, tiled roof, metal sheet and Fibro-cement.	m^2	758.3				
2.3	Bathroom (glazed tile area is calculated separately)	m^2					
	Brick walls, tiled roofs, woven panels prefabricated guard. poured in place concrete	m^2	258.9				
	Brick wall, reinforced concrete roof poured in place, walls of glass, glazed tile,	m^2	431.2				

No	Thanh Hoa province			No	Hoa Binh province		
	Types of affected houses and buildings	**Unit**	**Number**		**Types of affected houses and buildings**	**Unit**	**Number**
	floor tile slip						
	Thatch. bamboo	m^2	45.5				
2.4	Toilet (glazed tile area is calculated separately)						
	Brick walls, tiled roofs, prefabricated guard cloth to prevent type 1	Pit	63.8				
	Brick walls, tiled roofs, prefabricated guard cloth to prevent type 2	Pit	55.0				
	bamboo	pit	179.0				
2.5	fence wall						
	110 pavement brick	m^2	1,296.3				
	220 pavement brick	m^2	82.0				
	Ash brick	m^2	737.4				
	stone	m^2					
	Iron Flower Fence	m^2	141.0				
	Steel fence	m^2	102.0				
	concrete fence	m^2	65.6				
2.6	Well						
	a) Excavation						
	Excavation of deep wells <8m	m^3	27.2				
	b) Construction	m^3					
	Brick well	m^3	3.2				
2.7	Drilled wells (excluding pumps)						
	Diameter <50mm, deep to 50m	m	4.0				
2.8	Tanks						
	Water tank D=110	m^3	329.2				
	Water tank D >220	m^3	34.6				
	Water tank	m^3	28.5				
	septic tank	m^3					
2.9	Manicure set (independent detached houses or houses under construction in progress)						
	Freestone foundation	m^3					

No	Thanh Hoa province			No	Hoa Binh province		
	Types of affected houses and buildings	Unit	Number		Types of affected houses and buildings	Unit	Number
			1,512.0				
	Brick foundation	m^3	36.4				
2.10	Concrete types. including complete formwork (independent detached houses under construction or in progress)						
	Non-reinforced concrete, concrete (macadam) 100 #	m^3					
	Non-reinforced concrete, concrete (macadam) 150 #	m^3	20.7				
	Non-reinforced concrete, concrete (macadam) 200 #	m^3	3.5				
	Reinforced concrete beams, girders bracing, 1*2 rock piles marking 150 #	m^3					
	Reinforced concrete beams, girders bracing, 1*2 rock piles marking 200 #	m^3					
	Reinforced concrete floors cylinder automobile, umbrella couch, cloth, and the other components 1*2cm stone marks 150 #	m^3					
	Reinforced concrete floors cylinder automobile, umbrella couch, cloth, and the other components 1*2cm stone marks 200 #	m^3	43.5				
2.11	Floor						
	- concrete floor D=100	m^2	96.2				
	- cement floor	m^2	942.0				
	- concrete floor	m^2	496.6				
	- tiled floor	m^2					
	- tiled floor	m^2					
	- Titled floor 200*200 mm	m^2	60.0				
	- CERAMIC titled floor 200*200 mm	m^2					
	- CERAMIC titled floor 108*108mm	m^2	153.6				
	- China titled floor 300*300 mm	m^2	616.9				
	- CERAMIC titled floor 300*300 mm	m^2					
	- CERAMIC titled floor 400*400 mm	m^2	40.0				
	- GRANIT titled floor 300*300 mm	m^2	544.5				
	- GRANIT titled floor 400*400 mm	m^2	1,170.4				
	- III-grade wood floor, plywood D = 2cm	m^2					

No	Thanh Hoa province			No	Hoa Binh province		
	Types of affected houses and buildings	Unit	Number		Types of affected houses and buildings	Unit	Number
2.12	Paving work						
	- Glazed tile 150*200 mm and 200*250 mm	m^2	82.0				
2.13	Ceiling						
	- Lamb iris wood ceiling	m^2	50.0				
	- Plywood ceiling	m^2	50.0				
	- pattern Plastic ceiling	m^2	53.1				
	- Plastic ceiling 200*6000	m^2	1,110.9				
2.14	Sanitary equipment						
	- Sink	set	8.0				
	- lavatory	set	49.0				
	- squatting toilet	set	30.0				
	- urinals	set					
	- Water heater	set	5.0				
2.15	PVC water pipes						
	- PVC pipe : f< 32	m					
	- PVC pipe: f<110	m					
2.16	Fish ponds, excavation and embankment road, ditches, drain						
	- Volume of digging pond, ditches and drain by hand	m^3	3,135.2				
	- Embank pond, road and ditch, from the dug land by hand	m^3					
	- Fixing the banks of ponds, canals, drains into stone	m^3	15.2				
II	**Graves**						
1	Reburied grave land	grave	24.0				
2	Graves have enough time to reburied, but not yet exhumed; Buried graves by the time the inventory> 36 months, but according to local characteristics have not been reburied	grave	119.0				
3	graves	m^3					

(Source: By the result of survey was carried by PECC4 in August - September, 2015)

Some pictures of affected houses/structures by the Hoi Xuan hydropower plant project


01/08/2014


01/08/2014


XE MÁY
01/08/2014


01/08/2014


VIETTEL
Telecom
01/08/2014


01/08/2014

According to the survey results, there are 598HHs/2,841 people affected to their houses/structures in the project area, and they have to displace. This will cause a disturbance about their life and production. However, the ethnic composition of the region is quite homogeneous (mainly Thai. Muong and Kinh people) and centralizes villages with the solidarity, so when households are affected and have to displace. They will easy to integrate into their lives and less disturbed.

Table 4.22: Households/persons affected in the project work area

Impacted area	**Total PAHs**		**PAHs impacted on house**		**PAHs only impacted on productive land and others**	
	No. Households	***No. People***	***No. Households***	***No. People***	***No. Households***	***No. People***
Reservoir inundated areas	1,231	5,586	580	2,782	651	2,867
Within the construction area (borrow pits. roads. construction site and construction camp)	110	427	18	59	92	305
Within the public building area	8	32	8	32	0	0
Total	**1,349**	**6,045**	**606**	**2,873**	**743**	**3,172**

Among the affected structures, there are 150 graves, of which 24 have been re-buried, 119 unburied ones, …. The movement of these graves needs to consider to the ethnic minority tradition and custom.

❖ Damage on infrastructure. public works

Table 4.23: Public works affected by the Hoi Xuan HPP

No.	Items	Unit	Quantity
I	**Thanh Hoa province**		
1	**Thanh Xuan commune**		
1.1	CPC's head office	m^2	375
1.2	Clinics	m^2	475
1.3	Primary school	Lot	1
1.4	Nursery school at Eo village	m^2	400
1.5	Primary school at Thu Dong	m^2	574
1.6	Nursery school at Sa Lang	m^2	30
1.7	Primary school at Sa Lang village	m^2	500
1.8	Forest management station	m^2	100
1.9	Rural road connected highway QL15B to Eo village	Lot	1
2	**Phu Xuan commune**		
2.1	Primary school	m^2	1,330
2.2	Phu Xuan suspension bridge	Lot	1
2.3	Road from Phu Xuan suspension bridge to upstream	Lot	1
3	**Phu Thanh commune**		
3.1	Binh Minh co-operative	m^2	275
3.2	Primary school at En village	m^2	975
3.3	Football ground at Pang village	m^2	6,210
3.4	Spillway at Pang village	cái	1
3.5	Road from Chieng suspension bridge to En village	Lot	1
4	**Phu Le commune**		
	Road from Phu Le new bridge to Phu Le CPC's new head office	Lot	1
5	**Phu Son commune**		
5.1	Road from CPC to Chieng suspension bridge	Lot	1
5.2	Chieng suspension bridge	Lot	1
II	**Hoa Binh province**		
	Primary school at Don, Van Mai commune	m^2	32
	Nursery school at Don, Van Mai commune	m^2	124
	House of culture at Khan, Van Mai commune	m^2	500
	Primary school at Choi, Mai Hich commune	m^2	180
III	**Highway QL 15B**	**Lot**	**1**

The affected public works, infrastructure which does not have demand to continue using will be compensated in cash. Those wishing to submit any further use will be invested in building reimburse at other locations in local.

Some pictures on public works, infrastructure affected by the Hoi Xuan HPP

Mitigation measures:

To minimize the impact of land acquisition for construction projects in the hydroelectric sector on economy, income, life, and production of residents and project communes, the PO have to implement the following measures:

- Implement measurement and detailed inventory of losses of land acquisition for the project. To perform the conversion task of land use purpose before construction.

- Before land acquisition, affected households are allowed to harvest agricultural products on their land.

- Conduct damage compensation, support and resettlement for households and communes who are affected by land, trees, crops, buildings, structures, public facilities and infrastructure in accordance with regulations and before recovery of land for construction of the project. This will help AHs to quickly stabilize their life and production. Only be asked to hand over land after completion of compensation, support and resettlement for the affected households.

Based on the legality of land and assets on land, land area of the territories, and APs expectations, comments of AHs representatives and the local government, the PO has expected compensation plan for the affected households as follows:

+ For AHs with affected productive land: according to the survey of damage, affected production land of AHs are mostly planted production forests (bamboo); affected rice land area is small, about 49.1ha. Affected production land of most of the households is below 10% of their total landholding area. According to survey results of the affected households' expectations, in consultation with the local authorities and representatives of the affected people, and considered the local production land area, the PO has been expected to pay in cash to balance their household production land, agreed to transfer the land use rights to households in the area.

Currently, in order to ensure food security for people, during the project implementation, the PO need to cooperate with local authorities to find land. It can find land which can be reclaimed to conduct reclamation and arranging cultivate-resettlement for these affected households.

According to a survey of experts group in feasibility study phase, in Ba village - Phu Son commune can arrange cultivate-resettlement for affected households to scale an area of about 6.0 ha. According to the evaluation. the current conditions have some disadvantageous factors such as the large slopes (3-8 and 15^0), hard to irrigate and much stone, not adapted or less adapted for rice. Therefore, it is necessary to have improvement measure in order to cultivate crops. In addition to this area, the PO is recommended to continue find other land source for reclamation and improvement.

+ For AHs with affected houses: houses in the area have main structure of wood and bamboo which is easy to remove outside the project area. Further through investigation and interviews the affected households' expectations at the time of project implementation (July – August 2014 and August – September 2015), most households wish to receive compensation for the loss of housing and themselves moving up from the flooded areas. Therefore, the project owner shall compensate by cash for affected households and support as prescribed (relocation assistance. livelihood support.…) to AHs displace to a new location by themselves.

There are only 42 households in Sa Lang village who wish to receive land compensation and focusing resettlement. To meet the expectations of these households. the PO has been coordinated with local authorities. and local people to search and layout 01 resettlement areas in the Sa Lang with 42 households. The PO conduct land use planning and completion of the legal procedures for land use and resettlement areas; devising parcels of land with 300m^2 per lot, investing infrastructure and essential public facilities in the area (roads, electricity, water, schools, culture, ...) to help facilitate ensure a stable life for the affected households. Impacts of the construction of resettlement areas are mentioned in section below.

+ For the infrastructure and public facilities managed by local governments and other agencies: Implementing monetary compensation for public works, public infrastructure which are no need to use continue while preparing reconstruction at other places for works having needs to continue to use such as schools. CPC offices, Clinics, cultural house, etc, HW 15A passing through the locality of Hoa Binh and Thanh Hoa provinces will be inundated in the reservoir area and occupied in the dam area. This is an important traffic route so reconstruction for the inundated section will have to be done.

According to estimates at the present time, total cost of compensation.assistance and resettlement of the entire project (including all construction items) is 619.820 billion VND, with 18,762 billion VND was paid. In total for compensation, assistance cost of the hydropower plant, 12,376 billion VND was paid (see table below).

Details of compensation, assistance, resettlement and livelihood restoration for the affected households, including the development of ethnic minorities are presented in other reports, not mentioned in this report.

Table 4.24: Estimate costs of compensation, assistance and resettlement

No.	Work content	Implemented value
A	**Compensation, assistance and resettlement**	**12,495,755,648**
I	**Compensation and assistance ofhydropower plant construction site**	**12,376,714,048**
I.1	**Compensation and assistance of the important structures. and reservoir areas**	**11,808,368,895**
1	***Household compensation and assistance***	***9,769,697,461***
a	**Thanh Hoa province**	**9,769,697,461**
i)	Land compensation	7,158,284,500
ii)	House and architectural structure compensation	988,598,417
iii)	Commercial trees and crops compensation	1,120,028,454
iv)	Assistance policy	261,320,000
v)	Implementation cost	241,466,090
b	**Hoa Binh province**	**0**

No.	Work content	Implemented value
2	***Public structure construction and compensation cost***	***2,038,671,434***
i)	Public structure construction and compensation cost	2,038,671,434
I.2	**Tailings. sand pits compensation and assistance**	**568,345,153**
i)	Compensation cost and compensation implementation of the tailings site	568,345,153
II	**Compensation and assistance of the connecting line**	**119,041,600**
i)	Compensation for land permanent acquisition and assets attached to land	114,131,600
ii)	Implementation cost	4,910,000
B	**Extraction of cadastral map**	**7,209,902**
C	**Consultancy for compensation. assistance and resettlement**	**6,259,214,153**
D	**Total**	**18,762,179,703**

Note: The above compensation funding provided by the PO.

- Provide financial support to displace, clean houses/structures. Impacts on graves will affect the AHs'spirituality, customs, practices and beliefs, so it is necessary to notice during remove the affected graves.

- In addition to compensation for damage to land and property for people, support for life and production, relocation assistance, support career change and job creation are also provided as prescribed by the State and of the Thanh Hoa and Hoa Binh provinces. This ensures that livelihood of displaced households in the new place is equal to or better than the old place, in which vulnerable households (such as women headed households, ethnic minority households, elderly households households family policy, etc.) are given priority consideration.

In addition, the PO will implement measures to improve cultural and spiritual life of people and other supports such as funding for preschool, elementary; set up a library of books on literature, politics, society, science and technology, economics, art and mass culture; organizing cultural exchanges, sports, folk art and development support conservation culture. ethnic arts locally; building amusement parks and entertainment; gifts to the poor, poor student at school, the elderly, people with disabilities at the local level; recruiting unskilled workers work at the site; acquisition of supplies and materials by local people to produce and use construction and installation; prioritize long-term employed at the plant for those who are capable of training, professional qualifications; support training of local personnel; capital support plantation development; support conservation of local cultural heritage; ...

- Conducting compensation, assistanceand resettlement as regulations.

- Participate in addressing the grievances of people in the process of implementation of compensation, assistance and resettlement.

- Monitor the implementation of compensation, assistance and resettlement.

- Create jobs for local people: the labor selection process can recruit local people to do some simple, no technical qualifications in the project, and pay salary to increase income for local people. Prioritize the long-term employees at the plant for those who are capable of training, professional qualifications.

The adequate compensation.assistance and resettlement will help affected people quickly stabilize life to equal to or better than before the project appearance. This has to be a mandatory condition for the PO and included in the commitment sector.

- The damage compensation, assistance and resettlement need to implement democracy, openness and transparency. Basically, the compensation policy of the project is built according to the specific content of the provisions in the Land Law No. 45/2013 / QH13, Decree No. 43/2014 / ND-CP, Decree No. 44/2014 / ND-CP of the Government's, Decree No. 47/2014 / ND-CP and the decisions of the two provinces of Thanh Hoa and Hoa Binh.

- After finishing the compensation.assistance and resettlement, the PO shall coordinate with local authorities to investigate social studies, assessment of quality of life, quality of construction traffic, power supply system, etc, to have additional policies and measures to support timely processing to minimize the negative issues arise unexpectedly.

b. Impacts by concentrating construction workers on the project site

Number of workers on the site over the years of construction is as follows:

Table 4.25: Number of workers, staffs for the construction of Hoi Xuan HPP

Construction year	Number of workers
First year	1,565
Second year	2,355
Third year	3,261
Fourth year	3,040

The demand for food and entertainment of the staff and workers will contribute to promote trade and services development. The facility of services business will be formed to meet their daily needs. This will contribute to solve the problem of employment and income for local people.

Process of workers concentration in the project site also involves migrant labors from other areas to the construction area. The migrant labors in the construction area work mainly in service and food business, etc.

c. Creating employment opportunities for local people

Hoi Xuan HPP construction will be the primary basis for the restructuring of local labor through meeting the needs of inside labor of the project. This will create employment opportunities for local people.

Civil contractors and construction units can hire local workers to work in a number of work categories and pay their salaries. Due to the educational level of local workers, they will be hired for simple works such as clearing vegetation, protection of schools, sanitary cleaning, babysitting, picking clean stone, watering concrete for maintenance, cleaning of steel, stone wash, etc. This is a present to take advantage of human resources availability of local resources, problem solving jobs, increase incomes for workers, reducing costs for investors (shipping cost workers from other places. ...), reducing the social pressure by workers from other areas, limiting the issues related to security and order in the area (increasing the number of people staying in the area, increasing the social evils, conflicts between communities and groups ...).

The number of local laborers who will be recruited to build the project depends on the nature and volume of work and the demands of contractors, construction units in each work item.

4.1.2.2 Impact on the managementoflocal government; health.culture.customs and habitsof local people; construction andoperation workers

1. In preparationand construction phases

a. Impactsof land acquisitionforconstruction of the project

The households affected by land acquisition for the project might move to another place. Although the resettlement position located within the affected communes, it will more or less impact on the spiritual life, customs and production activities of the effected households as well as the households living in the place where the effected households will move to.

Excluding the affected households following the resettlement plan of the project, the left affected households aspire to receive monetary compensation and to find a residential place as well as to balance the cultivated land resource by themselves. Therefore, housing and land trading will happen between the local inhabitants and affected households, causing difficulties for management.

The population density at resettlement areas become higher, the integration process between ethnic groups will be therefore promoted. Between people moving in and the local inhabitants, there may be disunity, conflict and disputes in harmonizing traditional customs. Hence, before moving effected households to the resettlement areas, conducting meetings to unify people moving in and the local inhabitants their opinions are needed; this aims to prevent from the disagreements and contradictions in the community arising due to disunity.

Mitigation measures:

The Project Owner shall coordinate with the local government in the management to ensure security in the locality during the process of resettlement for affected households.

The Project Owner shall coordinate with local government carrying out the meeting with the households which have to move to another place in order to propagandize and mobilize the sense of unity and support each other. In addition, disseminate the cultural characters, beliefs of local people at the place where they will move to, in order to understand and integrate into their new community more easily.

In addition, the Project Owner shall coordinate with the local government to hold a meeting with the local communities where effected households moving to in order to propagandize and mobilize the sense of unity and support each other. Also, disseminate the cultural characters, beliefs of the resettled households for local people to be able to understand and integrate new immigrants more easily.

b. Impactsof minesand explosives

Mines and explosives survival after war in theconstruction site must be detected and treated – ifnot, they might result danger toconstruction workersandpeople as approaching.

The areas need to be detected and treated mines and explosives include: dam site, waterway powerhouse. OPY and auxiliary facilities such as (camps, material storage yard, disposal site, system of power and watersupply for construction and construction-operation roads, etc).

Mitigation measures

The Project Owner has been submitted in written to the military authorities to ask whether the mines and explosives still be survival from the war in the construction site. If any, the Project Owner must be responsible for hiring military specialized units toreconnoiter, detectand treat them before construction.

Warningsigns must be installed in the disarmed area which canbe dangerousfor peopleas approaching.

c. Impact of dust, exhaust fumes, noise wastewater and waste matters

- Impacts of dust and exhaust fumes:

Dust, exhaust fumes will impact on health of workers on the construction site and local people living in the surrounding area.

According to the calculation result above, the largest effect radius of the exhaust fumes, dust produced during the preparation and construction period by blasting work is about 4 kilometers. However, the blasting work will happen only in a short time of about 1 hour each day (usually from 11:30am to 12:00am and from 5:30pm to 6:00pm), but not continuous. Moreover, the project area located at the elevation lower than the surrounding area's elevation, together with being surrounded with stony mountains, the effect radius will be therefore much smaller than as predicted. The affected area is mainly within the radius of less than 650 meters.

Worker camps and some local people's houses in the project area although are far from the construction area and at the beginning of wind directions, but located along construction and operation roads. Construction time of the project will last about 4 years (including the preparation year). During the construction of the project, the Project Owner will implement mitigation measures; hence Impact on the environment will be significantly reduced. The impact is assessed at the medium level.

- The impact of noise:

Just like dust and exhaust fumes, noise will also directly impact on the health of workers and local people living around the project area, causing hearing problems.

The effect radius of noise ranges from 0.45-0.5 kilometer. With operation schedule of 1 shift per day, 2 shifts per day in case of rush time and the arrangement of camps and population distribution mentioned above, the impact of noise on health of workers and local people living around the project area is assessed at the medium level.

- Impacts of waste and wastewater:

The health of local people in the communesaround the project area and construction workers will be affected if the waste (especially waste garbage) is not collected treated and drained into landfill as specified.

Mitigation measures:

- Comply with mitigation measures against impacts caused by dust, noise, wastewater and waste matter as stated.

- Equip fully the equipment of labor safety for workers. Schedule working time properly ensure the duration contacting the noise as specified.

- Implement health examination periodically for workers to timely infect, manage and treat in case of occurring occupational disease.

d. Impact of construction of work items on the safety of construction workers and local people

The construction of work items can cause labor accidents e.g. traffic accidents (along the construction and operation roads or at positions intersecting with traffic roads); accidents caused by electric shock or blasting (blasting area); environmental problems (soil and rock sliding in excavation areas, cofferdam upstream and downstream broken, fire at petroleum and explosive depot). With accidents mentioned above, if the contractor.construction units and construction workers do not comply with regulations on safety of work and safety measures for workers, this will cause local people and investors loss of their economics and property; and will make threats against life safety of construction workers as well as local people in the project area and at the downstream.

Mitigation measures

Comply with labor safety measures, prevent from environmental incidents stated to avoid human and property losses, In particular as the following:

- The contractorundertakes to comply with the current regulations of the State on sanitary and laborsafety.

- The project area under constructionmust be protected in 24 of 24 hours, strictly control people and machinery, prevent unauthorized people from accessing the construction site.

- The Project Owner requires construction units to comply strictly the current regulations on transporting, storing and using explosives. In particular, explosives must be transported safely, with guards and escorts to prevent from losses. Explosives depot must be located far away from forest cover layer and the other works within the allowable scope. Establish thoroughly proceduresin accordance with regulationsprior toblasting. Perform properly blasting procedure: install warning signs and signal siren in blasting area to be able to hearclearly within allowable radius. The safe distance of seismic wave produced by blasting is 195.74 meters, therefore installing the check point warning blasting timeand placefor local people and construction workers is needed. Plan the blastings chedule sensibly; notify workers and local people in affected area known time. Location, radius ofdanger; and not allow workers and local people to go through the blasting area. Blasting shall only becarried out when finishing implementing safety measures for human, construction and other assets.

- Fueltank smust be arranged underground in bunkers with a minimum depth of 0.5 meter and far away from sources being capable of causing fire.

- Measures toprevent and mitigate impacts ofincidents of coffer dam broken:

+ Comply with technical solutions design criteria, construction schedule, etc as constructing upstream and downstream cofferdam.

+ Establish frequent flood prevention committee (24 of 24 hours) on the construction siteand in the areas with risk of breakdown.

+ Direct entire flow through the diversion construction.

+ Prepare materials to raise coffer dam as flood risks exceeding the design flood.

+ Promptly in form workers and move machinery on the construction site out of the danger area.

+ Promptly notify the local authorities at the downstream area to move out of the area being likely to be submerged to avoid assetand human losses.

+ In case ofcoffer-dam failure down, causing damageon land, property, crops and construction of local people, people at downstream and economic organization, the Project Owner must be responsible for compensation (if the damage is determined to be caused by the accident of coffer-dam failure down).

-The Contractor must prepare the measures to surmount, urgently evacuate local peoplein case ofaccident occur. Especially when fire occurring, it should implement measures to rescue and get fire under control timely.

- Organize, train and equip equipment for rescue teams. Medical devices and medicines must be always available at the construction site.

- Arrange high-voltage lighting system to ensure safety working conditions for all workers and staffsas implementing the construction in night.

- Workers at the construction site must be trained in labor safety and equipped fully safety working equipment. Specifically:

+ The Project Ownershall coordinate with construction contractors often open training courseson labor safety for their staffs andworkers on the construction site.

+ The workers participating in thebuilding works on site will be equipped with full safety working equipment with manual enclosed. All workers must us eappropriate safety equipment which is suitable for the workin progress.

- Before performing work, test the equipment, materials, machinery, etc. to detect damage timely. The work will be carried out only when having all machinery and equipment tested to ensure the working safety and hygiene standards.

- Install warning signs at dangerous road sections and areas with risks of lands lides and areas can be dangerous for people as approaching.

- Organizations, labor unions regularly inspect compliance with labor protectionregulations; employees must comply with working safety regulations and standards.

Applied standards and regulations:

- Comply withtechnical standards, designcriteria, construction schedule, etc.

- Applicable standards include QCVN QTD-7: 2009/BCT; QCVN QTĐ -5: 2009/BCT; TCVN5308:91. TCVN3985:99. TCVN4086:95. TCVN3254:89. TCVN3255:86. TCVN3146:86. TCVN4245:85. TCVN3147:90. TCVN2293:78. TCVN2292:78. TCVN4744:89. TCVN3146:86. QPVN2:1975. TCVN4244:86. TCVN5863:95 and QCVN: 2008/BCT.

e. Impacts caused by worker concentration in camps

Impacts relating to the concentration of workers in camps include:

- Impacts due to land acquisition for the construction of camps / housing for workers, consultants and PMB, acquired land area is about 3.48ha.

- The concentration of workers in the project site (number of workers is from 1,565 – 3,261 people – table 4.10) will generate domestic wastes which may impact on life environment, water and ambient environment if not have proper treatment and collection measures.

- Demand on firewood and forest products consumption of construction workers may increase illegal activities on forest resources such as wood exploitation; wild animal hunting, rare and precious wood and animals possession and trade. This may adversely affect to plants and animals in surrounding areas and neighbor protected areas.

- Impact on community health: the concentration of workers in the project site may bring strange diseases to spread / transmit to residents living in surrounding area. It may also cause increase in risk of illegal using and trafficking drugs; arise illicit relations, especially illicit relations with local women which is risk of spread of infectious diseases such as AIDS / HIV) for local people and inversely.

- The concentration of workers in the project site may also increase pressure on infrastructure system and social services such as increase in pressure on system of power supply, water supply system, traffic, health and education facilities, market,… of the locality.

- Demands on workers' food, accommodation, life activities, entertainment also increase pressure on services supply system of the locality but it also impulse the development of business activity, services of catering, entertainment in the locality, this will contribute to create jobs and occupational opportunities for local labors which will increase their income.

- Impact on securityin the area and the management of local government as well as culture, customs and beliefs of local people in the project area.

The concentration in large density of workers on the site (mostly men) and their dependents, together with free migration, can result in corollaries such as illegalland trading, conflict between labor groups, contractors; conflicts between staffs, workers with local people; resulting in social evils. These will cause the difficulties in security control.

The staffs, construction workers and their dependents (family, spouses, children), together with the free migration to the construction area can cause fluctuations in populationin the project area; temporarily in crease population density and the number of people staying at the locality. These will cause difficulties in civil status and society management for thelocal government in the project area.

The ethnic groups in the project area including the Kinh, Thai, Muong and, Tay live and concentrate in villages with high community of special customs and practices. Construction workers on the site come from many different places with different ethnic, culture, customs and practices, and beliefs, so there will be the mixing and interference between cultures. These can result in the loss of the inherent cultural characters, customs and practices, and beliefs here.

- Otherwise, workers may be also impacted by construction activities of the project relating to occupational safety and health such impacts due to dust, exhausts, noise; risks of traffic accident, accident due to blasting,… if the project has no safe warning measures during construction.

After finishing the project construction, almost workers will leave the project area, only a small amount of workers (<100 people) stay in and small quantity of new workers to the project area to carry out the operation of the plant. These operation workers will work and live for a long time in the locality, thus they will gradually adapt to living environment here, relating impacts will be reduced.

After construction workers leave the project area, temporary camps will be taken down, cleared. The ground will be leveled, improved to return the initial status for local residents to continue their production or grow trees on it.

Mitigation measures:

- Proper compensatation and assistance for the affected land and structures on land before acquring land for constructing camps.

- Implement domestic wastes, dust, exhausts and noise mitigation measures as above mentioned.

- Comply with safety measures as stipluated during the project construction to ensure safety for workers and people.

- Not use wood for cooking in camps. Propagandize the awareness of forest resources. Prohibit workers from trading, hunting and consumpting rare and precious timber and wild animals.

- Apply effective preventive measures to reduce possibility of disease transmission in the community and in the worker's camps such as:

+ In workers' camp area, build a medical facility with medical staffs and medical equipment and tools to serve normal diseases examination and treatment, and first aid for workers.

+ Having mobile medicine cabinets on the construction sites.

+ Propaganda, mobilization for keeping accommodation hygiene, using clean water, using bed nets when sleeping, vaccinating against diseases; eradicating mosquitoes and other insects.

+ Coordinate with the local medical station to take measures to prevent from common diseases such as malaria, normal fever, abdominal pain, dysentery; and propagandize measures to prevent from the spread of disease from household livestock, poultry, etc.

+ Coordinate with local health to have periodic health examination plans for workers and staffs; spray medicine to prevent from diseases.

+ Regularly inspect and instruct staffs and workers to prevent common diseases.

+ The project area is a hotspot for drug and HIV/AIDS hence it needs to increase security in the construction site and camps area to avoid bringing drug in the project area to sell to workers; promote propaganda and enhance the awareness of the harmful effect of drugs; promote propaganda and enhance the awareness of personal hygiene and sexually transmitted infection such as HIV / AIDS and other infectious diseases.

- To reduce pressure on the local infrastructure system, the project should implement the following measures:

+ Build a medical facility to serve normal diseases examination and treatment, and first aid for workers as above mentioned.

+ Build schools, kindergartens to meet the learning needs of the workers' children.

+ Build new operation and construction roads on the construction site; imprpove and upgrade existing roads used for constructing the project if they does not meet the quality and weight. Repair roads damaged, collapsed by the project's transportation.

+ Arrange reasonable materials transport time to avoid the concentration of vehicles at the same time.

+ When transporting oversize and overweight equipment, it should use special transport means.

+ Ensure power and water supply system for worker camps that it does not affect to the supply of electricity and water to people.

- The PO, civil contractors will register temporary residence for their workers and coordinate with local authorities in managing workers to ensure order and security, social evils elimination…

- The PO, civil contractors will coordinate with local authorities in maintaining the cultural characters, customs and practices, religion and belief of ethnics living in the project area. They can help ethnics to understand new culture, new life style from workers, but it must ensure that ethnics still maintain their typical cultural characters, customs and practices, religion and belief.

- After finishing construction, temporary camps will be taken down, cleared. The ground will be leveled, improved to return the initial status for local residents to continue their production or grow trees on it.

Notes: This ESIA report only presents preliminarily impacts. Details will be addressed in labor and working conditions report[1] *in accordance with "Performance Standard No. 2. Labor and*

[1] Main contents of the report on labor and working conditions conclude: (1) Assessing the need for workers' accommodation consisting: Assessing availability of workforce; availability of existing housing and whether housing is needed for the project

working conditions" of MIGA Performance Standards and "Workers' Accommodation" - A Guidance Note by IFC and the EBRD.

2. Operation phase

a. Impact of dust, exhaust fumes, noise

- The nois egenerated by the operation of machinery and equipment in the plant will affect to health of the operators. However, the plant will be installed advanced machines and equipment, the operators will be equipped with working safety clothing and equipment, together with being arranged to work in shifts, the impact of noise will be therefore not significant.

- The smelly air and odor produced during the decomposition process of the mass of living organisms submerged in the reservoir areawill cause atmosphere to be polluted, affecting to health of plant operators and local people living around the reservoir area. However, to mitigate these impacts on water quality of there servoir area and at the downstream as well as to ensure the beauty of construction, before impounding water for the reservoir, the Project Owner should carry out cleaning there servoir foundation. The mass of living organisms submerged in the reservoir area are mainly stumps, roots, generated grass, corpse ofanimals, micro-organisms and small animals living in and on the soil surface being not likely to move out ofthe reservoir foundation. The air pollution level caused by air produced during the decomposition process of the mass of living organisms will insignificantly affect to health of plant operators.

b. Impacts caused by worker concentration in operation phase

- Theconcentration in large density ofplant operators will increase the population density in the communes around theproject area. This can cause problems in terms of society and security such as create conflicts between the workers and local people; result in social evils such asgambling, drugs, prostitution. These will cause difficulties in civil status, society and security management for the local government in the project area.

---

and if so, what sort, (2) Assessing impacts of workers' accommodation on local communities and planning mitigation of potential negative impacts consisting: Impacts due to and acquisition and resettlement; specific impacts during the construction phase; impacts on community infrastructure, community services and facilities, community services and facilities, local businesses and local employment, community health and safety, community cohesion, dismantling and reinstatement, (3) Types of workers' accommodation, (4) Standards for workers' accommodation mention awareness of the national and local regulatory framework; determination of the standards to apply the location of facilities, the construction of housing and provision of facilities. Standards consist: national/local standards; general living facilities; room/dormitory facilities; sanitary and toilet facilities; canteen, cooking and laundry facilities; standards for nutrition and food safety; medical facilities; leisure, social and telecommunication facilities, (5) Management of workers' accommodation consists: management and staff; charging fees for accommodation and services; health and safety on site; security of workers' accommodation; workers' rights, rules and regulations on workers' accommodation; consultation and grievance mechanisms; management of community relations.

- Although there are not many plant operators (about 88 people), but they come from many different places with different education levels, culture, customs, beliefs as well as permanently living and working in the area, so there will be the mixing and interference of cultures, customs, habits and beliefs between local people and plant operators. By contacting the plant operators who are general at high education level, the awareness of local people will be therefore heightened.

Mitigation measures:

- Plant Management Board must be responsible for declaring temporary residence for the operators and coordinating with the local authorities in managing its personnel to ensure security as well as to eliminate social evils.

- The plant management and operation units must coordinate with the local authorities in maintaining the cultural characters, customs, habits and beliefs of the ethnic minorities living in the area; helping the ethnic minorities acquire the new cultures and life styles....but still maintain their cultural characters, beliefs, customs, habits and beliefs.

c. Impacts caused by the plant operation

- As completion of the project, the reservoir will be impounded water and put into operation, the climatic conditions around the reservoir area will be therefore improved. It will become more equable and beneficial to human health.

- As the project put into operation, the energy output will be brought into use. The electricity supplying for domestic activities will be enhanced, contributing to improve the cultural and spirit people lives.

- Impacts of erosion and bank sliding:

According to the analysis mentioned above, as with out Hoi Xuan hydropower project, river bank erosion and sliding status at the downstream happens strongly. This will cause the loss of land, works and assets on land and make threats against the safety oflocal people’s livesat both river banks. After Hoi Xuan HPP is put into operation, these impacts will be therefore decreased; these negative impacts will be reduced significantly.

-As the reservoir under process of water or flood discharge, it is necessary to notify local people to promptly move out of the affected area - if not. it will cause damage to land, property andassets on land even peopleat thedownstream.

-According toanalysis.the incident of Dam failure downis still capable of happening. This will extremely impact on the villages, communes and towns at the both riverbanks at the downstream, especially in densely populated areas like Quan Hoa district, resulting in injury and even death. The most visible impact on the economy is that it will cause damage to property and assets on theland.

Mitigation measures:

-Befor eputting the plant into operation, the Project Owner is responsible for establishing and sub mitting the reservoir operation procedure.

The management and operation units must strictly comply with the reservoir operation procedure approved by the Ministry of Industry and Trade.

Before implementing water or flood discharge, the management and operation units is responsible fortimely notify the local authoritiesin the project area and at the downstream and the competent agencies which relevant to timely give out the response measures in order to limit the human and economic losses.

The management and operation units must implement warning measures during the process of flood discharge suchas installing signal siren as discharging water or flood, notifying flood discharge on the local broad casting system and installing warning signs at the locations of water or flood discharge.

For the prevention and response measures to the incident of Dam failure down:

- To prevent dam breakdown, frequency and maximum design water level of the project shall be determined according to Vietnamese construction standard TCXDVN285: 2002 and Decree No. 209/2004/ND-CP of the Government. In addition, the design has proposed measures to handle impact of faults and tectonic destruction impacting on the dam site, emergency spillway has been included in the design to prevent dam from breakdown. However, the incident of Dam failure down is likely to happen.

In the event of flood exceeding the design frequency(p= 0.1%), the risk of Dam failure downmay occur. The mitigation measures areas follows:

+ Establish frequent flood prevention committee (24 of 24 hours) on the construction siteand in the areas with risk of breakdown.

+ Preparematerials to response to incidents of Dam failure down as flood being likely to exceedthe design frequency.

+Promptly notify operators and move machinery out ofthe danger area.

+ Promptly notify the local authorities at the downstream area to move people out of the area being likely to be submerged to avoid the assetand human losses.

Identify the scope of evacuation as Dam failure down or flood discharge through the spillway at various discharge regimes; as well as identify erosion scope and consolidation measures to reinforce the river banks at the downstream in the technical design phase. Continue to calculate and check flood and arrange spillway as happening flood frequency P=0.1%. Build the spillway its hydraulic model to test and adjust the spillway in design, determine the curve of water surface at the upstream and downstream area under the different discharge regimes.

+Frequently disseminate safety regulations need to be performed for local people to inform and organizee vacuation timely incase oflarge flood discharge. Frequently check the equipment related to flood discharge like opening and closing systems of the spillway.

4.1.2.3. Impacts ontraffic operations

a. For the road traffic

- The impact of land acquisition for the construction of work items:

The land acquisition for the construction of the powerhouse and reservoir will cause some roads in the area to be lost and submerged like Highway 15 and the inter-village and inter-commune road systems.

The dam site and the powerhouse of Hoi Xuan HPP barricade Highway 15. Therefore, besides the submerged segments in the reservoir area, there will be approximately 400 meters of Highway 15 at the dam site and powerhouse area being affected by construction of dam and powerhouse.

- Impacts caused by transportation of building materials; goods and article of daily necessity:

When implementing construction project, a large number of vehicles will be mobilized to transport machinery, equipment, raw materials, goods, article of daily necessity (food, food products, working safety clothing, etc,) serving for domestic activities of workers on site (see table below) who come from other places; and to transport internally materials on site. These will increase the density of vehicles affecting the operation of the road traffic; and may cause the road base subsidence of traffic routes to the construction site and the internal road system in the project area e.g. Highways 6 and 15 and some other roads in the project area. The most important of which is Impact on traffic and safety during participants traveling on Highway 16 from Hoa Binh town to Thanh Hoa city.

Total length of Highway 15 being affected will be 14,124 kilometers. Of which, about 13,724 kilometers will be inundated and 0.4 kilometer being appropriated for construction of the dam and powerhouse.

To ensure the traffic operation of this road at the inundated segment, there will be plan of building a bypass road with 21,705.5 meters in length (including 18,386.05 meters of new-built road and 3,319.00 meters of road being utilized), with same grade with Highway 15 (grade IV mountainous road).

It will be built a bypass road just for the 400 meters segment passing through the dam site and foundation pit. During construction of this segment, the vehicles still circulate on the old road. After completion of the bypass, the road segment in the foundation pits of dam site and powerhouse will be excavated.

During the construction process (i.e, the construction of the bypass road for Highway 15 at segment passing through the project area and OPY's foundation pit and dam at the left abutment), to ensure the safety for traffic, the construction agency and the Project Owner must strictly comply with the provisions of the transportation department on the construction and regulation, guard and notification of blasting time. After blasting, rock rolled down the road surface must be urgently removed to traffic through Highway 15.

Table 4.26: The number ofvehiclesand machineryon the construction site

Vehicles and machinery	**Engine**	**Number of machinery for each construction year**			
		1st year	***2nd year***	***3rd year***	***4th year***
Number ofexcavators, 1.25m^3	diesel	1	1	1	1
Number ofexcavators, 2.3m^3	diesel	16	4	10	1
Number of bulldozers,110Cv	diesel	6	3	4	1
Number of bulldozers, 140Cv	diesel	7	1	4	0
Number of bulldozers,180Cv	diesel	1	1	1	1
Number of compressors,25T	diesel	3	3	3	0
Number of compressors, 18T	diesel	1	1	0	1
Number of drillers, D76	diesel	3	6	13	0
Number of drillers, D105	diesel	17	4	8	0
Number of diesel compressors, 660m^3/h	diesel	18	4	8	0
Number of diesel compressors,1200m^3/h	diesel	3	6	13	0
Number of gas welding devices, 1000l/h		0	0	1	1
Number of trucks, 12T	diesel	83	18	48	1
Number of concrete transport vehicle, 6m^3	diesel	2	7	7	5
Number of street-cleaning lorries, 9m^3	diesel	1	1	1	0
Number of cranes, 16T	diesel	2	5	5	4
Number of cranes, 50T	diesel	0	1	2	2
Number of hand drillers, D42	diesel	3	1	2	0
Number of cutters, 5Kw	diesel	1	4	5	6
Number of welders, 23Kw	diesel	1	19	31	41
Number of shaving machines, 7Kw	diesel	0	4	8	10
Number of saw machines, 2.7Kw	diesel	0	6	13	17
Number of turning machines,10Kw	diesel	0	4	9	12
Number of grinders, 2.7Kw	diesel	0	3	5	7
Number of drillers, 2.5Kw	diesel	0	1	1	1
Number of drillers, 4.5Kw	diesel	0	6	12	16

Vehicles and machinery	Engine	Number of machinery for each construction year			
		1st year	*2nd year*	*3rd year*	*4th year*
Number of vibrator cylinder, 1.5kw	diesel	9	32	29	22
Number of concrete mixing plants	diesel	1	1	1	1
Number of crushing plants	diesel	1	1	1	1
Number of pumps	diesel	8	8	8	8
Number of tower cranes, 10T	diesel	1	3	3	3

- Impactscaused bynew-built and upgradedroadsfor construction:

In order to meet the requirements of the construction project, the infra structures pecially the road system, water and power supply for the construction and operation processes of the plant should be upgraded and new-built. For the scale of construction-operation roads, referring to the general construction plan (Figure 3).

- Forwater traffic:

The water traffics one of important types of transportin the area. Besidetraffic aspect, this is also one of the modes of transportation of bamboo (a major commodity in the region, also known as the strategic tree for Poverty Reduction) from the upstream source of Ma river to the downstream consumption.

Transporting bamboo on Ma river

In summary, the construction of hydropower project on Ma river will have a major impact on traffic operation. For road transport system (i.e, Highway 15), it will be affected but only in the construction period. Just for the water traffic, the duration of impact will be quite long affecting the circulation of commodities from the upstream to the downstream (from providers to consummer).

Mitigation measures:

- There should beappropriate regulation regime of vehiclesto prevent fromtraffic jamsonthe roads.

- Install barriers, warningsignsatroad segments being likely to happen accidents easily for people and vehicles involved in traffic known.

- Use of specialized vehicles in process of transporting oversized machinery to the site. Carry out upgrading and renovating the roads. when necessary, to prevent damage or depression of road base affecting traffic operation of local people.

- For those segments of road beingin undated in the reservoir area and being appropriated for construction of work items. if want to be used in continue, the PO will rebuildina new location to ensure the traffic as well as goods transportation and circulation for local people, including Highway15.

- For water traffic operation: the forming of Hoi Xuan HPP’s dam on the river, together with the presence of Trung Son HPP’s dam (at the upstream of Hoi Xuan HPP) will obstruct the traffic on Ma river from the upstream to downstream, especially the transportation of bamboo. This impact is unavoidable. However, currently, the transportation of bamboo to the consumption location, beside transported by water traffic, it has been mainly transported by road. Thus for transporting bamboo from the upstream to the dam sites of TrungSon and Hoi Xuan HPPs, type of transportation by water traffic willbe replaced by road traffic; and continue to be transported by water traffic from behind the Hoi Xuan HPP’s dam to the downstream.

Some photos of transporting bamboo by road traffic in the region.

4.1.2.4. Impactson the socio-economy

- Strengthen the power supply for living and production and the stability for the whole system.

In terms of transmitting the national power grid to household smeeting many difficulties; many villages, communes and districts in the project area and other areas being in status of lacking power especially in the northern provinces at present, the energy output of Hoi Xuan HPP (about 432.00 million kWh) will be very important source serving for the socioeconomic development as well as improvement of the quality ofpeople's lives. This hydropower project as being put into operation will be an important factor which will contribute to changethe face of many communes and districts of Thanh Hoa and Hoa Binh provinces in particular and of the North region in general. Specifically:

+ Power supply for domestic activity enhanced will contribute to improve the cultural and spirit life of local people.

+ Investment in construction of Hoi Xuan HPP will change the economic structure of the communes in the project areain positive way, contributing to the process of agricultural industrialization in rural localities.

- Tax sources collected from Hoi Xuan HPP will in crease the budget of the locality, contributing to raise the investment capital for other operations. This will result invery positive impacts on mountainous communes in the project area.

-As Hoi Xuan hydropower project put into operation, together with Trung Son HPP, will form the reservoir by reservoir landscape. With cool and fresh climate condition and special cultural characteristics of ethnic minorities; together with potential tourism destinations located on the territory of two provinces such as ecotourism destination at Kia Cave-Pu Luong (away 8 kilometers from the project). Ma Cave cultural and archaeological relic away from Hoi Xuan commune about 10 kilometers, the magic fish Cave (in Cam Thuy) and several natural reserve likes Pu Hu, Pu Luong, etc…will be the prerequisite for development of tourism services. The forming of the reservoir will promote the development of tourism activities, commercial services. Service facilities will be for medto meet the needs of tourists. Some types of tourism can be developed in the area such as boating, fishing, adventure tourism and ecotourism, etc. Development of tourism and service will contributeto the transformation of the economic structure and sectors for localities around the reservoir; it will also create employment opportunities for local workers and increase their income through rental boats, tourist guide tours, catering services, entertainment, etc. However, there should bea reasonable planto exploit these strengths for economic development and also to protect the ecological environment and biodiversity, preserve the archaeological relics as well as the specific cultural characteristics of the ethnic minorities.

4.1.2.5. Impacts on the objects using water in the project area as well as both at upstream and downstream

-As the reservoirformed with the large surface area and significant volume will create conditions for the development of fishery sectorin the communes in the project area.

In comparisonwith natural river, the aquaculture production will increase the exploited production of shrimp and fish all kinds. This will contribute to improve economic efficiency and nutrition source for local people. If there is sensible investment and management, aquaculture production will bring high economic efficiency.

- Impacts on water supply for domestic and production activities, water traffic and ecological environment:

+ Because Trung Son hydropower will generate power according to the load diagram, the downstream areas will be no water during the hours of generation. Therefore, when put into operation, besides the task of providing 432.00 million kWh of energy output to the national and regional power grids. Hoi Xuan hydropower will also regulate and maintain stable flow regime and tailrace water at the downstream of Trung Son hydropower; and ensure the environmental flow foraquatic fishery at the downstream (fishery and aquaculture). In addition, it will contribute to the maintenance ofthe water traffic transportation from its dam site to the downstream and ensure stable water supply for production and domestic activities at the downstream.

+ Besides the task of power generation, the reservoir of Hoi Xuan hydropower will also regulate the flow, maintain the water traffic activities at the downstream area and contribute to remove salt from the flow at the downstream (in case of there is only the Trung Son HPP with out Hoi Xuan HPP, sea water can penetrate deeply into the causes river estuaries cause the river flow to be salty; as the completion of Hoi Xuan HPP with its power generation of 24/24 hours, the tailrace water level will become stable, limiting the deep penetration of sea water into in river estuaries.

+ Moreover, the construction of Hoi Xuan HPP will enhance the irrigation capacity; increase the area of irrigated land and land-useratio in the dry season for the areas around the reservoir and at the downstream, contributing to stabilization and increase of crops its productivity and production. This will be very meaningful to the communes which economic agriculture is main sector. However, the irrigation being guaranteed or not will depend onthe planning and the investment in construction of irrigation systems.

+Sediment retained in the reservoir will reduce amount of alluvialon two sides ofriver at the downstream; reducethe natural nutrient resources of soil affecting the growth and productivity of crops. However, sediment retained in the reservoir will be not large accounting for only 37% of total sediment volume to the reservoir; the decrease of alluvial will not impact significantly on the downstream area.

- Impact on the objects using water and other economic objects:

+Impact onpower generation and Trung Son hydropower plant.

Impact scope of water levels in Hoi Xuan hydropower's reservoir on Trung Son hydropower at its upstream will be determined byi dentifying the water surface curve in the reservoir corresponding with 1% frequency flood.

Calculation results of reservoir water levels corresponding to 1% frequency intersect natural river water level at the elevation of 87.2m away from Trung Son HPP its dam and powerhouse approximately 6 kilometers.

Minimum tailrace water level of Trung Son hydropower is 89 meters. Its powerhouse has the installation elevation of 108 meters, the dam crest elevation is 163.7m and elevation of spillway weir is145m.

In conclusion, Hoi Xuan HPP reservoir will not affect the operation of Trung Son hydropower at its upstream.

4.1.3. Environmental risks and incidents

Some environmental risks and incidents caused by the project are as follows:

4.1.3.1. Breakdown of upstream and downstream cofferdams

The reasons can cause the cofferdams to be broken

+ Discharge and maximum WL of flood during construction period exceed the discharge and maximum WL of design flood with frequency of 5%.

+The quality of filling materials for the cofferdams does not meet quality as required and the compaction coefficient does not meet the standards.

+ Occur flood exceeds the food designed for construction as the cofferdam elevation does not get the design elevation.

+ Cofferdams have not been constructed in accordance the design.

Discharge and maximum WL of flood during construction periodexceed the discharge and maximum WL of design flood with frequencyof10%.

Impacts:

Incident of upstream and downstream cofferdams breakdown will not damage property, economy of PO, but it will also cause injuries to workers and residents living in the villages along Ma river its two river banks as well as material facilities and constructions at the downstream.

Mitigation measures:

+ Comply with technical solutions, design criteria, construction progress during construction of upstream and downstream cofferdams.

+ Establish frequent flood prevention committee (24 of 24 hours) on the construction site and in the areas with risk of breakdown.

+ Direct entire flow through the diversion construction.

+ Prepare materialsto raise cofferdamas flood risks exceeding design flood.

+ Promptly inform workers and move machinery on the construction site out of the danger area.

+ Promptly notify the local authorities at the downstream area to move out of the area being likely to be inundated to avoid the asset and human losses.

+ In case of cofferdam failure down occurs, causing damage on land, property, crops and construction of local people, people at the downstream and economic organizations. The Project Owner must be responsible for compensation (if the damage is determined to becaused by accident of cofferdam broken).

4.1.3.2. Landslide incidents during the construction process

According to the survey results, the terrain in the area is relatively steep, strong to medium cleavage; so landslide incidents of natural soil/rock (by the objective reasons) is popular in the region.

The risk of landslides can occur if the excavation of work items has not been in accordance with design and standards, and current regulations applicable or at the place of construction locating on abrupt terrain (e.g. the construction of bypass road and construction-operation roads). The risk of landslides will also cause injury to construction workers.

Mitigation measures:

- Comply with technical solutions, design criteria and regulations on construction of work items of foundation pits.

-Install warning signs at dangerous road sections and areas with risks of landslides and areas can be dangerous for people as approaching.

4.1.3.3. Fire at petroleum depot

In order to meet fuel demand for construction of work items, a petroleum depot will be built with capacity of 50 tons, covering an area of 0.2 hectare (see the general construction plan in Figure 3).

The main causes of the problem are mainly due to tank corrosion, defects during construction process of storage tanks, improper or unsafe management and operation of workers.

If there is any fires at petroleum depot (as well as explosive storage), it will cause huge damage to people, property and ecological environment (mainly forest cover around the project area). Therefore, safety measures for the petroleum depot must be cared and implemented seriously by the PO.

Mitigation measures:

- Fuel tanks must be arranged underground in the bunkers with minimum depth of 0.5 meter and far away from sources being capable of causing fire.

- In the design, the petroleum depot must be arranged away from the forest cover, residential areas to mitigate impacts caused by fire.

- It shall have emergency measures to rescue and get fire under control timely.

- Organize, train and equipequipment for rescue teams. Medical devices and medicines must be always available at the construction site.

Applicable standards:

- TCVN3254-89

- TCVN3255-86

4.1.3.4. Accidents due to incidents during transport, storage and use of explosives

The explosives warehouse will be built with a capacity of 230 ton covering an area of 0.25 hectare (see the general construction plan in Figure 3). During the construction process, if missing safety measures during transportation, storage and use of explosives as well as appropriate warning measures, the blasting work will cause injury to construction workers and local people operate near the blasting area.

Main cause of the problem is mainly due to the defect in the manufacturing process, the improper or unsafe management and operation of the workers.

Mitigation measures:

The Project Owner requires construction agencies to comply strictly the current regulations on transporting, storing and using explosives. Specifically:

- Explosives must be transported safely, with guards and escorts to prevent from losses.

- In the design, the explosive warehouse must be arranged far way from residential areas and other construction to mitigate impacts caused by the explosives.

- Perform properly the blasting procedures.

-It shall have emergency measures to rescue and get the fire under control timely.

- Organize, train and equipthe equipment for rescue teams. Medical devices and medicines must be always available at the construction site.

Applied standards:

- QCVN 2008/BCT

- TCVN 3146-86

- TCVN 3255-86

4.1.3.5. Incidents of dam failure

Main reasons cause the dam to be broken during operation area as follows:

Discharge and maximum WL of the reservoir during construction period exceed discharge and maximum WL of design flood with frequency of 0.1%

+Due to incidents of valve gate system e.g, getting stuck.

+ Due to incorrect forecast process resulting in untimely operation of the plant.

+ Due to breakdown of hydropower dam at the upstream (breakdown due to domino effect of hydropower cascade system on Ma river, of which Trung Son hydropower is directly).

+ Due to earthquake:

According to the latest figures from the Institute for Theoretical Physicsin 2003. The project is located in the zone arising earthquake with I_{max} = 8 (MSK-64); peak ground acceleration a =0.12-0.24g- a strong earthquake zone.

The project area is limited by two deep faults of Ma river and SonLa.

The modern activity of fault zone is evident in many places. Along the fault zone. There are presences of high geochemical and geothermal anomalies, landslide activities in many places, strong seismic activities and the potential in generate great earthquakes with magnitude of 6.5-7.0 in Richter scale.

The modern activities of Son La fault are quite strong and inherit the Pliocene period - Quaternary on spatial aspect as well as movement characteristics**.** The movements along the fault zone, mainly along the main fault, are generally large and uneven overall the zone. There are some sections with movement amplitude of hundreds of meters, also some show weaker movement and even some show no clearly signs of movement. Besides the slide and movement occurring along the faults, which has been determined by the geomorphic signs; there are also many other signs confirming the nature of its movements such as: the highly geochemical and geothermal anomalousness, cracks and landslides in many places (particularly in Lai Chau-Tuan Giao) as well as many strongly seismic shocks and great earthquakes with the amplitude of 6.5-7 in the Richter scale. In the project area, system of Ma river and Son La faults show intermittent signs and geomorphological weak deformation.

Although these faults show strongly active signs but the distance from the dam site to them is quite far with 16 kilometers and 4 kilometers respectively. There are only the grade III, IV and V faults in the area. These are the interior zone faults and not likely to cause shock.

Moreover, according to the study and statistic results of UNESCO on the earthquake of large reservoirs in the World. Hoi Xuan reservoir is less likely to cause a stimulated earthquake.

In conclusion, the construction of the reservoir and the dam site will be less likely to cause stimulated earthquake as well as activate the operation of the tectonic faults.

However, for prevention and giving timely measures to prevent, limit to the minimum the damages that may occur due to dam failure down. The Project Owner will implement measures as bellow:

Impact:

Incidents of dam failure down can cause injuries to workers and plant operators and local people in all the villages at the downstream.

The most visible impact on the economy is that it will damage the properties of the PO, then strongly impact on residential areas and projects at the downstream.

Mitigation measures:

- In order to actively prevent and mitigate impacts caused by dam failure down in hydropower cascade system at the upstream. The Management Board of plant operation must ensure communication with the Management Board of other hydropower plants on same Ma river system operate thoroughly (especially during flood discharge period), including Trung Son hydropower project which is the next hydropower cascade towards the upstream.

-To prevent and respond to incidents of dam failure down in Hoi Xuan HPP. the PO shall implement measuresas soon as in the stages of design and during construction process as well as operation of the project. Specifically:

+In the next stage, the PO shall coordinate with competent authorities to consider and assess in details the danger degree of earthquake and possibility of causing stimulated earthquake as construction of damand reservoir of the Hoi Xuan HPP.

+Before implementing the project development, exploratory drilling to take samples of geology for assessment of tectonic faults and seismic activities in the region to take mitigation measures against the impacts may occur due to the stimulated earthquake is needed.

+ Comply with standards and regulations on the design and management of construction projects in the country and on aboard.

+ Comply with design standards, technical solutions in construction of dam.

+ Comply with the operation procedures approved by the Ministry of Industry and Trade for Hoi Xuan hydropower project and inter-reservoirs operation procedure for hydropower cascade system on Ma river (if any).

+ Comply with safety measures during the operation of the project.

+ Establish frequent flood prevention committee (24 of 24 hours) on the construction site and in the areas with risk of breakdown.

+ Water levels and flood discharge in the reservoir area and at the downstream need to be monitored and regularly inform the Management Board of plant operation and the agency which relevant to take response measures timely.

+ Carry closely monitoring the movement of dam, water loss due to seepage to take the preventive and mitigation measures against the impact of Dam failure down.

+ Promptly notify the workers and local people to move out of the danger area.

+ Promptly notify the local authorities at the downstream area to move out of the area being likely to be flooded to avoid the asset and human losses.

+ Keep regular contact with the Management Board of the hydropower cascade at the upstream and downstream; timely notify the other agencies known the incidents, the options for dealing with incidents relating to flood discharge to solve problems in the coordination.

+ Incase of Dam failure down occurs, causing damage on land, property, crops and construction of local people, people at the downstream and economic organization. The Project Owner must be responsible for compensation (if the damage is determined to becaused by the accident of dam broken).

4.1.3.6. Fire caused by short circuit and electric shock during operation

During the operation of the plant, fire can occur if happening short circuit, overload, lightning, broken wires or incidents relating to transformer in the powerhouse causing injury to staffs and operators; and economic losses for the Project Owner.

The incidents of firedue to electric will only happen in placeand in a short time, because when the incident occurs, the protective relay installed at station will switch automatically. However, if the fire is not promptly extinguished it may spread far and wide.

Mitigation measures:

-Install earthling system and warning signs, danger signs at the plant and outside power yard OPY station in accordance with regulations.

-Arrange guard, not allow unauthorized people to access the plant, especially the outside power yard OPY station.

-During operation process, conduct periodic inspections, regular maintenance of safety equipment to detect and handle timely errors in the plant, outside power yard OPY station which are likely to cause electric shock, fire andwire broken orelectrical leakage.

Applicable standards: QCVNQTD-6: 2009/BCT-National Technical Regulationon electrical engineering- Operationand repair of electrical equipment in power systems.

-Layout water tanks and equipment, firefighting means for timely response to the emergency cases.

-Drain away the emergency oil of transformer in the plant: whenthere is an incident, the emergency oil will flows from the transformer to oil collection cabinet located in the foundation of the transformer.

- Train and organize regular inspection of fire prevention and firefighting.

- Coordinate closely withlocal authorities in fire prevention and firefighting.

-When occurring fire incident caused by electrical problems, firstly and quickly notify competent agency to cut the power source then follow the fire fighting process.

- Checkperiodically the plants andactivitiesof local people which are capable of affectingthe safetyof the plant the outside power yard OPY station.etc.

-Coordinate closely withlocal authorities in districts and communes to propaganda and disseminate knowledge about electrical safety for local communities. The method is to combine announcement on the loudspeaker system of the commune with a banner stick on the wall expressing the knowledge about fire prevention and firefighting.

4.1.3.7. Accidents during repair and maintenance of equipment

During repair and maintenance of equipment in the plant, the operators can be injured if not following the safety measures.

Mitigation measures:

- During the process of implementing repair, maintenance of equipment and machinery in the plat, there should be done with two people or more.

- When thunderstorms and lightning going to occur, stopall activities.

- During the course of work, not allow the unauthorized people come closer.
-Workers implementing the maintenance and repair of equipment must be equipped with full range of suitable working equipment.

- Check the equipment and tools used for repair work carefully; the work should be done if the tools meet the safety requirements.

- When working at high position:

All workers must have health checked to ensure the health required for work at high position.

The worker who climbing up the column must have a safe level of grade III and ensure the conditions required for work at high position. The seatbelts must meet the standard for usage with the latest test not more than 6 months. During the working and moving at high position, the workers must tie the safety belt which must be tightly hooked onthe column.

The construction equipment and tools must becare fully checked for quality and quantity before use. Carefully check the brake cables before climbing onto the column.

Do not work at high position when it is gettingdark, foggy weather or when occurring the wind grade V or higher.

4.1.3.8. Forest fire

The project area is surrounded by the forest cover. Therefore, forest fire can beoccurred in both during construction and operation process of the project; and it will cause the huge damage. The causes may be due to the careless use of fire by construction workers and operators or petroleum depot and explosive storage fire.

Mitigation measures:

- Disseminate to enhance sense of personnelin the use of fire.

- Fire protection available.

- When fire occurs, comply with the fire regulations to control and extinguish the fire promptly and limit to the minimum the damage caused by the fire.

4.1.4. Impacts which can not be mitigated and improved (the irresistible impacts)

- Impactsrelated to changes inecological landscape in the reservoir area. construction plan of powerhouse construction in particular and of the whole project in general.

- Impacts related tobeing changed to mud of the soil layer at the reservoir bottom as impounding water for the reservoir.

- Impact related to the variation of sediment flow at the upstream and downstream areas of the dam site.

- Impacts related to the reduction of river sediment.

- Impacts related to the changes in aquatic ecosystems in the reservoir area

4.2. Impacts and mitigation measures of the area of 220kV transmission lines connecting Hoi Xuan HPP to the national grid (hereafter called the 220kV TLs, or the TLs)

4.2.1. Impacts on bio-physical environment and mitigation and enhancement measures

4.2.1.1. Topography, geomorphology and landscape

1. Pre-construction and construction phases

In the pre-construction and construction phases, project implementation activities such as salvaging and clearing vegetation cover in tower foundations and paths for pulling cables of the 220kV TLs, leveling site, excavating and constructing tower foundation locations. These activities will lose vegetation and make the change of topography of tower foundations, etc. However, these activities only happened within the narrow ROW (21m) of the 220kV TLs (15.394km in length), which is about 32.12ha in the area and the area of eachtower foundation ranging from 148 m^2 to 1,365m^2.

To minimize Impacts, the PO has to implement the following measures:

- Only implement salvage and clearance within the land acquisition for each tower foundation locations, the clearance of the surrounding area will be prohibited.

- Cutting tree within the ROW will be restricted; this is only conducted in the paths of cable pulling, and applied for trees taller than the regulated height as stipulated in Decree No. 14/2014 / ND-CP dated 26 Feb 2014.

- People will harvest agricultural products on their land. Other trees on land will be cut and collected to burn or dispose with the control of the PO in order to avoid forest fire. These cut trees can be disposed in the landfills of the project. At positions far from the landfills, this waste will be disposed at the regulated area which is permitted by the local authorities;

- The spoil from the excavation pits will be used for embankment in and around the foundation pits, then implementing erosion control measures. After construction is complete, it is necessary to clean, recover, and return the temporarily acquired land.

- Under the ROW, people can resume farming activities on their land with a restricted level (meaning the height of trees ensure under the permitted level as stipulated in Decree No. 14/2014 / ND-CP dated 26 Feb 2014 and the distance from any point of trees to the power cables in a state of maximum deflection is not less than 3.0m) to restore the landscape and ensure coverage cover on the land surface to against erosion.

2. Operation phase

a. Topography, geomorphology

In this phase, topography and geomorphology are fairly stable because landslides and terrain changes will only occur at tower foundations which on weak geology in the rainy season.

Mitigation measures:

Measures to minimize Impact on the topography and geomorphology processes are as follows:

During the annual inspection of the 220kV TLs' ROW, the operation management unit will check, assess the stability and risk of landslide, erosion at each tower foundation in order to have timely mitigation measures.

b. Landscape

In general, during the 220kV TLs operation, tree cutting will be periodically performed for the TLs maintenance in order to ensure that the TLs will not affect the local landscape.

Mitigation measures:

During periodic inspection, the operation management unit will only tight trees/branches beyond the regulated distance. which affect the ROW and the safe operation of the TLs. not tight trees which not affect.

4.2.1.2. Ambient air

The operation process of the 220kV TLs will not generate dust emissions affecting ambient air quality.

The air environment will be only affected during construction of the TLs.

1. Pre-construction and construction Phases

In this period, the ambient air will be mainly affected by dust emissions arising from construction activities at tower foundations, as well as erecting tower and pulling cables. In addition, ambient air can be contaminated by the stench from garbage, waste water (if not collected).

a. Impacts of dust and emissions

Dust and emissions will be generated by the following sources:

- The activities such as transporting and handling materials, equipment (generated by the transportation means) primarily go along Highway 15 (this road belongs to mountainous areas with low traffic volume) and rural roads in the area.

- Activities such as excavating and constructing tower foundations.

There are 36 tower foundations along 15.344km in the entire length of the TLs, each two tower foundations have average distances approximately 427m.

Construction process for ground leveling, excavating tower foundations will be conducted by manual methods because the TLs is mainly located on steep slopes covered by woody bamboo.

The volume of excavated soil and rock of each tower foundation is about from $20m^3$ to $163.7m^3$. This volume is too small compared with the volume of leveling, excavating, and constructing of the main work items of Hoi Xuan HPP. Also, construction time per tower foundation is short, with average about 20 days, and the tower foundation are far from residential areas. Therefore, Impacts on the ambient air due to dust and emissions from construction of the 220kV TLs transmission lines for are considered negligible.

Mitigation measures:

To minimize dust and emissions, the PO shall implement the follow measures:

- Transportation means do not come into union, and comply with the load and velocity regulation. Trucks' bodies have to been covered. All means have to be licensed for activities of Vietnamese Register Bureau.

- Collecting materials and equipment at the collecting points scattered along Highway 15 for construction site of each tower foundations, not concentrating at one point.

- Watering the dusty area and tightly compacting soil after backfill.

- Daily spraying water at the dusty gathering materials points in the windy and dry days.

- Arranging reasonable construction time, ensuring that all construction items causing noise must be conducted in daylight.

- Having regular maintenance regime for machinery and construction equipment.

- Collecting and treating waste water, domestic waste as proposed.

Applicable standard:

- QCVN 05:2013/BTNMT

4.2.1.3. Noise

The process of excavating and backfilling foundations is mainly conducted by manual, thus during the TLs construction, noise will be generated from vehicles transporting building materials to the gathering points scattered along the TLs. Transportation means will be arranged individually. Moreover, the locations of power foundations are located mainly on mountain side with steep slope covered by bamboo forest. Therefore, building materials will be brought to tower foundations by mechanical and manual method. So the impact of noise will be negligible.

The protected areas in the surrounding areas will be not affected by the noise generated from the 220kV TLs construction.

Mitigation measures:

- Transportation means, machinery and equipment (included in the registration list to environmental standards and safety specifications of Register Bureau) have to meet the standard of technical and environmental safety.

- Having regular maintenance regime for machinery and construction equipment.

- Arranging the appropriate time.

- Having regulatory regime of means, machinery and equipment accordingly.

Applicable standard:

QCVN 26:2010/BTNMT

4.2.1.4. Soil and land resources

1. Pre-construction and construction phases

a. Impacts of solid waste

Sources of solid waste generated at this stage include:

+ Domestic waste from construction workers: food scraps, food bags, ragged clothes, bottles, jars, etc.

+ Cut trees during the ROW and tower foundation clearance.

+ Waste from building tower foundations: excavated soil from foundation pits. and remained building materials such as packing, clouts, etc. (in the construction site of foundations).

For the 220kV TLs, volume of leveled and excavated soil is small, with an average of about 327m^3/tower foundation. After finishing construction. excavated soil will be used to backfill and reinforce tower foundations (there is balance between excavated and backfilled soil, so remained soil will not be arisen)

❖ *Domestic solid waste (garbage)*

- Garbage road construction connecting line:

The construction teams for the 220kV TLs have 10 workers/01 tower foundation, with average time as 20 days/foundation. The average volume from workers of 0.2m^3/foundation is not high (average 01 people releases approximately 0.5 kg/day).

❖ *For fallen trees:*

Existing vegetation cover within Row consists of 0.35 hectares of rice; 29.97 ha of artificial forest (bamboo), the remaining rivers (0.98ha) and other land (0.82ha). People will salvage farm products on their land before the project's construction. Thus the volume of cut trees within the RoW is small.

Mitigation measures:

- *Garbage from construction workers*. Because the proposed 220kV TL goes along HW 15 and the main works of Hoi Xuan HPP, it is facilitated to transport waste from tower foundations to the landfills of the HPP. Also, the small volume of garbage from the TLs construction workers make easy to dispose and treat as the regulations. Excepting some foundations far from the landfills and difficult to access, pits can be dug at the bare land near to the foundations (that must be permitted by the local authorities) or within the ROW. These pits used for collect garbage, and treat by lime sterilization, bury and tightly compact. After finish construction these foundations, these pits have to been covered and replant trees.

- *Cut trees,* Before land acquisition for the project, the project owner has to facilitate for local people to harvest agricultural products on their land. Also, cut trees will be utilize for burned fuel in order to reduce the volume of waste. The remaining cut trees/branches will be collected and burned under the strict control to prevent wildfires, or transported and dumped into the project's landfills. In foundations too far from the landfills, cut trees will be disposed at the permitted position by the local authorities.

- *Soil and rock (spoils)*. There is balance between the volume of excavated and backfilled soil. Therefore. there is not any generated spoils.

- *Scraps of building materials*. This kind of waste will be classified into reuse or recycle kinds such as cement bags, cardboard, tins, cans, bottles, clothes, rags, etc, and other kinds. The reuse and recycle waste kinds will be bought to recycle enterprises while others will be burned with strict control or disposed at the landfills. Excepting for clouts contaminated by oil, grease will be collected and treated as regulation to prevent soil and water pollution.

b. Temporary acquired land for temporary gathering yards of materials, equipment

Because the majority of the proposed tower foundations are located on steep slopes, transportation means, mechanical vehicles, and equipment can not access. Therefore, gathering yards of materials will be arranged with 01 yard at each 2 foundations, its area is about 50-150 m^2 (depending on the requirements of each specific foundation) along HW15 or other roads nearly tower foundations. From the gathering places, materials will be transported to tower foundations by mechanical or manual.

Mitigation measures:

- For the temporary yards, These places can be rent land from local people, and local governments. After finishing construction, waste materials and scraps have to be cleaned up, recovered and returned land for the owners.

- Carrying materials to construction site of each tower foundation should use the existing trails which used by local people for growing bamboo.

c. Impacts due to erosion

The activities such as excavation, construction at tower foundations will make soil become loose, which accelerate the process of erosion, leaching soil nutrients.

Cutting tree within the ROW will reduce vegetation cover to protect the soil, increase the risk of erosion and landslides.

Mitigation measures:

- After finishing soil backfill at tower foundations, it is necessary to conduct tight compaction under the approved design, and reinforce and build embankment. Drainage, etc, as designed to protect the tower foundation.

- In order to maintain vegetation cover and avoid soil erosion, rehabilitate landscape, local people should resume cultivation on their land under the ROW after finishing the construction. Their cultivation have to comply with the restriction under the ROW as stipulated in Decree No. 14/2014/ND-CP dated 26 Feb 2014, the distance from any point of trees to the power cable in a state of maximum deflection is not less than 3.0m, crops and rice is not allowed to grow within 0.5m radius from the tower foundations).

2. Operation phase

- *Impacts of solid waste:*

During the 220kV TLs operation process, solid waste will be mostly from cutting trees/branches which encroach to the TLs safety in and out the ROW. This volume is small and the impact is negligible.

- *Erosion, landslides*

Because many proposed tower foundations locate on hillside, high mountain, therefore, during the 220kV TLs operation process, landslides and erosion can be happened in some tower foundations in rain, wind days if the reinforcement is not well. During maintenance, periodic inspection, if erosion and landslides at tower foundations are not detected in time, the under slopes will be dangerous, and tower can be collapsed.

Mitigation measures

- *Solid waste*. Collecting cut trees/branches within the ROW during the periodic maintenance processes will be regulated as follows:

+ At the TLs section passes through bamboo forest, this waste will be dispose at gathering points of the forest owners.

+ At the TLs section passes through land growing crops, gardens, this waste will be used for fire-wood.

- Minimize impacts to soil environment (soil erosion, landslides)

During operation, to minimize the effects of erosion, landslide around tower foundations, which can adversely affect the soil environment, the project's operation unit will be implement the following works:

+ Check the stability of the tower foundations.

+ Check embankments, drainage systems, erosion and landslide control systems around the tower foundations.

+ Regular reinforce the tower foundations.

4.2.1.5. Water quality

a. Impacts of domestic wastewater of construction workers and staffs

The proposed construction team is divided into 8 groups, with 10 people per each group. Hence, a small amount of wastewater will be generated, 0.8 m^3/group on average.

Mitigation measures:

Renting houses along the TLs route for accommodation of worker groups. Wastewater from daily activities of workers will be collected into collection systems of local people's house.

b. Impacts of construction waste

Wastewater generated during the construction process is from foundation pits, leaking from concrete mixing, water for concrete maintenance. This amount of wastewater is small with main component of suspended solids without toxic ingredients.

Mitigation measures:

Water from foundation pits: arrange drainage around foundation pits' bottom to pump underground water or rainwater in the pits to two other pits with the volume of 0.5m^3. Suspended solid in water pumped to the two pits will be deposited after the retention time. After that, the water will be release the surrounding rivers/streams.

Applicable standards:

- QCVN 08:2008/BTNMT

4.2.1.5. Terrestrial ecosystem and the adjacent Natural Reserves

1. Pre-construction and construction phases

a. Impacts of vegetation clearance to the ecological environment

- Impact on vegetation cover, flora:

Impacts on the ecological environment in this period are mainly cutting trees during the ROW and foundations clearance.

According to the survey results. the area of acquired land for tower foundations' construction is mainly covered by woody bamboo (about 29.97ha) and a small portion of people's crops (0.35ha) ;

Each one ha of bamboo has 300-350 clusters which have 8 trees per each (including 03 mature trees, 3 developing trees and 2 bamboo shoots). Thus, the number of bamboo trees to be cut down is about 72,000 – 84,000 trees.

All vegetation cover which must be cut will be harvested by local people before acquiring land for the project. In addition, within the TLs area there is not any rare flora species. As results, amount of cut trees will be small and impacts on the vegetation cover, flora and landscapes will be minimized, not affect the biodiversity and genetic resources conservation.

- Impacts on fauna:

Cutting tree and clearing in the TLs construction site will lose habitats of animals, divide living spaces and separate them away from the surrounding area. This is the inevitable impact on any construction projects.

However, animals in the area are mostly domestic animals and some species living near people like birds, rats, snakes, pig races, etc. There is no rare wild animal need to protect, so cutting trees will not affect the animal's habitats.

Moreover, vegetation cover of the surrounding and adjacent area of the 220kV TLs is artificial forest and protected areas. Therefore, animals living in the project area can be moved to the protected area (such as birds) to live, so impacts on fauna can be mitigated.

After finishing the construction, production activities under ROW can be resumed with the restricted level, the animals can come back for living and finding food.

Mitigation measures:

- Perform conversion of land use purpose for the acquired land of the projects.

- Carry out vegetation salvaging:

+ Before acquiring land for the project, people will harvest agricultural products on their land.

+ Remaining stems, leaves will be collected by the PO to burn with a control to prevent wildfires or transported to the landfills of the project to bury. The positions too far from the landfill, this waste will be disposed at the allowed area.

+ Only conduct vegetation salvage and clearance within the ROW line, prohibiting encroachment into the surrounding area.

+ Only clearing in tower foundations, paths used for pulling cable, and temporary acquired land for construction site. In the remaining area within the ROW. only trees taller than the specified height or trees outside the ROW which can affect the safety of the transmission line will be cut.

- In order to maintain vegetation cover and avoid soil erosion, rehabilitate landscape, local people should resume cultivation on their land under the ROW after finishing the construction. Their cultivation have to comply with the restriction under the ROW as stipulated in Decree No. 14/2014/ND-CP dated 26 Feb 2014, the distance from any point of trees to the power cable in a state of maximum deflection is not less than 3.0m, crops and rice is not allowed to grow within 0.5m radius from the tower foundations).

- The PO is responsible for cooperating with relevant agencies to reforest for the acquired forest land as stipulations. The reforest area has to equal the acquired land area for the project (including temporary and permanent acquired land). This area is determined exactly after cadastral measures.

b. Impacts due to focusing workers on construction site

The area around the project is mainly bamboo forest of people, so the concentration of construction workers will not affect the ecosystem.

For protected areas: Pu Luong Nature Reserve is the nearest with the project site, approximately 1.0km. From the project site to the NR. there is many steep slopes, difficult traffic. Therefore, the concentration of construction workers will not directly affect forest resources and terrestrial flora and fauna in particular Pu Luong Nature Reserve and other protected areas in general (Pu Hu, Hang Kia - Pa Co, and Xuan Nha). But consumer demand. buying and selling wildlife of workers can affect protected areas as this is motivation for hunting, illegal logging of forest resources in protected areas.

Consequence, management and propaganda about forest protection need to be done for workers in order to limit this impact. It is need to prohibit all unauthorized activities of workers for forest resources, including use, trade, hunting and illegal logging. Violators will be dealt with according to law.

2. Operation Phase

The ecosystem under the TLs ROW is mainly bamboo forest. Also, the operation unit will only cut trees which can affect the TLs safety during the maintenance process. Therefore, during the operation, the maintenance activities seem to not affect the forest resources and ecosystems.

Mitigation measures:

- Periodic inspecting and monitoring of vegetation growth within the ROW and outside with the risk of impacts on the TLs safety.

- Only cutting trees/branches can affect the safety of the transmission line in accordance with the provisions of Decree No. 14/2014/ND-CP of the Government.

- Do not cut trees/branches outside the scope of ROW without affecting safety of the TLs.

- Cut trees/branches will be collected at one positions, then transported and disposed in the regulated area of the locality or to be allowed for local people to use as fire-wood.

- Propagating and mobilizing farmers who have land under the ROW about that only trees with height under the stipulated level will be cut, which will help to avoid cutting economic trees and affecting their income.

4.2.2. Impacts, measures of mitigation and improvement of economics, culture and society

4.2.2.1. Impacts on land use, production, economics, income, life, people's life

1. Impacts of land acquisition and clearance for the project construction

Land acquisition for the 220kV TLs construction will conduct on the tower foundations. Land acquisition and conversion of land use for the TLs construction will not only reduce land area for other purpose, but also damage to houses, buildings and assets. These will affect economics. Income, life, study, producing, etc, of the affected people and people in the project area.

❖ *Loss of Land*

There are approximately 32.12 hectares of the project's affected land in many types, including the majority as forest land with 29.97ha (29.75ha of artificial forest and 0.23 ha of natural forests, which are use and managed by local people (see table below).

Table 4.27: Current land use in the acquired land area for the 220kV TLs connecting Hoi Xuan HPP to the national grid

Unit: m^2

No	Location	Total	Classification of land																									
			Land use of Individual and household									land use of commune People's Committee and other organizations																
			ONT	garden	RST	LUC	LUK	LNK	LNQ	BHK	NHK	BCS	DBV	DCH	DGD	DGT	DNL	DTL	DTT	DVH	DYT	NTD	DCS	SKC	SON	TSC	RSN	MNC
I	**The 220kV TLs**	**321,205.8**	**6,211.1**	**-**	**297,470.1**	**1,285.7**	**-**	**681.6**	**1,082.3**	**8,434.1**	**456.8**	**-**	**-**	**-**	**-**	**1,009.0**	**-**	**-**	**-**	**-**	**-**	**-**	**518.1**	**-**	**1,376.7**	**-**	**2,204.3**	**-**
1	**Thanh Xuan commune**	**96,204.2**	**1,815.6**	**-**	**93,277.8**	**-**	**-**	**-**	**-**	**-**	**456.8**	**-**	**-**	**-**	**-**	**286.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**368.0**	**-**	**-**	**-**
	Thu Dong village	**31,283.3**	1,815.6		29,033.6	-	-	-	-	-	262.9		-	-	-	128.0	-								43.2			
	Eo village	**34,497.2**			34,059.3											113.1									324.8			
	Tan Son village	**30,423.7**			30,184.9						193.9					44.9												
2	**Phu Xuan commune**	**84,262.8**	**-**	**-**	**74,036.4**	**1,285.7**	**-**	**-**	**-**	**8,156.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**618.7**	**-**	**709.0**	**-**
	Pan village	**32,972.7**			31,445.5	1,285.7				232.4															552.4			
	Mo village	**51,290.1**			42,590.9					7,923.9															66.3		709.0	
3	**Phu Le commune**	**67,876.1**	**2,391.2**	**-**	**61,916.3**	**-**	**-**	**681.6**	**917.5**	**-**	**-**	**-**	**-**	**-**	**-**	**234.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**240.2**	**-**	**1,495.3**	**-**
	Sai village	**67,876.1**	2,391.2		61,916.3			681.6	917.5							234.0									240.2		1.495.3	
4	**Phu Thanh**	**36,055.5**	**1,832.1**	**-**	**33,546.6**	**-**	**-**	**-**	**-**	**277.8**	**-**	**-**	**-**	**-**	**-**	**315.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**83.6**	**-**	**-**	**-**
	Do village	**19,557.8**			19,491.6																				66.2			
	Trung Tan village	**16,497.7**	1,832.1		14,055.0					277.8						315.4									17.4			
5	**Van Mai commune**	**36,807.2**	**172.2**	**-**	**34,693.0**	**-**	**-**	**-**	**164.8**	**-**	**-**	**-**	**-**	**-**	**-**	**173.6**	**-**	**-**	**-**	**-**	**-**	**-**	**518.1**	**-**	**66.2**	**-**	**-**	**-**
	Khan village	**13,820.2**	172.2		12,791.5				164.8							173.6							518.1					
	DSCL area	**22,987.0**			21,901.5																				66.2			

(*Source: data provided by VNECO Hoi Xuan Investment and Electricity construction JSC)*

Note: Symbols of land use is as in table 3.38.

In 32.12 ha affected land, there is only 1.07ha of permanent acquired land for tower foundations, the remaining area (31.05ha) is temporarily acquired. After finishing the construction, local people can continue cultivation on their temporary acquired land in the ROW (with the restriction). Therefore, impacts on land, economics, and income of local people will be reduced.

Table 4.28: Total affected land area in land use of the 220kV TLs

No.	Affected land types	Thanh Xuan commune	Phu Xuan commune	Phu Le commune	Phu Thanh commune	Van Mai commune	Total
	The 220kV TLs	**96,204.2**	**84,262.8**	**67,876.1**	**36,055.5**	**36,807.2**	**321,205.8**
I	**Permanent acquired land for tower foundations**	***2,644.1***	***2,903.9***	***2,858.2***	***1,153.2***	***1,103.3***	***10,662.7***
1	RST	2,644.1	2,738.2	2,858.2	1,153.2	1,103.3	10,497.0
2	RSN	-	709.0	-	--		709.0
II	Temporary acquired land under the ROW	**93,560.1**	**81,358.9**	**65,017.9**	**34,902.3**	**35,703.9**	**310,543.1**
1	ONT	1,815.6	-	2,391.2	1,832.1	172.2	6,211.1
2	RST	90,633.7	71,298.2	59,058.1	32,393.4	33,589.7	286,973.1
3	LUC	-	1,285.7	-	-	-	1,285.7
4	LNK	-	-	681.6	-	-	681.6
5	BHK	-	-	917.5	-	164.8	1,082.3
6	TSN	-	8,156.3	-	277.8	-	8,434.1
7	NHK	456.8	-	-	-	-	456.8
8	DGT	286.0	-	234.0	315.4	173.6	1,009.0
9	DCS	-	-	-	-	518.1	518.1
10	SON	368.0	618.7	240.2	83.6	66.2	1,376.7
11	RSN	-	-	1,495.3	-	-	1,495.3

(*Source: data provided by VNECO Hoi Xuan Investment and Electricity construction JSC)*

Notes:

- Access roads for constructing tower foundations will be upgraded on the existing public roads, trails, no new road, so it will not affect the communal land area for other purpose.

Land acquisition will lose land and affect land use of households. They include 3 households affected with permanent land acquisition for construction of tower foundations while 41 households have both temporarily and permanently affected land, 226 households have temporary affected land and restriction of use under the ROW. However, the affected land area is small, so impact on land use and production of people are insignificant.

Table 4.29: Total households affected land of the 220kV TLs

No.	Location	Number of household affected land		
		Permanent	Temporary	Both
	The 220kV TLs	**4**	**226**	**41**
1	**Thanh Xuan commune**	**0**	**50**	**14**
	Thu Dong village		19	5
	Eo village		25	6
	Tan Son village		6	3
2	**Phu Xuan commune**	**2**	**63**	**9**
	Pan village		23	4
	Mo village	2	40	5
3	**Phu Le commune**	**2**	**68**	**13**
	Sai village	2	68	13
4	**Phu Thanh**	**0**	**27**	**0**
	Do village		8	
	Trung Tan village		19	
5	**Van Mai commune**	**0**	**18**	**5**
	Khan village		7	1
	DSCL area		11	4

❖ Loss of trees. crops

As mentioned above, damaged trees due to the TLs construction only consist of bamboo and a little crop, rice distributed along the route. Therefore, the percentage of affected land to the AH's landholding area is small, most of AHs still have land outside the ROW. Furthermore, after construction is complete, the land below the ROW will be resumed to cultivate, so the impact of farming losses is considered small.

❖ Loss of houses, buildings

Table 4.30: Houses/buildings affected in the 220kV TLs

Affected Houses/buildings	**Thanh Xuan commune**	**Phu Xuan commune**	**Phu Le commune**	**Phu Thanh commune**	**Van Mai commune**	**Total**
1. House						
a. House on stilts (number/m^2) (metal roof, wood (bamboo) wall, bamboo floor)	3/182		3/133	1/25		7/340
b. House at grade 4 (number/m^2) (metal (tile) roof, brick wall, cement floor)			1/63	4/209		5/272
2. Kitchen (number/m^2) (thatched (metal) roof, wood wall, bamboo floor)			3/63	1/15		4/78

(*Source: Data provided by VNECO Hoi Xuan Investment and Electricity construction JSC)*

According to the survey there are 12 houses and 04 kitchens of 16 affected households within the ROW. House's structure is quite firmly with metal (or tile) roof, wooden walls (or bamboo, brick), wooden floor (or cement). Because the AHs still have land outside the ROW, and all of them wish to receive compensation cash in order to move, the project owner will pay compensation for them to displace by themselves. After receiving the compensation and assistance, the AHs will be relocated and reused their building materials to rebuild houses/kitchens on their land outside the ROW. With the short displacement (within the area), people life and production will be not much disturbance.

❖ Damage infrastructure, public works

The 220kV TLs will not acquire land of public works and infrastructure.

Mitigation measures:

To minimize the impact of land acquisition for the project in the area of the 220kV transmission line connecting Hoi Xuan HPP to the national Grid, ensure economy, income, life, and production of affected peoples and project communes, the PO have to implement the following measures:

- Implementing measurement and detailed inventory of losses in the acquired land area for the project; performing the conversion of land use purpose before construction.

- Before land acquisition, the affected households will be allowed to harvest agricultural products on their land.

- Conducting damage compensation, assistance and resettlement for households and communes who are affected land, trees, crops, buildings and structures in accordance with regulations and prior to the land acquisition for the project's construction in order that AHs quickly stabilize their life and production. The PO only acquires land after full paying compensation, assistance cost for AHs.

On the legal basis and the impact level on land and properties, as well as land area of the locality, expectations of local peoples, comments of representatives of AHs and local authorities, the PO will compensation by cash for AHs so that they will displace outside the ROW but still on their land and balance their productive land. After receiving compensation. AHs will displace to rebuild on the remaining land outside the ROW. In addition to compensation, the PO also has the assistance policies for AHs to stabilize life and production.

Details of compensation, assistance, resettlement and income restoration for APs by the TLs in particular, the entire project in generally are described in other documents, not mentioned in the ESIA.

- Conducting compensation, support and resettlement satisfactorily and as regulated.

- Participating in addressing the grievances of people in the process of implementation of compensation and resettlement assistance.

- Monitoring the implementation of compensation, assistance, and resettlement under the law.

- Creating jobs for local people: local people can be hired to do some simple works in the project's construction. This will help them to increase their income for stabilize their life.

The mandatory conditions for the PO are that the compensation. support and resettlement adequately will help APs quickly stabilize life which equal to or better than post-project period. These will be recorded in the commitment of this ESIA.

- The damage compensation, support and resettlement have to implement democratically, openly, and obviously, Basically, the compensation policy of the project is built according to the specific contents in Land Law No. 45/2013/ QH13. Decree No. 43/2014/ND-CP. Decree No. 44/2014/ND-CP and Decree No. 47/2014/ND-CP and relevant decisions of Thanh Hoa province.

- After completing the compensation, support and resettlement, the PO shall coordinate with local authorities to investigate social studies, assess the quality of life, quality of construction traffic, power supply system, etc, in resettlement areas for additional policies and measures to support timely processing to minimize the negative issues arise unexpectedly.

2. Impacts due to the concentration of construction workers on project site

The demand for food and entertainment of staffs and construction workers will contribute to promoting trade, development services.

3. Creating employment opportunities for local workers

Construction of TLs will create employment opportunities for local workers.

Contractors and construction units can hire local workers to work in accordance with their qualifications in some project categories and pay salaries for them. These works can be clearing vegetation, cleaning ground, protecting schools, cleaning toilets, picking clean stone, watering for concrete maintenance, cleaning steel, stone wash, sand wash, etc. By doing this, the available human resource in locality can be effectively used, which help to solve the problem of employment and increase income for workers. Further-fore, investment costs of the project will be reduced (e.g, not have cost of shipping workers from other places, etc.). Also, the pressure on society due to increase workers from other places will be mitigated, and social evils will be restricted (because increase of new member in the society can result in the rise of social evil and conflicts between local people and new comers)

The number of local laborers recruited to build the project will depend on the nature and volume of work and the demands of contractors, construction units in each work item.

4.2.2.2. Impacts on the management of local government, health, culture, customs and habits of people, construction workers and operators

1. Pre-construction and construction phases

a. Impacts of land acquisition for the project

Land acquisition for the project will cause movement of AHs to new places. However, the movement is only to other places within the territory of affected communes, local people’s and AP’s spiritual life, customs and production will likely to be affected (local people here meaning people are living in the places where AHs move to resettlement).

Households wishing to receive compensation will find new houses and balance their productive land fund. Therefore, in the project communes, there will be happen housing and land transfer between local residents and APs. This will be difficult problem for management.

Mitigation measures:

- The PO need to coordinate with the local government in the management, security and order in the area during the resettlement of affected households.

- The PO will collaborate with local government to organize meetings with displaced households to propaganda and mobilize their awareness on unity, solidarity spirit of mutual support. Also, cultural identity, religious beliefs of indigenous peoples need to be disseminated for DPs in order to understand and integrate into their new community easier.

b. Impacts due to UXO

UXO is a considered problem of Vietnam after many years of the wars, so UXO likely exist in the area of the 220kV TLs. Therefore, it is necessary to avoid danger for workers and local people.

Mitigation measures:

- The PO sent a letter for the local authorities for consulting about UXO in the project area. In addition, specialized units of the military will be hired for mine clearance the necessary areas before the construction if it is determined that there is remaining UXO.

- Hanging the warning signs in mine clearance area where can be dangerous for people.

c. Impacts of dust, emissions and noise, wastewater, solid waste

- Impacts due to dust, emissions and noise:

Dust, emissions and noise arising from transport means for the 220kV TLs' construction, and from excavation activities in tower foundations will contaminate ambient air, and affect people's health. However, the number of transport means for the 220kV TLs construction is small (usually only 2 – 3 ones), and they will not operate at the same time. Also, the construction time for each tower foundation is short, and the distance between two towers is quite far, most of foundations are on high slopes far from residential area. Therefore, impacts due to dust, emission and noise primarily affect construction workers during working. Furthermore, workers will arrange in shifts and be equipped with protective clothing, so the effects of dust, gases, noise on the health of construction workers will be negligible.

- Impacts due to sewage and garbage:

Health of construction workers and staffs may also be affected by bad smelling of sewage and garbage if they are not collected.

Mitigation measures:

- Complying with mitigation measures for impacts of dust, emissions, noise, sewage, garbage.

- Fully equipping facilities of labor protection for workers. Arranging working time for workers to ensure appropriate exposure time to noise as prescribed.

- Performing periodic health examination for workers to take remedial measures and appropriate treatment if occurring occupational diseases.

d. Impacts of the 220kV TLs' construction to the safety of construction workers and local people

The 220kV TLs' construction can cause labor accidents such as traffic accidents (along construction – operation roads, in cross-roads), electric shock (easy happen during conductor pulling at cross-points with other power lines, and during operation, maintenance the TLs), environmental problems (landslides in the area conducting excavation works, etc.) if the contractors, the construction units, construction workers do not comply with the regulations on occupational safety for workers.

Mitigation measures:

Complying with occupational safety measures, prevention of environmental incidents outlined. Specifically as follows:

- Contractors commit to implement the current regulations on occupational safety.

- The processes of tower foundation construction. tower election, cable pulling have to be tightly controlled to ensure the safety of residents and construction workers.

- The contractor shall prepare respond action, emergency evacuation in case of incidents, particularly fire prevention.

- Organizing, training and equipping rescue teams. The medical devices and drugs for first aid have to to be available at the construction site.

- Establishing a high-voltage lighting system to ensure safe working conditions for everyone during the construction at night.

- Workers at the construction site must be trained in workplace safety, and equipped a full range of equipment and labor protection. Specifically:

+ The PO shall coordinate with the civil contractors to open training courses on occupational safety for officials and workers involved in the construction site.

+ Workers involved in building will be equipped with full protective tools with user manuals. All workers have to use appropriate protective tools for working.

- Before performing work, it is necessary to test equipment, supplies. machinery for detecting damage and to ensure meeting the OHS standards, and only starting work when finishing this test.

- Hanging the warning signs at the dangerous road sections, areas prone to landslides and areas where are dangerous for people to access.

- Organizations and unions regularly inspect the observance of labor protection ordinance of employees.

- Complying with measures to ensure safety when installing tower, hanging cables on the tower arms, particularly as follows.

+ In the construction process. the civil contractors must comply with the technical regulations on safety in the construction of overhead power transmission lines QCVN QTD-7: 2009/BCT (National Technical Regulation on electrical engineering - Executing power projects); QCVN QTD -5: 2009/BCT - National Technical Regulation on electrical engineering - Inspection of electrical equipment and systems;

+ The foundation construction and tower erection will not use the explosives because most of earthworks are used by manual.

+ Construction workers on high will be arranged to stand on shelves to ensure safety. Heavier tools have to have hanging or other safety means.

+ The large-size steel structures will be reinforced by temporary bracing devices, ensuring stability for installation. Before winching or craning steel structures, cables and junctions of the equipment must be inspected. It is noticed to ensure safe distances with power conductors.

+ Complying absolutely with the rules of safety on electrical equipment installation. Workers who transport electrical equipment are trained about safety regulations for transporting and installing electrical equipment.

+ Moving, installing electrical equipment have to use specialized equipment for tieing up, not use steel wires. chains to tie the insulating parts, connectors of base holes.

+ Before testing the power cables of the 220kV TLs and electrical devices, it is necessary to stop all related works and workers in the distribution cabin have to go out.

+ Fuses of power circuits of installed devices/equipment have to be opened during the construction. They will be only closed to control equipment/devices after all workers are in safe locations.

+ When working on height:

All workers will be examined their health, ensuring health standards for work at height.

People who are responsible for climb up the column must have a safe level of grade three or more and qualify for work at height. Security belts have to meet the standard for use and the nearest inspection of safety does not exceed 6 months ago. People working and moving on height have to wear security leather belt which is firmly attached into towers/columns.

Construction equipment and tools are carefully checked for quality and quantity before use. Carefully check the brake cables before climbing onto towers.

Do not work at height when it is getting dark, foggy weather, or wind grade V or higher.

Applicable standards and regulations:

- Complying with technical solutions, design criteria, construction progress, etc.

- Some applicable standards and regulations are: QCVN QTĐ-7:2009/BCT; QCVN QTĐ -5:2009/BCT; TCVN5308:91, TCVN3985:99, TCVN4086:95, TCVN3254:89, TCVN3255:86, TCVN3146:86, TCVN4245:85, TCVN3147:90, TCVN2293:78, TCVN2292:78, TCVN4744:89, TCVN3146:86, QPVN2:1975, TCVN4244:86, TCVN5863:95,

e. Impacts due to concentrating workers

- Impact on people's health due to the construction of workers:

The concentration of construction workers on the project site can bring strange diseases and spread to people living near the construction area.

Healthcare demands of workers will cause pressure on the local medical facility for medical equipment, medicines, medical physicians, medical works, etc. However, number of construction workers of the 220kV TLs is small and divided into small groups along the route length. Therefore, the pressure on local health facilities will be decreased.

- Impacts on security, local governance; cultural customs and beliefs of people in the project communes

The concentration of workers in the construction site (mostly men) and those go follows can lead to illegal land transfers, conflicts between labor groups, conflicts between civil contractors, workers and local people. These will rise to social evils (drugs, prostitution, gambling, etc), causing difficult to control security.

Construction workers, staffs, followers (family: spouses, children, etc.) and free migrants will cause fluctuations in population in the project area, a temporary increase of the population density. These will make difficult for local government in project communes to manage the demographic and social issues.

- The project area includes the Kinh, Thai, Muong, and Tay living in villages, with high community and unique customs and traditions. The appearance of workers from other places will bring different ethnic, cultural background, customs, and beliefs to this territory. This will lead to the interference of cultures and may lose the inherent cultural identity traditions, beliefs of ethnic groups.

Mitigation measures:

- Effective preventive measures to reduce possibility of disease transmission in the community and in worker's camps need to be applied, they are propaganda, mobilization for keeping hygiene, using clean water, using bed nets when sleeping, vaccinating against diseases; eradicating mosquitoes and other insects; enhancing medical equipment, medicines and doctors, nurses, ambulance.

+ Collaborate with the local health center to take measures to prevent common diseases such as malaria, fever normal, abdominal pain, dysentery, and propagandize measures to prevent the spread of disease from household livestock, poultry, etc.

+ Set up the mobile medicine cabinets involved in the project's construction.

+ Combine with local health to have plans of regular health examination for civil contractors' staffs and workers.

+ Regularly inspect and instruct staff and workers to prevent common diseases.

- The PO, civil contractors will register temporary residence for their workers and coordinate with local authorities in managing workers to ensure order and security, social evils elimination.

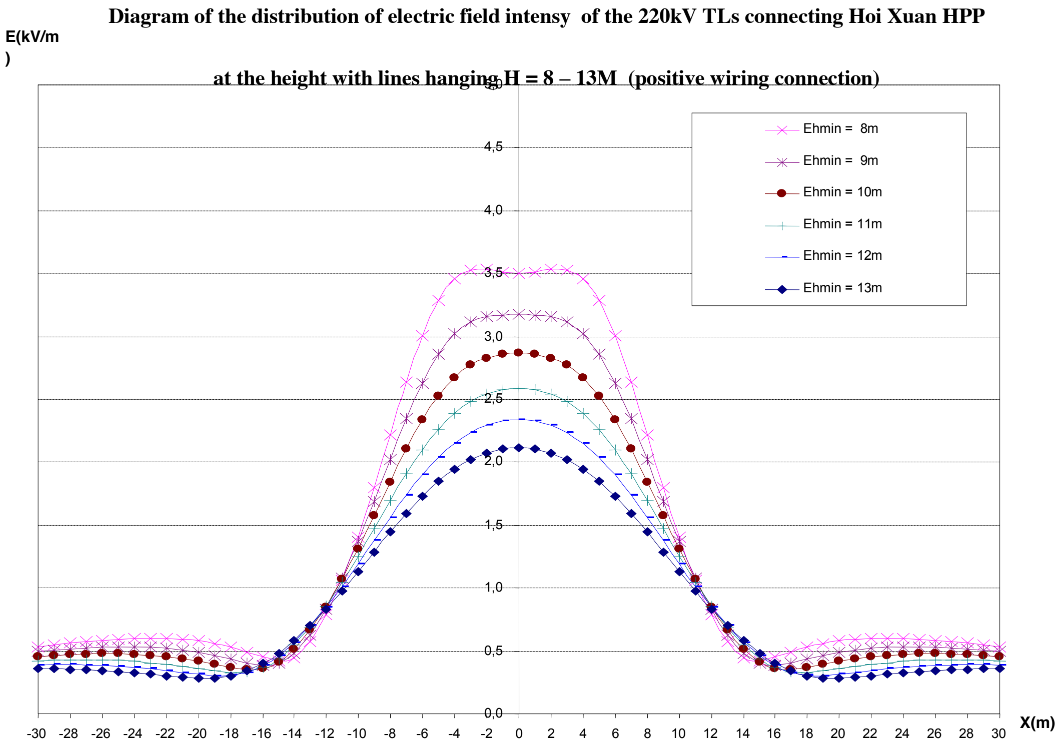
- The PO, civil contractors will coordinate with local authorities in maintaining the cultural identity, traditions and beliefs of people living in the area. They can help ethnic people to understand new culture, new life style from workers, but they ensure that ethnic people still maintain their typical cultural identity, beliefs, customs and practices.

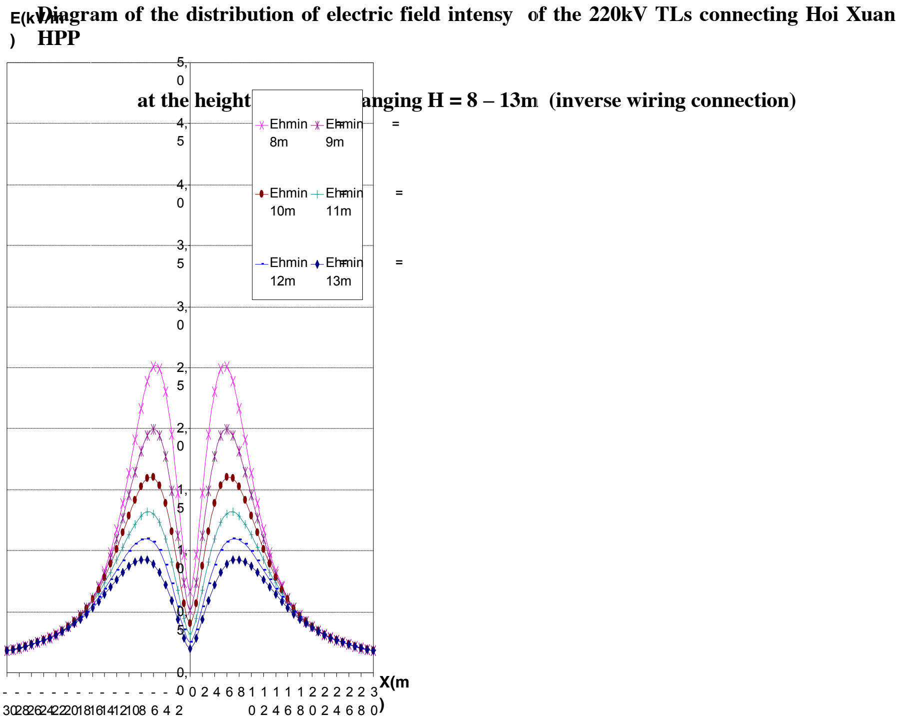
2. Operation Phase

a. Impacts of project operation

The design and calculation process has been complied with IEC standards and Code of electrical equipment - Part II 11TCN-19-2006. Particularly, minimum distance from the lines in stationary state and maximum sagging to the ground is 8 m for the cultivation area, 3 meters for residential areas; 14m for rivers/water bodies; 8.5 m for railway surface; and 8m for road surface.

The below graph shows the largest calculated value of the electric field strength of any points on the height 1m from the ground within the ROW.





Based on the chart, the comment can be drawn out that at the height ofthe line suspension in accordance with Vietnamese Standard; electromagnetic field at any point away 1m from the groundis less than 5kV permeter. Within the range of ROW of the transmission lines, the electric field strength at a line suspension height of 8 to 13 meters is less than 3.5kV per meter for the case of positive phase upon mixed wired and less than 2.5kV per meter for the casein phase opposition.

According to the request at the DecreeNo. 14/2014/ND-CP of the Government the electric field strength must be less than or equal to 5kV per meter at any point out side house high above the ground 1 meter, and less than or equal to 1 kV per meter at any point inside house high above the ground 1 meter. In addition, according to the standard of low frequency electric field strength issued enclosed with the Decision No.3733/2002/QD-BYT by the Ministry of Health, the allowable maximum electric field strength in the work place is 25kV per meter. Therefore, within the range of ROW of the transmission lines, the electric field strength ensures the requirements, including requirements for the electric field strength for the housing area specified in the DecreeNo. 14/2014/ND-CP.

According to the provisions No.183/NL/KHKT dated April 12th 1994 of the Ministry of Energy which specifies the allowable level of electric field intensity with industrial frequency according to working and traveling time in the areas affected by the magnetic field; and specifies the check of electric field strength at work placeas shown in the table bellows:

Table 4.31: The electric field strength and the limited time of working per day

Electric field strength (kV/m)	**<5**	**5**	**8**	**10**	**12**	**15**	**18**	**20**	**20<E≤25**	**>25**
The limited time of working per day (hour)	Not limited	8	4.25	3	2.2	1.33	0.8	0.5	1/6	0

(Source: Decision No.183/NL/KHCN dated April 12th 1994 of the Ministry of Energy now is the Ministry of Industry and Trade)

Workers operate the transmission lines will be arranged to work in shifts.

Thus, with the electric field strength calculated above, the electric field affects only the operator in working time and it is less than the allowable level. The electric field strength will not affect the health of people living and working under the transmission lines.

Mitigation measures:

- The operation agency conduct periodically to measurethe electric field strength in accordance with the regulations of the Electricity sector or when there are complaints of local people.

- The operation staffs and workers, and local people must comply with the working time in the areas affected by electric field in accordance with the regulations of the Electricity sector.

**** Electric corona and discharge***

The electric discharge usually occurs during the rainy days with high humidity, it can cause electric leakage at the pole which dangers to the human oranimals asapproaching. However, the distance between the transmission lines is guaranteed accordance with design, and all the poles are grounded and installed with warning signs on them, this phenomenon will therefore rarely occur.

Mitigation measures:

- Perform earthing and install the warning signs at the poles as prescribed.

- Ensure the height of line suspension as prescribed and perform periodic inspections height from the lines to the objects as specified to timely prevent from the unfortunate incidents which may occur.

- Disseminate to enhance the sense of the safety of high-voltage lines for people to avoid violate the ROW of discharge during the production and domestic activities under the transmission lines.

4.2.2.3. Impact on traffic operations, infrastructure, public works and other works

This transmission lines crosses 02 times with the 22 kV transmission lines, 02 times with 0.4 kV transmission lines and 03 times passes over Highway15. Therefore, there should be the sensible measures to pull and stretch the lines – if not, it will affect the normal operation of these objects. There are some houses/buildings within corridor of the transmission lines. Therefore, during the operation, if the height of line suspension does not meet the requirements, it will also affect the operation of these constructions.

In addition, the transport of building materials and equipment for construction of the foundation of power poles will increase the density of vehicles on Highway 15 and the rural roads around the project area; this will cause road surface to be damaged and subsided increasing the risk of traffic accidents.

Mitigation measures:

Mitigation measures during the construction process:

To arrange time for transporting materials and equipment sensibly, avoid the peak hours. The transport vehicles must keep the safe distance, carry the right load within the ranges of allowable speeds; the oversize and overload equipment must be transported by specialized vehicles; install the warning signs at dangerous positions in order to avoid traffic jams, damage, road base subsidence, and to avoid the traffic accidents. In the event of damage, road base subsidence caused by the transportation of materials, machinery and equipment to the construction project, the Project Owner and the construction Contractors are responsible for repairing and restoring the status.

+ Before suspending the lines pass above the National Highway 15 and rural roads or over the overhead existing transmission lines, the project owner must arrange the system supporting wire; install warning sign away from the construction position around 100 to 200 meters and inform the competent authorities. As pulling and stretching the lines over Highway 15, the Project Owner must has specific plan to inform the competent authorities at the district and communes; and arrange guards to ensure the proper operation of the vehicles and human as participating into the traffic.

+ As pulling and stretching the lines over the existing power lines, the Project Owner must has a specific plan to inform the authorities at district and commune; temporarily switch off the power source to ensure the safety of workers and local people during construction, as well as let the localities known to actively produce, minimizing impacts that may occur.

+ The houses/buildings are allowed to exist in the corridor of the transmission lines must be earthed as specified. Perform periodic inspections of grounding equipment or when there is the claim of local people to promptly replace or repair to ensure the health of local people.

Mitigation measures during the operation process:

The maintenance agency must periodically check the minimum safe distance from the lines to the road and other electric wires as prescribed to give out appropriate treatment measures.

4.2.3. The environmental risk and incident

1. During construction process

a. Forest fire

The area around the transmission line are covered by forest vegetation, thus the operations of cutting down the trees for clearance purpose, constructing power column foundation and stretching wires must be managed and closely monitored. If not, the forest fire may occur because of the careless use of fire. Especially, there are sections of the transmission lines located near the Pu Luong Natural Reserve (about 1.0 kilometer); if the fire spreads far and wide fire, the Natural Reserve will be significantly impacted.

Mitigation measures:

- Because the transmission lines mainly pass through the forest, therefore during the process of cutting down the trees for clearance of the safe corridor of the transmission lines, the Project Owner must coordinate with forest owners either to thouroughly harvest, collect and transport trees to the forest owners their collection yards to handle; or burn in controlled manner to prevent forest fires.

During construction process, if the forest fire occurs, the Project Owners and construction agency must stop the work to mobilize all workers, use every means to extinguish the fire; quickly inform the forest owner.local peopleandthefireagencies. After completing the process of fire fighting, personal cause the forest fire or his agencies must be responsible for pay all cost for fire fighting and the cost for reafforestation equal to the area of lost forest.

b. Rock and soil slide

The route of transmission lines passes through high and steep mountainous terrain which is full of obstacles and difficult of access. The foundation of power poles located on a hillside of high mountains, the rock and soil slide therefore might occur during the construction process especially in during the rainy season.

Mitigation measures:

- Duringthe construction of column’s foundations on the slopes and hillside, if the rock and soil slide occur, the Project Owner and construction agencies must pause the work to rescue and support and do the compensation in case of this incident fills over the flow, housing, works and productive land; then check and study the geological conditions and reinforced measure again to treat properly or move the pole to another place if necessary.

2. During the operation phase

a. Incident of landslide

The route of transmission lines passes through high and steep mountainous terrain which is full of obstacles and difficult of access. During the operation of transmission lines, foundation of power poles at some positions canbe eroded and slided due to rain, wind, groundwater or bad consolidation measures. During the periodic maintenance and inspection processes, if being not detected promptly, the erosion and landslides at column’s foundation can cause danger for the positions under the slope and can cause power poles to be fallen down. The land and rock slide can cause the deposition of productive land of local people where the route of transmission lines passes through.

Mitigation measures:

During the periodic maintenance and inspection processes on the transmission lines, the management and operation agency will implement:

- Check each individual foundation position to detect promptly the erosion, landslides which can cause the column to be fallen down.

- When signs of landslides and erosion at the foundation positions, the solidation measure will be carried out immediately.

b. The tilt and collapse of power poles

During operation of the transmission lines, the foundation of some columns can be subsided and eroded due to groundwater or bad consolidation measures for pole foundations. During the periodic maintenance and inspection processes if being not detected promptly, the erosion and landslides at column’s foundation can cause power poles to be leaned and fallen down.

The power poles can also be leaned collapsed due to the natural disasters such as storms, winds, floods, etc.

Mitigation measures:

- For the poles located on the weak foundation, carrying out the consolidation measure, construction of riprap and pile driving, etc. to preventsoil erosion in the rainy season to ensure the foundation under safe conditions.

- The operation agency should periodically check the stability of the pole’s foundations for early detection of erosion, subsidence and cracks, etc.

- Check the riprap, drainage system and erosion control systems around the pole’s foundation.

- Promptly repair and consolidate the foundation as discovering the signs of deterioration.

- In some areas where have the high voltage poles passing cross the rivers and streams, the management and operation agency of the transmission lines will coordinate with local authorities to prohibit exploitation activities on shore and in the riverbed to prevent the pole’s foundation from erosion.

c. The incidents of fire, explosion and electric shock

These incidents usually occur during the operation phase of the project. The main reasons are that the operators do not properly implement in accordance with the regulations and local people are not aware of the safety issues of high voltage power grid, etc.

+Electric shock: if the operators do not strictly comply with safety rules and in operation and usage of electrical devices. The incident of electric shock may occur. This incident generally occurs in place and directly to the operator who causes the problem. As the incident occurs, the protective relays will automatically break the circuit.

+ Fire and explosion: may occur when happening short-circuit or overload, lightning or broken wires, etc. These incidents caused by the electric problems will only happen in place and in a short time; because when the incidents are detected the protective relays placed in transformer substations will automatically break the circuit breaker and the automaticfire protection system will be activated automatically. However, these incidents can cause a fire which if being not promptly extinguished, it may lead to the risk of fire spreading far and wide.

However, such incidents rarely occur because the design has been carried out in accordance with standards and operators have been trained on safety measures.

Mitigation measures:

- Preventative measure for fire incident:

+ Install warning signs on to high voltage power poles.

+ Install lightning protection systems in all high voltage power poles as specified.

+ When the fire occurs due to electrical problems, quickly notify the competent authorities for power cut then comply with the fire fighting procedures.

+ Check plants periodically inside and outside the safe corridor which may affect the safety of transmission lines.

+ Periodically inspect lightning rods, grounding system of several households which are allowed to live within the safe corridor of the transmission lines or when there are the complaints of local people.

- Preventative measure for electric shock:

+ Install grounding system and warning signs for all high voltage poles as prescribed to prevent the unauthorized people from approaching.

+ Coordinate with the local government to propaganda and disseminate knowledge about safe corridor of the transmission lines for people in the project area, especially the households whose cultivated land located underand closely the ROW. and the households whose housing located within and closely the ROW. The method is to use a banner sticking on the wall expressing the knowledge about fire prevention and fire fighting.

+ Periodically measure and check the height of line suspension and safety distance as prescribed; especially at the position where the transmission lines passing over the rivers, traffic roads, the existing power lines and the residential areas.

d. Forest fire incident

During operation, the workers their careless use of fire during maintenance and repair of the transmission lines can cause forest fires. Therefore, the operation agency should coordinate with the forest owners and households to participate together in the testing and monitoring the maintenance and repair of the transmission lines which passing through the forest area under their management. In addition, asking the staffs who perform the maintenance and repair of transmissions lines to comply with regulations on maintenance and repair of the high voltage transmission lines.

Also, the forest fire may occur due to short circuit, overload or lightning, etc.

Mitigation measures:

The operation agency should perform the following tasks:

- Propagandizing and training for workers in the inspection of safe corridor and maintenance of transmission lines to be sense of protecting forest resources as well as preventing forest fire by using fire safely during the maintenance.

- In the process of checking the safe corridor and maintaining the transmission lines, carrying out cleaning the trees their branches and roots or collecting and transporting to the specified position. These will be handled by let them to be thoroughly harvested or used as the firing matter by local people.

- Install warning signs of fire danger at some places within the forest range.

- The Project Owner coordinates with the communes and households in the project area to make the forest fire prevention plan together

4.3. The environmental impacts, mitigation measures and improving the resettlement area

According to the survey results of the aspirations of the affected households during the implementation progress of the project (from August to September 2015), only 42/199 households that will be affected on their houses in Sa Lang hamlet. Thanh Xuan commune and have the wish to receive land compensation and focusing resettlement. In order to meet the aspirations of these households, the project owner has been coordinated with local authorities, local people for searching and arranging a resettlement area in Sa Lang hamlet to these 42 households. The project owner will implement the planning of land use and will complete the legal procedures for land use rights of the resettlement area, perform cleaning works, ground leveling, dividing the land plots in the area with average area per plot of about 300m^2, the project owner will invest infrastructures and essential public facilities in this area (roads, electricity, water, schools, culture house, etc…) in order to ensure a stable life for the displaced households. The households will remove their houses and transport the materials that can be fully utilized to reconstruct their houses at new location, which shall be allocated in the resettlement area.

The current status of the resettlement area as follows:

- Sa Lang resettlement area is planned to arrange the resettlement for 42 displaced households and 11 other households of Sa Lang village, Thanh Xuan commune.

- Location of resettlement area: Sa Lang resettlement area belongs to the territory of Sa Lang hamlet, Thanh Xuan commune, Quan Hoa district, Thanh Hoa province, which is located behind the existing residential area of Sa Lang, in the north contiguous with the streams; in the south and the west contiguous with the bamboo hills; in the east contiguous with Sa Lang residential area.

- The current status of the resettlement areas:

+ Transport: the resettlement area has the trails of people.

+ Electricity: The area is currently no residential electricity

+ Domestic water: On the area that has the water pipe from stream to the domestic water tanks according to the World Vision Program.

+ The current status of land use of resettlement area: plantation forest land of people of Sa Lang hamlet.

- The area scale of resettlement area: Sa Lang resettlement area has a total area of 78,026m^2.

The details of alternative of planning and arrangement of resettlement and resettlement relocation at Sa Lang resettlement area are presented in the report of resettlement alternative, income restoration and development of ethnic minorities, which are not mentioned in this report.

The environmental impacts below are caused by the implementation of the resettlement works of the displaced families of Sa Lang hamlet at Sa Lang resettlement area.

4.3.1. Impacts. mitigation measures and improving the physical, biological environment

4.3.1.1. Topography, geomorphology and landscape

1. Stage of preparation and construction

In the stage of preparation and construction of resettlement areas, the project owner will implement of all collection activities, clearing vegetation coverage; remove surface soil layer; ground leveling; subdivision of land; execution of earthworks of infrastructure and essential public facilities such as the roads into resettlement areas and internal roads in the resettlement areas; supply systems of electricity, water; cultural house; schools; etc... These activities will lose vegetation coverage layer; make the terrain somewhere are flattened, somewhere are dug deeply, somewhere are elevated, etc ... the land surface is dug so the topography and landscape are changed, The dug rock, soil will loose, unitary incapacity to facilitate the processes of erosion, washoff, landslides, landslides, pouring rocks, which are developed.

In order to minimize impacts, the project owner will implement all of the following measures:

- Conducting the gathering, clearing vegetation coverage within the acquired area of the project, prohibiting the gathering in the surrounding area. Before land acquisition, people will perform all gathering agricultural products on their land.

- Collecting and transporting the waste rocks, soils and the felled trees to burn with a controlled manner to prevent forestfires; or dump into the places that are allowed by local governments for processing, landfilling, leveling and compaction. After the completion of construction works of resettlement areas, the project owner will conduct cleaning, ground leveling of the temporarily occupied areas and greening tree planting.

- Planting trees in resettlement areas at public places, along the transportation roads... to beautify the landscape, increase surface coverage level, improve the environment and prevent soil erosion.

4.3.1.2. Atmosphere

1. In the stage of preparation and construction of resettlement areas

The process of transporting materials, removing surface coverage, ground leveling, stone earthworks for building the infrastructures and the public works will create dust and waste gases, that makes the pollution of air environment of the resettlement areas.

However, the infrastructures, the public works are scattered distribution in resettlement areas, the number of material transport means are less, which do not go into a fleet and the volumes of earthworks of each work items are generally small, so the dust and waste gases arising from transport of raw materials and due to execution of work items are small and scattered, not concentrated in the resettlement areas; so impacts of dust and waste gases to the atmosphere in the resettlement area are estimated small.

Mitigation measures:

- Implementing the measures to minimize dust, waste gases arising from the construction of work items in resettlement are similar to the measures to minimize dust waste gases arising from construction of work items in the hydropower area.

2. Operation stage of resettlement area (relocation of the affected households in the Sa Lang hamlet into live in the resettlement areas)

During this period,the dust and waste gases will be mainly arised by the transport activities and the cooking in daily life of people. These are the basic activities, the essential needs of people whether they live anywhere.

4.3.1.3. Noise

The environment of resettlement areas will be impacted by the noises arising from the blasting activities at foundation pits (scope of influence: the blasting areas of foundation pits) and by the operation of the transportation means (scope of influence: along the routes for transporting materials), due to the operation of the equipment, machines during construction process (scope of influence are mainly in the construction areas: roads, electrical supply systems, construction area of cultural house, schools, etc ...). In addition, due to the voices of construction workers.

According to the above assessment, the noises are generated by the operation of material transportation means, due to the construction machines of the work items from 70 - 96dB at a distance of 15m compared to the source, in the case of the resonance can reach 73 - 99dB. However, the noise decreases rapidly with the distance to the source, about 6dB when the distance doubles, therefore at the distance of 450m compared to the noise source, the noises of most means, equipments are less than 70dB, ensuring the allowable noise levels in common areas that are from 6 to 21h.

The noises arising from mine exploding activities have the great influence range but the mine exploding time very short time. It only occurs in the work item areas in resettlement areas, most of the work items are constructed by the mechanical measures combined with the handmade measures, only the construction of new roads needs to implement the mine exploding. so Impacts are assessed not large.

The arising noises mainly affect on the health of construction workers and a number of households around the construction area during the execution time. The noises are generated by the construction of resettlement areas, that does not affect on the neighboring Nature Reserves.

Mitigation measures of noise impacts are implemented similar to mitigation measures of hyropower project area.

4.3.1.4. Climate and hydrology

Acquisition of land, clearance of plants for constructing the resettlement areas will lose the forest coverage layer with an area of about 77.236,5 m^2, accounting for 98.99% of total area of resettlement. contribute to increase the surface runoff, increase flood intensity (flood focus is faster), contribute to the climate change in the area.

Mitigation measures:

- Vegetation clearance within the acquired area. Strictly forbidden to cut trees to the outside.

- The project owner coordinated with the related agencies will conduct the replacing afforestation according to regulations with the area is equal to the acquired area.

4.3.1.5. Land and land resources

1. In the stage of preparation and construction

a. Impacts of solid waste

Generating sources of solid waste at this stage including:

+ The solid waste due to the construction of work items including: waste soil, construction materials are spilled, removed.

+ The trees are cut down during the process of site clearance for building infrastructures and public facilities in the resettlement area.

+ Domestic waste of construction workers (mainly in the camp area): excess food. the damaged clothes and footwear, empty bottles, etc…

The solid waste is generated by the construction activities in the resettlement area. which will occupy the land for dumps (rock, soil waste dumps, and rubbish dump). In addition, the water from the rubbish dump will leach into the ground cause the land pollution, if the rubbish dump is not built and treated according to the process and ensure environmental sanitation. Rags for machines with oil are the hazardous waste if not collected; they will also cause the pollution of the environment of soil, water.

❖ Acquired land for waste dumps of soil, rock:

The soils are excavated from the foundation pits of constructions will be utilized to reinforce the foundation and backfill into the low-lying areas in the resettlement area. Thus, the volume of the waste rocks, soils are mainly the rocks, soils that are removed from the surface coverage layer, ground leveling, about 33,420m^3.

❖ Acquired land for the domestic solid dumps

In the construction stage of resettlement areas, the number of workers will be arranged suitably with each project items, ranging from 10-30 people/items. With the volume of domestic waste averages 0.5kg/person/day and the density of solid waste is 500kg/m^3, so the daily waste at each construction items is from 0.01 – 0.03m^3/day. This waste volume is very small. However, the composition of domestic waste is mainly organic substances: removed vegetable, fruit peel, rise, soup and excess food, which are a favorable environment for the development of micro-organisms, especially the micro-organisms can cause the harmful for people and can affect on soil environment, water surface sources. Thus, it should have the measures to collect and treat the domestic waste effectively.

In addition, the compositions of the waste are also including the inorganic substances such as: plastic bags. cans (beer cans, cans of canned meat), etc… There are also: clothes, footwear, hats, removed papers, etc… There substances are difficulty or inability to decompose and needed to have the treatment measures.

❖ For the felled trees

Vegetation coverage in the project area is mainly the planted forests (Bamboo forest) (account for 98.6% of total acquired land), which are all harvested before the acquired land, thus volume of the felled trees is not large.

Mitigation measures

- Domestic wastes will be collected. transported to the dumps, which were planned for resettlement area; and treatment and burial according to rules, in order to prevent the pollution of soil, water in the dump areas and surroundings. Specifically:

+ Contractors and the construction unit must implement according to the regulations on the general sanitation of the construction area, the public waste bins will be arranged on construction area to collect and transport the garbage to the specified places. Total volume of wastes will be generated during construction, which will be focused at the dumps planned for the resettlement area.

+ Building a sanitary landfill of domestic waste according to regulation standards on environmental sanitation.

+ Waste in bins will be collected to the dumps every day.

+ After each day of waste collection must be covered with a thick soil layer of 10cm to minimize the odor and activities of insects.

The soils are excavated from the foundation pits of constructions will be utilized to reinforce the foundation and backfill into the low-lying areas in the resettlement area.

The rest rocks, soils will be collected and transported to the allowed locations of the local strictly according to the disposal process of hydropower project area for preventing the environmental problems such as erosion. landslides. flash floods, etc … during flood season.

- For the furniture, common items, construction materials, which are spilled, removed: Classification of the waste materials can rescued such as covers of cement, cardboard, cans, bottles, damaged clothes, shaving cover, etc... will be used to sell for scrap, making fuels, cleaning the machines (damaged clothes), etc ... The materials can not be reused, which will be collected to burn or dump into the landfills and bury with the garbage. The oily rags will be collected for treating according to the regulations to prevent the pollution of soil and water.

Before acquiring the land for the project, people will harvest all the agricultural products on their land: using trees, branches as fuels to reduce the volume of waste. The rest wastes will be cleaned and burned a controlled manner or dumped into the landfills to bury with the garbage.

Applicable standards:

- QCVN 25:2009/BTNMT

b. Impacts due to erosion

The construction activities of the work items will make friable soil, rock to accelerate the process of erosion, wash away of soil nutrients.

In addition, the operation of vehicles, machines and equipment can change the soil physical properties (the density, grain structure, etc...) or cause the soil pollution due to the oil leakage in the maintenance process.

Mitigation measures:

- Planting trees in the temporarily occupied areas:

After completion of construction, the contractors and construction units will clear, bulldoze the site plan of the temporarily occupied areas (worker camps, garbage dumps, waste rock dumps, yards, the areas of material exploitation, etc...). Then the plants will be planted for greening these areas. The planted area is equal to the area of temporarily occupied land during the implementation time of the project. This area will be determined accurately after cadastral surveying to give the land area for the project construction.

- Implementing the periodic maintenance of machines, construction equipment to ensure non-leakage of oil into environment, polluting the soil and water.

4.3.1.6. Mineral resources and building materials

According to the survey results and mineral resources map of Quan Hoa district, the resettlement area does not have the common building materials and the valuable minerals.

4.3.1.7. Water quality

1. In the phase of preparation and construction

Water environment of the resettlement areas in the construction stage is mainly due to the activities of construction workers. In addition, there are also the waste water of construction progress and the rainwater runoff.

a. Impacts of domestic wastewater produced by the staffs and workers on the construction site

The number of construction workers will range from 10 - 30 people suitable to each work item. Domestic water demands of construction workers are about 120liters/ person/day. Amount of generated domestic wastewater ranges from 0.96m^3 to 2.88m^3/day/item.

This waste water is very small and scattered distribution in the execution location of infrastructure items and public facilities in the resettlement area. However,. the composition of domestic wastewater is organic substances, which is a favorable environment for the development of pathogenic micro-organisms that contaminates the environment with the stench if not collected and handled appropriately.

Impact mitigation measures:

The construction time of the work items in the resettlement are short, so the impact mitigation measures due to the waste water have been proposed as follows:

- Hire the portable toilets installed near the worker camps, houses of management staffs to collect gray water waste (urine and feces). The contractor periodically contracts with the functional agencies to treat this water waste.

- For the common wastewater (from cooking, washing dishes, cleaning floor, bathing and washing clothes…): digging holes to collect them. The holes are tightly closed to anaerobic microorganisms that have activity conditions and avoid the activity of insects and the development of harmful infectious microorganisms. After the construction is completion, conduct to sprinkle lime, disinfection and land leveling return the ground and planting trees.

b. Impacts of construction wastewater

- Construction wastewater: it is mainly the pumping water of foundation pit. Wastewater generated by the washing activities of building materials and the excess water in the mixing and maintenance of concrete is very small, the major components are the suspended solids that are not harmful to the environment, so they will be pumped and discharged directly into the environment. The waste water in foundation pit will be directed into the collection pit to deposit the sediment before pumping into the environment.

- Car washing water and waste oil in the progress of repairs and maintenance: The number of vehicles and equipment for building the work items at the resettlement site are very few; the construction period is short, so the project has not the repair, maintenance station. The process of maintenance, repair of machines and equipment will be made in the motorcycle repair facilities in the locality. Therefore, the wash water, waste oil from the process of repair, maintenance will be collected and processed according to the regulation in these facilities.

c. The impact of the toxic chemical OB survived from war

Before implementing the resettlement areas, the Project Owner has been submitted in written to the military authorities to ask whether the toxic chemical OB still be survived from the war in the reservoir area or not.

If these authorities confirm the existence of the toxic chemical OB in the resettlement area, the Project Owner must be responsible for hiring the specialized units to reconnoiter, detect and treat it to prevent widespread into the environment and prevent pollution of surface water, ground water sources and soil environment, indirect impacts on crops, livestock and the heath of people living in the resettlement area.

2. In the phase of operation

When the resettlement area is finished, the affected households have the focus resettlement demand that will relocate their houses and rebuild in the resettlement area.

Wastewater in this stage is the domestic wastewater of households and rainwater overflows through resettlement areas. This is the essential waste source of the residential areas.

Domestic wastewater of households will be collected into sanitation system of households.

Overflow rainwater will be collected into the general drainage system of the resettlement area. Composition of rainwater is harmless, so it will be flowed into environment.

4.3.1.8. Terrestrial ecosystems and national parks surrounding the project area

1. In the phase of preparation and construction

a. Impact of vegetation clearance to ecological environment

- Impacts on vegetation coverage, flora:

Impacts on ecological environment in this period mainly fell the plants, during construction progress of work items in the resettlement area. These activities will reduce the area and reduce the continuity of living space, split the movement of animals and plants on land.

According to the survey results. the area of land acquisition for building resettlement areas is mainly the plantation forest (bamboo) and people will be harvested all products before acquiring the land for the project. there are not the rare plants, so Impacts on vegetation coverage, the flora, landscape will be insignificant, does not affect the biological diversity and genetic resources conservation.

- Impact on the fauna:

Trees will be cut down and cleanup that will lose the habitat of animals, divide the living spaces and chase them away from the surrounding areas. This is the inevitable impact of any works.

Animals here are mostly the grazing farming animals, but here are a number of wildlife species live near people such as birds, rats. Snakes, pig races, bamboo rat, iguana, etc ... but there are not rare wild animals necessary to protection, so fallen trees will not significantly affect on the animal's living space. Moreover, surrounding areas are covered by the plantation forest (bamboo) with the similar conditions, so there will be very good habitat for the animals moving to live when the resettlement areas start building.

Pu Luong, Pu Hu, Hang Kia - Pa Co, Xuan Nha Nature Reserves pretty close to the project area, so some species (mostly birds) may move into these area to live and search for food.

Mitigation measures:

- Implementation of gathering all vegetation coverage

+ Before acquiring the land and ground clearance for building the work items, in the reservoir area, people will gather all agricultural products on their land.

+ The remaining branches and leaves will be collected with controlled meaner to burn or pour into the dumps, and they will be leveled after pouring.

- Only implement gathering, clearing vegetation coverage within the acquired area of the project, prohibiting the gathering in the surrounding areas.

- The project owner is responsible for coordinating with the related agencies to implement the afforestation to replace the acquires forests according to the regulation. Afforestation area is equal to the acquired forest are by the project owner for the project construction. This area will be determined accurately after cadastral surveying to give land for the project construction.

- Planting trees in the temporarily occupied areas such as work camps, soil, rock dumps, material yards, etc ... after the completion of construction.

- Planting trees in the resettlement area along the roads, the public works to beautify the landscape and increase the surface coverage.

b. Impacts of noise. dust and waste gas

Waste gases, dust and noise not only impact on the air environment, the healthy of people but also have certain influence on the lives of animals and plants, especially the animal are very sensitive to noise. However, the project area does not have the rare wildlife species. The wild species are distributed in the region live near people such as toads, sparrow, house mouse, field mouse, dry snakes, water snakes, muntjac, wild boar, rugged, bamboo rat, babbler, rackle, etc... Species of domestic animals such as buffalo, cow, chicken, etc... are familiar to the noise, so they will be less affected by noise caused by the project.

The dust generated by construction activities will stick on the surface of leaves that will reduce the photosynthetic capacity and water evaporation of vegetation, but the impact is at weak level.

Nature Reserves where are the storage and living of many rare plant and animal species, but the nearest distance from the resettlement boundary the Pu Hu Nature Reserve is 2km, the noise arising from most construction vehicles, equipment and machines will reach 70dB at a distance of 450 meters, the biggest noise is the noise of mine exploding but the time is very short, instantaneous and most work items have not performed mine exploding during construction except for breaking stones of roads into resettlement areas so that noise generated by the machines, construction equipment of resettlement areas have little impacts on the Nature Reserve.

c. Impact by focusing on the construction workers

The demands for fuel, food of construction workers will increase the exploitation. hunting. storing and selling firewood. wild animals illegally, adversely affects on plants and animals in the surrounding area and the Nature Reserves. In addition, the workers concentrate on road and the freedom migrants will make difficult for management in the area, while also creating conditions for operations of forest destroyers.

The infringement ability to the Pu Hu and Pu Luong Nature Reserves is great because the resettlement area is located nearly. Particularly Hang Kia - Pa Co and Xuan Nha Nature Reserves are far 26km and 30km from the resettlement and it is limited on geography, there is no possibility of the physical access of workers to the nature reserves but the consumption demand for forest produces of the workers can promote the illegal activities of people on these nature reserves. So measures should be taken in a positive way to prevent the trespass of workers, immigrants freely and local people to the nature reserves when the project is deployed.

Mitigation measures:

- Project owners, building contractors and construction units must have the measures to closely manage the construction workers, prohibit illegal activities of harming the forest resources, especially the Nature Reserves. Violators will be severely dealt with according to the law.

- The project owner will combine with the local government and the forest management units (Management Board of Nature Reserves) in the management, protection of forest, and propagation for the workers, immigrants freely in the project area and local people on the consciousness of forest protection.

- The felled trees during the clearance of site and reservoirs will be used for fuels and construction wood, but there are not illegally harvested wood for fuel and construction wood.

2. In the stage of operation

When the resettlement area are finished, the displaced households in the Sa Tune will be living in resettlement areas.

Around the resettlement area is forest coverage. in order to satisfy the cultivated land demand and increase the income, the households can go to the surrounding forests that are managed by the agencies, management units (e.g: Communal People’s Committee) to forest clearance, land reclamation or exploitation of firewood, wildlife hunting, etc...

The resettlement area is also quite nearly the nature reserves, especially Pu Hu and Pu Luong Nature Reserves so that people are able to access these nature reserves to hunting and illegal forest exploitation, particularly exploitation of the rare wood animals with high value that will affect on the conservation function of the nature reserves.

Impact mitigation measures:

- In addition to the compensation, adequate support for people according to the regulations to quickly stabilize the life and production of the affected households,the project owner needs to take measures to support the recovery of people's income to ensure the income, the living standards for households affected by the project in general, the households are affected at Sa Lang hamlet in particular, which are as or better than the previous one, in which the vulnerable households (such as the household head is woman, ethnic minority households, elderly households, policy households, etc...) are given priority consideration.

Through surveys, interviews the aspirations of the affected people and local government representatives, the project owner may consider implementing the support measures as follows: To allocate more forest land for the households to management and protection; support local people in the expansion of cottage industries such as semi-processed bamboo to increase the production value of bamboo trees instead of just selling raw as present; hiring the local workers to work during construction process of Hoi Xuan HPP; support training and recruiting the local workers to work for long time after Hoi Xuan HPP starts operating; support local people improve production efficiency in the area of remaining productive land, etc... Support works to create jobs for the local workers to help stabilizing and increasing the income of households and contributing to limit the illegal land reclamation; limit the idle workforces that have time into the forest hunting, illegal wood exploitation.

The measures and income restoration programs for households affected by the project will be mentioned in more detail in the report of resettlement plan, income restoration and development of ethnic minorities.

- Local authorities and Management boards of Nature reserves will implement well the management and protection of forests, prevent people go into the forest for land reclamation. Hunting, illegal wood exploitation. Propagating the awareness of protecting forests, rare plants and animals for people.

- The local government will allocate more forestland for local people to management, care and protection according to the forestland allocation program for local people to raise awareness of forest protection, avoiding the illegal forest encroachment if the communes are still the forest areas that are assigned to management by the State.

- The authorities of villages, communes in the resettlement area (Sa Lang hamlet, Thanh Xuan commune) will implement the management measures to quickly stabilize social order and security in the resettlement area.

- For the resettlement households have sufficient production land to ensure their life, the project owner will coordinate with local authorities to balance production land in the area to regulate for the affected households to reduce the pressure on forest resources due to the illegal land reclamation activities by local people.

4.3.2. Impacts, mitigation measures and improving the environment of economics, culture and society

4.3.2.1. Impacts on land use, production, economics, income, life, daily activities of local people

1. In the stage of construction

a. Impacts of land acquisition for the project construction and site clearance

Land acquisition and conversion of land use purpose for building the resettlement area will not only reduce land fund and the loss of land fund for other purposes, but also damage to houses, buildings and assets on the ground, affecting on economics. Income, life, daily activities, studying, producing, etc. of local people (living and production in the resettlement areas).

❖ *Damages on Land*

When the resettlement area will be deployed approximately 7.8026 hectares of affected land types that mainly is the forest land of 7.724 hectares (see table below).

Table 4.32: Current status of land use of acquired areas for the resettlement area

No.	Location	Total (m^2)	Land use by households and individuals (m^2)	
			Land of ONT	Land of RST
I	**Resettlement area**	**78.026**	**789.5**	**77,236.5**
1	***Thanh Xuan commune***	***78.026***	***789.5***	***77,236.5***
	Sa Lang village	78.026	789.5	77,236.5
	Total	**78.026**	**789.5**	**77,236.5**

(Source: The data provided by Hoi Xuan VNECO Investment and Electricity Construction Joint Stock Company)

Acquisition of land for building the resettlement areas will affect on the land use of 53 local households/252 people (being live and product in the resettlement areas). However, the affected land area is small, so impacts on land use, production of people are assessed at low level.

❖ Damages on crops. plants

As mentioned above, the damaged trees in the resettlement areas are mainly bamboos and most households have the production land out of resettlement areas, so impacts will reduce.

❖ Damages on houses. architectural works

According to the survey of 5 households/19 people will be affected in construction area of the resettlement areas. The household will receive compensation for damages and are arranged in a resettlement area along with other resettlement households. So the impact is not significant.

❖ Damage on infrastructures. public works

The resettlement area does not have any infrastructures and public facilities, only a trail of local people. When the resettlement area is built, the infrastructures, essential public works will be new construction, including the system of roads. Then the movement of people in the resettlement areas and the surrounding area will be easy, more convenient.

Impact mitigation measures:

To minimize impacts of land acquisition for building the project in the resettlement areas on economic, income, life, daily activities and production of local people, the project owner will implement the following measures:

- Implementing of measurement and detailed inventory of the damages in the recovery of land for building resettlement areas. Implementing of conversion of land use purposes before the resettlement area starts building.

- Before land acquisition, the households will implement gathering all products on their land.

- Implementing of damage compensation. support and resettlement of the affected households and communes on land, trees, crops, buildings and structures in accordance with regulations before the land acquisition for the households to quickly stabilize their life and production. The project owner is just asked to ground handover after completion of compensation. support and resettlement of the affected households.

On the basis of legality and level of impact on land and assets on the ground, the situation of land fund, aspirations of people, and the opinions of the representation of the affected people and the local authorities. The project owner will implement monetary compensation for the affected households to balance their production land, agreed to transfer the land use rights with the households in the area. A household affected on house will be monetary compensation for the damage and are arranged in the resettlement areas. After the resettlement is completed. This household will join other resettled households housing to relocate their houses and rebuild on the allocated land plots.

Besides the compensation. the project also has the support policies for the affected households to stabilize life and production.

Total cost of compensation and resettlement assistance of the resettlement areas is 5.066 billion VND, that has achieved 0.119 billion VND.

Details of compensation, support, resettlement and income restoration for affected households in the resettlement areas in particular, the entire project generally are described in other documents. not mentioned in this report.

- Implementing the compensation, support and resettlement satisfactorily according to the regulations.

- Participating in solving the claim of local people in the process of implementation of compensation and resettlement assistance.

- Monitoring the implementation of compensation and resettlement assistance according to the law.

- The households are eligible to stay and they wish to stay in the ROW, which will be support to be earthed to ensure the electric field strength at the permitted level. ensuring health and safety for people.

- Create jobs for local people: when building the project. the project owner can recruit the local workers to do some simple things, requiring no technical qualifications and they are paid the salary and improved their income to ensure the life stability.

The compensation. support and resettlement satisfactorily help the affected people quickly stabilizing their life, which are equal to or better than the previous one, this is the mandatory conditions for the project owner and will be written in the part of implementation commitment.

- The damage compensation. support and resettlement must be the exercise of democracy, publicity and transparency. Basically, the compensation policies of the project are built specifically according to the contents. which are regulated in the Land Law No.45/2013/QH13. Decree No.43/2014/ND-CP. Decree No.44/2014/ND-CP. Decree No.47/2014/ND-CP and the decisions of the two provinces of Thanh Hoa and Hoa Binh.

- After the compensation. support and resettlement are completed. the project owner shall coordinate with local authorities to investigate sociology, assessment of quality of life, quality of construction traffics, power supply system, etc… in order to have the supplementing policies and the processing measures to support timely to minimize the arising negative issues unexpectedly.

b. Impact by focusing construction workers on the construction site

The demands for victuals, and entertainment of the staffs, construction workers on the resettlement areas will contribute to promote the development of trade and services. The facilities of services business will be formed to meet their daily demands, these will contributes to solve the problem of employment and increase the income for local people.

c. Creating the employment opportunities for local workers

Building the resettlement areas that will create employment opportunities for local workers.

The contractors and construction units can hire local workers to work in a number of work items and pay the salary for them. Due to the level of local workers are low, so they will do the simple manual works suitable with their qualifications such as: clearance of vegetation coverage and ground; protection of construction site. cleaning and sanitary, prizing stone, concrete maintenance, cleaning of steel, washing rock and sand, planting grass, etc... This will take advantage of existing human resources of locality, solve the problems of job, increasing income for workers, reducing costs for investors (cost for moving workers from other places, etc...), and reducing pressure on society due to workers from other areas go into the project area, limiting security issues in the area (increasing the number of people staying in the area, increasing social evils and conflicts in the community and between groups of people etc...).

The number of local workers will be used for building the project that will depends on the characteristics and volume of works and the demands of contractors, construction units in each work items.

4.3.2.2. Impact on the management of local government; health, culture, customs and habits of people. construction workers and operators

1. In the stage of preparation and construction

a. Impacts by the land acquisition for building the project

Acquisition of land for building the resettlement areas has made the households living in the resettlement areas that have to move to a new place. However, according to the survey, only 01 household is living in resettlement areas (01 household is affected on house). After the resettlement area are completed, this household will move to a new location in the resettlement area. Therefore, their habits, cultural life are not disordered much.

b. Impact by UXO from the war

UXO from the war in resettlement areas (if any), if they are not searched and processed, they can cause dangerous for construction workers and people when approaching.

Mitigation measures:

- The project owner has sent a document to the functional agencies for comments about the UXO from the war in the project area. Hiring the specialized units of the military to disarm the UXO in the necessary areas before the construction starts if it detects the UXO.

- Hang warning signs in the areas to be dangerous for people when approaching.

c. Impacts due to dust. waste gases and noise. waste water. garbage

Construction scale of work items in the resettlement areas are small, scattered, so dust, waste gases, noise, waste water, garbage arising from the construction activities in the resettlement area will impact directly on construction workers. Impacts are assessed small.

Impact mitigation measures:

- Implementing effectively the measures to minimize dust, waste gases, wastewater, garbage.

- Fully equipped facilities for labor protection for workers. Arrangement of working time is suitable to ensure the noise exposure time according to regulations.

- Performing periodic health examinations for workers to have handling measures and appropriate treatments if occupational diseases occurs.

d. Impacts due to construction of work items to the safety of construction workers and local people

Construction of work items can cause labor accidents: traffic accidents (along the construction route), electric shock accidents, accidents due to mine exploding activities (transportation route area), etc; environmental incidents (soil and rock slides in the area of foundation pits etc...) if the contractors, the construction units, construction workers do not comply with the regulations on labor safety and safety measures for workers.

Mitigation measures:

Comply with measures for labor safety, prevention of environmental incidents have mentioned. Specifically as follows:

- Contractor must commit to comply with the implementation of current regulations the State on the labor safety.

- The project owners requires construction units strictly adhere to current regulations for transportation, storage and use of explosives.

- Contractor shall prepare corrective measures. urgent evacuation in case of incident, especially the activities of prevention and protection of fire. There are emergency measures, fire protection timely.

- Implementing organization, training and equipment for the rescue teams. The medical devices and drugs to be first aid must be available at the construction site.

- Establishing a high-voltage lighting system to ensure safe working conditions for all people during the construction at night.

- Workers who work at the construction site must be trained in labor safety, and a full range of equipment for labor protection. Specifically:

+ The project owner shall coordinate with the building contractors often open the training courses on labor safety for officials and workers involved in the construction site.

+ Laborers involved construction are equipped with full protective equipment and have the user manuals. All workers must use the protective tools suitable with the construction works.

- Before implementing the works. checking equipment, supplies, machinery, ... to detect the damages. The workers just start working when the equipment, machines are ensured according to OHS standards.

- Hanging warning signs at dangerous road sections. areas prone to landslides and the areas can be dangerous for people when approaching.

- Organizations, labour unions will regularly inspect observation of labor protection ordinance; the employees strictly comply with the ordinances and labor safety standards.

e. Impact by focusing workers

- Impacts on health by focusing workers:

Construction workers focus on the construction site can bring strange diseases and transmit to people living near the construction area.

Healthcare needs of the construction workers to cause the pressure for the local medical facilities on medical equipment, medicines, medical staffs such as nurse, doctor, healthcare works, etc...

- Impacts on security in the area, the management works of local government; culture, customs and beliefs of people of the project area.

Concentration of workers on construction sites (mainly men that can lead to conflicts between contractors, conflicts between officials and construction workers with local people, giving rise to the social evils (drugs, prostitution, gambling, etc...); etc... causing difficulties in controlling the security and order.

Officers, construction workers to the construction area will cause fluctuations in population in the project area, increase temporarily population density and the number of people staying in the locality will cause difficulties for management works on demographic, social management.... of local authorities of the project area communes.

- The project area includes Kinh, Thai, Muong, Tay that live and concentrate according to hamlets, have the high community with unique customs and traditions. Construction workers on the site come from different places, different ethnic, culture, customs, beliefs are also different. so on the territory of commune in the project area will occur the mixing, interference between cultures and may lose the cultural identity of ethnic groups, traditions, beliefs that are inherent here.

Mitigation measures:

- Applying effective preventive measures to reduce the possibility of disease transmission in the residential community and construction workers such as propaganda, sanitation; fresh water use, hanging net before going to bed; vaccinate against some diseases; eradication of mosquitoes and other insects; establishing the mobile medicine cabinet at the units involved in construction; periodic health examination for staffs, construction workers, etc...

- The project owner, construction contractors must declare the temporary absence, temporary residence for construction workers and coordinate with local authorities in managing workers to ensure security and order, exclusion of social evils, etc...

The project owner, contractors, the construction units will coordinate with local authorities in maintaining the cultural identity, customs, beliefs of the ethnics living in the area: helping the ethnics to acquire the new culture, new lifestyle, etc... but still maintain cultural identity, beliefs, customs of its ethnicity.

2. In the stage of operation

When the resettlement areas is completed, the resettled households moving into resettlement areas to live will affect on the managements work of local authorities, destabilizing the society, etc... However, the resettlement area will be built in the area of the affected household at Sa Lang hamlet (meaning the affected households must resettle in the territory of Sa Lang hamlet), so the removal of the resettled households to live in the resettlement area will less cause social disturbance, less impact on the management works of local authorities. The resettlement of displaced households will quickly return to.

Mitigation measures:

- During the process of the households displacing in the resettlement area, the project owner will coordinate with local authorities to strengthen management works and support the displaced households (if necessary) for quickly stabilizing their life.

- During construction of the resettlement area, they should also be noted to have appropriate adjustment with the characteristics of culture, society, customs, practices and beliefs of each ethnic group.

4.3.2.3. Impacts on traffic operations and other infrastructures

Currently in resettlement area that only has a trail of people without electricity. When the resettlement areas is completed, the transportation system will be new built according to rural road standards; the system of electricity and water will also be built to provide for the households in the resettlement areas; schools, cultural house and infrastructures, essential public facilities will also be built new. So the traffic operations in the area will be more favorable, the essential demands for infrastructures, public works of people in resettlement area will be guaranteed.

However, as planned, to facilitate local people's travel, exchanges, commodity exchanges, in addition to the road network, the project planned a wharf and a access road to wharf in order to local people can move, go to the the other river bank by boat in the resettlement area. However this wharf is located in the downstream of the dam, in normal conditions, the operation of the boat is in stable condition, but in the case of upstream hydropower projects. including Trung Son HPP let out water and flood, river water level increase faster and river flow will become more powerful, this can cause unsafe for people in case of traveling by boat. Therefore, the PO should coordinate with the locality to have effective and safe wharf exploitation and management plans to avoid unfortunate incidents.

4.3.3. Risks and incidents of environment

4.3.3.1. Landslides of rock, soil in the construction process

Risk of landslides can occur, if during the construction progress of work items are not in accordance with the design. the current standards, regulations, or it will occur at the construction location arranged on the abrupt terrain (e.g construction of roads, etc...). Landslide incidents of rocks, soils can cause injury to construction workers.

Mitigation measures:

- Compliance with technical solutions. the design standards when construction of foundation pit, digging and backfilling work items.

- Hang the warning signs in areas prone to landslides and the areas can be dangerous for workers and people when approaching.

4.3.3.2. Forest fire incidents

During construction process of resettlement areas. careless when using of fire construction workers can cause forest fires, etc...

Mitigation measures:

- Around the resettlement area is mainly forest, so during the process of fallen trees, clearing ground, the project owner must coordinate with forest owners for gathering, cleaning, transporting the felled trees to the landfills that are planned of the resettlement areas for appropriate handling and preventing forest fire, or burning a controlled manner to prevent forest fires.

If the construction process occurs forest fire incidents, the project owner and construction units must implement: pausing construction process; concentration of workers use every means of fire extinguishing to rescue the forest; quickly inform for forest owner, people and the firefighting functional authorities. After completing the process of fire, the individual or unit cause forest fires that are responsible for paying the cost of firefighting to rescue the forest and cost for forest plantations equivalent to the loss of forest area.

4.4. Environmental impacts. mitigation measures and improving upstream and downstream areas

According to the above analysis, the project owner only implement the research and evaluation of environmental impacts by the project area at the upstream and downstream areas, which are from damsite of Trung Son HPP to the confluence location with Luong river. Specifically as follows:

4.4.1. Impacts, mitigation measures and improving environment of physics and biology

4.4.1.1. Topography, geomorphology and landscape

1. In the phase of preparation and construction

When Hoi Xuan HPP starts building. on main flow of Ma river will appear Hoi Xuan damsite, the cofferdams and diversion culverts for building the damsite, altering the topography, geomorphology and landscape around the damsite area. This is the inevitable impact occurs when building any hydropower projects.

During this period, natural flow in the upstream area will be discharged into the downstream area through diversion culverts, so basically geomorphological processes in the upstream and downstream areas will still occurs according to natural law, the topography of the upstream and downstream area of the damsite will be not affected.

2. In the phase of operation

When Hoi Xuan HPP is stored of water and starts operation. In the upstream of damsite will form Hoi Xuan reservoir, the flow velocity of the reservoir reduce, so the ability to carry sediment of the water decreased. so a part of sediment will be deposited in the reservoir of the damsite upstream. According to the survey, the deposited sediment in the reservoir are mainly in the tail and middle of the reservoir that will change the topography of riverbed of the reservoir area.

Due to topography of the reservoir expands and extends about 29km in the upstream. the distance is 9.5km from Trung Son damsite, that will reduce the erosion impacts on the banks of downstream area due to the covering peak operation regime of Trung Son HPP.

For the downstream area of Hoi Xuan damsite, about 37% of the sediment deposited in the reservoir that will reduce the sediment flow into downstreamincreasing the ability to carry sediment of flow, thus increasing the erosion, ability on banks of the downstream area. However, Hoi Xuan HPP has the daily regulation regime, generating 24/24hours so the water level in downstream area is maintained stabler than the natural flow, so the sediment, erosion in the downstream area by changing water levels are stabler than the natural river flow when without Hoi Xuan HPP. Thus, the combined effects on topography, geomorphology in the downstream area of Ma river before and after building Hoi Xuan HPP will not change much compared to the natural flow.

Impact mitigation measures:

Basically Impacts related to the changes on topography, geomorphology and landscape are essential for all hydropower projects, irrigation works and reservoirs. However, in order to limit the sedimentation, topography changes of riverbed of Hoi Xuan reservoir area, the measures will be implemented as follows:

- Unit of management and operation of Hoi Xuan HPP must protect vegetation coverage, especially the forest coverage around the reservoir area and on banks within their management range. Strictly forbidden all mining activities on submerged land and semi-submerged land areas within the reservoir area and surrounding.

- Unit of management and operation of Hoi Xuan HPP will coordinate with local authorities to protect vegetation coverage and plant trees for greening in barren land areas on the reservoir basin. Propagating the awareness of forest protection for people, coordinate with the locality and functional agencies to guide people that have the farming methods and land uses appropriately, etc ... to reduce the soil erosion on the basin into the reservoir.

4.4.1.2. Hydrology

1. In the phase of preparation and construction

According the analysis above, in the construction phase of Hoi Xuan HPP, the natural river flow is directed through the diversion culvert, so in normal conditions, hydrological regime on Ma river in the project area is basically still comply with natural law.

However, when flood occurs in Ma river, if discharge ability of diversion culvert does not guarantee to discharge all flood or the cofferdam does not ensure the requirements on quality and specifications, that could lead to break the cofferdam, while the flow regime into the downstream will not follow the natural laws and causes negative impacts on downstream areas.

Measures to prevent and minimize Impacts:

- Implementing proposed measures to prevent and minimize Impacts due to incidents of broken cofferdam.

2. In the phase of operation

When Hoi Xuan HPP starts operation, hydrological regime in the upstream and downstream areas are clear distinctions:

- In the upstream area: about 29km of Ma river infront of Hoi Xuan damsite in the downstream to location of 9.5km far from Trung Son damsite, hydrological regime will change from flow hydrological regime to reservoir hydrological regime.

- In the downstream area:

+ In dry season:

Water discharge from Trung Son hydropower plant in generation hours (7 hours, from 10h to 12h and from 18h to 21h) is retained in Hoi Xuan reservoir to generate electricity all hours in day with the flow of about 70.56m^3/s, hydrological regime in the downstream area of Hoi Xuan area is stabler than natural river flow. This is one of positive impacts of the project on the downstream areas.

+ In flood season, the inflow of Hoi Xuan reservoir is large, so water level of Hoi Xuan reservoir is kept at high levels for power generation.

Hoi Xuan HPP uses the discharge water of Trung Son HPP to generate electricity, so hydrological regime in the downstream of Hoi Xuan HPP in flood season is basically accordance with hydrological regime in the downstream of Trung Son HPP and relatively similar to hydrological regime of natural river flow.

However, in the cases of Dam failure incidents, similar to incidents of broken cofferdam, hydrological regime in the downstream areas does not comply with natural laws and cause negative impacts on the downstream area. Impacts are more seriously when comparing to natural river flood due to Dam failure, all the water in the reservoir (reservoir capacity corresponding to full supply level is 63.65 million m^3) and entire flood volume into the reservoir (entire flood volume into reservoir with design flood frequency of P= 0.5% is 2.320 million m^3) that will discharge to the downstream area and create a huge flooded area.

Measures to prevent and minimize Impacts:

- Implementing proposed measures to prevent and minimize Impacts due to incidents of dam failure.

4.4.1.3. Climate

Hoi Xuan HPP reservoir is small, narrow, running along river, so it have little impact on climate conditions of the reservoir upstream area and the damsite downstream area.

4.4.1.4. Water quality

1. In the phase of preparation and construction

According to above assessment, water quality in the upstream and downstream areas of Hoi Xuan damsite will be affected in negative way by the domestic wastes of construction workers (waste water. garbage) and the wastes from construction activities if no measures to collect and process them.

According to calculations, if all the domestic waste water of construction workers discharges in Ma river, which will only increase a very small amount of suspended solids (about 0.0035mg/l) and other substances due to the flow of Ma river is large (244.1m^3/s).

However. in fact the project will have measures to collect and treat waste water, garbage, and construction waste, including oil waste, machinery washing water, except wastewater during the maintaining process of concrete of damsite, which iscurrently no measures to collect effectively. Thus, iImpacts of building the project for water quality in the downstream area will be decreased.

In addition, water quality in the upstream and downstream areas can also be polluted by erosion, washout rocks, soil. However, the project owner has proposed mitigation measures to minimize this impact.

2. In the phase of operation

Source of impacts on water quality in the upstream and downstream areas of Hoi Xuan HPP is inundated biomass when the reservoirs stores water and starts operation.

However, the reservoir foundation area is mostly Ma riverbed and special surface water land and irrigation land (accounting for 58.35% of totalinundate area in the reservoir foundation area); vegetation coverage is mainly useful plants (planted bamboo forest, rice and vegetables, accounting for 32.1%) and the remaining part is residential land, infrastructure, public and other non-agricultural land. Due to vegetation coverage is useful plants, so they are gathered by people. Moreover in order to protect water quality and ensure landscape of the project area, before the reservoir stores water, the project owner will implement to clean the reservoir foundation, so the biomass is flooded small, including tree roots, regeneration grass (about 3,046.45 tonnes), dead bodies of plants and small animals living in and on the soil surface. Therefore, additional components due to biomass decomposition are not large, the BOD increases about 0.287507mg/l. N increases by about 0.00183 mg/l. P increases about

0.000345mg/l. Amount of water in the reservoir is exchanged regularly in day through the inflow of reservoir and the discharge flow into the downstream to generate electricity, so the DO in the reservoir is changed very small by thebiomass decomposition, decreases about 0.01mg/l compared to amount of DO in natural flow to the reservoir.

In above agents, phosphorus is deciding factor for reservoir eutrophic problems, so amount of phosphorus in reservoir can reach to steady state after putting on the reservoir, which is very important. Phosphorus can be reduced by various mechanisms (biology, chemistry, physic), so average storage period of phosphorus is used than average storage period of hydraulic power.

According to documents ”Environmental Impact Assessment - Methods and Applications (by Le Trinh, 2000), phosphorus is considered as one of sustainable agents, a mount of phosphorus in basic biomass is decomposed about 95% in 2.7years and 99% after about 4 years. After this period, amount of phosphorus in the reservoir can reach steady state. Accordingly, amount of phosphorus into the downstream area will also reach the steady state.

Impact mitigation measures:

- Implementing clearance of the reservoir foundation before the reservoir stores water, including clearance of residential areas and graveyards. especially the toilets. livestock barn, removal of grave areas.

4.4.1.5. Aquatic ecology, fish and fisheries

1. In the phase of preparation and construction

- Impacts by generated waste during the construction process:

According to above analysis, the water environment is less changed by the construction waste thanks to the treatment methods of construction wastes. So it has little impacts on aquatic life, fish and fisheries.

- Impacts by impounding construction and storing water in reservoir:

According to the research results to build Hoi Xuan reservoir that will only affect on the migration of fish and other aquatic organisms have the migratory behavior along the river, no fishes that migrate from river to the sea and from the sea to the river to reproduce and search for food are affected by the project (see Chapter 3). Therefore, impacts on fish and aquatic are reduced.

2. In the stage of operation

During the operational stage, when Hoi Xuan reservoir stores water and starts operation according to daily regulation regime, generating 24h /24h withsteady flow indry season (70.56m^3/s), along with the additional flow between two dams and Luong river (14.0m^3/s), the environmental flow in the downstream maintains at a good level for aquatic ecosystems, including fish and fisheries (flow in the downstream reaches 34.64% of the natural flow on river at Hoi Xuan damsite).

For the reservoir area, in the first time the soil in reservoir bottom is unstable, the natural fish production is exploited quite high, then gradually stabilized. Compared with river flow, the water in reservoir has the stratification in depth, so it can develop reservoir fisheries. This will contribute to increase the diversity of aquatic ecosystems and increase fishing production, increase amount of nutrient inputs for people.

According to the survey, the habitat in the project area is suitable for high-value and rare fish species. Currently, the project area has many rare species living in natural environments and many species are also fed by people for high economic efficiency sush as “Bagarius, green catfish, Sinilabeo lemassoni”, etc... The appearance of Hoi Xuan reservoir will increase the aquaculture area and development of these species, contributing to increase aquaculture production and supply of rare species for the area.

4.4.1.6. Terrestrial ecosystems along two banks and nearby Nature Reserves

1. In the phase of preparation and construction

During the construction stage of the project, the ecosystem along the two banks of the upstream and downstream areas will be impacted by the construction progress of the project. The main impacts are including:

- The project area is mainly distributed along Ma river (about 29km). The process of cutting trees, clearing the construction site will cause loss of habitat, foods of some animals. The species have the ability to move, that will move out to the surrounding area to live, this make increasing the number of living individuals of the same species in the surrounding areas, including the Nature Reserves. The occurrence of these species can cause the competition for food and habitats for the existing species in the area. However, according to the survey, the animals in the project area are mostly species such as wild boar, muntjac, bamboo rats, mice, snakes, birds, etc... They are the species that have the widely ecological range and the surrounding areashaving similar ecological conditions with the project area, so these animals should easily adapt to new habitat when they move to. The flying species (such as birds) can move to the surrounding areas or the further areas such as the Nature Reserves to live. The hydrophilous species and foraging near streams (such as reptiles, amphibians, otters, etc...) will move to the riverside areas outside the project area to live.

- The focus of the project's construction workers can also harm to vegetation coverage, forest resources near Nature Reserves and the upstream and downstream areas of the project.

- In the process of cutting, clearing trees in the project area that may also violate to forest resources in the surrounding areas.

- Implementing the gathering, clearing trees within the acquired area of the project, prohibiting the gathering in the surrounding area. The project owner will coordinate with local authorities and forest owners in the process of gathering, vegetation clearance.

- Propagating and educating the awareness of protecting forest resources for construction workers. Closely management of construction workers, prohibiting all invasive activities on forest resources. Handling according to the law for the violated activities on the protection and management of forest resources.

2. In the stage of operation

When the project starts operation, the reservoir is stored water, a river section of Ma river in the upstream area is about 29 km, which will be become a reservoir, the water surface area is expanded. the air humidity and soil moisture increases. this creates the development conditions for aquatic species and the plants prefer moist. Around the reservoir area and the downstream area are mainly Dendrocalamus, bamboo, etc… these are the economic plants bring the main source of income for people (according to the interview survey, 1ha of bamboo can bring average income for people about 20-25millions/ha, a household in the project area has average of 2.9ha bamboos, total revenue from bamboo is about 60-75 million VND/household/year). They are the species preferring moist, highly suitable for damp areas along rivers and streams, so when the reservoir is formed, the air humidity, soil moisture increase, that will be the favorable conditions for the development of these species.

The formation of the reservoir also help strengthening the ability of irrigation and supplementing the irrigation water for crops, increasing the area of irrigated land and land-use ratio indry season for the areas around the reservoir, contributing to stability, increasing productivity and crop production.

The stable flow regime andstable water level in the downstream are the important irrigation water source and increasing the irrigation ability for the downstream area in dry season.

4.4.2. Impacts, mitigation measures and improving economic environment, culture and society

4.4.2.1. Impacts on the land use along two banks

As mentioned above, the reservoir has the daily regulation regime, so the water level in the downstream will being stable, this will increase the irrigation ability, supplement irrigation water source for crops; increase the land use ratio in the upstream, downstream areas in dry season, it is very favorable for the communes have main economic branch of agriculture.

4.4.2.2. Impacts on economics, production of people along two banks in the upstream and downstream areas

The increase of irrigation water source and land use ratio when the project in operation will contribute to stability, increased productivity, production of crops for the households that have cultivation land along the two banks in the upstream and downstream areas.

However, when cofferdam or damsite is broken, total amount of water stored in the upstream area will flow into the downstream area with high velocity and high volume and the downstream area will be flooded widespread, this damages buildings, trees, crops, houses and other properties on the land of people in the downstream area, even life-threatening of people. Therefore, in order to prevent and reduce incidents caused by Dam failure, coffer Dam failure, the project owner must strictly comply with the reservoir operation schedule that was approved by the functional authorities. building the plans and programs of Dam failure protection. preparing the manpower and equipment necessarily to be ready to respond when incidents occur, the project owner must coordinate with the related authorities and comply with the commands of the Committee of Flood and Storm Control of Thanh Hoa province and implementation of other proposed measures to prevent and minimize impacts.

4.4.2.3. Impacts on the works of water exploitation and water use in the upstream and downstream areas

- In the upstream: Presently, Trung Son HPP is an important work and most significant in the upstream of Hoi Xuan HPP.

Damsite of Trung Son HPP is located at an elevation of 160m, the minimum downstream water level is 89m, powerplant has the floor elevation of 108m, and installed floor elevation is 72.47m.

Trung Son HPP has the installed floor elevation but according to the above analysis, Hoi Xuan HPP has FSL at 80m, which is located about 38.5km from Trung Son damsite. At FSL, the tail of Hoi Xuan reservoir is far about 9.5 km from Trung Son damsite. When the reservoir water level is corresponding to flood frequency of 1% and the natural river water level is at 87.2m, then the tail of Hoi Xuan reservoir will far 6km from Trung Son Hydropower. Therefore, the construction of Hoi Xuan HPP will not affect on the generating operation of Trung Son HPP.

Conversely, the appearance of Hoi Xuan reservoir is near Trung Son damsite, this will reduce the erosion impacts that caused by the operation regime for covering peak of Trung Son HPP.

- According to the survey, presently in downstream areas, it has not any water exploitation works.

4.4.2.4. Impacts on flooding status (flood drainage ability in the upstream area and flooding in the downstream area)

When Hoi Xuan is built, a part of flood will be kept in the reservoir to the FSL, so this will contribute to be slow the flooding in the downstream area.

However, when flood into the reservoir has the risk of exceeding the design flood or risk of Dam failure, in order to ensure the safety of head works, the entire flood into reservoir will be discharged in the downstream with a large discharge, combined with flood in downstream areas that will increase the extent of flooding in downstream areas, especially when flood in the downstream occurs simultaneously with flood discharged from the reservoir.

To minimize impacts, the project owner must properly implement the following measures:

- Compliance with the approved reservoir operation schedule.

- Strictly comply with the commands of the Committee of Storm and Flood Control during the process of flood discharge.

- Keeping frequent contact with the management boards of the hydropower plants on hydropower cascade and the management boards of water use works on main flow of Ma river, timely information about flood discharge, etc… in order to the units are known and coordinate together to solution.

- Close monitoring of flood situation changes. Water level and flood flow in the reservoir area and downstream area will be monitored and regularly informed to the Board of Management and Operation of powerplant and the related units, including the Committee for Flood and Storm Control of Thanh Hoa province to them to consider and have the plan for prevention, timely response measures.

- Implementation of monitoring storms and floods (24/24 hours).

- Flood discharge process must ensure total discharge flow into the downstream that is not greater than flow to the reservoir.

- Timely inform for workers and people move out of dangerous area when discharging the flood.

- Urgently notify for the local authorities in the downstream moving people out of area that have the ability of flooding to avoid damages to people and properties.

+ In case of discharge of flood that cause damages on land, properties, crops and buildings of local people, people in downstream area, economic institutions, the project owner must be responsible for compensation.

4.4.3. Impacts cannot mitigate and improve

With the project's impacts on the upstream and downstream areas, erosion impact on banks and river bed due to decrease of sediment into the downstream that can not mitigate. This is on inevitable effect of any irrigation works, hydropower works.

4.5. Environmental impacts, mitigation measures and improve cumulative effects

Currently, on main flow of Ma river, it has 5 hydropower cascades that have been invested to built as Hoi Xuan HPP, Trung Son HPP (in the upstream and the upper cascade of Hoi Xuan HPP, about 38.5km from Hoi Xuan damsite). Ba Thuoc I HPP (in the downstream and the lower cascade of Hoi Xuan HPP, about 25km from Hoi Xuan hydropower), Ba Thuoc II HPP and Cam Thuy II HPP, there is also Hua Na II HPP and Cua Dat II HPP on Chu river that is a river tributary of Ma river.

Because of the hydropower cascades on Ma river system. flow of Ma river from Trung Son HPP damsite to the downstream does not follow natural laws anymore. In which. from the reservoir tail of Hoi Xuan reservoir to downstream, the flow is influenced by both Hoi Xuan HPP and Trung Son HPP and the hydropower cascades are such as Ba Thuoc I, Ba Thuoc II.

However, according to the analysis above (see Section 1.4, a summary report of the ESIA), the report only implement assessment of cumulative impacts due to the operation of the hydropower cascades on Ma river system from the upper cascade of Trung Son hydropower to the confluence location with Luong river.

On Ma river section from Trung Son damsite to the confluence location with Luong river, there are two hydropower cascades of Hoi Xuan HPP and Trung Son HPP. So, in this section, the report will consider the cumulative impacts of two hydropower cascades above for the downstream area according to two scenarios as follows:

- Scenario 1: on main flow of Ma river, there is Trung Son HPP, without Hoi Xuan HPP.

- Scenario 2: on main flow of Ma river, there are both Trung Son HPP and Hoi Xuan HPP.

Below is table of basic parameters of hydropower cascades on Ma river:

Table 4.33: Main parameters of hydropower cascade scheme on Ma river

No.	Project	Trung Son HPP	Hoi Xuan HPP
1	Average annual discharge Q_o	235	244.1
	Total annual flow W_o (10^6m^3)	7,695	7,947
2	Normal water level (NWL) (m)	160	80
3	Dead water level (DWL) (m)	150	78.5
	Water level before flood (m)	150	-
4	Reservoir volume at NWL(10^6m^3)	348.53	63.65
5	Reservoir volume at DWL (10^6m^3)	112	55.92
6	Effective reservoir volume (10^6m^3)	236.40	7.73
7	Reservoir volume for flood prevention (10^6m^3)	112	-
7	Reservoir surface area at NWL (km^2)	13.13	6.19
	Dam crest elevation (m)	163.7	86
	Spillway weir (m)	145	65.0
	Number of spillway cells	6	5
	Peak flood discharge corresponding with design frequency P=0.5%	10,400	10,175
	Peak flood discharge corresponding with check frequency P=0.1%	13,400	13,585
	Discharge through spillway (P=0.5%)	8,841	9,193.39
	Discharge through spillway (P=0.1%)	12,046	12,367.82
	Energy dissipation	Injecting nozzle	At the toe of spillway by hydraulic jump
3	Installed capacity (MW)	260	102
	Number of Units (Unit)	4	3
	Installing elevation (m)	72.47	-
	Elevation of powerhouse's floor (m)	108	75.8
	Max. discharge through powerhouse (m^3/s)	-	519.24
	Min. tailrace water level (m)	89	50.00
	Average annual energy output E_0 (10^6 KWh)	1,029.47	432.00

4.5.1. Hydrology

Currently, there are two hydropower projects under construction on Ma river, including Hoi Xuan and Trung Son. Two projects are use water from Ma river and return to it, not transfer water to other rivers. Therefore, when Hoi Xuan HPP is constructed in the downstream of Trung Son HPP, it will not cause Ma river's flow change.

Trung Son HPP's reservoir have regulatory regime in many years. This has advances that water will be stored in flood season for generate power in dry season, which will increase flow in dry season for the downstream. However, there are some drawbacks such as operation regime of load power, this means that the HPP only generate power in a few hours per day. This will lead to differences in flow and water levels at the downstream and between hours of power generations.

Specifically:

- Without Trung Son hydropower, Ma river flow from Vietnam-Laos border to downstream area follows natural regime (less impacted by irrigation works). In dry time, flow rate Q and water level H at Hoi Xuan hydrologic station fluctuate according to natural law, average Q in dry time is 120 m^3/s, average H is 52.01 m, environmental phenomena such as soil linkage of river banks are stable, living habits of people along river banks are close to natural flow.

- With Trung Son hydropower (yearly regulation), its operation regime for peak load demand, there will be a big change to water flow, particularly to fluctuation of water level and daily flow rate (presented in below table).

Table 4.34: Changing process of daily water level in dry time with frequency P=90% at Hoi Xuan hydrologic station, with the existence of Trung Son hydropower project and without existence of Hoi Xuan hydropower project.

Time (hour)	**$Q_{discharge}$ (Trung Son) (m^3/s)**	**Q_{add} (Trung Son-Hoi Xuan hydrologic station) (m^3/s)**	**Q_{total} (m^3/s)**	**Downstream water level at Hoi Xuan hydrologic station (m)**
18	134.1	18.2	152.3	52.3
19	268.2	18.2	286.4	53.0
20	402.3	18.2	420.5	53.6
21	536.4	18.2	554.6	54.1
22	0	18.2	18.2	50.9
23	0	18.2	18.2	50.9
24	0	18.2	18.2	50.9
1	0	18.2	18.2	50.9
2	0	18.2	18.2	50.9
3	0	18.2	18.2	50.9
4	0	18.2	18.2	50.9
5	0	18.2	18.2	50.9
6	0	18.2	18.2	50.9
7	0	18.2	18.2	50.9
8	0	18.2	18.2	50.9
9	0	18.2	18.2	50.9

10	72.2	18.2	90.4	51.8
11	72.2	18.2	90.4	51.8
12	72.2	18.2	90.4	51.8
13	0	18.2	18.2	50.9
14	0	18.2	18.2	50.9
15	0	18.2	18.2	50.9
16	0	18.2	18.2	50.9
17	0	18.2	18.2	50.9

At Hoi Xuan hydrologic station. in dry time. daily water level is 3.2 m different ranging from peak load hours and low load hours. In peak load hours, downstream water level is 2.09 m higher than natural river water level. In low load hours, it is 1.11 m lower than the natural one. For section from Trung Son dam to integration point with Luong River (Luong river is upstream of Hoi Xuan hydrologic station), changes on flow regime and water level are much bigger because of no additional water volume from Luong river (Luong river has flow rate of around 13.4 m^3/s). Additional sources for this section are mainly from small rivers and springs, total flow is 4.8m^3/s. This will bring about substantial negative impact on ecosystem, life and habits of inhabitants along the river banks, agricultural irrigation, aquatic fishery, erosion, land slide, threatening human safety, property and constructions on land, etc.

To summarize, without Hoi Xuan hydropower, Trung Son hydropower with operation regime for peak load demand will cause big and long-term damage to the economy and environment.

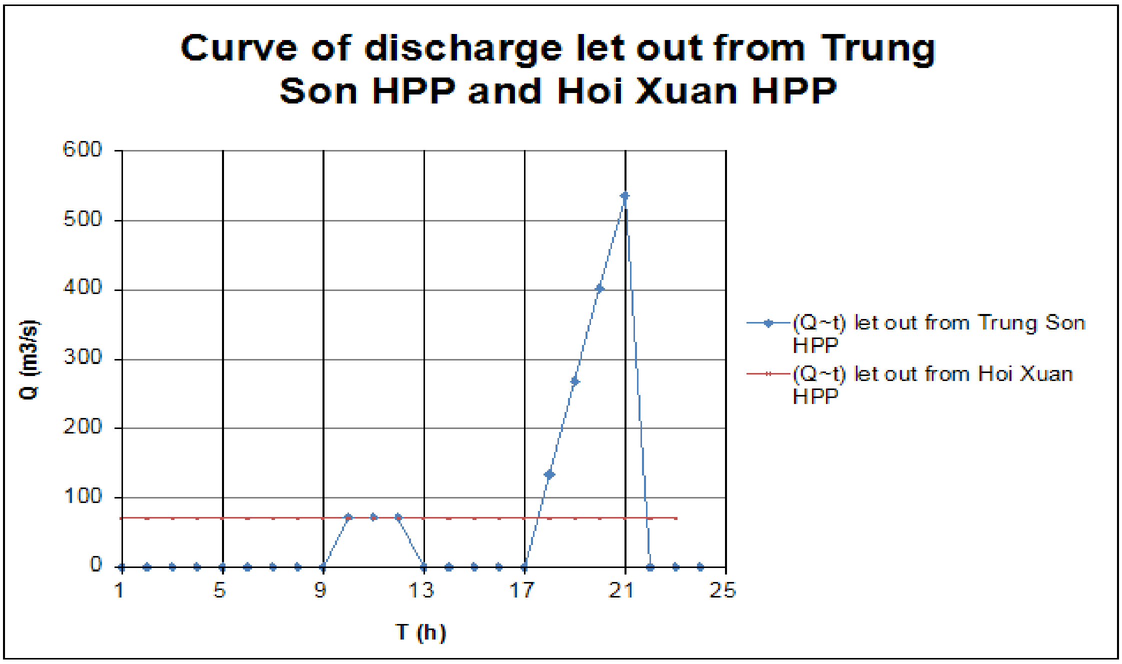
- With the existence of Hoi Xuan reservoir:

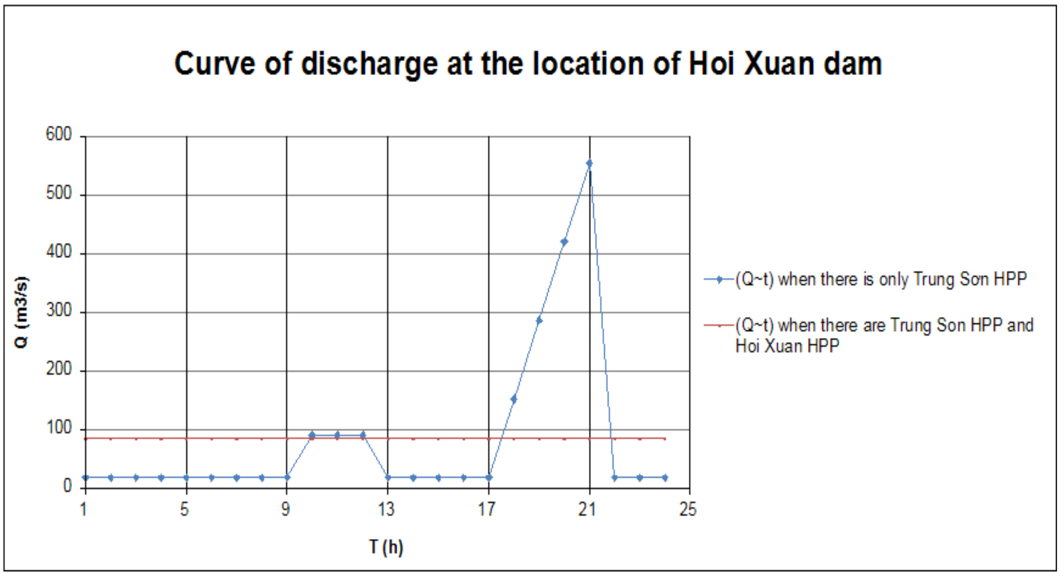
The reservoir operates according to daily regulation, 24 hours a day with Q for generation is 70.56 m^3/s.

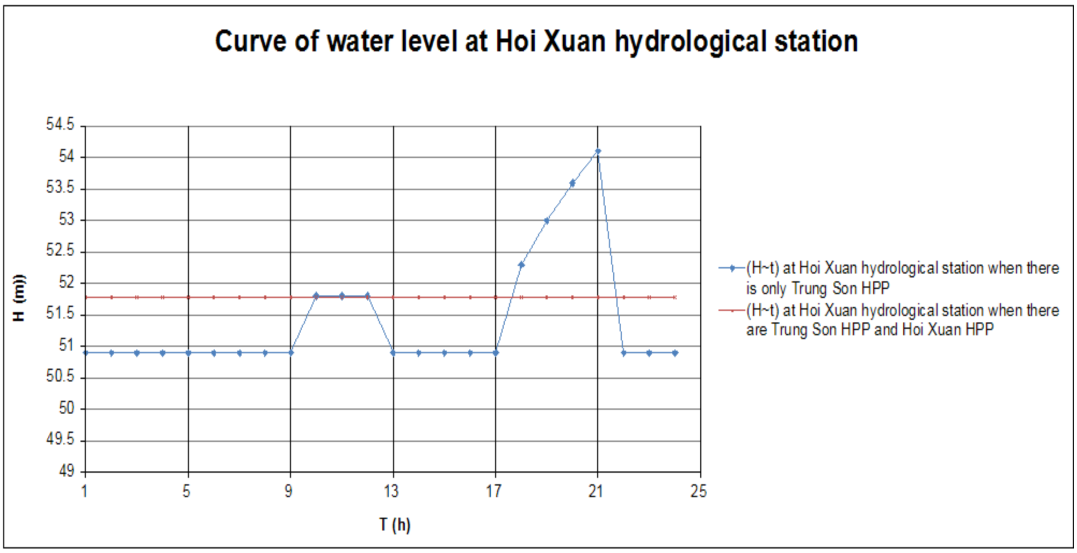
Table 4.35: Changing process of daily water level in dry time with frequency P=90% at Hoi Xuan hydrologic station, with the existence of Hoi Xuan hydropower project.

Time (hour)	**$Q_{discharge}$ (Hoi Xuan HPP)**	**Q_{add} (Hoi Xuan HPP-Hoi Xuan hydrologic station)**	**Q_{total}**	**Downstream water level at Hoi Xuan hydrologic station**
	(m^3/s)	(m^3/s)	(m^3/s)	(m)
18	70.56	14.0	84.56	51.78
19	70.56	14.0	84.56	51.78
20	70.56	14.0	84.56	51.78
21	70.56	14.0	84.56	51.78
22	70.56	14.0	84.56	51.78
23	70.56	14.0	84.56	51.78
24	70.56	14.0	84.56	51.78
1	70.56	14.0	84.56	51.78
2	70.56	14.0	84.56	51.78
3	70.56	14.0	84.56	51.78
4	70.56	14.0	84.56	51.78

Time (hour)	$Q_{discharge}$ (Hoi Xuan HPP)	Q_{add} (Hoi Xuan HPP-Hoi Xuan hydrologic station)	Q_{total}	Downstream water level at Hoi Xuan hydrologic station
5	70.56	14.0	84.56	51.78
6	70.56	14.0	84.56	51.78
7	70.56	14.0	84.56	51.78
8	70.56	14.0	84.56	51.78
9	70.56	14.0	84.56	51.78
10	70.56	14.0	84.56	51.78
11	70.56	14.0	84.56	51.78
12	70.56	14.0	84.56	51.78
13	70.56	14.0	84.56	51.78
14	70.56	14.0	84.56	51.78
15	70.56	14.0	84.56	51.78
16	70.56	14.0	84.56	51.78
17	70.56	14.0	84.56	51.78







With this operation regime, downstream flow behind dam is more stable than natural flow, the flow rate is 70.56 m^3/s, and the water level is 51.78 m^3/s.

In conclusion, without Trung Son hydropower project, the flow of Ma river from Vietnam-Laos border to downstream area runs according to the natural law. When having Trung Son project and not having Hoi Xuan project, downstream daily flow rate and water level fluctuate in a large range, causing environmental problems and negative impact on the economy. With Hoi Xuan reservoir, daily regulated, generating power every day, the downstream flow regime (flow rate, water level) in dry time is more stable. Environmental flow behind Hoi Xuan plant will be more stable with daily regulation and necessary flow for downstream area is about 50% of discharged flow of the plant. This is to affirm that Hoi Xuan hydropower serves a crucial role in regulating environmental flow on Ma rive, downstream section of Trung Son. The construction of Hoi Xuan hydropower is a need.

4.5.2. Climate

When Hoi Xuan hydroelectric power commissions, the reservoir's ending point at FSL is 9.5km far from Trung Son hydropower project. This reservoir will be together with Trung Son HPP's reservoir to be form inter-reservoir system on Ma river with the length of 70km from Trung Son reservoir's ending point (at the upstream) to Hoi Xuan's dam site. This inter-reservoir system will help to climatic condition in the area to become better.

Because the reservoirs are narrow and long, running along Ma riverso they will not significantly affect climate regimes throughout the basin. However in some areas near the reservoir, there are some changes of climate features as follows:

* *Heat regime*. When Hoi Xuan and Trung Son reservoirs fully store up water and put into operation, the fluctuation of temperature duringday and year will be decreased. Specifically, the maximum value will be decreased while the minimum value will be increased.

* *Relative humidity*: Absolutely low humidity will rise up in all months of year. Average humidity virtually unchanges, upward about 1% on the hottest dry months.

Consequence, when forming the reservoirs, special weather phenomena and extreme values,of temperature and humidity tend to reduce and become more regulative. This has both positive and negative impacts. Specifically:

- For humans, the temperature difference between land and water create a cool breeze, especially in the dry season. This is good for people's sleep, nervous system and blood pressure, so it is good for health of workers and local people.

- By contrast, when humidity increases, pests and pathogens around the reservoirs' area will have conditions to develop, it is also a negative impact on the growth of trees and crops.

4.5.3. Environmental flow

When Hoi Xuan HPP is added into hydropower cascade on Ma river, this cascade will include 02 hydropower projects as Trung Son and Hoi Xuan.

Without Hoi Xuan HPP, Trung Son HPP will operate in a peaking mode; this means that power is generated during peak hours while water is stored up in off-peak hour. Therefore, the issues of environmental flow at downstream should be considered to evaluate the cumulative impacts of the project.

In each project. environmental flow downstream of each dam hydropower cascade has been addressed in each specialized reports adopted by the MONRE in the approval decision: Decision No. 216/QD-BTNMT dated 01 Feb 2008 on approval of environmental impact assessment of Hoi Xuan HPP, and Decision No. 1257/QD-BTNMT dated 17 June 2008 on approval of environmental impact assessment of Trung Son HPP. According to the approved reports, the project will take measures to minimize Impact on environmental flows downstream caused by the operation mode, especially Trung Son HPP with operation regime of covering peak is paid high attention to issues of environmental flow and make plans to ensure environmental flows in the downstream. so the river section between the hydropower cascades totally dehydrated in dry season. although the flow is reduced in comparison with the pre-project period. It can summarize the main content of environmental flow of hydropower cascades as follows:

- For Trung Son HPP: to ensure environmental flows of the downstream in dry season, to ensure aquatic life and minimize the impact of peak covering mode of operation, the project is designed to discharge water to the downstream in off-peak hours with maximum flow of 72.2m^3/s corresponding to the frequency P = 90%.

When storing up water in Hoi Xuan reservoir. water level at the reservoir ending point corresponding to FSL 80m is equal to water level of natural river at the position with 29km far from Hoi Xuan dam site, and 9.5km far from Trung Son's dam site. At designed flood water level (corresponding to the designed frequency of 0.5%) the ending point is 32.5km far from Hoi Xuan dam site, about 6km from Trung Son dam. This will help to reduce erosion due to the peak covering operation of Trung Son HPP.

Consequently, with Hoi Xuan HPP. in addition to reducing impact of erosion, impacts of environmental flow caused by a peaking mode operation of Trung Son will be smaller, only affect river section 6-9.5km after Trung Son HPP dam site. A maximum discharge flow 72.2m^3/s at off-peak hours in dry season of Trung Son Hydropower will ensure to maintain environmental flow in the river section at very good level for ecological environment.

- For Hoi Xuan HPP:

Hoi Xuan HPP will use water discharged from Trung Son HPP to generate power.

+ In flood season, water discharge to Hoi Xuan reservoir is much, so the flow will be maintained high water levels for power generation constantly, so environmental flow in the downstream of Hoi Xuan HPP will be fully guaranteed.

+ In dry season:

For the purpose of power generation and water addition for the downstream to prevent salt water in dry season to promote and improve the environment of Ma river at assurance flow of 70.56m^3/s. Hoi Xuan reservoir capacity was calculated to store sufficient volume of water for power generator in 24 hours. Effective storage volume of Hoi Xuan reservoir calculated and proposed 7.73 million m^3. With this volume, in dry season, released discharge of Trung Son HPP will be stored in Hoi Xuan reservoir to generate power all hours per day (24/24 hours) to ensure discharge 70.56m^3/s, reaching 28.91% of natural flow to Hoi Xuan dam, maintaining at good level for ecological environment.

This water volume combined with flow of 0.6m^3/s of the area from Hoi Xuan HPP to the confluence with Luong River and flow of Luong river 13.4m^3/s, total flow at the confluence with Luong river is 84.16m^3/s, accounting for 34.64% of natural flow to Hoi Xuan dam, level remaining well for environment.

Ma river from the confluence with Luong river to the downstream is also received additional water sources such as Chu river and other branches, therefore environmental flow will be improved and remaining ecology.

Thus, when Hoi Xuan HPP is completed and put into operation, environmental flow in the downstream will be maintained stably at level better for ecological environment (charged from good to very good).

In summary, both with and without Hoi Xuan HPP, hydrological regime of Ma river will not change because there is not cut the flow.

When Hoi Xuan HPP is completed and put into operation, environmental flow in the downstream of Trung Son hydropower will be guaranteed better, reducing the impact of power generation with peaking mode of Trung Son hydropower.

Trung Son hydropower keeps water in flood season and releases in dry season, this will increase flow in dry season. Together Hoi Xuan HPP with the power generation in constantly mode, water volume discharged toward the downstream will be stabilized. Therefore, the accumulative impacts of two projects is positive, the downstream flow increases in dry season and maintain stability, to ensure the ecological environment, without causing negative impact on the environment, economy - society and people living in the downstream.

4.5.4. Water quality

According to available documents, on main flow of Ma river has two hydropower projects, the reservoir will be gathered, cleared before storing water in accordance with the EIA report of the project, which has been approved. With the method of vegetation clearance in the EIA report, ,water quality of the reservoir after storing water will ensure the existing Vietnam standards. Vietnam regulations on ensuring the aquatic life, and for other purposes. However, in the first time of operation, the substance concentration in water will increase than before, due to the remaining substances in the reservoir (including tree roots, regeneration grass, dead body of organisms, the small organisms living in and on soil surface that can not move out of the submerged area), humus and minerals in soil will be degraded, disrupted the structure.

According to results of the survey, measurement and analysis of water quality in the process of implementing the ESIA report in August 2014 and the results of environmental monitoring of Hoi Xuan hydropower project, water quality of Ma river section from Trung Son damsite to Hoi Xuan damsite and the downstream of Hoi Xuan damsite is generally contaminated with some parameters exceeded the allowable limits (Chapter 2). The reason due to the sampling works were done when Trung Son and Hoi Xuan HPPs are under construction and the sampling workswere done in rainy season, the flow in the upstream carries more silt and the rainwater overflows on ground construction, spoil dumping area that washout of unconsolidated material, mineral salts on the surface to increase amount of suspended substances, organic substances, increasing the turbidity of the water environment of Ma river, decreasing the self-cleaning ability of the river water.

From Hoi Xuan HPP area to the downstream does not have any waste sources from industrial production activities, so the substance concentration in water is diluted and gradually stabilized and reduced to the allowable limit, the self-cleaning ability of the water environment is restored.

In the stage of operation, the construction activities of Trung Son and Hoi Xuan HPPfinished. Trung Son hydropower reservoir has a volume of about 348.53 million m^3, average flow of 235.0 m^3/s and Hoi Xuan hydropower reservoir has a volume of about 63.65 million m^3, average flow of 244.1m^3/s, these will contribute to reduce the substance concentration in water in the area from Trung Son damsite to the downstream, and ensure self-cleaning ability of river section.

Impact mitigation measures:

In order to ensure water quality in the downstream of damsites, to ensure the self-cleaning ability of the river. The project owner must properly implement the proposed programs of management and monitoring on environment, closely monitoring the implementation of impact mitigation measures on the environment, especially the measures to collect and process the waste of the construction units and construction contractors and the appropriate sanctions for violating units of environmental protection of the project.

4.5.5. Water use

According to the survey results, areas around the reservoir have some population groups but the water for daily activities of local people is taken from the water sources according to the World Vision program (100% of communes have clean water according to the World Vision program). Water for agricultural production is mainly the water of river tributaries, gravity water and irrigation water by rain. there are not use the water on Ma river, so the construction of both Hoi Xuan HPP and Trung Son HPP will not affect to the water supply for consumption and production. However, on Ma river, there are the water transportation activities, aquaculture, so the construction of hydroelectric projects in general. Trung Son and Hoi Xuan HPP in particular on Ma river system will affect to the river water use of other objects. Specifically:

- The construction of Trung Son HPP and Hoi Xuan HPP on Ma river will affect to the water transport activities on the river:

Currently, according to the survey. on Ma river, there are transport operations of bamboo into the downstream to sale. Therefore. the construction of Trung Son HPP and Hoi

Xuan HPP will create the obstacles hindering the transport of bamboo by the water transport from upstream to downstream. However. according to the survey, in addition to transportation by waterway, the transportation of bamboo is mainly transported by road, along which the roads have been upgraded, renovated and new built, these ensure the goods transportation. movement of people, so impacts on transportation of bamboo and travel from upstream to downstream by water transport may be completely replaced by road transport.

Also on the river, local people still go back and forth between the left bank and right bank by boat. This activity is a horizontal water transport on the river, so the construction of damsites will not effect in the case of normal operation. However, when the constructions discharge flood, especially when the constructions discharge flood simultaneously (water level in the downstream will rise faster and larger) that usually create the eddies on the river in the river downstream of damsite, which cause the dangers and unsafe for people traveling by boat. People should be noted in the course of travel to avoid the unfortunate incident.

Impact mitigation measures:

In order to limit the risk, incidents during the goods transport, travel on the river in the downstream after the dam site, the project must have warnings in dangerous areas, river sections when discharging water, flood. Before discharging water, flood, the management unit must notify to the local authorities and people to be known and limiting the travel in dangerous areas due to water discharge, flood discharge.

4.5.6. Sedimentation. erosion

- In the absence of Hoi Xuan HPP:

In the absence of Hoi Xuan HPP, on Ma river system has only Trung Son HPP. According to the calculations, amount of sediment deposited in Trung Son reservoir includes total amount of bed sediment and about 75% of the suspended sediment. During the design process has calculated the ability of sediment deposition so that the dead storage of the reservoir can store the entire deposited sediment during the operation time of construction to ensure the safety of the reservoir operation.

Because the sediment is largely kept in the reservoir, so when out of the reservoir, the flow will bring large energy to cause the destruction of shorelines in the downstream of powerplant. combined with the operation regime for covering peak, the difference of water level between peak hours and off-peak hours is very large in day, so the ability of bank erosion in the downstream without Hoi Xuan HPP is large. Specifically: When without Hoi Xuan HPP, in the downstream of Trung Son damsite on Ma river, there are the water during the operation hours (7 hours) and there is no water in the non-operation hours (the remaining 17h), the difference and fluctuating of water levels during a day is about 3.2m. In non-operation hours, the river water level is lower than the water level of the natural river about 1.11m. And in operation hours, the river water level is higher than the water level of the natural river about 2.09m. With the water level fluctuation in day will make rocks, soils in the shorelines, which are changed the physical properties continuously, so the rocks, soils will loss the cohesion ability and will be weaken and easily broken, these causes the erosion of shorelines in the downstream area.

Currently, the assessment of sedimentation and erosion in the downstream of the constructions on river systems in Vietnam have not evaluated specific and exactly, so there is no basis to assert the validity of the study and the prediction of the level of erosion.

- When building Hoi Xuan HPP:

+ Areas in the downsteam of Hoi Xuan HPP damsite:

When the reservoir built, the flow velocity is reduced suddenly into the reservoir, so the ability of carrying sediment of water will decrease significantly, the sediment is mainly deposited in the reservoir, altering topography of reservoir, reducing operation capacity of the reservoir, reducing effective of construction, but because of Trung Son HPP is the upstream cascade of Hoi Xuan HPP, so the sediment into Hoi Xuan reservoir will be decreased significantly, mainly the sediment from the center region of two damsites Trung Son. Hoi Xuan and the sediment through the turbine of Trung Son powerplant. According to calculations, amount of annual sediment into the reservoir is about 0.417 million m^3, amount of sediment deposited in the reservoir is 0.159 million m^3, accounting for 0.25% of the reservoir dead storage, so the impact caused by depositing in the reservoir is small.

The sediment deposited in the reservoir have little impacts on the topography of the reservoir and effects of construction but 37% amount of sediment deposited in Hoi Xuan also increases the ability of erosion in the downstream area of Hoi Xuan HPP damsite. However, the regulatory regime is daily regulation regime, so the water level, the flow are stable associated with the construction of energy dissipation systems, the ability of erosion in the downstream of Hoi Xuan HPP damsite will be reduced.

+ The area from Trung Son damsite to Hoi Xuan damsite

When Hoi Xuan reservoir is built. the river section of about 29km to 32.5km (depending on each water level) from damsite to the upstream will be turned into a reservoir, the river flow regime will be replaced by the reservoir hydrological regime, the reservoir water level reaches the position about 9.5 to 6km from Trung Son damsite.

Hoi Xuan HPP has the reservoir tail that are located about 9.5 to 6km from Trung Son damsite, so when Hoi Xuan HPP is built, the water from Trung Son powerplant only affects on the shoreline areas in the downstream about 6 - 9.5 km instead of affecting all the downstream area in the absence of Hoi Xuan. This reduces the erosion caused by the operation of Trung Son HPP.

In addition. in order to reduce impacts of erosion due to water discharge, flood discharge of Hoi Xuan HPP. Trung Son Hydropower has the energy dissipation system by injecting nozzle to reduce the kinetic energy of water.

Thus. along with the construction of Hoi Xuan HPPin the downstream and the design solution for energy dissipation of Trung Son HPP and Hoi Xuan HPP, the erosion impacts in the downstream area due to the operation regime for covering peak of Trung Son HPP will be decreased.

In order to fully assess Impacts of all hydropower cascade system to sedimentation and erosion of hydropower projects need to have a separate evaluation subjects with the long time and it is not in this report.

4.5.7. Aquatic ecosystem and fishery

*** Reservoirs**

Hydropower projects in cascade system, one to be constructed. it will cause decrease in aquatic species quantity which is specific for river-type flow and increase in aquatic species quantity which is specific for reservoir-type flow; form reservoir aquatic ecosystem which has an increase in species composition and individual quantity in comparison with natural flow (including both number of fish species which are raised by human activity). Reservoirs which are constructed are advantageous conditions to develop reservoir fish farming.

Compared with river natural aquatic ecosystem, reservoir aquatic ecosystem will experience 4 periods. Each period has special characteristics of structure, composition and aquatic organisms under direct impacts by water environment parameters. Reservoir aquatic ecosystem development through periods is as follows:

- Disorder period: this period happens immediately after forming reservoir, it can last about 10 years. This period has 2 sub-periods in series: high nutrient sub-period (the first time of reservoir after storing water – about 5 years) and nutrient decrease sub-period.

- Stable period: is period going after disorder period.

- Fertilized period: is period going after stable period.

- Bogged period: is the final period of reservoir, beginning since sediment volume reaches MOWL.

*** The upstream and downstream areas:**

Hydroelectric and irrigation dams are biggest obstacles to fish and other aquatic organisms to migrate along rivers because the dams are usually much higher than the river level. According to this rule, Trung Son dam is the highest cascade on Ma river. In theory, this dam will prevent the movement of aquatic life and migratory species along the river to spawn and feed. particularly fish migration upstream to downstream.

Hoi Xuan HPP locates in the downstream of Trung Son HPP but not to be the lowest cascade. The lowest one is Cam Thuy II located far from the estuary about 85km and in the nearest downstream. adjacent to Hoi Xuan HPP is Ba Thuoc I with 25km far from Hoi Xuan HPP. Therefore, in theory, Hoi Xuan will not prevent the migration of fish from upstream to downstream, and vise versa.

In fact, according to the study results of PECC4 and other experts, there is 54 fish species having migration behaviour from the sea to the river but only the length of migration is mainly less than 40 km from the estuary; the species with the farthest migration is to distance less than 80 km. There are 4 species migrating from the river to the sea for spawning and feeding, all of them are living in the downstream.

Thus. the construction of Trung Son and Hoi Xuan HPP will have some certain impacts on migratory species along the river, but do not affect the behavior of fish migrating from river to the sea and vise versa.

4.5.8. Flooding

*** The possibility of a flood control:**

According to the functions and tasks, in 2 hydropower cascades, only Trung Son HPP has the task of preventing flooding for the downstream.

Flood stages of Trung Son HPP are considered with the storage capacity for preventing flood of 150 million m^3, of which nearly 75% are regular flood prevention capacity (112 million m^3):

- Early flood period, from June 1st to July 14th;

- The main flood period, from July 15th to September 15th; and

- The late flood period, from September 16th to November 15th

Regulations of flood control in Trung Son HPP’s reservoir with flood control for the downstream include flood periods as follows:

Periods of early flood and late flood

The water levels before flood of Trung Son hydropower reservoir during the periods of early flood and late flood must not exceed the normal water level of 160 m according to the basic principles: maintaining the water level of the reservoir equal to the normal water level of 160 m by discharging water through the generating units and the operation mode of the spillway gates; After flood peak. the water level of reservoir must low the normal water level of 160m.

In case of the commands of the Committee of Storm and Flood Control of Thanh Hoa province, the water level of reservoir must be lowered to the water level of 150 m to be ready for flood control in the downstream. The lowering of the water level must be implemented a sequence to ensure causing the damages to the downstream.

Main flood period:

The water level before flood of Trung Son hydropower reservoir during the main flood period must not exceed the water level of 150 m according to the basic principles: maintaining the water level of the reservoir equal to the water level of 150m by discharging water through the generating units and the operation mode of the spillway gates; After flood peak. the water level of reservoir must low the water level of 150m.

In case of the commands of the Committee of Storm and Flood Control of Thanh Hoa province, the water level of reservoir must be lowered to the water level of 145 m to be ready for flood control in the downstream. The lowering of the water level must be implemented a sequence to ensure causing the damages to the downstream.

Thus, Trung Son HPP has the duty of flood control in the downstream with the regular capacity of 112 million m^3. For the main flood period, Trung Son hydropower could be flood control in the downstream with a capacity of 150 million m^3 according to the commands of the Committee of Flood and Storm Control of Thanh Hoa province.

The water of flood is stored in the reservoir, flood control for the downstream; these contribute to reducing and slowing flood for the downstream area.

Hoi Xuan HPP has not function of flood control but it stores a part of flood volume which also contribute to slowing flood for the downstream.

*** Flood discharge**

To ensure the safe operation. the project has been established and submitted to the Ministry of Industry and Trade to approve the reservoir operation schedule for each project. However, these projects are independent of each other so it is difficult to the control of flood discharge of hydropower cascades on Ma river system.

Song Ma river is a large river and has large hydropower potentiality in the Northern region, presently a series of hydropower projects were built to exploit the energy potentiality of Ma river, if it has not a general operation schedule to ensure flood discharge synchronously on the whole Ma river system, it is difficult to control the floods, and the damages caused to the downstream during flood discharge and water discharge could be very large due to the cumulative impacts of the process of flood discharge of the hydropower cascade on Ma river system.

*** Dam failure incidents:**

In case of dam failure incident on these hydropower cascades could cause dam failure incidents in the chain on all Ma river system and impacts on the downstreamwill be particularly severe. The dam failure incidents can cause artificial flood and flood by flood, so the flooding scope will be expanded due to these cumulative impacts.

However, according to colleted information, Trung Son HPP – the upper hydropower cascade of Hoi Xuan HPP, in order to prevent and respond to Dam failure incident, the project owner coordinated with other related units and agencies will establish and rehearse emergency plan with the support of the World Bank. So, the Dam failure incidents will be studied by experts to prevent and build the emergency response plans, the contingency plan exercises to be able to deal quickly in case of occurring Dam failure incidents and minimize the damages.

*** General assessment:**

Now. for impacts assessment and investigation for the whole system, it lacks data on terrestrial and aquatic biodiversity, water quality, water use, flood situation, thus need have detailed study and special assessment for the whole system. Impacts caused by development of hydropower project series in the whole system can be summarized as below:

- Reservoir water use capacity to improve flood control.

- Reservoir use capacity to maintain a great water volume in dry season.

- Sediments are deposited in reservoir.

- River and reservoir bank erosion due to daily water level change.

- Change in water quality due to terrestrial biomass is submerged when reservoir is stored water and put into operation.

- Destroying aquatic ecosystem and residence areas along river relating to downstream environmental flow.

- Changing river water-type aquatic ecosystem into reservoir-type aquatic ecosystem. Reducing population and biodiversity of natural fish species in reservoir, specially fish species have migratory habit.

- Increasing the loss of water by evaporation because of wide reservoir space.

4.6. The scope and quality of available documents; unavailable important documents; the uncertainty of the forecasts and the contents that does not need further research

ESIA report is prepared based on the following sources:

- Secondary documents: these documents were obtained from agencies of the project provinces, districts and communes by the expert groups. These documents include:

+ The statistics of economic – social, healthcare, culture, education, population, ethnic;

+ Documentation of planned economic - society development.

+ Documentation of the environmental status.

+ Documentation of ecology and preservation areas.

+ Documentation of land use, land-use planning.

+ Decisions and policies.

+ Maps, diagrams.

+ And other relevant documents. List of documents is in the ESIA report summary.

This is the secondary documentations, which is considered, selected, synthesized cited in the report by the Consultant. The accuracy and reliability of these documentations depend on issuing agency.

- The previous studies:

Based on the zoning research to conduct the reports. the expert group has evaluated and reviewed the contents research for reference, quotations from which literature review? Researching the studies previously conducted on that basis in the area and begins collecting these documents.

The collected studies are mainly studies on biodiversity conservation, genetic resources conservation in regional preservation areas, research on fish and fisheries in Ma river basin.

- The documents prepared and supplied by project owner include:

+ The project design documents provided by the project owner such as project investment description, construction management description, technical design documents, design drawings, etc.

+ The investigative documentary about the project provided by the project owner such as damage survey result, expectation of compensation survey result, assistance and resettlement, public consultation result and disclosure about ESIA report.

+ Other documents provided by the project owner such as environmental monitoring results of the project; compensation and resettlement plan, compensation policy, resettlement assistance and life restoration for affected people.

- The researches done by teams of expert of the Consultants.

In the above documentary resources, besides the secondary documentaries' confidence level depends on the issuing agency, the remaining materials used in the report are highly reliable. The uncertainty of the forecast reports is mentioned in each content of impact assessment (Chapter 4).

CHAPTER 5. ALTERNATIVES

5.1. No-project alternative

For “do-nothing” alternative: Energy demand in Vietnam in recent years has grown at a rate of 13-15% per year and will continue to grow at a steady moderate to high level in the upcoming years, according to the latest demand forecast. Specifically, the load demand for the aspects of economic development is 108,880 GWh in 2010 and 194,304 GWh in 2015, corresponding to maximum capacity demand of 16,048 MW in 2010 and 30,803 MW in 2015. Average rate of production growth in the period of 2011 – 2015 is 14.0% (basic scenario). According to electric source development plan, the capacity of electric source in the period of 2011 – 2015 will be 22,890MW. lacking about 7,913MW in comparison with power demand (excluding contingency). Thus, this alternative will impact on economic development of the country.

Besides, in more and more complex and violent climate change context, the construction of Hoi Xuan HPP will not only satisfy the demand on energy for economic development but also contribute to reducing the greenhouse gas emission about 68,261.4 tons CO_2 per year as compared to using fossil fuel for power generation.

<u>Prediction of environmental changes occurring in the study area prior to project implementation</u>

Based on characteristics of natural components, human activities and weather changes, if Hoi Xuan HPP is not appeared, in the studied area also,has and will occur the following phenomena:

1. Landslides, rock slides

The proposed Hoi Xuan HPP locates on Ma river basin in the western Thanh Hoa and Hoa Binh provinces, where is high mountains of Vietnam northwest. These mountains go through NW-SE direction and are cleaved from strongly to moderately level, their slopes’surface has quite high slope. According to study results reported in protection development of Quan Hoa district in 2020, steep hill land accounts for 90.7% of natural land area of the district in which the land with slopes from leve l8-15^0 accounts for 13% of total natural land area, 30% of land with slope from 15-20^0 and 50% of land with slope above 20^0. So the possibility and rock here is very high.

The study area has highland areas such as intrusive mass if Muong Lat, Pu Luong, and limestone mountains, etc. Their slopes have linear-shape with high slope (above 30^o), or up to 45-50^o at some collapsed walls. The structure of soil covering slopes is thin, about below 0.5 m, even not cover (appear bedrock) in some places. The main exogenous process on these slopes is collapsed and landslided.

The less than 15-30^o slope areas with uneven and graded side-view are weaker separated. The structure of covering layers includes crushed grit, and debris with the thickness from 0.5m to 1m. This type of topography is distributed throughout the study area. The main exogenous process is slipping away, slipping flowing.

Some pictures of landslides in the project area

2. Climate change

The impact of climate change on the high mountainous terrain region includes droughts, floods, landslides, forest fires and disease.

Quan Hoa is assessed as one of localities severely affected by climate change. Through actual weather events over the past 10 years (1999-2009) in Thanh Hoa province, there were 4 flash floods and landslides that killed 12 people, washed away 47 houses, 76 small irrigation dams and heavily damaging the traffic and irrigation works. In which, the typical case was flash flood and landslides in Quan Hoa and Thuong Xuan districts in 2005, that killed 8 people, and caused vehicles congestion on tens of kilometers roads, swept away 17 houses, 76 small dams, hundreds of power poles, and tens of hectares of cultivated land. In 2006, flash floods, landslides happened in Trung Thanh and Thanh Son communes, Quan Hoa district, killing two people, 8 houses collapsed and swept away; 335 hectares of rice and crops buried or damaged; 02 small dams and 462 mini hydropower washed etc.

Temperature tends to rise in recent years with average temperature 0.1-0.4^{o}C higher than the last 10 years. The heat tends to appear early and ends late with more frequency, occur locally and complicated, more number of heat and sunny days, especially by hot days lasting throughout 30 days in summer 2008 with absolute temperature of 39 - 41^{o}C. In summer 2010, there were many intense heat waves, 40 – 43°C as absolute highest temperature happened in many places, and south to southwest winds blow constantly throughout the day.

Cold air tends to appear sooner (late August) and more abnormal, with more frequency and complex changes. The intensity is not as strong as that in previous years, but there are some historical turns; e.g in the beginning of 2008, a cold air turn extends continuously over 20 days, including several days of damaging and deep cold weather. In general, the cold air in recent years is more complex operations with more turns but not strong intensity. Some non-cold winters have made difficult to produce winter-spring crop.

Rain progress has many differences with rainingrule in many years, in the dry season, there is little rain but rainfall is more than 100 mm in some days. Rainfall fluctuations between areas are large, in some years, rainfall in the coastal plain areas is larger than mean annual rainfall from 500mm to 800mm. but rainfall in mountainous areas is lower than mean annual rainfall from 300mm to 700mm. Rain spells are less than in both quantity of spell and intensity compared with previous years, especially there is heavy rain on widespread due to storms and tropical depressions.

Due to large rain fluctuations. rainfall is not much, rainy season usually comes late and ends early, the area usually occurs drought and water shortage in the winter-spring harvest, as well as the summer-autumn harvest. Winter-spring harvest has drought occurred on wide spread in 1993, 2003, 2004, 2005, 2007, 2008 and 2009, water shortages are from 30% to 80%, some areas have 45 consecutive days without rain. The winter-spring harvest in 2010 - 2011 occurred drought and the water shortage on widespread due to the rainy season in 2010 ended prematurely, the rainfall was lower than the mean annual rainfall.

Data showed that climate change has potential impacts on different domains, localities and communities, increases the effect possibility and create a risk of slowness or reverse of development in the rural areas, especially in coastal areas and mountainous areas where can be affected at the greatest level due to climate change. Domains which are considered easily to be affected due to climate change include: agriculture and food security, land resources, water resources, health, habitat, especially people in coastal and mountainous areas, where sea-level rise, salinity, flash floods, landslides often occur. The increases of the extreme climate events and disasters, both in frequency and intensity due to the climate change are the regular threats immediately and in the long term for all sectors, regions and communities. Hurricanes, floods, drought, heavy rain, hot sunshine, whirlwind, natural disasters occur every year in many regions of the country, they cause damage to production and life. The prolonged droughts in many regions have also caused the arid soils. For agriculture, the structure of plants, animals and crops may be changed in some areas. The temperature rises and the temperature fluctuation is larger, including the maximum temperature and minimum temperature, together with the fluctuations of the other weather factors and other disasters, these increase the possibility of developing pestilent insect. epidemic diseases which directs to reduce the productivity and production, increase the risks to agriculture and food security.

Thus, whether with or not the Hoi Xuan HPP, the phenomenons are still happening. However, when Hoi Xuan HPP is built, the phenomenons can be reduced or enhanced. Specifically, the land acquisition for the project would reduce the forest area, reduce the surface coverage, increase the flooding intensity. So in order to minimize these impacts of the project, according to regulation, the Project Owner will cooperate with the authorities to refund forest planting.

In the context of climate change is more complex and intense, the construction of Hoi Xuan HPP not only affect on climate change but also contribute to reduce greenhouse gas emissions by about 68,261.4 tons of CO_2/year compared to the use of fossil fuels to generate electricity (compared with the generators of coal-fired, oil or liquefied petroleum gas power plants).

5.2. With alternative: the project will be implemented

According to the analysis mentioned above, the investment in construction of Hoi Xuan HPP is necessary for satisfying the power demand for economic development, reducing the lack of power in the future as well as the greenhouse gas emission and contributes to stabilize for the whole power system.

In order to limit to the minimum the damages and impacts on environment of the project, some alternatives of alignment have been given out to analyze for selection of the main specifications. They are included as below:

5.2.1. Alternatives of damsite

On the basis oftopographicaland geological documentsof the region, three alternatives of damsite have been given out to study as belows:

- Damsite No.1: located in Thanh Xuan commune, Quan Hoa district, Thanh Hoa province, away from Trung Son HPP around 38.5 kilometers towards the downstream. Its coordinates according to the VN2000 coordinate system are as follows: X = 2 261 955; Y = 505 015

- Damsite No.2: away from the damsite No.1 about 3.5 kilometers towards the downstream.

- Damsite No.3: away from the damsite No.1 about 0.5 kilometers towards the downstream with the coordinates.

Also, according tothe document "Planning on hydropower cascade on Ma river" established by Power Engineering Consulting JS Company 1m(Adjusted and supplemented in July 2005)m the Hoi Xuan HPP's damsite has been arranged at the location away from the damsite No.2 about 2 kilometers towards the downstream. The study showed that the Hoi Xuan HPP can not be arranged at the position as specified in the Planning because this area has some the following characteristics:

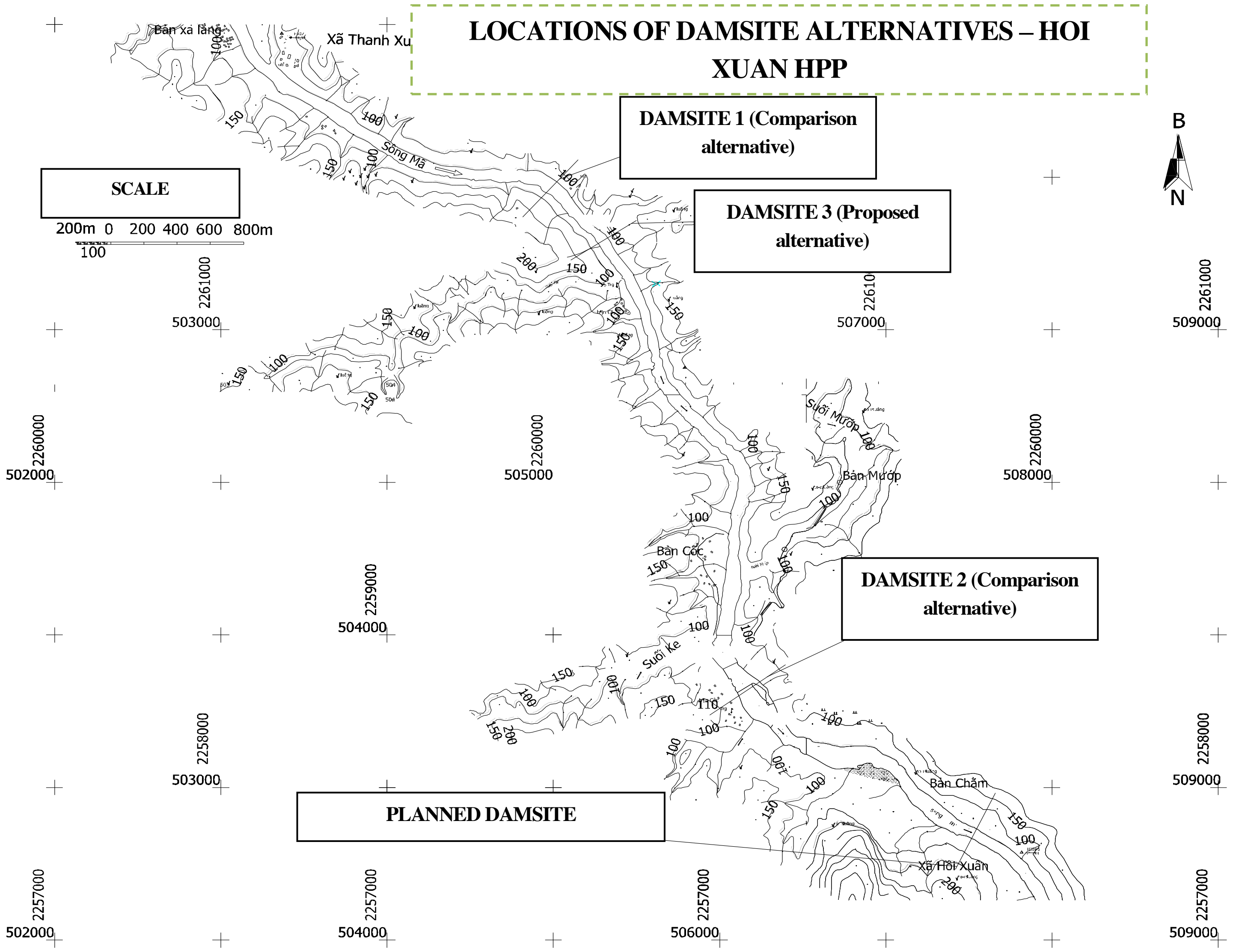
The geology of the construction foundation is mainly limestone with karst cave on the left abutment. This may cause reservoir water seepage, threat the dam safety and life safety, people's economy and living activities in the downstream.

- The number of local people who has to move to another for settlement increases much more because of the additional compensation for several households in the two Coc and Cham villages, Hoi Xuan commune, Quan Hoa district.

In the stage of Pre-Feasibility Study, the two damsite No.1 and No.2 alternatives have been compared each other and the results were as below:

- For geology engineering: the foundation of damsite No.2 is limestone with many Karst caves (shown in the geological investigation report) but the alignment No.1 does not.
- For the length of alignment: with the same installed capacity of N_{lm}=90MW. the length of damsite No.1 is 253 meters and 395 meters for the damsite No.2. The dam height of the damsite No.1 and No.2 are 46.3 meters and 45.5 meters respectively.
- For the mineral in the reservoir foundation: the damsite No.2 has a mineral mine near the damsite but the No.1 does not.

The considerations mentioned above showed that the risk of water loss of the reservoir was quite large. The foundation of limestone in geology distributes on a large area and the karst formed at many places; these will cause difficulties in seepage treatment. In addition, with the long damsite located closely to the mineral mine. Therefore, the damsite No.2 alternative will not have economical effectiveness and many risks such as risk of the loss of water seepage and risk of dam safety, life safety and impact on people's economy and living activities in the downstream in case of reservoir dam failure occurrence because of underground erosion of karst caves and the mineral mine will be submerged because of water impoundment in the reservoir. Thus, the comparison and selection of alignment will be done with the two damsite No.1 and No.3 alternatives.


LOCATIONS OF DAMSITE ALTERNATIVES – HOI XUAN HPP
DAMSITE 1 (Comparison alternative)
DAMSITE 3 (Proposed alternative)
DAMSITE 2 (Comparison alternative)
PLANNED DAMSITE
SCALE
200m 0 200 400 600 800m
B
N
Bản xa lăng
Xã Thanh Xu
Sông Mã
Suối Mướp
Bản Mướp
Bản Cốc
Suối Ke
Bản Chầm
Xã Hồi Xuân
502000
503000
504000
505000
506000
507000
508000
509000
2261000
2260000
2259000
2258000
2257000

- **The basis to compare the damsite alternatives:**

The damsite alternatives No.1 and No.3 stand about 0.5 kilometer apart. There is not any sudden change in terrain, the project scale as well as their impacts on environment, damages, people's economy and living activities, and displacement are equivalent. Therefore, the basis to compare and select the damsite will base on the following creation:

- The normal water level: 80.00m
- Installed capacity (N_{lm}):102MW
- The structure of construction

+ Gravity concrete dam.

+ Concrete spillway located in the riverbed with dimensions of n*(B*H) =6*(14*15)m.

+ The waterway located on the left bank at the toe of dam, including intake, penstock, powerhouse and outlet channel.

+ The diversion culvert arranged on the left bank.

Table 4.36: The specifications of the two damsite alternatives

No.	Parameters	Symbol	Unit	Damsite No. 1	Damsite No. 3
A	**General parameters**				
1	Project grade			grade II	grade II
2	Normal Water Level	NWL	m	80.00	80.00
3	Dead Water Level	DWL	m	78.50	78.50
4	Check flood water level (p=0.1%)	CFWL	m	84.75	85.55
5	Design flood water level (p=0.5%)	DFWL	m	81.66	81.96
6	Total reservoir volume	Wtb	10^6 m^3	62.05	63.65
7	Effective reservoir volume	Whi	10^6 m^3	7.62	7.73
8	Dead reservoir volume	Wc	10^6 m^3	54.43	55.92
9	Installed capacity	Nlm	MW	102	102
B	**Main dam**				
1	Type			Gravity concrete dam	
2	Dam crest elevation		m	87.20	86
3	Maximum dam height	H_{max}	m	48.4	43
4	Dam crest length	L	m	291.4	243.2
C	**Spillway**				
1	Dimensions	n*(B*H)	m	6*(14*15)	5*(15*15)
2	Weir elevation	nt	m	65.00	65.00

3	Forms of energy dissipation			Bottom dissipation	
D	**Intake**				
1	Type			Arrange in dam body	
2	Intake sill elevation		m	66.50	65.00
3	Dimensions of operation valve	n * B*H	m	6 * 7 * 9.5	6 * 6.2 * 9.67
E	**Powerhouse**				
1	Type			Opened type powerhouse at the toe of dam	
2	Turbine type			Kaplan	
3	Floor elevation	S	m	78.00	75.8
4	Turbine elevation		m	46.50	47.9
5	Number of units		unit	3	3

Quantity and economic indices of two damsite alternatives

Table 4.37: Quantity and total investment cost of two damsite alternatives

No.	Work items	Unit	Damsite No.1	Damsite No.3
I	**QUANTITY**			
1	Soil excavation, aQ	10^3m^3	16.70	13.75
2	Soil excavation, edQ	10^3m^3	517.92	494.34
3	Soil excavation, IA1	10^3m^3	579.64	378.64
4	Soil excavation, IA2	10^3m^3	787.01	642.07
5	Weathered rock excavation, IB	10^3m^3	841.26	581.57
6	Original rock excavation, IIA	10^3m^3	490.73	393.03
7	Utilized rock fill	10^3m^3	32.88	32.88
8	Reinforced concrete, M300	10^3m^3	22.28	20.28
9	Reinforced concrete, M250	10^3m^3	147.36	143.40
10	Reinforced concrete, M200	10^3m^3	18.70	18.12
11	Concrete, M150	10^3m^3	67.36	56.51
12	Concrete, M300	10^3m^3	6.70	6.08
13	Masonry with mortar M100	10^3m^3	21.15	19.53
14	Filter crushed stone	10^3m^3	16.92	15.62
15	Rock gabion with steel mesh (0.5*1*2m)	10^3m^3	3.56	2.35
16	Brick	10^3m^3	1.39	1.39
17	Asphalt hemp sack	10^3md	11.22	10.84
18	Grouting curtain	10^3md	6.14	5.64
19	Anchored drill (D32)	10^3md	5.79	6.64
20	Consolidation grouting	10^3md	5.16	4.85
21	Rubber joint	Ton	1.23	1.10

No.	Work items	Unit	Damsite No.1	Damsite No.3
22	Reinforcement all kinds	ton	9,417.00	9,089.87
23	Steel balcony	ton	42.00	41.68
24	Turbine	ton	882.00	882.00
25	Generator	ton	1,164.00	1,164.00
26	Auxiliary equipment	ton	204.64	204.64
27	Hydro-mechanical equipment	ton	2,998.74	2,994.69
II	**ECONOMIC INDICES**			
1	Total investment cost	Billion VND	1,965.45	**1,922.59**
2	EIRR	%	11.24	**11.65**
3	ENPV	Billion VND	200.75	**262.51**
4	B/C		1.12	**1.16**
	Recommendation			**Selected**

(Note: total investment cost as selecting the damsite alternative is excluded the cost of 220kV transmission lines)

Comparison and selection of the damsite alternative

- On the work items: with the NWL of 80.00 meters, the two dams have about the same length (272.0m for the alternative No.1 and 252.1m for the alternative No.2).

- On the transport and construction conditions: because the two damsites stand about 0.5 kilometer apart and located following closely to Highway 15, the transport and construction conditions of the two alternative are the same.

- On the geology: the alternative No.1 its work items located in the distribution area of sericit quazt schist, clay schist while the alternative No.3 its work items located in the distribution area of sericit quazt schist belonging to Ma river stratum. The comparison results between the two alternatives showed that the alternative No.3 is less impermeable than the alternative No 1; the rock layer IIA in alternative No.1 located more deeply than alternative No.3. In conclusion, the geological conditions in the damsite alternative No.3 is more favorable than the alternative No.1.

- On the quantity and construction cost: with the same NWL of 80.00 meters and the installed capacity of 102MW, the alternative No.3 is lower than the alternative No.1 in the quantity and construction cost of and better than in the economic and financial indices.

- On the environment aspect, damages, people’s economy and living activities and displacement: the two damsite alternatives standing about 0.5 kilometer have the same NWL of 80.0 meters part, they located on the original riverbed. Therefore, their impacts on environment, damages, people's economy and living activities and displacement are basically the same.

According to the results analyzed above, it is recommended to select the Damsite alternative No.3 as the proposed alternative.

5.2.2. Comparison and selection of water level

On the bases of construction quantity and the cost for compensation and resettlement of the alternative 3, it has carried the hydro energy calculation for the four different alternatives of water level with different dam scale and incremental steps of NWL between the options of 2.5 meters, the DWL will be determine, in corresponding to the NWL, how to suitably arrange the intake and sure enough reservoir volume for short-term regulation. The studied results of four alternatives are shown in the following table:

Table 4.38: The studied results of four alternatives

Parameters	The studied results of four alternatives			
NWL	75.0	77.5	80.0	82.5
DWL	72.8	76.0	78.5	81.5

The results of hydro energy calculation show that the higher the NWL raises, the higher the N_f and E_o increase. However, according to survey data on population and economic activities, the number of households to be compensated, resettled will increase from 293 households (at the NWL of 75.00m) to 418households (at the NWL of 77.5m),517households (at the NWL of 80.00m) and to 878 households (at the NWL of 82.5m).

The basic design of work items of damsite alternative No.3 to study the NWL as follows:

+ Dam type: gravity concrete dam.

+ Concrete spillway located in the riverbed with dimensions of n*(B*H) =5*(15*15)m.

+ The waterway located on the left bank at the toe of dam, including Intake, Penstock, Powerhouse and Outlet channel.

+ The diversion culvert arranged on the left bank.

The most effective water level combination will be determined through the analysis of hydro energy.

Table 4.39: Calculation results of hydro energy for selection of water level

Parameters	Unit	Alternative

NWL	m	75	77.5	***80***	82.5
DWL	m	72.8	76.0	***78.5***	81.5
Wtb	10^6 m^3	37.63	50.51	***63.38***	81.95
Wc	10^6 m^3	30.16	42.78	***55.65***	74.52
Whi	10^6 m^3	7.47	7.72	***7.72***	7.43
Qmax	m^3/s	590.48	569.86	***559.71***	547.07
Qf	m^3/s	68.29	69.06	***69.15***	69.46
H_{max}	m	22.71	25.21	***27.71***	30.21
H_{min}	m	14.74	17.61	***20.12***	22.88
H_{aver}	m	18.73	21.49	***23.99***	26.71
N_{lm}	MW	84.0	93.0	***102***	111.0
N_f	MW	13.16	14.74	***16.24***	17.81
Eo	10^6 kWh	336.18	383.07	***425.43***	465.29
Number of hours at N_{lm}	hour	4.002	4.119	***4.171***	4.192

Table 4.40: Quantity and economic indices as calculating and selecting the water level

No.	**Parameters**	**Unit**	**Alternative**			
			75.00	77.50	***80.00***	82.50
I	**QUANTITY**					
1	Soil excavation, aQ	10^3m^3	11.46	12.61	13.75	13.75
2	Soil excavation, edQ	10^3m^3	431.40	440.28	494.34	503.17
3	Soil excavation, IA1	10^3m^3	334.94	356.05	378.64	388.42
4	Soil excavation, IA2	10^3m^3	625.29	638.23	642.07	729.41
5	Weathered rock excavation, IB	10^3m^3	544.44	586.57	581.57	642.44
6	Original rock excavation, IIA	10^3m^3	478.50	453.27	393.03	473.87
7	Utilized rockfill	10^3m^3	32.88	32.88	32.88	33.34
8	Reinforced concrete, M300	10^3m^3	20.28	20.28	20.28	20.28
9	Reinforced concrete, M250	10^3m^3	137.30	140.05	143.40	148.74
10	Reinforced concrete, M200	10^3m^3	17.96	18.14	18.12	21.98
11	Concrete, M150	10^3m^3	36.70	46.82	56.51	68.62
12	Concrete, M300	10^3m^3	6.08	6.08	6.08	6.08
13	Masonry with mortar M100	10^3m^3	17.58	18.57	19.53	20.27
14	Filter crushed stone	10^3m^3	14.06	14.85	15.62	16.21
15	Rock gabion with steel mesh (0.5*1*2m)	10^3m^3	2.35	2.35	2.35	2.35
16	Brick	10^3m^3	1.39	1.39	1.39	1.39
17	Asphalt hemp sack	10^3md	8.87	9.83	10.84	11.83
18	Grouting curtain	10^3md	4.97	5.29	5.64	5.98
19	Anchored drill (D32)	10^3md	6.64	6.64	6.64	6.64
20	Consolidation grouting	10^3md	4.85	4.85	4.85	4.85
21	Rubber joint	ton	0.88	0.99	1.10	1.21
22	Reinforcement all kinds	ton	8.777.45	8.923.54	9.089.87	9.550.05
23	Steel balcony	ton	41.68	41.68	41.68	41.68

No.	Parameters	Unit	Alternative			
			75.00	77.50	***80.00***	82.50
24	Turbine	ton	885.00	849.00	882.00	834.00
25	Generator	ton	1.080.00	1.119.00	1.164.00	1.182.00
26	Auxiliary equipment	ton	196.50	196.80	204.64	201.60
27	Hydro-mechanical equipment	ton	3.008.59	3.001.82	2.994.69	2.989.23
II	**ECONOMIC INDICES**					
1	Total investment cost	Billion VND	1.726.02	1.803.16	***1.922.59***	2.123.00
2	EIRR	%	10.22	11.18	***11.65***	*11.54*
3	ENPV	Billion VND	30.39	173.86	***262.51***	270.97
4	B/C		1.021	1.113	***1.161***	1.150
	Recommendation				**Selected**	

The analysis results show that the water level combination of NWL and DWL (80.0 meters and 78.5 meters respectively) has brought the most economic and technical indices; the degree of impacts on environment, damages, people's economy and living activities, dispalcement is much lower than the combination alternative of NWL/DWL = 82.5m/81.5m. Therefore, it is recommended to select the combination alternative of NWL/DWL = 80.0m/78.5m as the proposed alternative.

5.2.3. Comparison and selection of installed capacity

For the current medium and small-scaled hydropower projects, to operate them most efficiently, the annual operating hours of installed capacity must be in range of from 4,000 to 4,500 hours. Therefore in this report, several alternatives have been given out to compare and select how to ensure the annual operating hours of installed capacity in range of about 4,200 hours.

On the basis of damsite alternative No.3 with NWL of 80 meters, it has carried out to study 3 alternatives of installed capacity: Nlm = 99MW, 102MW and 105MW.

Table 4.41: Calculation result of hydro energy and economic indices for selection of installed capacity N_{lm}

Parameters	Unit	Alternative		
HYDRO ENERGY				
Q_{max}	m^3/s	542.06	***559.71***	576.85
Q_f	m^3/s	69.15	***69.15***	69.15
H_{max}	m	27.71	***27.71***	27.71
H_{min}	m	20.13	***20.12***	20.10
H_{aver}	m	24.05	***23.99***	23.97
N_{lm}	MW	99.0	***102.0***	105.0
N_f	MW	16.24	***16.24***	16.25
Eo	10^6 kWh	422.52	***425.43***	428.13

Annual operating hours of N_{lm}	hour	4.268	***4.171***	4.077
ECONOMIC INDICES				
Total capital	Billion VND	1,913.74	***1,922.59***	1,939.04
EIRR	%	11.62	***11.65***	11.62
ENPV	Billion VND	257.46	***262.51***	260.16
B/C		1.16	***1.16***	1.16
Recommendation			*Selected*	

According to the table above. the installed capacity alternative N_{lm} = 102MW has brought the best economic and technical indices. Therefore, it is proposed to select the N_{lm} = 102MW to be studied in the next stage.

5.2.4. Comparison and selection of number of Units

Hoi Xuan hydropower is the lower cascade of the Trung Son HPP, its operation regime will be therefore done in comprehensive operation with the Trung Son HPP.

The number of units will be select on the principle of how to exploit to the maximum the water resource behind the Trung Son HPP, and the project will bring the economic effectiveness with the lowest cost is lowest; In addition, it must ensure the discharge to remove salt from river water as well as supply water for the dowmstream area.

On the bases of damsite alternative No.3, the water level combination of NWL/DWL= 80.0m/78.5m and the installed capacity N_{lm} = 102MW, it has carried out to study two alternatives 3 Units and 4 Units in the tables below.

Table 4.42: Calculation result of hydro energy for selecting the number of Units

Parameters	Unit	Alternative	
		3 Units	4 Units
Q_{max}	m^3/s	***519.24***	516.81
Qf	m^3/s	***69.14***	69.14
H_{max}	m	***27.70***	27.70
H_{min}	m	***20.28***	20.28
H_{aver}	m	***24.11***	24.11
N_{lm}	MW	***102***	102
N_f	MW	***16.61***	16.68
E_o	10^6 kWh	***432.61***	434.10

Table 4.43: The quantity and economic indices for selecting the number of Units

No.	Parameter	Unit	Alternative	
			3 Units	4 Units
I	**QUANTITY**			

No.	Parameter	Unit	Alternative	
			3 Units	**4 Units**
1	Soil excavation, aQ	10^3m^3	13.75	13.75
2	Soil excavation, edQ	10^3m^3	494.34	521.06
3	Soil excavation, IA1	10^3m^3	378.64	404.32
4	Soil excavation, IA2	10^3m^3	642.07	702.88
5	Weathered rock excavation, IB	10^3m^3	581.57	667.28
6	Original rock excavation, IIA	10^3m^3	393.03	453.55
7	Utilized rockfill	10^3m^3	32.88	29.27
8	Reinforced concrete, M300	10^3m^3	20.28	20.28
9	Reinforced concrete, M250	10^3m^3	143.40	152.00
10	Reinforced concrete, M200	10^3m^3	18.12	18.93
11	Concrete, M150	10^3m^3	56.51	56.46
12	Concrete, M300	10^3m^3	6.08	6.08
13	Masonry with mortar M100	10^3m^3	19.53	19.58
14	Filter crushed stone	10^3m^3	15.62	15.66
15	Rock gabion with steel mesh (0.5*1*2m)	10^3m^3	2.35	2.35
16	Brick	10^3m^3	1.39	1.39
17	Asphalt hemp sack	10^3md	10.84	10.84
18	Grouting curtain	10^3md	5.64	6.23
19	Anchored drill (D32)	10^3md	6.64	7.24
20	Consolidation grouting	10^3md	4.85	4.85
21	Rubber joint	Ton	1.10	1.10
22	Reinforcement all kinds	Ton	9,089.87	9,560.49
23	Steel balcony	Ton	41.68	46.89
24	Turbine	Ton	882.00	717.00
25	Generator	Ton	1,164.00	1,222.00
26	Auxiliary equipment	Ton	204.64	269.64
27	Hydro-mechanical equipment	Ton	2,994.69	3,054.68
II	**ECONOMIC INDICES**			
1	Total investment cost	Billion VND	***1,922.59***	2,086.42
2	EIRR	%	***11.84***	10.92
3	ENPV	Billion VND	***294.52***	156.77
4	B/C		***1.18***	1.09
	Recommendation		***Selected***	

The results of hydro energy and economic calculation show that the three-Unit alternative has brought the better economic indices. Therefore, it is recommended to be the proposed alternative.

In conclusion, according to the analysis, comparison and selection results., the stage of Feasibility Study, the damsite alternative No.3 has brought the most efficient in the economy and finance, and the acceptable degree of impacts on environment or damages, people's economy and living activities and resettlement. And in the stage of Technical Design, some parameters may be changed, so the main specifications of the project are as follows:

Main specifications of the proposed alternative (the stage of Technical Design):

- Normal water level (NWL) 80.0m.
- Dead water level (DWL) 78.5m.
- Total reservoir volume (Wtb) $63.65 * 10^6 m^3$.
- Dead reservoir volume (Wc) $55.92 * 10^6 m^3$.
- Effective reservoir volume (Whi) $7.73 * 10^6 m^3$.
- Maximum discharge Q_{max} $529.2 m^3/s$
- Firm discharge $70.56 m^3/s$
- Maximum water head H_{max} 27.0m
- Minimum water head Hmin 16.5m
- Average water head H_{aver} 21.5m
- Installed capacity N_{lm} 102MW.
- Firm capacity (N_f) 16.61MW.
- Number of Units 3
- The annual energy output (E_o) $432.00 * 10^6 kWh$.

CHAPTER 6. ENVIRONMENTAL AND SOCIAL IMPACT MANAGEMENT

6.1. Environmental management, Mitigation Standards/Measures for Minimizing Impacts

6.1.1. Construction Phase

Mitigation standards and measures for minimizing impacts during the construction phase are shown in the following table.

Table 6-1: Mitigation Standards/Measures for Minimizing Impacts During Construction

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
Reservoir Preparation (Clearing, grading, excavation, leveling, truck hauling, etc.)	Noise	Impact to local villagers, livestock breeding and wildlife.	Noise levels should not affect local households, livestock breeding or wildlife species.	- Construction activities shall occur mainly in daylight hours. - If activities occur outside of daylight hours, local villagers will be informed and agreement will be sought from local authorities. - Periodic inspection and maintenance of vehicles, equipment and machinery to ensure technical.
	Dust	Decreased air quality can impact construction workers, local villagers and surrounding environment.	Dust level created must not impact the health of construction workers, local villagers and surrounding environment.	- Water work area and associated roads. - Transportation vehicles shall follow in the designated area and road. - Use exposed stockpiles and material as soon as possible. - Cover any exposed materials during transportation.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	Loss of forest cover	Impact productive land and artificial forest.	Construction activities to be confined to designated areas to minimize loss of forest cover.	- RLDP will allow affected villagers to remove economic valuable trees on their land. - Avoid excess clearing for project requirements. - Vegetation debris shall be either disposed and/or burned at designated sites.
		Alteration of potential income.	No long term impacts to those households dependent on forestry production.	- Organizations and individuals affected shall be fully compensated for their land and damage to assets. - Resettlement households shall be provided productive land for cultivating bamboo and forestry production. - RLDP will have training programs to diversify incomes.
		Impact to biodiversity and habitat.	No impact to listed species, biodiversity and habitat.	- Avoid clearing in restricted and protected areas. - Education and training to enhance contractors and construction worker’s awareness on necessity of protection of surrounding areas and biodiversity. - Assist in protected areas management.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	Road Traffic	Increased road traffic	Minimize impacts to local villagers	- Minimize traffic in villages and other populated areas. - Install traffic signs. - Roads shall be kept free from mud, debris and other traffic obstacles. - Education for increasing community traffic awareness. - Do not over transport regarding the capacity of the street. Do not attempt to expand the loading capacity of truck. Use special vehicles to transport oversized, overloaded vehicles.
		Deterioration of roads	Minimize road damage	- Repair and maintain roads, as necessary. - For existing roads that are not qualified regarding quality and loading capacity, the project owner will carry out renovation and upgrading to meet the transporting demand of the project before use to avoid damage, roadbed subsidence that may affect the transportation of local people.
	Landmines and explosives remnants from war	Affect to the safety of workers	Ensure the safety for workers	- Conduct clearance of remaining mines, explosive ordinances of war.

Impact Agent	**Issue**	**Impact**	**Mitigation Objective/ Standard**	**Project Improvement and Mitigation Measures**
	Accidents and unexpected incidents	Increased risk to personal health and safety during construction activities	Minimize risks to local villagers or construction workers' personal health and safety	- Training and monitoring of worker safety shall be provided by contractor as stipulated. - Protective equipment and tools are to be provided to workers by the construction contractor. - Implement regular inspection of equipment and machinery.
	Vehicle and equipment maintenance and storage	Gas emissions and particulate matter decrease air quality	Air quality standards are maintained throughout construction	- Maintain vehicles in accordance with manufacturer specifications. - Repair vehicles and equipment, as necessary.
		Storage and discharge of oils, lubricants and other hazardous materials during operation and maintenance	No hazardous materials shall be released into the environment.	- Provision and maintenance of designated storage and fueling areas. - The contractor registers their ownership of hazardous waste with the Department of Natural Resources and Environment Thanh Hoa, Hoa Binh.
	Domestic waste (garbage, Litter, domestic water waste. etc.)	Impact to ecosystems (water, soils, vegetation, etc.)	Waste production shall not impact surrounding ecosystems	- Domestic waste is properly collected and disposed of at approved locations. - Implement recycling program where possible.
	Natural organic debris: plant residues (stump, stems,	Impact to ecosystems (water, soil, vegetation,	Waste production shall not impact surrounding	- Natural organic debris, include plant residues (stump, stems, leaves...), waste

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	leaves...). waste people leave during the relocation and resettlement	etc.)	ecosystems	people leave during the relocation and resettlement, shall be either disposed and/or burned at designated sites to avoid forest fire. - Concerning areas that were used to built toilet, livestock barn and grave, after being cleared, these areas are lime sterilized, disinfected to ensure water environment of the reservoir.
	Infrastructure and public constructions	Loss of infrastructure and public works	Ensure. maintain infrastructure and public works for people	- Compensate in cash for items of infrastructure. public construction no needs for further use. - Reconstruct items of infrastructure, public construction that is needed to be used in future.
	Impact or alteration of cultural, archaeological or historical sites	Damage or destruction of site contents	Minimize damage during excavation activities	- Follow procedures in “Chance Find Procedures” and “Reservoir Clearing Plan”. - Coordinate planning of cemetery sites with local authorities to ensure that they are suitable with local cultural custom.
		Damage or destruction of newly discovered sites	Minimize impact to newly discovered sites until properly investigated	- Discovery of new sites shall follow “Chance Find Procedures”.
	Resettlement of households	Loss of housing	Villagers shall be either	- Provision of new homes in designated

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	and villagers as a result of reservoir creation		resettled or compensated	resettlement areas according to resettled households' expectations. - Compensation in cash shall be provided for self-relocation. Initiation of community livelihood plan (CLIP) to diversify household income. - Information. education and communication activities and social programs shall be put in place to assist both resettled households and those that are currently in resettlement areas. - Implement rehabilitation plan to diversify income sources and restore livelihood of people, prevent deforestation for agriculture and illegal logging of forests in surrounding areas.
		Disturbance to family networks, community structure and cultural and ethnic identities	Resettled villagers shall reestablish their current way of life in new communes	- Information. education and communication activities and social programs shall be put in place to assist both resettled households and those that are currently in resettlement areas.
	Expansion of households in host communes	Alteration to community culture and ethnic heritage	Villagers in affected communes shall maintain current way of life	- Information, education and communication activities and social programs shall be put in place to assist both resettled households and those that are currently in resettlement areas.
		Increase demand for	Exploitation of natural	- Coordination with local authorities, and

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
		shared natural resources (land, forest…)	resources is confined, especially forest resources	protected area management board to enhance the awareness of local communities of natural resource management. - Local government support project owners to grant production land to the household.
		Increased demand on community & health services	Adequate services shall be provided	- Support on facilities, training and capacity shall be provided to improve and maintain public service.
		Increased pressure on infrastructure systems and public constructions in areas where resettled households moved to	Prevent increasing pressure on infrastructure systems and public constructions in areas where resettled households moved to	- Reconstruct items of infrastructure, public construction needs to be used in the new location in future. - The project owner has appropriate supporting measures to ensure the capacity of the infrastructure system and public works in the host communes.
		Increased disease transmission	No increase in disease transmission rates	- Initiation of regional health plan. Expansion or creation of new sanitation facilities.
		Disturbance to family networks, community structure and cultural and ethnic identities	Existing villagers shall maintain their current way of life	- Initiation of community livelihood plan (CLIP) to diversify household's income. - Information, education and communication activities and social programs shall be put in place to assist both resettled households and

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
				those that are currently in resettlement areas.
		Increased pressure on the management of local authorities where resettled households moved to	Maintain good management of local government to ensure security in the resettlement area	- Strengthen the management of local authorities on relocation and resettlement of households to ensure security and order in the province.
	Job creation for local workforce	Potential exploitation of local workforce as available labor	Equal employment opportunities	- Salaries and work details shall be agreed to by the contractor and local workers. - Implement the community livelihood development plan for job creation and increase income.
	Forest fire	Affect to the ecological environment	Prevent forest fire	- Prepare plan for forest fire prevention. - Coordinate with local governments and agencies to prevent forest fires. - Raise awareness of workers on forest fire prevention.
Dam Site Construction (Clearing, grading, excavation, leveling, blasting, truck	Noise and vibration creation	Disturbance to local households, livestock and wildlife species	Noise and vibration levels should not interfere with daily activities	- If construction is required outside of working hours, community and households shall be informed. - Blasting activities should be implemented within the designated time and local people shall be informed prior to blasting. - Periodically inspect and maintain vehicles,

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
hauling, stockpiling. waste disposal, road development, transport vehicles, river diversion, transport vehicles, camp site construction, labor force and camp followers).				equipment and machinery.
	Dust generation	Refer to above section on "Dust generation"		
	Alteration of forest cover. production land	Refer to above section on "Alteration of forest cover"		
	Soil erosion	Increased sedimentation	Minimize soil erosion and sedimentation	- Implement soil erosion and sedimentation control measures at susceptible locations (i.e, Steep slopes, sandy soils, etc.) - Construction activities shall avoid working in wet conditions - Disposal areas: comply the disposal processes to minimize soil erosion causes by flow. - Clean up, return to original state and plant trees on temporary occupied areas to increase the coverage, limit soil erosion.
		Slope instability	Slope integrity shall be maintained throughout construction	- Installation of rock or stabilization structures. - Proper grading practices and water diversion structures.
		Alteration of productive topsoil	Maintain topsoil stockpiles for future use	- Perform topsoil removal of built-up areas such as dam construction area, construction of the plant, open power yard, construction – operation road, ancillary items... and at the

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
				specified place serving the reimbursement in future. - Implement the Construction and Worker Camp Management Plan for reinstatement.
	Water transportation	Obstruct water transportation	Maintain the waterways for transportation in the downstream of the dam and reservoir area	- Connect transportation routes to maintain traffic in the basin.
	Road transportation	- Refer to above section on "Road transportation"		
	Accidents and unexpected incidents	- Refer to above section on "Accidents and unexpected incidents"		
	Landmines and explosives remnants from war	- Refer to above section on "Accidents and unexpected incidents"		
	Vehicle and equipment maintenance and storage	- Refer to above section on "Vehicle and equipment maintenance and storage"		
	Domestic waste and Natural Debris	- Refer to above sections "Domestic Wastes" and "Natural Debris" for further details		
	Borrow pit and quarry creation	Removal of subsurface and creation borrow pit and quarry	Land gradient and drainage are maintained	- Excavated rock or gravel shall not compromise river bed and banks or impede flows. - Confine activities to approved locations.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
		Abandonment of borrow pits and quarries	All disturbed areas are properly reclaimed after construction	- Implement the Construction and Worker Camp Management Plan for reinstatement.
		Dust and debris created during transportation of materials	Minimize the creation of dust and debris during transportation	- Implement protective measures during transportation (i.e, covering loads, reduced travel speeds, etc.). - Reduce dust by wetting the transporting routes. - Clean up spilled sand along the transporting routes.
	In-stream construction activities (installation of coffer dams, river diversion, machinery equipment operating, etc.)	Decreased water quality (sedimentation pollution, etc.) and impacts on aquatic ecosystems	Minimal disturbance to water quality and aquatic ecosystems	- Construction activities should occur during low water levels. - Maintain river diversion structures throughout construction. - Minimize in-stream activities. - Proper maintenance of vehicles and equipment. - Implementation of clean-up activities and restoration of side channels.
	Impact or alteration on cultural, archaeological or historical sites	- Refer to above section on "Impact or alteration on cultural. archaeological or historical sites"		

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	Infrastructure and public constructions	- Refer to above section on "Infrastructure and public constructions"		
	Resettlement of households and villagers as a result of reservoir creation	- Refer to above section on "Resettlement of households and villagers as a result of reservoir creation"		
	Expansion of households in host communes	- Refer to above section on "Expansion of households in host communes"		
	Job creation for local workforce	- Refer to above section on "Job creation for local workforce"		
	Forest fire	- Refer to above section on "Forest fire"		
Construction of Camp, working office (site clearing, camp site construction, concentration of labour forces and followers in the camps)	Site clearing	- Refer to above sections in "Dam Site and Reservoir Preparation" for additional details on clearing impacts.		
	Construction of new camp buildings	Increased demand for building materials	Exploitation of local natural resources shall be minimized for construction purposes	- Make use of excavation site and reservoir clearing materials for construction.
		Installation requirement for sanitation services	Adequate provision of sanitation and disposal services	- Provide adequate and compliant sanitation services. - Designated discharge points for sanitation shall be addressed as procedures stipulated prior to discharging to environment.
		Noise and dust creation	- Refer to previous "Noise" and "Dust" section for further details	
		Domestic waste	- Refer to above section on "Domestic waste" for further details.	
	Impact created by the transportation of the materials	- Impact created by the transportation of the construction materials is negligible. Refer to above section on "Road transportation".		

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	for the construction of working camp			
	Infrastructure and public constructions	- Refer to above section on "Infrastructure and public constructions"		
	Landmines and explosives remnants from war	- Refer to above section on "Refer to above section on "Accidents and unexpected incidents"		
	Accidents and unexpected incidents	- The risk of accidents and unexpected incidents due to the construction of work camp, office is negligible. Refer to above section on "Accidents and unexpected incidents"		
	The resettlement of households and villagers due to the construction of work camp and office	- The resettlement of households and villagers due to the construction of work camp and office is simultaneously implemented with the construction of main items.		
	Job creation for local workforce	- Refer to above section on "Job creation for local workforce"		
	"Boom-town" effect from rapid population and resource demand increase	Rapid population causes regional inflation on resource demands	The workers will be provided with appropriate services an local people will be benefit form these services.	- Encourage local residents to develop services to provide construction materials, food and other essential commodities to workers. As a result, increase income of people. - Coordinate with the local government to facilitate the formation of various types of services. Provide financial support to expand and maintain the operation of services.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
		Increased demand for electricity domestic water (drinking, food preparation, bathing, etc.)	Construction workers and local villagers shall receive clean, reliable water supplies	- Provision of domestic water supplies for the construction camp shall be assured and not conflict with local water usage.
		Domestic wastewater production and sanitation services may cause social conflict	Construction workers shall be provided with proper facilities for on environment sanitation and waste disposal	- Domestic wastewater in worker camp shall be directed to a holding tank before discharging environment. - Domestic wastewater in construction sites shall be collected and treated in agreement with local government.
		Increased power/fuel demands may cause social conflicts	Power/fuel shall be supplied without compromising existing resources or exploiting natural areas (i.e. firewood)	- Enforce regulations to prevent exploitation of natural resources (firewood). - Provide additional fuel supplies to prevent conflict with local villagers Increase security around protected areas, especially along roads.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	Health Impacts of Construction Worker Camps	Increased disease transmission rates	Decreased disease transmission rates	- Contractor shall be required to regularly test of health of construction worker and construction local worker according to Vietnam Law as stipulated. - Construction workers and local workers shall receive necessary health care services. Camp clinics shall be established. - Education and promote awareness on personal hygiene and sexually transmitted disease.
		Increased drug use and trade	Construction worker are strictly prohibited to use, trade and transportation drug	- Contractor construction workers and local worker shall be routinely healthy tested. - Increase security in construction campsite, especially on roads and rivers. - Drug education and awareness programs.
	Health Impacts to local villagers and communes	Increased disease transmission rates	Minimize the risk of exposure to local villagers	- Healthy facility is supported by local medical centers. - Educate and promote awareness on personal hygiene and disease transmission.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	Disturbance to biodiversity and increased pressure on protected areas	Decreased forest cover. increased road traffic noise and vibration creating disturbance to local villagers. livestock and wildlife species	Minimize disturbance to protected areas, people, livestock and wildlife	- Strengthen the protection and management of protected areas and forests surrounding areas. - Implement rules of behavior for workers. - Prohibit trading, hunting and consumption of precious timber, meat of wild animals and other wildlife in the construction areas.
	Alternate cultural identity and ethnicity	Impact on customs, culture and ethnic identity. Increase of social evil and crime	Minimize impacts on customs, culture and ethnic identity. Minimize theincrease of social evil and crime	- Develop programs and activities that support the conservation of cultural heritage and ethnic. - Develop education and awareness raising program of national identity for local people, especially the young generation. - Enhance the security and order in the villages. - Plan on separated living quarters for construction workers.
	Forest fire	- Refer to above section on “Forest fire”		
Construct the transmission lines (the distribution	Dust generation	- Refer to above section on “Dust generation”		
	Noise and vibration	- Refer to above section on “Noise and vibration”		
	Alteration of forest cover. production land	- Refer to above section on “Alteration of forest cover, production land”		

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
line supplies power for the project construction, the transmission line connects to the National Grid)	Impact or alteration of cultural. archaeological or historical sites	- Refer to above section on "Impact or alteration of cultural. archaeological or historical sites"		
	Soil erosion	- Refer to above section on "Soil erosion"		
	Increase road transportation	- Refer to above section on "Road transportation". - Particularly during wire spreading, at the crossover point with transportation route, safety measures have to be implemented for persons and vehicles involved in traffic. As well as, place scaffold over roads, classify traffic, place signs in two sides of the road ...		
	Power lines crossing	May cause impact on power lines crossing during wires spreading	Avoid to pose impact on power lines crossing during wires spreading	- Comply to safety measures during wires spreading over power lines at the crossing point, such as: place scaffold when spread power wire, ensure a safe hanging distance with current power lines. - Coordinate with local authorities to temporary cut the power during wire spreading.
	Landmines and explosives remnants from war	- Refer to above section on "Refer to above section on "Accidents and unexpected incidents"		
	Accidents and unexpected incidents	- Refer to above section on "Accidents and unexpected incidents"		
	Vehicle and equipment maintenance and storage	- Refer to above section on "Vehicle and equipment maintenance and storage"		
	Domestic, construction waste	- Refer to above section on "Domestic, construction waste"		
	Increase demand for shared natural resources (land, forest…)	- Refer to above section on "Increase demand for shared natural resources (land, forest…)"		

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	Alternate cultural identity and ethnicity	- Refer to above section on "Alternate cultural identity and ethnicity"		
	Job creation for local workforce	- Refer to above section on "Job creation for local workforce"		
	Forest fire	- Refer to above section on "Forest fire"		
Constructing residential area	Dust generation	- Refer to above section on "Dust generation"		
	Noise and vibration	- Refer to above section on "Noise and vibration"		
	Alteration of forest cover. production land	- Refer to above section on "Alteration of forest cover, production land"		
	Impact or alteration of cultural, archaeological or historical sites	- Refer to above section on "Impact or alteration of cultural. archaeological or historical sites"		
	Soil erosion	- Refer to above section on "Soil erosion"		
	Increase road transportation	- Refer to above section on "Increase road transportation"		
	Infrastructure and public constructions	- Refer to above section on "Infrastructure and public constructions"		
	Landmines and explosives remnants from war	- Refer to above section on "Landmines and explosives remnants from war"		
	Accidents and unexpected incidents	- Refer to above section on "Accidents and unexpected incidents"		
	Vehicle and equipment maintenance and storage	- Refer to above section on "Vehicle and equipment maintenance and storage"		
	Domestic, construction waste	- Refer to above section on "Domestic, construction waste"		
	Increase demand for natural resources sharing due to land acquisition (land, forest…)	- Refer to above section on "Increase demand for natural resources sharing due to land acquisition (land, forest…)"		

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Improvement and Mitigation Measures
	Resettlement of households and villagers as a result of the construction of the resettlement areas. Increase in number of households in communes/village/hamlet having resettlement areas	- Refer to above section on "Resettlement of households and villagers as a result of construction of resettlement areas" and "Increase in number of households in communes/village/hamlet receives resettled households"		
	Impact on the heath of local people	Increase in demand on using sanitary and health care services in the area where the resettled people will move to.	local people under the resettlement plan will be supported with suitable services	- Propagandize, enhance the awareness of personal hygiene and infectious diseases. - Supply fresh water, build toilets. - Ensure that resettled residents have an access to appropriate health services in the locality.
	Job creation for local workforce	- Refer to above section on "Job creation for local workforce"		
	Forest fire	- Refer to above section on "Forest fire"		

6.1.2. Operational Phase

Mitigation standards and measures to minimize impacts during the operational phase are shown in the following table.

Table 6.2: Mitigation Standards/Measures to minimize impacts during operational phase

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
Reservoir operation Operation of hydropower plant (turbine; flow to downstream; cargo trucks...)	Submerged biomass	Reduce oxygen levels in the water due to decomposition of biomass	Maintain oxygen levels for aquatic life	• Follow the approved hygiene plan to ensure that the reservoir area is cleaned before the impoundment. • Continue to implement the monitoring. sampling. analysis and assessment of water quality and water in reservoir after operation. • Recommend on additional measures to be conducted when needed.
		Odor caused by biomass decomposition	Prevent the formation of odor	Implement approved hygiene plan for reservoir area to minimize amount of emissions generated by the biomass decomposition in the water that may cause noxious odors.
		Biomass decomposition can cause eutrophication	Nutrient content and reservoir quality is maintained	Follow the approved hygiene plan to ensure that the reservoir area is cleaned before the impoundment. • Periodically monitor water quality. • Recommend on additional measures to be conducted when needed.
		Increase amount of waste, floating debris that may obstruct the normal operation of the turbine	Prevent floating garbage and other debris to clog the intake	• Conduct specified measures according to reservoir cleaning and hygiene plan. • Operate equipment inlet trash in accordance to the regulations.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
	OB toxic chemicals	Water pollution affects the development of aquatic life, human health, and other water users	Prevent the wide dispersal of OB toxic chemicals that may cause water pollution, avoid impact on people's health and other water users.	• Conduct reconnaissance to detect OB before impoundment (if detect).
	Sedimentation in reservoir	Increased sedimentation behind impoundment	Maximize useful life of reservoir	Maintain management and protection measures of watershed forest in the catchments area to minimize erosion and sedimentation in the reservoir. Maximize useful life of reservoir by continuous monitoring and us of sedimentation model for calculation of reservoir sedimentation.
	Erosion in the upstream and downstream areas	Hoi Xuan reservoir will contribute to reduce erosion in downstream area due to the load operational mode of Trung Son Hydropower		

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
	Flood	Together with Trung Son hydropower in upstream, the process to retain water in Hoi Xuan reservoir will contribute to slow flooding. reduce damages caused by floods to the downstream	Together with Trung Son hydropower in upstream, the process to retain water in Hoi Xuan reservoir will contribute to slow flooding, reduce damages caused by floods to the downstream	Comply with approved procedures for reservoir operation.
	Reduce sediment transport to downstream	Along with Trung Son reservoir, Hoi Xuan reservoir will reduce amount of sediment transported to downstream, affecting agricultural land, aquaculture production in downstream area	Ensure the integrity of downstream habitat	Collectandanalyze water samples periodically to assess the sediment's concentrations downstream

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
	Changing hydrological flow in upstream and downstream areas	Maintain flow. water levels; stabilize and regulate flow downstream by covering peak operation mode of Trung Son Hydropower	-	Comply with approved operational procedures.
	Environmental flow	When Hoi Xuan reservoir is built, environmental flows are maintained and stabilized at a higher level than the case of having only Trung Son reservoir, maintain good ecology, and contribute to removing salt from reservoir's water downstream	-	-

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
	Artifacts having cultural / historical significance	There is submerging risk to valuable antiques/artifacts having cultural historical significance in the reservoir and the downstream due to the discharge of flood and dam failure incidents	Prevent damage and loss to cultural / historical sites within reservoir and downstream areas	• if the value antiquities are discovered during construction, vegetation clearance, investors have the responsibility to inform relevant authorities for appropriate measures as prescribed. • Locations, which have risk for erosion, will be monitored during operation. • Further study, research and investigation will be complied with Law on Cultural Heritage. • Develop plan to preserve and/or relocate historic, cultural relics/monuments (e.g: additional surveys, consultation with the Law on Cultural Heritage ...).
	Induce earthquake excitation and trigger the activity of tectonic faults	An earthquake excitation occurs can shift the dam causing water reservoir leakage or dam failure	Prevent earthquake excitation and the reactivation of tectonic faults	Conduct research to thoroughly explored geological conditions during project implementation to take appropriate measures. Conduct regular monitoring the shifts of the dam. Regularly and periodically monitor water levels, flow of reservoir to evaluate the potential loss of water in reservoirs.
	River transportatio n	Obstruct river transportation	Maintain the waterways for transportation in the downstream of the dam and reservoir area	Residents will continue navigation activities in the reservoir area and the downstream of the dam when the reservoir is formed. Connect transportation routes to maintain traffic in the basin.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
	Tourism services	Landscape of reservoir is the prerequisite for the development of tourism activities	-	Associate with other tourism resources to exploit the tourism potential. Encourage recreational activities and tourism towards sustainable travel to prevent impact to aquatic.
	Land and soil resources	Loss of land	-	-
	Noise due to the plant operation	Noise generated during plant operation is relatively low but constantly affect operational staff	Noise must be limited within the allowable range that does not pose affect health of operational workers	• Design and select advanced, modern technology, machine and equipment. Comply the proper procedure to operate machinery and equipment. • Perform appropriate maintenance of machinery and equipment. • The muffler will be installed on machines where necessary to reduce noise. • Arrange working time of operational workers under the provisions.
	The hazardous waste generated during operation	Pollute the environment	Do not discharge into the environment	Take measures to collect and thoroughly treat hazardous waste; do not discharge into the environment.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
Operational Staff	Incident caused by transformer oil	Transformer oil is hazardous substance to the environment	Prevent the leakage of transformer oil to environment	Develop plan to collect transformer oil when incidents occur. Sign contact with functional agency to properly collect and process.
	Explosion fire incident	Cause economic losses to investors, and pose impact on the power supply system	Avoid, prevent explosion incident during the operation of the plant	Periodically inspect and maintain equipment and machinery of the plant to quickly detect incident are likely to cause explosion. Develop plans for fire protection as prescribed. Provide regular training on fire safety for the operational staff.
	Electric shock accident	Directly threaten to life of operational staff	Prevent electric shock accident during operation	The operational staff must be regularly trained on principles of electrical safety. Operational staff are equipped with appropriate protective equipment.
	Road transportatio n	Increase in noise, dust and density of vehicles	Ensure the activities of vehicles will not disrupt or affect local residents.	Repair and maintenance operation roads as needed. Install traffic signs in dangerous position on the operation routes. Properly maintain traffic vehicles according to specified procedures.
	Produced electricity	Power supply to the national grid to meet power needs for socioeconomic development	-	-

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
	Concentrating operators	Increased demand on usage of resources	Sustainability of natural resources shall be maintained	Education and awareness on management of natural resources. Co-management of existing natural resources between operational staff and communes.
		Increased demand for community and health services	Services shall adequately support operational staff and local villagers	Facilities and services shall be provided to operational staff.
Activities of the operational management road		Impact to existing cultural and ethnic minority groups	Cultural and ethnic minority groups shall not be permanently affected	Provision of communication networks and social programs shall be introduced to assist minority groups. if necessary.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
		Impact on the management of local government, and on the local security and order	Impact on the management of local government, and on the local security and order	Declaration of temporary absence or temporary residence for workers and officers. Require workers and officers comply with law on social security in the local area, do not cause conflict and disunity with locals.
	Waste, waste water	Change water quality of the downstream area	Uphold the downstream area's water with Vietnam quality standards	Comply with the requirements of the approved report on environmental impact assessment.
	Dust	Decreased air quality for affected commune and households	Minimize affects of dust created on health of affected groups	Continuous maintenance of roads. Pave roads, if necessary.
	Noise and vibration	Refer to "Noise and vibration creation" sections under "Construction impacts" for further details		

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
Operational line	Traffic system	Improved transportation	Roads shall be maintained to facilitate local transportation	Road maintenance and repair
	Transmission line	Supplying power from Hoi Xuan HPP to the national power grid to meet the needs of socio- economic development		
	Process of repair and maintenance of transmission lines	Impact on the ecological environment by cutting tree down and violating the ROW	Not letting trees affect operation safety of the power line	Periodically check the encroachment of the tree inside and outside the ROW of the transmission lines. Propagating and forbidding to plant new fast-growing trees under line's the ROW to avoid potential impact on the transmission lines.
	Safe for transportation operations, infrastructure at crossover point; houses and buildings under ROW	Impact on transportation operations, power lines at crossover point; houses and buildings under ROW	Ensure no impact on transportation operations, power lines at crossover point; houses and buildings under ROW	Periodically check the suspension height to have appropriate remedies

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
	Electromagnetic field	Impact on the health of people living under the ROW and nearby area	Ensure no impact on people's health	Grounding for houses and buildings under the ROW. Measuring electromagnetic fields in accordance to operating procedures. Measuring electromagnetic field when local people have complaints.
	Power pole falling down incident by landslides, wind storms	Impact on the operation of the power lines	Prevent power pole falling down incident to happen	Periodically check the stability of the pole foundation to have handling measures in time. Reinforcing pole foundation if sink, crack and erosion sighs appear. Relocate the pole foundation's position if necessary.
	Broken or burnt cord, electric shock, lightning strike incident	Impact on the operation of the power lines	Prevent these incidents to happen	Periodically maintain and check on the power line to detect the problem in time. Grounding for power line. Propagating and educating people to be conscious of safety of high-voltage grid to avoid breaking the lines.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
Operation of resettlement areas	Essential infrastructure and public constructions of resettlement areas are newly built and upgraded	Residents is benefited	-	-
	Waste water, waste	Contaminate the environment of soil, water and air	Limiting to discharge directly into the environment	Gray waste (feces, urine) is collected in latrines, toilets of households. Domestic wastewater is usually collected in the public drainage system of households, and is filtered, decomposed before draining into the environment. Domestic waste is collected to planned landfill.
	Moving people to resettlement areas	Management of local government, security and order in the province	Ensure the management of local government, security and order in the province	Local government strengthen the management to ensure the security and order in the area. Propagate and educate people to respect customs and culture of indigenous people.

Impact Agent	Issue	Impact	Mitigation Objective/ Standard	Project Mitigation Measures
	Natural resources (land, forest…)			Implementing compensation and assistance measures to appropriately restore people's livelihood. Investors coordinate with local authorities to seek measures supporting people to quickly stabilize their life and production; and seek solutions for alternative sources of revenue to recover their incomes in order to limit people illegally use forest land for production, hunting, or logging. Propagate the awareness of forest protection, rational exploitation of natural resources.
Reservoir operation	Submerged biomass	Reduce oxygen levels in the water due to decomposition of biomass	Maintain oxygen levels for aquatic life	• Follow the approved hygiene plan to ensure that the reservoir area is cleaned before the impoundment. • Continue to implement the monitoring. Sampling, analysis and assessment of water quality and water in reservoir after operation. • Recommend on additional measures to be conducted when needed.
		Odor caused by biomass decomposition	Prevent the formation of odor	Implement approved hygiene plan for reservoir area to minimize amount of emissions generated by the biomass decomposition in the water that may cause noxious odors.

6.2. Environmental Supervision Framework

Environmental supervision is a process to ensure project-related construction activities are completed in compliance with the Vietnamese Government, regulations and mitigation measures as outlined in the ESIA and EMP. With respect to the Hoi Xuan HPP, supervision is required primarily during construction activities.

6.2.1 Construction Supervision – Environmental Unit of VNECO HOI XUAN

- EMP/ESIA provisions are incorporated into contractor documents;

- Adequate resources and personnel are in place to supervise EMP/ESIA performance;

- Contractor and all sub-contractors comply with EMP/ESIA regulations on a daily basis;

- Audits or compliance reviews are completed on a scheduled basis and the results provided to either the MIGA or Government of Vietnam; and

- All monitoring resources are properly implemented and data is adequately recorded for reporting purposes.

The Project Environmental Officer (PEO) will represent the VNECO HOI XUAN for project-related matters and will be responsible for ensuring the ESIA and EMP mitigation measures are employed.

The environmental unit of VNECO HOI XUAN will be responsible for supervising and monitoring all construction activities.

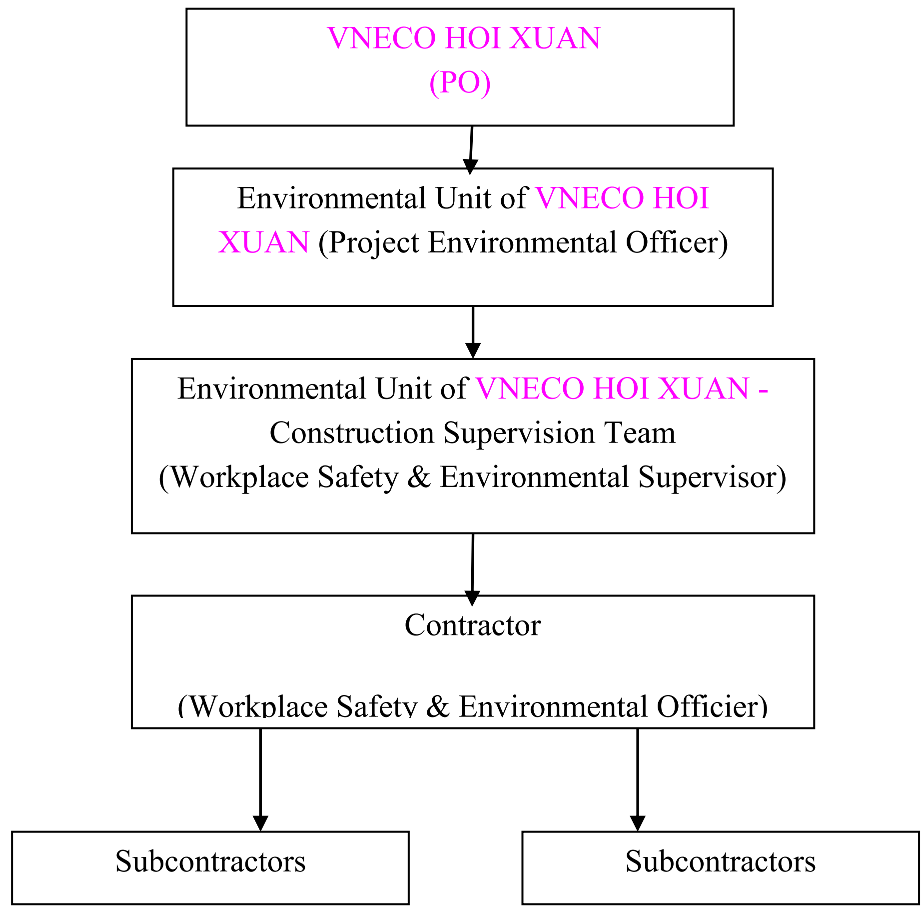


Figure 8.1: Supervision Structure of Hoi Xuan HPP

6.2.2 Construction Supervision – Contractor Responsibility

The Contractor (and sub-contractors) shall organize representatives within an Environmental Team (ET), which shall be lead by the Workplace Safety & Environmental Officer (SEO). Collectively, the ET and SEO shall ensure construction activities abide by EMP/ESIA requirements.

For additional details on roles and responsibilities refer to the Construction Camp Management Plan in Annex A. Table 6.3 describes the supervision framework for overseeing environmental and socio-economic parameters for the construction of the Hoi Xuan HPP.

Table 6.3: Construction Supervision Framework of the Contractor

Issue	Location: Where is the issue?	Parameter: What is being overseen?	Procedure: How is the issue managed?
Forest/vegetation clearing; house, auxiliary, building and grave clearing	Dam, power way, powerhouse, OPY, and other auxiliary works. Boundaries of the reservoir. Cleaning residential area (House, auxiliary work). Moving grave area (old cemetery) and assembly grave area to be moved (new graveyard). Connection power line, power line for construction, Resettlement area. Storage and disposal sites.	- Harvesting techniques. - Debris storage and disposal sites. - Exploitation of natural resources. - Involvement of local community in clearing.	Daily observations Reporting incidences Report provided to VNECO HOI XUAN altermination of clearing.

Issue	Location: Where is the issue?	Parameter: What is being overseen?	Procedure: How is the issue managed?
Noise	Construction site Project – adjacent communes	Amount of noise being created during construction hours and days. Frequency of disturbance to local villagers.	Visual and auditory observations. Report forms Monthly reporting to VNECO HOI XUAN
Dust	Construction site Access Roads Water withdrawal sites	Amount of dust generated during construction activities	Daily observations. Incident reporting Monthly reporting to VNECO HOI XUAN
emission	Construction area (08 locations: dam construction site, house power (KK1), auxiliary works area (KK2); house and work areas (KK3, KK4); roads (KK5) area, construction of resettlement areas (KK6), regional transmission line construction (KK7, KK8). The villages near the project The place of water for irrigation and moisture	The level of pollution emissions at construction sites; camps; access road, etc. Parameters monitored: CO_x, NO_2, SO_2, Pb	Daily observations. Measured parameters of dust 01 times / week. Monthly reporting to VNECO HOI XUAN
Management of hazardous materials (fuels, lubricants, explosives, etc.)	Hazardous materials storage site	Storage facility location. security and maintenance.	Inventory checklists Reporting incidents or accidents

Issue	Location: Where is the issue?	Parameter: What is being overseen?	Procedure: How is the issue managed?
			Quarterly reporting to VNECO HOI XUAN
Solid waste	Designated landfill Construction site Camp sites	Amount of waste generated at construction and camp sites. Amount of waste disposed at the landfill. Recycling of material. Littering and contamination of environment.	Waste tracking sheets or register Incident reports Monthly reporting to VNECO HOI XUAN
Sewage waste	Construction site services Camp site services	Quantity and quality of sanitation services provided. Misuse of sanitation services. In appropriate disposal of human waste.	Daily checklists Incident reports. Monthly reporting to VNECO HOI XUAN.
Water	- Construction area: + Surface water: 4 position (end of Hoi Xuan	- Water supply	Reports on abnormal issues.

Issue	Location: Where is the issue?	Parameter: What is being overseen?	Procedure: How is the issue managed?
	reservoir (NM1), middle reservoir HX (NM2), behind the the dam HX (NM3), the position before the confluence with the river flow (NM4)). + Groundwater: 02 positions (well / water supply source for operation workers (NN1), groundwater seeping from excavation pit of the plant (NN2), underground water form excavation for water transmission line construction (NN3)	- Quality of water supply: + Surface water monitoring parameters include: pH, DO, COD, BOD_5, TSS, NO^{2-}, NO_3, PO_4^{3-}, S, As, Cd, Pb, Cr, Cu, Zn, Ni, Fe, Hg, Oil grease, Coliform, Ecoli. + Groundwater pH, TSS, COD, NO^{2-}, NO_3, SO_4^{2-}, CN, As, Cd, Pb, Cr, Cu, Zn, Mn, Hg, Fe, Se, Ecoli Coliform. - Misuse of water sources storage purposes. - Use the wrong purposes of natural water sources. - Pollute water sources.	Establishing monthly report and submit to VNECO HOI XUAN.
Potable Water	Construction site Camp site	Misuse of water reserves. Misuse of natural water sources. Contamination of water resources.	Daily checklists. Incident reports. Monthly reporting to VNECO HOI XUAN.
Construction	Construction site	Vehicles/equipment operating at	Daily checklists

Issue	Location: Where is the issue?	Parameter: What is being overseen?	Procedure: How is the issue managed?
equipment and vehicle maintenance	Vehicle/equipment storage area Access roads	standard levels Excess oil, fuel, lubricant leaks and gas emissions Disorderly conduct or misuse of equipment /vehicles	Incident reports Quarterly reporting to VNECO HOI XUAN
Worker Code of Conduct and Safety	Construction site Camp site	Safety, security and orderly conduct of construction workers. Accidents and unplanned events. Conflict with local villagers.	Environmental and safety meetings held regularly Incident report forms Quarterly reporting to VNECO HOI XUAN

The monitoring positions are shown in the Figure 3.

6.3 Construction Phase

- Monitoring during Hoi Xuan HPP construction phase will have two principle purposes:
- Implement systematic observations to periodically measure the result of proposed mitigation measures; and
- Continue data collection in order to compare baseline environmental conditions with conditions during construction and operation.

The majority of construction monitoring shall be done visually and verified by the Construction Supervisor. Checklists shall be conducted to identify potential environmental and social issues early. Proper courses of actions shall be proposed if any proposed mitigation measures are not in compliance with Government of Vietnam regulations or unable to properly reduce and/or eliminate environmental and/or socio-economic impacts.

The Environmental Unit of VNECO HOI XUAN will be responsible for carrying out environmental sampling and monitoring on all environmentally related issues regarding the Construction Contractor's activities. If necessary, the Environmental Unit will hire outside consultants to undertake sampling. The Environmental Unit will develop and maintain a database of all project related monitoring and supervision data.

Monthly reports shall be issued to the VNECO HOI XUAN and where required, the MIGA, to summarize construction activities, document those that require amendment and to identify whether or not remedial actions are needed.

Table 6.4 identifies the monitoring activities to be carried out during the Construction Phase.

Table 6.4: Construction Monitoring Plan Framework

Issue	Responsibility: Who will monitor?	Duration: When is monitoring done?	Parameter: What is being tracked?	Location: Where does monitoring occur?	Procedure: How is the issued or recorded?
Noise	IEMC/ VNECO HOI XUAN	Daily observations	Frequency of disturbance to local villagers Requirement for sound barrier installation. As required	Construction site Adjacent communes	Auditory or with portable noise monitoring equipment

Issue	Responsibility: Who will monitor?	Duration: When is monitoring done?	Parameter: What is being tracked?	Location: Where does monitoring occur?	Procedure: How is the issued or recorded?
					Reporting Forms Monthly reporting.
Air quality	IEMC/ VNECO HOI XUAN	Construction Contractor: weekly testing IEMC/ VNECO HOI XUAN: 03 months / 01 times	Amount of dust generated Requirement for spraying roads, site to control dust and water supply.	Construction site Access roads Water withdrawal sites	Visual Reporting forms Monthly reporting

Issue	Responsibility: Who will monitor?	Duration: When is monitoring done?	Parameter: What is being tracked?	Location: Where does monitoring occur?	Procedure: How is the issued or recorded?
Water quality	IEMC/ VNECO HOI XUAN Construction Contractor	Construction Contractor: Monthly testing IEMC/ VNECO HOI XUAN: 03 months / 01 times	Parameters: Surface water: pH, DO, COD, BOD_5, TSS, NO^{2-}, NO^{3-}, PO_4^{3-}, CN, As, Cd, Pb, Cr, Cu, Zn, Ni, Fe, Hg, oil grease, coliform, ecoli + Underground water: pH, TSS, COD, NO^{2-}, NO_3^-, SO_4^{2-}, CN^-, As, Cd, Pb, Cr, Cu, Zn, Mn, Hg, Fe, Se, Ecoli, Coliform + Waste water: pH, TSS, TDS, DO, BOD_5, NO_3^-, NH_4^+, NO_3^-, total P, coliform, detergents, oil and grease.	- Ma river. - Water supply for construction and workers - Positions releasing wastewater	Water sampling Laboratory Testing Monthly reporting
Water resources	IEMC/ VNECO HOI XUAN Construction	Weekly testing	Amount of water available for construction site,	Water reserves and resources Construction and	Monthly Reporting

Issue	Responsibility: Who will monitor?	Duration: When is monitoring done?	Parameter: What is being tracked?	Location: Where does monitoring occur?	Procedure: How is the issued or recorded?
	Contractor		camp site and resettlement communes	campsites Project affected communes	Consultation with project affected communes
Sedimentation and erosion	IEMC/ VNECO HOI XUAN Construction Contractor	Daily, as required	Amount oferosion and sediments being released, particularly into water resources	Construction Site Borrow pit Sites Cleared areas	Visual Observations Daily Environmental checklists Monthly reporting

Issue	Responsibility: Who will monitor?	Duration: When is monitoring done?	Parameter: What is being tracked?	Location: Where does monitoring occur?	Procedure: How is the issued or recorded?
Natural protected areas	IEMC/ VNECO HOI XUAN Construction Contractor	Monthly	Tress into Protected Areas Exploitation of Natural Resources	Natural Protected Areas Access roads	Visual Observations Security Checks Monthly reporting
Chance finds of culturally significant artifacts or sites	IEMC/ VNECO HOI XUAN Construction Contractor	Daily. as required	- Accidental discovery of culturally significant artifact or site	Excavation Sites Borrow sites Construction site	Visual Implement Chance Find Procedures
Auxiliary project components (roads,	IEMC/ VNECO HOI XUAN Construction		Road traffic and Associated issues (noise, dust, displacement of people, etc.)	Access roads Transmission line areas	Visual Refer to other sections for

Issue	Responsibility: Who will monitor?	Duration: When is monitoring done?	Parameter: What is being tracked?	Location: Where does monitoring occur?	Procedure: How is the issued or recorded?
transmission lines, etc.)	Contractor				additional information (i.e, Noise, Dust, etc.)
Site reclamation	-IEMC/ VNECO HOI XUAN Construction Contractor	Post-construction Salvage. reinstatement of land	Ability of soils, vegetation, water resources, fauna and biodiversity to replenish after construction	- Construction Site - Camp sites	Monthly Assessments Quarterly reporting

6.4 Operation Phase

Monitoring during the operation phase shall reflect those environmental and socio-economic issues that may persist upon completion of construction activities. For the Hoi Xuan HPP, the following are some of the issues that will require monitoring:

***Hydrology**:* Hydrological monitoring stations shall be implemented to primarily measure Ma river's inflow, the newly constructed reservoir's storage volume and amount of water discharged downstream. Monitoring hydrological features of the Hoi Xuan HPP shall be used in conjunction with water quality data to identify how the Trung Son dam is affecting Ma river and associated rivers and tributaries.

Water Quality: Measuring water quality is a rapid evaluation of the general condition of the water within Ma river, reservoir and downstream of the dam site. The frequency and location of monitoring sites shall assist in providing an early detection if there are deviations from normal standards and help in determining if further actions are required.

Sedimentation:Sedimentation is a concern once the dam has been constructed and the reservoir has been inundated. Sediment monitoring shall assist in determining annual sediment volumes being introduced into the reservoir and the lack of sediments being transported Environmental Management Plan Hoi Xuan HPP downstream. Continuous monitoring, sampling and calculation of sedimentation in the reservoir shall be undertaken.

***Downstream Erosion**:* The possible erosion of downstream historical/cultural artifacts is potential concern. Identified sites subject to potential erosion shall be identified and monitored during project operation.

Aquatic Biodiversity and Fish: The creation of a physical barrier due to the Hoi Xuan dam shall directly impact aquatic life and alter species biodiversity. Routine monitoring would assist in creating species profiles and determine how species are adapting to the newly constructed dam site.

***Resettlement of Displaced People and Downstream Users**:* The Hoi Xuan HPP project shall physically displace numerous people and alter the livelihoods of several upstream and downstream communes. Due to the high percentage of ethnic minority groups, the persistence of poverty in the area and housing of permanent operational staff, monitoring of the success of resettlement and compensation activities is critical to ensure potential impacts do not persist upon construction activities. Monitoring programs shall incorporate several phases of public consultation to verify if additional actions are required.

***Auxiliary Project Components*:** The Co-Luong to Co-Me road requires post-construction monitoring to ensure its operation does not negatively (i.e, noise, dust, etc.) impact those adjacent-living communes, increase access into Protected Natural Areas and provides a medium for drug export and trade.

Table 6.5: Operation Monitoring Plan Framework

Issue	Responsibility: Who will monitor?	Duration: When is monitoring being done?	Parameter: What is being monitored?	Location: Where is the Parameter being monitored?	Procedure: How is parameter being monitored?
Hydrological flows of the Ma river	VNECO HOI XUAN	Weekly and monthly reporting Quarterly reporting	Hydrological flows Reservoir volume	Hoi Xuan HPP dam site and reservoir	Water gauge Stations Flow measuring devices
Water quality levels in Ma river, groundwater and wastewater	VNECO HOI XUAN Laboratory staff are trained	Weekly and monthly reporting Quarterly reporting	Parameters: Surface water pH, DO, COD, BOD_5, TSS, NO_2^-, NO_3^-, PO_4^{3-}, S, As, Cd, Pb, Cr, Cu, Zn, Ni, Fe, Hg, oil and grease, coliform, ecoli Groundwater pH, TSS, COD, NO_2^-, NO_3^-, SO_4^{2-}, CN, As, Cd, Pb, Cr, Cu, Zn, Mn, Hg, Fe, Se, ecoli, coliform	The end of lake and reservoir, behind the dam downstream Hoi Xuan HPP and at place before the confluence with the Luong, groundwater supply of water for living of operation workers	The list of the necessary checks and water quality forms. Laboratory testing

Issue	Responsibility: Who will monitor?	Duration: When is monitoring being done?	Parameter: What is being monitored?	Location: Where is the Parameter being monitored?	Procedure: How is parameter being monitored?
Sedimentation	VNECO HOI XUAN	Monthly reporting Quarterly reporting	Decaying debris, nutrients, level of eutrophication.	Down stream-upstream Hoi Xuan HPP dam site and reservoir	Laboratory testing Checklists and environmental reports
Aquatic biodiversity	VNECO HOI XUAN	Monthly reporting by Environmental Inspectors Quarterly reporting to VNECO HOI XUAN	Aquatic Communities (algae, vegetation, etc.) and fish species	Hoi Xuan HPP dam site, reservoir and downstream	Limnological sampling of microflora, microfauna and benthonic communities Electro-fish Sampling Consultation with upstream /

Issue	Responsibility: Who will monitor?	Duration: When is monitoring being done?	Parameter: What is being monitored?	Location: Where is the Parameter being monitored?	Procedure: How is parameter being monitored?
					downstream
Erosion downstream	VNECO HOI XUAN	Quarterly reporting	Erosion impacts downstream on historical and cultural artifacts	Buildings. historical and culturally significant sites	Visual Photos Reporting forms
Noise	VNECO HOI XUAN	Quarterly reporting	Noise created Operating Hydroelectric Plan Noise created from traffic on access roads Frequency of disturbance to local villagers	Hydroelectric plant and access roads Adjacent communes	Auditory Visual Reporting forms
Dust	VNECO HOI XUAN	Quarterly reporting	Amount of dust Being generated	Access roads	Visual Reporting forms

Issue	Responsibility: Who will monitor?	Duration: When is monitoring being done?	Parameter: What is being monitored?	Location: Where is the Parameter being monitored?	Procedure: How is parameter being monitored?
			Nuisance/ disturbance to households		

6.5. Implementation schedule and cost estimates

6.5.1. Implementation schedule

Implementing EAP sync with the preparation and construction of the project.

6.5.2. Frequency of reporting

Table 6.6. Frequency of reporting

STT	The report was prepared by	Submitted	Frequency of reporting
1.	Contractors submit investors	VNECO HOI XUAN	01 times before starting construction and then 01 months / 01 times
2.	Construction supervision of VNECO HOI XUAN	VNECO HOI XUAN	-Weekly Monthly Quarterly
3.	Community supervision (if any)	VNECO HOI XUAN	When communities have any complaints about the safety performance of the project.

STT	The report was prepared by	Submitted	Frequency of reporting
4.	Independent supervision	VNECO HOI XUAN	Quarterly
5.	VNECO HOI XUAN	EVN	Six moths/1 times
6.	EVN	MIGA	Six moths/1 times

6.5.3. Capacity Building and Training

6.5.3.1. Education courses/seminars / training

A key component of EAP success depends of effective capacity building of the VNECO HOI XUAN. the training of staff and all others involved in the EAP, including the construction contractor and all sub-consultants. These efforts will also be assisted by the implementation of technical assistance by outside consultants.

All those responsible for the management, implementation and operation of any aspect of the EAP shall be adequately trained for their role. Training records shall be maintained on site, for each employee, to provide evidence for auditing/inspection purposes.

The following training shall be considered for each organization.

1. VNECO Hoi Xuan Investment and Electricity Construction JSC (VNECO HOI XUAN)

The **VNECO HOI XUAN** shall establish an environmental unit to oversee the preparation, implementation and oversight of the EMP and its associated sub plans. The environmental unit shall be provided with enough technical and financial resources to complete this oversight role; external resources or contractors may be required. Specific training to the environmental unit should be provided as follows:

- Principles and procedures for environmental impact assessment;
- Fundamentals of environmental management;
- Compliance assessment, monitoring and follow-up;
- Environmental audits;
- Social impact assessment and public consultation; and
- Fundamentals of aquatic ecology and environmental flows associated with construction and operation of hydroelectric projects (including trained expertise in water quality testing and analysis).

2. Supervising Engineer

The supervising engineer shall have environmental staff trained to ensure contractor compliance with EMP requirements. Alternately, the Supervising Engineer can subcontract this responsibility to adequately trained personnel. Training records, including attendance and specific course, shall be maintained for inspection by the **VNECO HOI XUAN**. Specific training to the environmental unit should be provided as follows

- Principles and procedures for environmental impact assessment;
- Fundamentals of environmental management;
- Compliance assessment, monitoring and follow-up;
- Air, soil and water sampling procedures;
- Construction impacts, including civil works, sediment and erosion control, soil handling and vegetation removal;
- Waste management;
- Fuel and hazardous materials management;
- Fundamentals of aquatic ecology;
- Construction camp management; and
- Auditing and follow-up

3. Construction Contractor

The construction contractor shall have environmental staff trained to ensure contractor and all subcontractor compliance with EAP requirements. The construction contractor shall maintain training records, including attendance and specific course, for inspection by the **VNECO HOI XUAN**. Specific training to the construction contractor environmental unit should be provided as follows:

- Principles and procedures for environmental impact assessment;
- Fundamentals of environmental management;
- Compliance assessment, monitoring and follow-up;
- Air, soil and water sampling procedures;
- Construction impacts, including civil works, sediment and erosion control, soil handling and vegetation removal;
- Waste management;
- Fuel and hazardous materials management;
- Construction camp management;
- Community relations and public consultation procedures; and
- Auditing and follow-up.

4. Independent Environmental Monitoring Consultant

The Independent Environmental Monitoring Consultant shall be trained in the oversight and compliance assessment of large infrastructure projects, including the preparation of compliance reports and environmental sampling procedures, including the following:

- Principles and procedures for environmental impact assessment; Fundamentals of environmental management;

- Compliance assessment, monitoring and follow-up;
- Air, soil and water sampling procedures;
- Construction impacts, including civil works, sediment and erosion control, soil handling and vegetation removal;
- Waste management;
- Fuel and hazardous materials management;
- Construction camp management;
- Community relations and public consultation procedures; and
- Auditing and follow-up.

5. Technical Assistance

In addition to staff training. technical assistance for outside consultants has been included into the training budget. Technical assistance could be full-time on-site within the **VNECO HOI XUAN** or include short visits by outside consultants to provide training seminars and workshops.

6.5.4. Estimates cost of implementing of the EAP

Estimated costs for the initial implementation of the EAP are presented below in Table 6-8. Costs have been defined on an initial set up basis, **VNECO HOI XUAN** will revise these costs and develop annual operating costs for the EAP.

Table 6.7: Preliminary Estimate of EMP Costs

EMP Component	Cost (USD)
1. Contractor	In the contract
Engineering Supervision (includes sampling for environmental quality)	**250,000** (10-25% of engineering supervision cost)
2. Independent Environmental Monitoring	**250,000** (4 years)
3. Institutional Strengthening, Training and Capacity Building ▪ Formation of **VNECO HOI XUAN** environmental unit ▪ Local authorities. communities and other stakeholders ▪ On-site training ▪ Off-site training ▪ Local capacity building ▪ Equipment and logistics	**250,000**
4. Technical Assistance to **VNECO HOI XUAN** environmental unit ▪ Provision of outside consultants Manual of functions and procedures ▪ Assist in development of environmental database ▪ Special issues – e.g, water quality ▪ EMP protocols and procedures ▪ Assist in development of **VNECO HOI XUAN** Environmental Unit ▪ Assist in implementation of updated management plans ▪ Contractor liaison ▪ TORs	**300,000 (3 years)**
5. Chance Finds Procedures and Cultural Property Salvage (including downstream erosion assessment)	**200,000**
6. Biodiversity and Protected Areas ▪ Support to Protected Areas Management Plans ▪ Provision of wardens ▪ Infrastructure and equipment ▪ Education ▪ Tiger Action Plan ▪ Infrastructure and equipment ▪ Education	**200,000**
7. Regional Health Program	**150,000**
Total Initial EAP Costs	**1,550,000**

6.5. The union of environmental action plan and the project

6.5.1. Institution implementation

a) Detailed design and biding document process

During the detailed design and bidding documentation, **VNECO HOI XUAN** is responsible for including both ESIA and the appropriate part of the ESIA (such as mitigation measures and responsibilities of the contractor) into an appendix of the bidding documents and contracts with contractors. The engineer is responsible for referring ESIA to ensure that environmental issues are taken into account fully in the final design.

While setting up bidding documents and contracts, the contractor is required to ensure adequate information about their obligations and responsibilities in the implementation of measures to minimize environmental impact and compliance commitments.

b) Pre-construction and post-construction phase

VNECO HOI XUAN will allocate Construction Supervision Consultant and/or field engineers to be responsible for daily monitoring of the contractors' implementation of safety measures. They will carry out the following major tasks:

Before beginning construction, confirmation of damages to people affected as well as the completion of mine clearance

Review and approval of the EAP at the field will be performed by contractors before the project commencement;

During the construction process, closely monitoring the implementation of mitigation measures during the construction phase;

Confirm compliance with EAP and check any damages caused by the contractor. If necessary, make a record compensation required contractors/restore construction areas as specified in the contract. The implementation issues of environmental safety of the Contractor will be included in the progress report of the sub-projects;

Roles and responsibilities of stakeholders in the implementation of the EAP are described in the table below:

Table 6.8 Institutional Arrangements perform EAP

No.	Responsibility	Mission	Agency
1.	Project owner	Final responsibility for the general management for the project including environmental management	**VNECO HOI XUAN**
2.	Environmental official	Detailed responsibility for environmental issues	**VNECO HOI XUAN**
3.	The project management and implementation unit	Responsible for the coordination and overall management of the project implementation including guidance and supervision of the EAP implementation of: - Establishing and implementing the plan for management activities, environmental monitoring during construction. - Coordinate with other parties related to the environmental management activities. - Conduct internal monitoring and controls. - Supervise and provide funding for supervision activities. - Report on environmental information for stakeholders	**VNECO HOI XUAN**
4.	Operation unit	Responsible for operation of the project including the management activities and environmental monitoring during the operation phase	
6.	Construction Monitoring Consultant	Responsible for supervising construction contractors in the construction phase which includes the implementation of environmental management, monitoring under the EAP.	Monitoring of **VNECO HOI XUAN**
7	Independent Monitoring	Responsible for supervising construction contractors in the construction phase, which includes the implementation of environmental management, monitoring under the EAP.	Consultants chosen by

No.	Responsibility	Mission	Agency
	Consultant		**VNECO HOI XUAN**
8.	Civil contractors	Responsible for the execution and compliance with the technical requirements under the EAP, includes: Apply measures to minimize potential negative impacts in accordance with the description in the EAP. Actively communicate with local people and act to prevent disturbance during construction. Ensure at least one staff member monitoring compliance with EAP before and during construction. Ensure all construction activities have sufficient documentation from relevant organizations Ensure all workers and staffs understand the process and their duties in implementing the EAP. Reporting problems and solutions to the PMB. Report on local government and the PMB if the accident occurred on the environment and coordinate with other agencies and relevant stakeholders to address key issues.	Consultants chosen by **VNECO HOI XUAN**

Perform tasks in EAP, including:

- Implementation of mitigation measures.

- Monitoring the implementation of mitigation measures during the construction phase.

- Perform test environment.

- Coordinate the activities during the EAP implementation and ensure finance for operations.

- To organize / participate in training courses, seminars...

Report:

The report will be made during the implementation of the monitoring program, to gather reports on the impact or people complaining about the project, in consultation with the social and affected by the project and test the effectiveness of the program or mitigation measures available within the ESIA. The table below describes the types of reports will be made, **VNECO HOI XUAN** will be providing the update report to MIGA with the frequency depending on the nature of the non-compliance and monitor progress.

Table 6.9: Types of established reports

Responsibility	Report	Report's purpose	Frequency of report submission	Submit to
Contractor & Personnel of Safety and Environment	Accidents or Incident	Filing/notification of accident or unforeseen events.	Within 24 hours the incident	**VNECO HOI XUAN** /CST
	Non-compliance	Detailed description of the cause, nature and impact of any non-compliance actions on the environment and the socio-economic.	Within one week of the event	**VNECO HOI XUAN** /CST

Responsibility	Report	Report's purpose	Frequency of report submission	Submit to
	Chance discovery	Documentation and registry of newly discovered artifacts	Within 24 hours from when artifacts are discovered	**VNECO HOI XUAN** /CST Competent agencies
	Monthly compliance report	Report to the construction supervision team	Report of compliance and non-compliance measures on a monthly basis	CST
Construction supervision team (CST)	Daily compliance checklist	Checklist of environmental and social compliance of construction	Daily	Internal
	Monthly Compliance Report	Monthly report of compliance within 10 days of receipt of report from contractor	Monthly	**VNECO HOI XUAN**
Project environmental officer & Independent environmental monitoring consultant	EMP updates. including any changes in management or monitoring procedures	For approval prior to implementation	As required, prior to implementation	**VNECO HOI XUAN**
	Key changes in project activities that may trigger environmental approvals	Ensure compliance with environmental regulatory approvals	As required, prior to implementation	**VNECO HOI XUAN**
	Environmental monitoring reports	Notification of non-compliance with standard environmental guidelines and parameters	Dependent on environmental parameter: weekly, monthly, quarterly or annually	**VNECO HOI XUAN**
VNECO HOI XUAN	RLEMDP and sub-plans	Ensure resettled/displaced households transition	On-going	**VNECO HOI XUAN**, MIGA

Responsibility	Report	Report's purpose	Frequency of report submission	Submit to
Environmental unit		successfully into resettlement sites		

6.6. Public consultation and information dissemination

6.6.1 Introduction

Public consultation is an important component of Hoi Xuan HPP and plays a key role in:

• Complete ESIA / EMP for the project;

• Develop a plan for resettlement, livelihood and development of ethnic minorities and component information management and communication.

• The consultation process designed to be a dialogue between the functional parts of **VNECO HOI XUAN** with village leaders, families, local authorities at communes districts and provinces affected.

6.6.2 Objectives

• Inform families and affected communities, local government and social organizations on the impact that the project may cause and propose measures to mitigate such impacts. Information provided in RLEMDP and ESIA/EMP should be announced before the area affected by the project, the Centre for development information (VDIC) in Vietnam and the Center for Public Information of the World Bank world (Info shop) in the United States at least 3 weeks prior consultation;

• Collect comments / feedback to complete the ESIA / EMP and RLEMDP;

• There was initial agreement / commitment to collaborate with local authorities in the implementation phase of the project.

6.6.3 The provisions and requirements

- Performance Standards 1 - Assessment and Management of Environmental and Social Risks and Impact in the document “Performance Standards on Environmental and Social Sustainability” isued by MIGA October 1st, 2013.

- Decree No. 29/2011/ND-CP of the Government dated 18/4/2011 on strategic environmental assessment, environmental impact assessment, and environmental commitment.

- Circular No. 26/2011 / TT-BTNMT 18/7/2011 of the Ministry of Natural Resources and Environment Regulations detailing a number of articles of Decree No. 29/2011 / ND-CP of the

Government dated 18 Apr. 2011 government regulations on strategic environmental assessment, environmental impact assessment, environmental commitment.

6.6.4 The public consultation and disclosure of information previously

In the process of filing a previous project, from Nov 2nd - Nov 14th, 2009, the project has conducted information disclosure and public consultation with local authorities and those affected by the project, conducted interviews with a number of beneficiaries and affected by Hoi Xuan hydropower projects.

This consultation, the project conducted consultation with 18 villages of 11 communes in the reservoir area, the headwork area, and the downstream and upstream (including villages along the reservoir, the main work area; construction and operation roads, and villages affected to land and not displaced and could be impacted on the environments....). Some feedbacks of this consultation and information disclosure are listed as follows:

Table 6.10: Statistics content and comments in the community consultation on the report on environmental impact assessment (2 / 11-14 / 11/2009)

No	Date	Meeting place	Village	Meeting content	Comments
1	6/11/2009	Hoi Xuan Commune People's Committee Hall. Quan Hoa district	Muop village	The project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation, resettlement and report on environmental impact assessment, the decisions to approve the project and the impact assessment environment.	Agree to the policy of Hoi Xuan HPP construction. - The project construction has positive role for the economy, culture and society. - Creating jobs for local workers during construction and operation period. - Recommend the project owner to apply compensation policy, support, migration and resettlement for stable life of households; increase incomes and create jobs for their children. - Support project, there is positive impacts for the local contribution and improve the quality of life - Negative impacts when build the project is inevitable. However the negative effects have been prevention, mitigation and environmental protection plans, etc.
2	5/11/2009	Thanh Xuan Commune	Sa Lang village	The project owner presentation on the contents: - About Hoi Xuan HPP; the overall	- Agree for building Hoi Xuan HPP - Agree with the locations to build resettlement areas in the form relocated

No	Date	Meeting place	Village	Meeting content	Comments
		People's Committee Hall, Quan Hoa district	Vui village	planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation. resettlement and report on environmental impact assessment. the decisions to approve the project and the impact assessment environment.	to ensure the construction of resettlement criteria function countryside, ensuring stable long life for people. - Agree on methods to protect ecological environment and natural - The project have benefits like flow regulation and pushing salty - Creating jobs for people during construction - Tampering with people's lives in displaced time. - Contribute to the local budget; promote development of culture, economy and society.
3	4/11/2009	Van Mai Commune People's Committee Hall	Khan village Co Luong village	The project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and	- The project will contribute to the power supply system, flow regulation and pushes salinity toward the downstream. - Creating jobs for people during construction - The project will upgrade many technical infrastructure for the region. - The Construction of project will create

No	Date	Meeting place	Village	Meeting content	Comments
				society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation, resettlement and report on environmental impact assessment, the decisions to approve the project and the impact assessment environment.	ecological environment, harmonious atmosphere, etc. - Planning of the project is developing a number of jobs such as farming, tourism. - Unanimity on plans to build resettlement areas what the project owner presented - The unanimity is given by The Commune People's Committee and locals agree on the plan for Hoi Xuan hydropower construction.
4	13/11/2009	Trung Thanh Commune People's Committee Hall	- Phai village	The project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation.	- The project will bring the power supply source to the locality and country. - Promoting economy development, improving the quality of life of people. - Creating jobs and contributing to local budgets - The land acquisition of the project and disturbance of people living during displaced time - The project has protection plan for the natural environment and landscapes

No	Date	Meeting place	Village	Meeting content	Comments
				- Discussion of investor documents: documents relating to compensation. resettlement and report on environmental impact assessment, the decisions to approve the project and the impact assessment environment.	- The project owner assured the locals that detailed construction plans of resettlement areas will have been rural functionality to ensure the technical factors and infrastructure system for long-term stable living - Unanimity on the plan for Hoi xuan project construction
5	14/11/2009	Thanh Son Commune People's Committee Hall	Thanh village	The project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation, resettlement and report on environmental impact assessment, the	- The project will bring the power supply source to the locality and country. - Supply power, improve the quality of life for people - Creating new jobs such as fish farming in reservoir, tourism, etc. - Creating fresh view of Landscape Ecology. - The land acquisition of the project and disturbance of people living during displaced time - Unanimity of the local inhabitants and authorities on the plan for Hoi Xuan project construction. - Unanimity on the construction plan of

No	Date	Meeting place	Village	Meeting content	Comments
				decisions to approve the project and the impact assessment environment.	resettlement areas with ensured technical infrastructure: electricity, roads, schools, stations, cultural houses and the water supply system to ensure long-term stability living for local inhabitants.
6	5/11/2009	Thanh Xuan Commune People's Committee Hall	- Eo village Tan Son village Gia village	the project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation, resettlement and report on environmental impact assessment, the decisions to approve the project and the impact assessment environment.	- The project will contribute to the power system and region. - Creating jobs for local inhabitants. - Development of new professions: aquaculture, tourism. - Causing disturbance of people living during displaced time and construction period. - Unanimity on the construction plan of project. - Unanimity on the construction plan of resettlement areas - Unanimity on protect plan of ecological environment and nature
7	11/11/2009	Phu Luan Commune	Pan village,	the project owner presentation on the	- The project provides an annual

No	Date	Meeting place	Village	Meeting content	Comments
		People's Committee Hall	Mo village, Phi village	contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation, resettlement and report on environmental impact assessment, the decisions to approve the project and the impact assessment environment.	electricity output to the country. - Improving the life quality of locals. - Infrastructure construction to ensure life quality for locals. - Causing disturbances of people living in displaced time. - Resettlement area and relocated area are not far from the former place. Therefore they do not change the living habits of people, limit flooding and landslides. - Support is given by the Commune People's Committee to the plan for Hoi Xuan project construction.
8	12/11/2009	Mai Hich Commune People's Committee Hall		The project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation	- The project provides power supply to the system, plus additional water in the dry season. - Creating jobs for local inhabitants. - Causing the disturbances of people living in displaced time.

No	Date	Meeting place	Village	Meeting content	Comments
				schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation. resettlement and report on environmental impact assessment, the decisions to approve the project and the impact assessment environment.	- The impact of land acquisition to the local living and cultivation. - Support is given by the Commune People's Committee to the construction plan for Hoi Xuan project.
9	4/11/2009	Phu Thanh Commune People's Committee Hall	Do village on village	the project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and	- The project provides power supply to the system. - Creating jobs for local inhabitants. - Causing the disturbances of people living in displaced time. - Rebuilding and upgrading the infrastructure in the region. - Contribution to the local budget. - Unanimity on plan for compensation,

No	Date	Meeting place	Village	Meeting content	Comments
				compensation. - Discussion of investor documents: documents relating to compensation, resettlement and report on environmental impact assessment, the decisions to approve the project and the impact assessment environment.	support, resettlement and migration. - The unanimity of the Commune People's Committee on the plan for the Hoi Xuan project construction. - Unanimity on the plans for natural environment protection.
10	3/11/2009	Phu Son Commune People's Committee Hall	Chieng village	The project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation. resettlement and report on environmental impact assessment, the decisions to approve the project and the	- Support and unanimity on the plan for the Hoi Xuan project construction. - Creating jobs for local inhabitants. - Development of new professions: aquaculture, tourism. - AHs will be ensured that infrastructures in the planned resettlement sites are ensured. - The assured locals that detailed construction plans of resettlement areas will have infrastructure system for long-term stable living. - Agree the policy about the project construction. - Unanimity on the plan for project construction.

No	Date	Meeting place	Village	Meeting content	Comments
				impact assessment environment.	
11	2/11/2009	Phu Le Commune People's Committee Hall	Sai village	the project owner presentation on the contents: - About Hoi Xuan HPP; the overall planning of the project and approval of the environmental impact assessment, project scale and implementation schedule ... - Socio-economic significance of the project, the environmental impacts and society, measures to mitigate the impact. - The clearance, resettlement and compensation. - Discussion of investor documents: documents relating to compensation, resettlement and report on environmental impact assessment, the decisions to approve the project and the impact assessment environment.	- The project will contribute to flow regulation and push salinity. - The project meets the needs of developing power supply for the locals and improves the life quality. - Creating jobs for local inhabitants. - Development of new professions: aquaculture, tourism. - The project construction has positive role for the economy, culture and society. - Negative impacts when build the project is inevitable, However the negative effects have been prevention, mitigation and environmental protection plans, etc. - Unanimity on the plan for project construction.

6.6.4 Stakeholders

Stakeholders are affected peoples directly and indirectly, and local authorities of project communes, districts, and provinces.

6.6.5. Public consultation and information dissemination

a) Public consultation

* Public consultation in the project implementation

Public consultation with the affected communities

Consultation will be carried out in each affected villages/ communities. A meeting will be held in each village or hamlet in consultation with the participation of as many people as possible and any of the concerned organizations/individuals. There may be more efforts to encourage women and others to attend because they are able to be removed from the participants; to consider holding separate meetings with any groups reluctant to attend the meeting. A brief oral summary of the project, its impacts and mitigation measures proposed will be presented at the meetings. All questions/comments and requests will be properly recorded and responded when appropriate. Discussion groups will be held if necessary. Besides Vietnamese, translating into local languages discussion will be made when necessary. Capture images and the camera can be done but not affect the consultation process. Minutes on the subject of meetings have been included for each of the consultations that have been agreed with representatives of the subjects consulted. A brief report describes the consultation process and the findings will be made no more than 1 week after the completion of consultation.

Public consultation with the communes in the downstream likely affected by the project.

The commune/villages in the downstream potentially affected can only be fully assessed when the plant puts into operation. The consultation documents will be published in the affected villages and consultation meetings will be held in the communes' center with the participation of representatives of the villages. The contents of the consultation will be adjusted accordingly.

Information provided at the meeting shall include (i) general information about the project; (ii) possible impacts on the local community of the district and mitigation measures; (iii) summary of the main findings from the public consultation; (iv) mitigation measures and implementation plan compensation / resettlement and livelihood restoration proposed; and (v) the responsibility of VNECO HOI XUAN and local authorities and the proposed collaboration between the two parties. Consultation proposals include group discussions to facilitate all attendees can participate. In addition to providing information and receive comments/feedback, hope that local authorities help to know the roles and their responsibilities, and a principle agreement/commitment between VNECO HOI XUAN and local government be constructed in association with a subsequent plan. A summary report of the consultation process and the findings must be made no more than 1 week after the completion of consultation.

b) Information dissemination program

Disclosure of information about the project is necessary during project implementation, ESIA will be announced in Vietnamese at the affected CPCs by a minimum of 60 days prior to construction.

Disclosure ESIA

Vietnamese ESIA report after approved by MIGA will be disclosed by the Project Owner at the affected CPCs, interested organizations can access, read.

English ESIA report will be submitted to MIGA's Info shop for publication.

* Community consultation during construction and operation of the Project

During construction and operation of the project, the project owner will organize public consultations to make adjustments of the EMP. During the construction phase of the project, construction supervision consultant will be hired to oversee the engineering, supervision and implementation of the ESIA commitments as well as to coordinate with project consultation held local authorities, the affected households. ... committed to the implementation of the project ESIA. The opinion obtained (if any) will be transferred to the project owner, project owner then coordinate with the contractor to perform.

6.6.6 Community consultation implementation

Community consultation implementation in the project preparation phase will be divided into two times:

+ Time 1: at the period of identifying the scope for ESIA’s TOR.

+ Time 2: After finishing the draft ESIA

Results of public consultation in ESIA at the first time (from 28 Jul. 2014 - 6 Aug. 2014) are as in the following table:

1. Hoi Xuan

- EIA framework fully render about impact on the environment as well as measures to mitigate the impact of the project. However, it does not clearly mention Impact on the cultural life of the indigenous people and the worker force when they come to the construction area.

- The affected project area is not in the preservation area, thereby there is no need to mention this issue. The ecology of project area is mainly Luong bamboo trees so the area's ecosystem is poor with no rare species.

- The Framework fully outlines impacts, mitigation measures but does not specify the implementing method, and whether it is feasibility for Vietnam environment or not?

2. Thanh Xuan

- The projects do not directly impact on the preservation area so there is no need to mention this issue. The project would affect Luong planting area, so the ecosystem here is mainly the Luong bamboo, vegetation cover is mostly shrubs with no rare species. Focus less on this part and focus more on the parts of the socio-economic impact by the project.

- Establish policies to create jobs, make use of local labors during the construction and operation.

3. Phu Xuan

- There are some issues which are not related or have very little impact to the project. Therefore it is necessary to ignore them to focus on the main contents such as: Impact on ambient air, water, noise, and especially people's daily lives, social security are required to make more specific action programs.

- The responsibility and the monitoring issues of the surveillance unit are needed to make clearer. Avoiding the "all talk and no action" situation or not putting all efforts into action situation.

4. Phu Thanh

- Propose to specify the gender issue. The impact as well as the measures to minimize the impact.

- Section 5.1.4 "Impacts. mitigation measures and improving economy - environment - culture - society" refers only to economic, production issues of 2 ethnics along the shores when operating the facility. As a result, when the hydroelectric plant impound water in the dry season and discharge water in rainy, it will greatly affect to the neighbor areas downstream.

- Develop a clear livelihood plan to minimize the economical impact on households that lose their land. This plan must be consistent with the local to be most efficient.

5. Phu Le

- When constructing the project, the commune is not significantly affected by noise, dust or exhaust gas emission. The biggest impacts are people's economical problems, households losing productive land. Thereby, solving people's livelihood issue should be implemented more specifically.

- The framework also sets out the schedule of the project, but still not specify the construction time frame.

- The framework does not specify the issue of clearing the reservoir foundation when the hydropower plant stores up water.

- Addressing the job creation matter to people in Hoi Xuan hydropower plant for local government to cooperate with the project's investor.

6. Phu Son

- Agree on the items that the framework presents to minimize Impact on the socio-economic environment of the project area. However, it should specify these items in the next stages.

- Monitoring officers and units need to have additional responsibilities in order to improve the quality and effectiveness of the construction.

7. Van Mai

- For the ESIA framework, basically comply with Impacts as well as solutions to mitigate the impact of the project.

- Van Mai commune's impacts are only on houses, lands, fruit trees in the reservoir, and it does not impact on exhaust gas emission, dust, noise as reported earlier. However, the framework report should add more mitigation measures by providing funding for local authorities to carry out the site clearance.

8. Mai Hich

- The framework report have mentioned all the issues that local governments and people concern. All Impacts along with the corresponding mitigation measures are well handled. Highly agree with the presented report.

9. Trung Thanh

- Agree with the presented framework report of the environmental impact assessment. Additional mitigation measures should be added by improving the paddy fields to implement the land for land exchange. Implementing land for land exchange with people that still have much land to households that lose over 60% of their lands.

10. Thanh Son

Agree with the policies. mitigation measures that the framework of environmental impact assessment has mentioned. Assessing its feasibility to see if it is suitable to Viet Nam or not? Apply covering measures to trucks transporting sand, stone, soil and combine with spraying water on the road to ensure that dust will not affect the health of people in the region.

11. Trung Son

The framework report has not mentioned the operating procedures of the. The consultant should complement this item.

The framework report only mentions two hydropower but not the rest of the hydropower plant on Ma river

Some pictures of public consultation in ESIA at the first time:


Picture of public consultation at Hoi Xuan commune


Picture of public consultation at Thanh Xuan commune


Picture of public consultation at Phu Xuan commune

Picture of public consultation at Phu Thanh commune

Picture of public consultation at Phu Son commune

Picture of public consultation at Van Mai commune

Picture of public consultation at Trung Thanh commune

Picture of public consultation at Thanh Son commune

Picture of public consultation at Phu Le commune

The results of public consultation in the second time from 16 August 2014 to 23 August 2014 are as follows:

1. Hoi Xuan commune

- Agreeing with mitigation measures outlined in the report but the PO needs to clarify a few things:

+ To avoid the effect of cutting trees outside the reservoir, we suggest marking out the specific boundary of the reservoir. During the project construction, all arisen problems will have to be discussed with the CPCs and APs. Fire fighting and protection measures have to be strictly applied during the project construction.

- Construction units must declare temporary residence for workers with local governments, even in the change of human resources during the construction.

- Construction units and the PO in cooperation with local authorities to closely manage human labor in the project area, not allow for workers to undermine security and order in the locality.

- To minimize impacts, compensation and assistance have to be completely compensated before the land acquisition for the project.

2. Thanh Xuan commune

- The project will not directly impact on the conservation areas, so this issue should not need much to mention. The project would only affect the bamboo forest, so affected ecosystem will be mainly bamboo trees, poor shrubs without rare species.

- Need to have policies to create jobs, make use of local labor during the project construction.

3. Phu Xuan commune

Agree with content of the project's impacts affecting the natural and social environment stated in the draft ESIA.

Agree with the solutions and measures to minimize Impacts of the project as presented in the ESIA document.

Coordinating with district Councils of compensation, assistance and resettlement to implement good compensation, land clearance for households affected by the project

The PO has to comply with environmental law and regulations of the law on environmental impact assessment.

4. Phu Thanh commune

During the construction and operation phases. the PO need to seriously implement mitigation measures as outlined in the report

- Strictly implement the environmental laws and regulations of the law on environmental impact assessment.

- The material vehicle's bodies transporting for construction must be covered.

- Recommend the PO, construction units implement measures to minimize adverse impacts to environmental protection as stated in the environmental impact assessment report which was approved by the competent authorities.

- The PO have to implement compensation, support for land, crops and assets of affected households before implementing project to avoid adverse impacts disrupt people's lives.

5. Phu Le commune

Suggest the project owner to fully implement the compensation of land, crops and assets satisfactorily prior to withdrawal of the project.

The project owner needs to comply with environmental law and regulations of the law on environmental impact assessment.

- During the construction at positions at traffic road, constructive measures must be applied reasonably so as not to affect traffic and movement.

- During the construction, the construction units have to monitor and declare their temporary residence for construction workers to avoid disorderly local security, not allow for construction workers to violate assets, crops of local people.

6. Phu Son commune

- The report highlighted impacts of the project caused during construction and operation. Also, some mitigation measures are proposed to minimize correspondingly. It is needed to add assistance measures for APs who lost > 40% of their productive land because local people mainly engage in agriculture and planting bamboo.

- In the communes, there is very little paddy field, it is necessary, therefore to find other land resources for ‘land for land’ in order to ensure social security.

7. Van Mai commune

- For the draft ESIA, basically agree with the effects as well as offer solutions to mitigate the impact of the project. It is necessary to clarify mitigation measures and their feasibility.

- Please follow the environmental laws of Vietnam and other provisions of the PPCs

8. Mai Hich Commune

- During the construction phase, the PO creates the conditions for local workers involved in the construction project for the simple items

- During operation, periodically check the electrical field around the powerhouse area. Propagandizing for people to understand and be aware to protect the plant in during the construction and operation.

9. Trung Thanh commune

Highly agree with the items that the report mentioned to minimize impacts on the socio-economic environment of the project area. However, it should specify the items in the next phases.

Monitoring issues need add the responsibility for officers and supervise units to improve the quality and effectiveness of the work

10. Thanh Son commune

Agree with policies, mitigation measures mentioned in the ESIA. They need to be assessed the feasibility and consistent with Vietnamese Law. Vehicle's truck need to be covered during transportation process to reduce impacts on people's health due to dust.

11. Trung Son commune

Agree with the impact assessment in the ESIA, mitigation measures need to be more detailed, and reconsider their feasibility.

Implementing all of commitments on environmental protection mentioned in the ESIA.

Implementing mitigation measures on likelihood proposed by the project after approved by the authorities agencies.

Some pictures of public consultation in ESIA at the second time:

Picture of public consultation at Hoi Xuan commune

Picture of public consultation at Thanh Xuan commune

Picture of public consultation at Phu Xuan commune

Picture of public consultation at Phu Thanh commune

Picture of public consultation at Phu Son commune

Picture of public consultation at Van Mai commune

Picture of public consultation at Trung Thanh commune

Picture of public consultation at Thanh Son commune

Picture of public consultation at Phu Le commune

6.7. Assessment Monitoring EMP

Environment Division of VNECO HOI XUAN will evaluate, monitor and periodically audit the effectiveness of the EMP, including all planning components. Audit Program to adequately cover the scope, frequency and methods typical audit is required for infrastructure projects large. Frequency of audit must reflect the intensity of the activity (more common in the construction process), the severity of the environmental impacts and social and non-compliance noted in previous audits.

6.7.1. The EMP Consideration

Environment Division of VNECO HOI XUAN will review the EMP to assess the effectiveness and relevance as follows:

Implement fully annual evaluation;

After an incident is reported, or a serious non-compliance; and

After an additional request, updates or changes to the EMP, or a component plan.

Consider the EMP should consider the following points:

The adequacy of collecting, analyzing and reviewing data;

Report;

The non-compliance; and

The corrective action was implemented

EMP will be reviewed periodically to assess the procedures and environmental controls to ensure that we continue to apply to the activities being carried out. Environment Division of VNECO HOI XUAN will implement the following consideration:

Complete EMP will be reviewed at least once a year;

Relevant parts of the EMP will be reviewed after an incident is reported;

Relevant parts of the EMP will be reviewed after receiving a partial plans have been updated; and

At the request of stakeholders, including the DONRE, MONRE, MIGA, contractors, engineers monitored the host community or population.

The review will include the collection and analysis of data analysis, monitoring reports, incident reports, complaints and feedbacks from stakeholders, the report DONRE, MONRE, and marginal the consultation meetings and training records to evaluate the effectiveness of the EMP process. Site visits, interviews and other audit methods can also be used.

The plan will be updated to comply with the procedures in Section 6.7.2

6.7.2. The EMP Control and Update

This document will be issued as a controlled document for all organizations and personnel involved. The process must be followed to control the release of the document, consider its effectiveness and provide updates as:

The text issued by the Environmental division of VNECO HOI XUAN will be numbered;

The environment division will conduct a review of any portion of adjustment relating to the EMP;

Environmental Approval, issued a new approval, receipt of a written request of the MONRE / DONRE, or change the internal processes on the basis of corrective action or improvement methodology or process analysis.

CONCLUSION

Hoi Xuan HPP consists of a 102 MW hydropower plant and a reservoir with total storage volume of 63.65 mill.m^3, minimum operating storage volume of 55.92 mill.m and effective storage volume of 7.73 mill.m^3. The project uses natural flow to generate electricity, so the reservoir does not have active storage volume.

The project is proposed to construct in Ma river, located between Trung Son HPP in the upstream and Ba Thuoc I in the downstream, located in the territory of 2 provinces of Thanh Hoa and Hoa Binh in North of Viet Nam. Total investment for the project is estimated at 3,169,267 bill.VND. The proposed construction period lasts about 4 years. The annual generated electricity yield is proposed to be 432.00 million kWh. The reservoir will inundate about 7.5km^2 at FSL.

Major potential environmental impacts caused by the project include (i) the loss of inhabitants' productive land, house/auxiliary structure and assets on the land; the loss of infrastructure, public works and other structures on the land, (ii) Resettlement for the households impacted on their houses, (iii) the loss of forest cover, (iv) the loss of continuousness of Ma river due to constructing damsite (considered in accumulative impact of hydropower cascade system in Ma river).

Among impacts of the project, the most important impact directly affecting to inhabitants' life is that the project will cause impact on the house/auxiliary structure of 617 HHs/2,919 persons. Structure of the house/auxiliary structure is mainly made by wood, cottage, bamboo... so it is easy for taking down and moving to re-install at new place. Based on the status of land resources in the locality, results of public consultation and PAHs' expectation, almost PAHs impacted on their houses and must be displaced for resettlement have expectation that they will be received cash compensation and they themselves will take down their houses, salvage materials of the old house for re-installing at new place whichwill be appropriate with their custom and practice, and culture. Only 42 PAHs in Sa Lang village, Thanh Xuan commune have expectation to be resettled in the concentrative resettlement site. To meet the expectation of these PAHs, the PO in coordination with the local authority consider land resources in the locality and found 01 site with the area of 7.8026ha in-located in the territory of Sa Lang village for constructing the resettlement site for the PAHs of Sa Lang village.

The project also impact on productive land of 1,447 HHs/6,466 persons. Because there is no more land resource for production and all HHs impacted on productive land have expectation to be received cash compensation, thus the project will compensate by cash for the PAHs in order to self-balance productive land (e.g they will receive land transfer from other HHs having much productive land in the locality).

To ensure that PAHs are early stabilized life. production and income rehabilitation, beside compensation for the damages, the PO implements assistance measures as stipulated and has income rehabilitation programs for them, especially ethnic minority HHs. HHs with woman householder and other fragile HHs. Assistance measures and income rehabilitation programs will be studied, implemented in details in Resettlement. Livelihood Rehabilitation and Ethnic Minority Plan (REMDP).

For the loss of forest cover, the PO will coordinate with relative agencies to plant forest for replacement with an area being the same acquired forest area as stipulated.

Environmental impact mitigation measures; environmental risk prevention measure and countermeasures have been developed to mitigate, and regularly or periodically monitor those impacts. Adverse environmental and social impacts of the project can be minimized to acceptable levels by implementing adequately environmental and social management activities. Details of these activities are given in EMP of the ESIA report, and Resettlement, Livelihood Rehabilitation and Ethnic Minority Development Plan (RLEMDP).

The proposed Hoi Xuan HPP's environmental benefits include (i) reducing the lack of electricity for economic development, satisfying demand on load in rush hour, increasing stability for the whole system, (ii) independence of fuel price variations, (iii) less emission of greenhouse gases, (iv) Regulate flow for the downstream of Trung Son HPP, including high and stable discharge and water level remaining in dry season, environmental flow ensurement at good level for ecology, bank reduce in Ma river downstream behind Trung Son damsite, (v) along with Trung Son HPP in the upstream. Hoi Xuan reservoir also contribute to make slow flood, flood reduce for the downstream; contribute to water supplementation and salty reduce for the downstream in dry season, (vi) a general contribution to the development of the area. The issue of environmental protection improvement and awareness enhancement are some of the salient items included in the project planning to adequately address environmental impacts to an acceptable level.