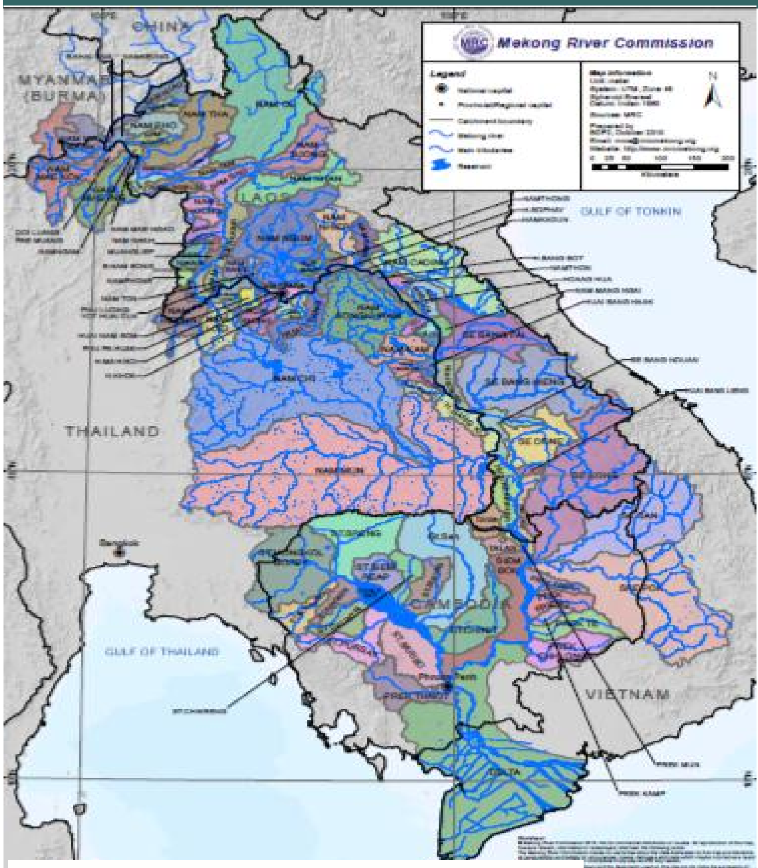
LAO PEOPLE’S DEMOCRATIC REPUBLIC

PAKLAY HYDROPOWER PROJECT

Environmental and Social Impact Assessment
Transboundary Environmental and Social Impact Assessment & Cumulative Impact (TBESIA & CIA)
Final - February 2020



POWERCHINA

NCG

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ASEAN	Association of South East Asian Nations
BOD	Biochemical Oxygen Demand and Chemical Oxygen Demand
BOT	Build Operate Transfer
CIA	Cumulative Impact Assessment
CMPE	Centre of Malariology, Parasitology and Entemology
COD	Chemical Oxygen Demand
DAFEO	District Agriculture and Forestry Extension Office
DHO	District Health Office
DOE	Department of Electricity, Ministry of Industry and Handicrafts
DPRA	Development Project Responsible Agency
ED	Essential Drugs
EDL	Electricité du Laos
EIA	Environmental Impact Assessment
EMO	Environmental Management Office
EMMP	Environmental Management and Monitoring Plan
EU	European Union
FCZ	Fishing Control Zone
FFS	Final Feasibility Study
FishMAP	Fisheries Monitoring Action Plan
FS	Feasibility Study
GFL	Great Fault Line
GMS	Greater Mekong Subregion
GOL	Government of Lao People's Democratic Republic
GWh	Gigawatt hours
ha	Hectare
HC	Health Center
HPP	Hydropower Power Project
HSAP	The Hydropower Sustainable Assessment Protocol
IEE	Initial Environmental Examination
IPP	Independent Power Producer
IUCN	International Union for Conservation of Nature
JMP	WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation
LDCs	Least Developed Countries
MA95	(1995) Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin
MAF	Ministry of Agriculture and Forestry
MDG	Millennium Development Goals

MEM	Ministry of Energy and Mines
MFCB	Mega First Corporation Berhad
MIH	Ministry of Industry and Handicrafts
MONRE	Ministry of Natural Resources and Environment
MOH	Ministry of Health
MOU	Memorandum of Understanding
MRC	Mekong River Commission
MW	Megawatt (1 million watts of power)
NBCA	National Biodiversity Conservation Area
NCG	National Consulting Group
NEAP	National Environmental Action Plan
NGPES	National Growth and Poverty Eradication Strategy
NMRC	Lao National Mekong River Commission
PHO	Provincial Health Office
PAP	Project Affected Persons
PLHPP	Paklay Hydropower Project
PRC	People's Republic of China
RAP	Resettlement Action Plan
RESDALAO	Renewable Energy for Sustainable Development Association
SIA	Social Impact Assessment
SMMP	Social Management and Monitoring Plan
SOW	Statement of Work
STD	Sexually-transmitted disease
TBA	Traditional Birth Attendant
TOR	Terms of Reference
UNICEF	United Nations Children Fund
VHK	Village Health Kit
VHV	Village Health Volunteer
WHO	World Health Organization

1 INTRODUCTION

1.1 Background

Paklay Hydropower Station is the fourth hydropower station (from upper to lower) of the 11 hydropower stations planned for the main stream of Mekong River with Sayaburi Hydropower Station located in the upstream and Sanakham Hydropower Station located in the downstream. Paklay Hydropower Station is a large hydroproject with the main function of power generation and concurrently other multiple functions such as navigation. In the planning report of 1994, the normal pool level of Paklay Hydropower Station is 250m and the installed capacity preliminarily proposed is 1320MW.

Since there is overlap and contradiction in the planned water levels of hydropower stations in the planning report of 1994, the Lao government entrusted the Compagnie Nationale du Rhône (referred to as CNR) of France to carry out recheck and re-demonstration about planning of the 5 hydropower stations (Pak Beng~Sanakham) in Laos. In September of 2009, CNR put forward the final research report Optimization of Mekong Main Stream Hydropower.

On June 11, 2007, the joint venture of Sinohydro Corporation Limited and China National Electronics Import-Export Corporation (referred to as "joint venture") signed an investment and development memo (MOU) for BOT items of PAKLAY Hydropower Station with the Lao government. In November, 2007, the joint venture officially entrusted Hydrochina Zhongnan to carry out the feasibility study on the project of Paklay Hydropower Station.

In November, 2007, Hydrochina Zhongnan began to move in the site to carry out field survey and investigation. In May, 2008, we finished the field survey and investigation as well as field experiment of this stage.

On August 26, 2009, the Lao government gave a notice to the joint venture by letters requiring that the normal pool level of the Paklay Hydropower Station should not be higher than 240.00m. On March 25, 2010, the joint venture made it clear by letters that the feasibility work is carried out based on normal pool level 240.00m as basic water level and required that relevant results of comparison with a normal pool level of 245.00m should be provided at the same time.

In July, 2010, Hydrochina Zhongnan completed the feasibility study on Paklay Hydropower Station as required above and submitted to the joint venture the relevant results of the following recommended dam sites.

On April 28, 2011, the joint venture held the *Technical Review Meeting about Feasibility study Report on Laos Paklay Hydropower Station* in Beijing, in which technical review of the feasibility report submitted by Hydrochina Zhongnan in July, 2011 was carried out. The main conclusion and comments of the review are as follows:

a) The report has reached the design depth of feasibility stage. The design is generally rational and feasible.

b) It is required to give up the lower dam site scheme which has better economic indicators and choose the upper dam site as the recommended one. The report compared the schemes for lower and upper dam sites from two aspects, i.e. technical and kinetic energy economic indicators, which shows that the lower dam site scheme has larger installed capacity, larger mean annual energy output and better construction conditions than the upper dam site scheme. Thus the lower dam site scheme should be preferably selected. However, the relocated population of the lower dam site scheme is about 10,000 ranking the first among the five hydropower stations planned for Mekong River Basin (in Laos) and has aroused the attention of the Lao government. Considering that the relocation problem concerns the local people's livelihood and social stability and that the various uncertainties will increases investment risks, the lower dam site scheme which brings more economic benefits has to be abandoned to select the upper dam site one.

Based on comments in the meeting, Hydrochina Zhongnan Engineering Corporation carried out exploration and feasibility study again for the upper dam site.

On November 29, 2011, the surveying team entered the site and carried out topographic surveying of the road leading to the upper dam site (along the Nanpeng River reach). On January 10, 2012, field surveying was completed. Technicians in geology, drilling, geophysical prospecting and testing disciplines arrived at Paklay one after another on February 24, 2012 to carry out exploration again for the upper dam site and on May 10, all the field work was completed.

In December 2012, the feasibility report in which the upper dam site was recommended, and corresponding attached drawings (draft for review) were submitted to the joint venture.

In April 2014, the feasibility study report of the Paklay HPP successfully passed the review conducted by China Renewable Energy Engineering Institute.

In August 2014, the feasibility study report (approved draft) of the Paklay HPP was submitted to the joint venture.

In July 2015, the feasibility study report of the Paklay HPP successfully passed the interim review conducted by the Ministry of Energy and Mines of Lao PDR.

In September 2015, the joint venture arranged for the Ministry of Energy and Mines of Lao PDR, and CNR — the third review organization appointed by the Government of Laos (experts from Brazil, engaged by CNR, would be responsible for the review of water quality and fish way) to conduct site survey for the Paklay HPP, and held a kick-off meeting on the third review of the feasibility study report of the Paklay HPP.

In December 2015, CNR — the third review organization, submitted the *Report on Interim Review for Feasibility Study Report of Paklay Hydropower Project* (draft).

In January 2016, the joint venture arranged for the Ministry of Energy and Mines of Lao PDR, CNR — the third review organization (including experts from Brazil employed by CNR to be responsible for review of water quality and fish way), and POWERCHINA Zhongnan Engineering Corporation Limited to hold an interim review meeting in Vientiane.

In March 2016, experts from Brazil submitted the *Report on Interim Review for Water Quality and Fish Way of the Paklay Hydropower Project*, and a compliance checklist.

On April 25~30, 2016, the joint venture arranged for POWERCHINA Zhongnan Engineering Corporation Limited and CNR to conduct technical exchange after interim review. On May 20, CNR submitted the *Report on Technical Exchange of Feasibility Study Report of Paklay Hydropower Project* and an adjusted compliance checklist.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

In May ~ July 2016, POWERCHINA Zhongnan Engineering Corporation Limited and experts from Brazil conducted 3 written exchanges concerning issues mentioned in the *Report on Technical Exchange of Feasibility Study Report of Paklay Hydropower Project* and the compliance checklist.

The feasibility study report (revision) was revised according to the *Report on Interim Review for Feasibility Study Report of Paklay Hydropower Project*, the *Report on Technical Exchange of Feasibility Study Report of Paklay Hydropower Project*, the *Report on Interim Review for Water Quality and Fish Way of the Paklay Hydropower Project*, opinions of 3 written exchanges, the adjusted compliance checklist, and technical requirements specified in relevant standards and regulations. In this feasibility study, the 240.00m normal pool level is taken as the basic water level and feasibility study for downstream Sanakham Hydropower Station is also considered. So the influence of backwater jacking of the reservoir of the downstream Sanakham Hydropower Station is considered for tailwater level of Paklay Hydropower Station. Reservoir inundation results in the report were provided by NORCONSULT. For environmental impact assessment of the Project, please refer to relevant reports submitted by NORCONSULT (on August 1, 2011, the joint venture and National Consulting Group (NCG) signed the consulting service contract of ESIA, to complete environmental and social impact assessment of upper and lower dam sites respectively based on the normal pool level of 240 m a.s.l. At present, the final environmental impact assessment report has been submitted to the Ministry of Natural Resources and Environment of Lao PDR for approval).

The Paklay HPP as a mainstream hydropower developmentneeds to maintain the required downstream flow regulation that sustain ecosystems and social and socio-economic systems among riparian countries in the Lower Mekong Basin (LMB) inclusive of the Lao PDR, Thailand, Cambodia, and Vietnam. In addition, the changes of biophysical conditionsthat may occur from the creation of a project or group of cascaded projects need also to be assessed. These and other matters are the subjest of the transboundary and cumulative impact assessment (TBESIA/CIA).

Figure 1: Paklay HPP

1.2 The Mekong River and the Mekong River Basin

The Mekong River originates in the snow-capped Tibetan Plateau in People's Republic of China. From the heights of Tibet, the river drops a total of 5,000m altitude before reaching the Delta in Socialist Republic of Vietnam.From Tibet to the estuary, the Mekong has its length of approximately 4,800 km. The mid-distance of the Mekong is at Chiang Saen District (KM 2,400) in Chiang Rai Province of Kingdom of Thailand.

The mean annual discharge of the Mekong is around 475 x 10^9 m^3. In the upper reaches the course of the river is incised within the landscape, turning to a braided channel in its middle reaches before flowing out on to the vast flood plains in Cambodia and Vietnam. A specific feature of the river is found in Cambodia where the annual cycle of flow into and out of the Tonle Sap Lake, created by the rise and fall of the flows in the mainstream.China contributes 16% of the discharge while Myanmar 2%, Lao PDR 35%, Thailand 18%, Cambodia 18%, and Vietnam 11%.

The Mekong River Basin (MRB) is divided into two parts[1], as shown on Figure 2. The upper basin is in Tibet and Yunnan Province of China where it is called the Lancang River and includes some sections of the river in Myanmar and Laos (Upper Mekong). The LMB starts from Chiang Saen (on the Thai side) and Ban Kuan (on the Lao side) to the South China Sea.

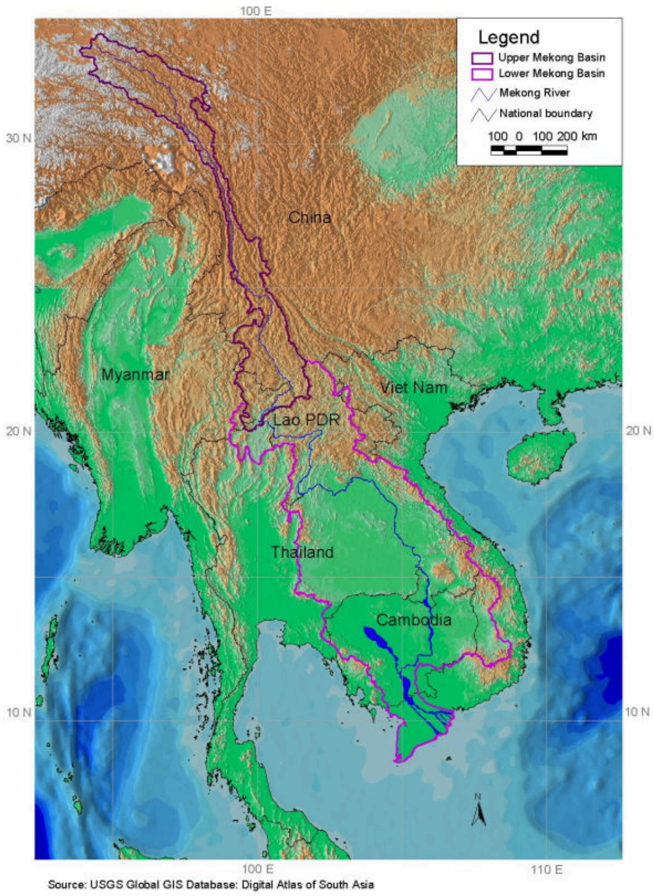


Figure 2: The Mekong River and the Mekong River Basin

[1] Overview of the Mekong Hydrology of the Mekong Basin, MRCS, ISSN: 1728 3248

The LMB catchment area is approximately 600,000km^2 and comprises almost all of Cambodia and the Lao PDR, one-third of Thailand (mainly in northeastern region and small part of northern region), and one-fifth of Vietnam (the Central Highlands and the Delta). The mean annual rainfall ranges from 1,000 mm near central north-eastern Thailand, to 4,000 mm in the Truong-Son mountain range between Laos and Vietnam. There are nearly 100 tributaries that feed the Mekong mainstream (40%-45% of mainstream flows). The key ones include Nam Ngum and Nam Theun in Lao PDR, Mun and Chi in Thailand, Se San and Tonle Sap in Cambodia. Some 62 million people live in the LMB area, more than 40 percent of the total population of these countries. The population density is highest in the Delta provinces.

In April 1995, the Mekong Agreement was signed by Thailand, Lao PDR, Vietnam and Cambodia. The Agreement codified principles of regional cooperation and established the Mekong River Commission. Under the Agreement, MRC member countries agree to cooperate in all fields of sustainable development, and in the utilization, management and conservation of water and related resources in the Mekong River Basin including but not limit to navigation, flood control, fisheries, agriculture, hydropower, as well as environmental protection.

For hydropower development in the LMB, the full potential of the basin is estimated at 30,000 MW. To date, only about 8% has beendeveloped.

A summary of Basin characteristics is presented in Table 1. The catchment in the upper Mekong is steep and narrow, covers 24 percent of the River's total catchment area and contributes 18 percent of total annual flow (long term average of 1986-2000). The rate of annual flow contribution from the upper Mekong varies from year to year, more significantly for dry years. The catchment is wider where the river enters the lower part; from there more large tributaries exist. The river systems are characterized by the seasonal rainfall of wet and dry season. The tributaries on the left bank in Lao PDR contribute the largest amount of any country, 35 percent of the flow.

Table 1: Mekong River Basin Characteristics

Description	Mekong Basin Countries						Total MRB
	China	Myanmar	Lao PDR	Thailand	Cambodia	Vietnam	
Area (km^2)	165,000	24,000	202,000	184,000	155,000	65,000	795,000
Catchment (% of MRB)	21	3	25	23	20	8	100
Flow (% of MRB)	16	2	35	18	18	11	100

Note: MRB = Mekong River Basin

Sources: Overview of Mekong Hydrology, MRCS and report of the WUP project of MRCS

1.3 Main Objective

The Mekong River and its ecosystem are identified as shared transboundary resources among riparian countries. The transboundary impacts meanwhile reflectproject (or group of projects)activities that potentially cause changes in biophysical conditions that primarily relate to hydrological and sediment changes. These changes may induce positive and negative impacts to the downstream areas which may require investigation. The overall purpose of the proposed TBESIA/CIA is to provide decision makers with timely information on the potential transboundary and accumulative environmental and social consequences. The report should help to ensure that decisions on such projects take into account such consequences as well as facilitate mechanisms for potentially affected people and governments to participate in the decision-making process.

As of this writing, no transboundary and CIA guidelines have been issued in Lao PDR either by the Ministry of Natural Resources and Environment (MONRE), the Department of Energy Planning and Pilicy, Mnistry of Energy and Mines, or the Mekong River Commission (MRC). Only two other hydropower-related CIAs have been completed recently: namely, the Nam Theun 2 and Nam Ngum 3 projects. Another still remains under consideration (Don Sahong HPP).

The approach we have chosen, while similar in some respects to aspects of the three prior CIAs, is to look both at the “additional” impact of the PaklayHPP in the Lower Mekong as well as looking at other sectors and resources. From the outset it must be acknowledged that a TBESIA/CIA is not a “crystal ball” that predicts the future but only an indicator of potential future cumulative impacts. The Paklay HPP TBESIA/CIA looks at a limited number of development scenarios in two future years and evaluates the PaklayHPP’s contribution to those scenarios.

1.4 Framework and Scope of Investigation

1.4.2 General Framework

The TBESIA/CIA scoping was already conducted based on an orientation field trip by key environmental and social (E&S) specialists during the first week of October 2011.The frequently asked questions are not related to the Paklay HPP alone. With other projects in the Mekong mainstream the key question is: “Do they provide significant transboundary and cumulative impacts and to what extent?”The method of answering is based on the environmental flow approach as diagrammed in the Figure below.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

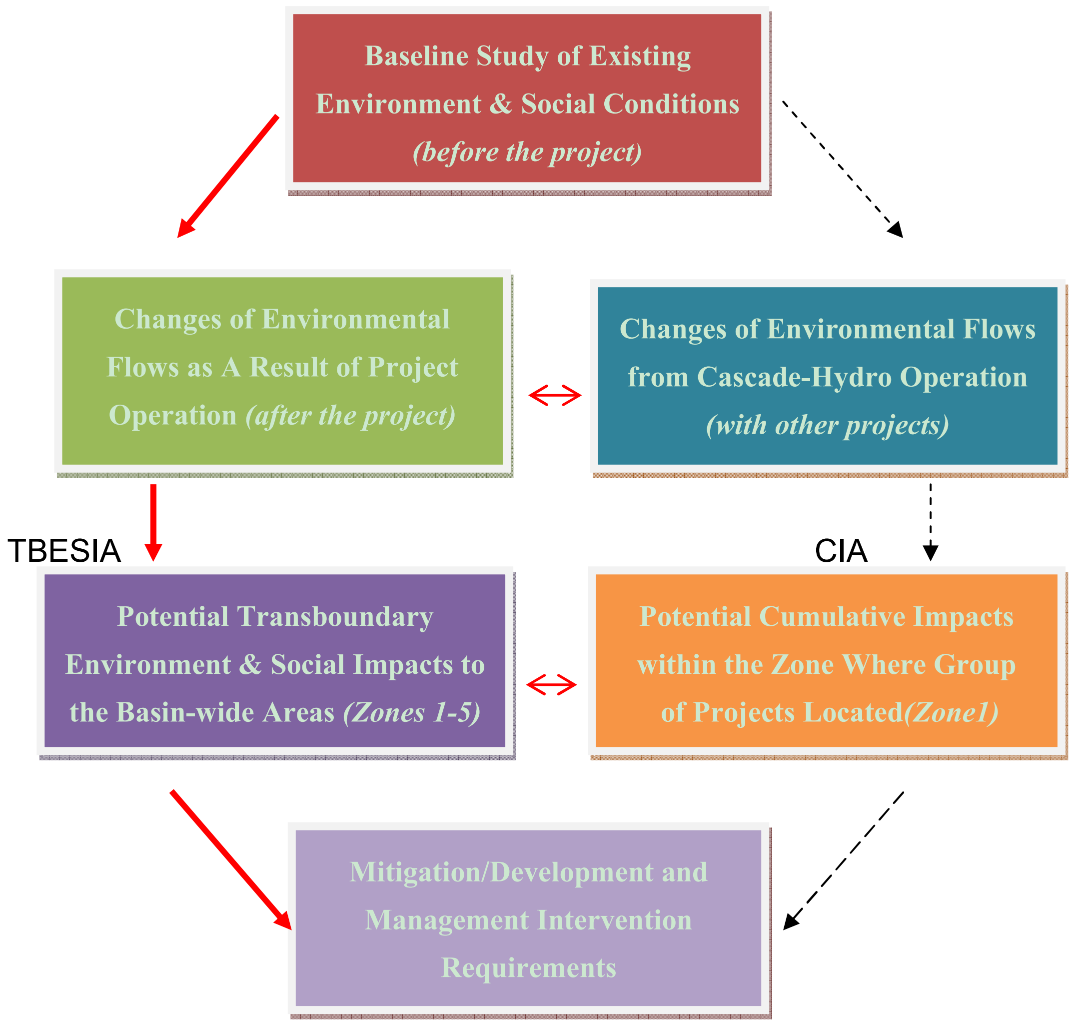


Figure 3: General Framework for TBESIA/CIA Study

1.4.3 Scope of Investigation

The scoping team agreed on the following issues to be addressed in the TBESIA/CIA report.

a) Key biophysical and social condition (before the project)

- ***Mekong River Flows***
- ***Sedimentation***
- ***Fish Migration and Fisheries***
- ***Navigation***
- ***Water Quality and Sediment***
- ***Dam Safety***
- *Climate Change*
- *Population, Ethnicity and Culture*
- *Socio-economic Livelihoods*
- *Health and Nutrition*
- *Tourism*

b) Hydrology and Sediment Changed (after the project)

- Scenarios and modeling of hydrology and sedimentation
- Identification of hydrological and sediment changes

c) Transboundary and Cumulative Impacts Issues

- Fish migration and fisheries
- Navigation
- Water quality
- Dam safety
- Climate change
- Population and culture
- Socio-economic Livelihoods
- Health and nutrition
- Tourism

d) Mitigation and Management Interventions

- Project-Level Mitigations/Development Mechanism
- Basin-Level Mitigations/Development Mechanism

1.4.4 Study Zone

The study zones were divided based on the combination nature of transboundary resources and the political boundary. Five zones in the LMB have been identified as follows:

- Zone 1: Northern Laos – Pak Tha (KM 2281) to Pak Heuang (KM 1736)
- Zone 2: Thai-Laos – Pak Heuang (KM 1736) to Ban Woenbuk (KM 904)
- Zone 3: Southern Laos – Ban Woenbuk (KM 904) to Cambodian border (KM 723)
- Zone 4: Cambodia – Cambodia border (KM 723) to Vietnam Border (KM218)
- Zone 5: Southern Vietnam – Vietnam border (KM 218) to Mekong Delta (KM 0)

It seems reasonable from the recent interviews (with riparian people in the Zone 1) that normally the people on each river banks utilizes the transboundary resources (the Mekong River and its ecosystems) within a walking distance (and/or on the bicycle) of 5 km corridor from the river with no cost of transportation.

Figure 4: Identification of Impacted Zones

1.5 Methodology

1.5.2 Relevant Regulatory Framework in Lao PDR

To understand a basin-wide environmental flow requirements including water quality, quantity, timing andduration of water flows, sediment and nutrient flows to maintain ecosystem integrity andsocial systems, the following methodologies are employed in the study:

a) Desk works

- Preparation of overall work plans for the study
- Reviews of TBESIA/CIA related documents including policy and legal framework
- Reviews of cross-cutting issues such as climate change, gender and vulnerable groups.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

b) Technical workshops

- Organized periodical workshop among the study teams
- Workshop between the studyteam and the Chinese hydro engineers.

c) ***Interviewsand focus groups***- One or two meetings each were held for community in each zone.

d) ***Expert Surveys and consultations*** – Conducted by discipline specialists in their responsible aspect.

e) ***Sampling surveyand case study***– To represent in each zone (for social assessment) some villages both urban and rural communities were surveyed to identify their socio-economic and livelihood conditions.

f) ***Scenarios and modeling***– Using to identify changes in hydrology and sedimentation.

1.5.3 Methology for Impact Assessment

The determination of whether adverse transboundary environmental impacts are significant involves consideration of the following factors:

a) Context Factors - Context factors potentially relevant to the determination of significance of a transboundary environmental and social impact include, for example:

- The potentially affected human populations and vulnerable segments of population (e.g., children, elderly persons)
- Geographic extent (region and localities)
- Ecological context
- Unique characteristics of the geographic area (e.g., proximity to historic or cultural resources, park lands, wetlands, wild and scenic rivers, or ecologically critical areas)
- Where provided by the Potentially Affected Party, standards regarding the protection of health or the environment as specified in international, national and sub-national legal instruments
- Probability of occurrence
- Scientific uncertainty.

b) IntensityFactors - Intensity factors potentially relevant to the determination of severity or magnitude of transboundary environmental impacts include, for example:

- Degree to which environmental impacts involve unique or unusual risks
- Degree to which a project is precedential in establishing a regulatory precedent or the issuance of a permit in a new area and therefore may cause future projects to be carried out with significant transboundary environmental and social impacts
- Duration, potential for recurrence and frequency of impacts
- Degree of irreversibility of impacts
- Relationship to other projects that, even though individually insignificant, cause cumulative or can reasonably be anticipated to cause significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment and is independent of whether a project is temporary in nature or is broken down into small component parts
- Degree to which physical or biological impacts of the project may adversely affect important historical or cultural resources or, traditional uses by indigenous people of cultural, historical and natural resources
- Degree to which a project may adversely affect threatened or endangered species or its habitat that has been determined to be critical
- Degree to which biodiversity is affected
- Degree to which natural ecological systems and landscapes are transformed
- Degree to which a project may foreclose or reduce the quality or availability of renewable and non-renewable resources.

1.6 Limitations and Problem Solving in Data Collection

The study team experienced problems in data collection. They are as follows:

1) Limited time for investigations - the comprehensive surveys cannot be done for all zones that have the total length of more than 2,000 km with 5 km corridor on each river bank
2) Most countries in the LMB lack baseline data except in some areas in Thailand and Vietnam
3) Lack of data on the current status of environmental and social issues
4) The scenarios and modeling for hydrology and sedimentation need a time series data.

In solving the above problems, the following methods are used:

1) Use of satellite images, maps and GIS expertise to identify some transboudary resources and population.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

2) Fresh quantitative social survey can be performed only in some provinces of the Lao PDR, the remaining data will be extracted from disclosed secondary information (from previous studies/documentation, reports and from online internet access, etc).

3) A number of fresh data are available based on professional opinions and judgments through their site visits and in-depth interviews.

1.7 Policy and Legal Framework

1.7.1 Sustainable Hydropower Development

a) The 10th Lao PDR Party Congress

The **10th Congress of the Lao People's Revolutionary Party** (LPRP) was held in Vientiane from 18–22 January 2016. The congress occurs once every five years. A total of 685 delegates represented the party's 252,879 card-carrying members. Addressed directive for Mellenium Development, Environmental Protection and Natural Resources Management as follows:

Graduation from Least Developed Country status by 2020is a key long-term objective of theGovernment and leadership of Lao PDR. To become eligible for graduation,a country must meet thethreshold for two of the three criteria established by the United Nations. In terms of GNI per capita,Lao PDR is closeto the threshold for graduation, and withitsprogress towards the MDGs Lao PDR isat the 95percentlevel for the human assets index. It is evident that progress toward attaining thesetwo thresholds is robustly linked to achieving the MDGs.Lao PDR is, however, judged morevulnerable on the third criteria, exogenous shocks. LDC graduation by 2020 is achievable withsuccess in implementing the 7th NSEDP. The Government recognises the need for a smoothtransition strategy,and a conference will take placenext year to prepare the strategy for graduation.

b) Hydropower Environmental and Social Sustainability in Lao PDR

The 2005 National Policy on Environment and Social Sustainability of the Hydropower Sector in Lao PDR – An important GOL’s environmental policy improvement was found on the new national policy on Environment and Social Sustainability of the Hydropower Sector in Lao PDR which was recently adopted in June 2005. It applies to all large hydropower dams (installed capacity more than 50 MW or inundated area more than 10,000 hectares) that constructed after 1990.

This policy employed the development principle based on Nam Theun 2 Hydropower Project with the integrated approaches to river basin where cumulated impacts and mitigation with appropriate institutional and financing mechanism were mentioned. The hydropower project should address the followings:

- Full Environmental Impact Assessment (EIA) including cultural and archeological resources

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

- Identification of Project Affected People whose assets, resource use and livelihoods, and/or social or cultural structures are in voluntarily altered by the project. In addition all involuntary resettlement and social development plan will be performed based on the Resettlement Decree
- Watershed Management and Conservation should be effectively conducted through offsetting any loss of natural terrestrial habitat based on NT2 Watershed Decree 39 of 2005. This includes compensation measures to people residing within protected areas
- Continuous consultation with affected communities are required with comprehensive environmental education and awareness activities
- Disclosure on information (Lao and English) related to project consultation report, impact assessment, mitigation plans and monitoring report are required with provision of information centers in project area and in Vientiane
- Compliance with all relevant obligations including concession agreement under Lao national laws, policies, strategies, action plans and international conventions through regular monitoring and reporting
- The developer will cover cost of implementing all environmental and social safeguard under the user pay principle
- Organizing third-party monitoring and assessment with respect to the environmental and social guidelines set
- Periodically review the lessons learned from implementation of this policy
- Annual Status of Environment and Social Compliance Report will be prepared and disclosed.

c) The 2009 Hydropower Sustainability Assessment Protocols

The Hydropower Sustainable Assessment Protocol (HSAP) is intended to be a set of practical guidelines to allow hydropower projects – existing and planned – to be audited in a timeframe that is primarily responsive to the needs of private financiers, developers andoperators. However, the HSAP hopes that its 2009 protocol will be tested by a wide range of groups, including civil society, and eventually endorsed by civil society as well. The HSAP is divided into four sections (International Hydropower Association 2009b). The framework covers the different stages of a project cycle, beginning with

- o Strategic assessment of projects to provide energy and water services.
- o Preparation of hydropower projects (i.e. various studies and plans conducted prior to award of construction contracts).
- o Implementation of hydropower projects.

Each section of the operation of hydropower projectsincludes a number of issues (economic, social, environmental, and political) against which a hydropower project or development initiative can be scored from low to high according to observed practices (see Figure and Table below). Each section builds on previous sections, but is also designed to work as a stand-alone assessment.

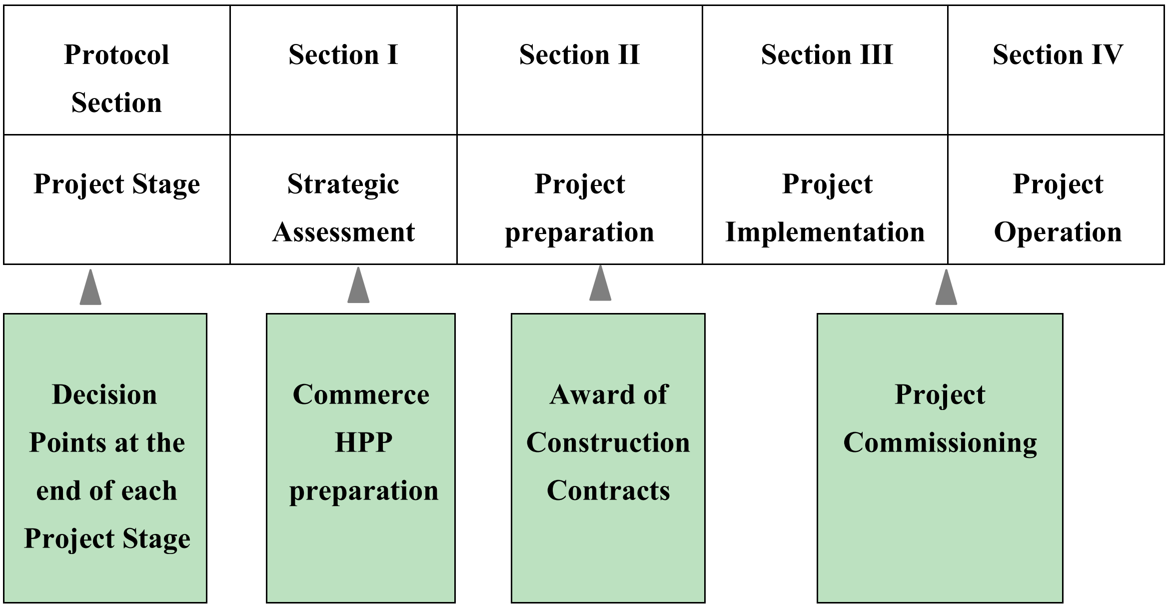


Figure 5: Structure of Hydropower Sustainability Assessment Protocol

Table 2: Hydropower Sustainability Assessment Protocol: summary of assessment criteria and Indicators

Section / Purpose	Examples of key criteria and associated questions
<u>(I) Strategic Assessment</u> Assess strategic basis for a proposed hydropower project	A set of nine criteria (Aspects), including: Demonstrated need – Is the proposed project justifiable as a preferred source of electricity and/or water services? When demand for electricity and water services is assessed, what is the quality of that assessment process? When energy and water development goals have been set, what is the quality of the consultation process? Options assessment – Does it cover the full range of planning approaches including energy and water conservation? What is the quality of the analytical framework? How well do directly affected stakeholders support options assessment? Regional and national policies and plans – What is quality of existing plans for energy, water, conservation, and economic development? How well do plans provide guidance for hydropower project planning? How consistent is a proposed project with plans? Political risk – How comprehensive is political risk assessment? What is the level of political risk? (Examples of political risk include: risk of political interference, corruption, expropriation of a company, problems with

Section / Purpose	Examples of key criteria and associated questions
	currency conversion, and political violence.) Institutional capacity – Do management plans exist to deal with public sector capacity limitations? To what degree can such limitations be managed? *Results can inform decisions to invest (or not invest) in preparation of a new project. For existing projects, results can inform major decisions related to improving or decommissioning.*
(II) Project Preparation Assess quality of various project investigations, plans, and designs	A set of 28 criteria (Aspects), including: economic and financial viability, environmental impact assessment (EIA), social impact assessment, benefit sharing, project affected communities, resettlement, indigenous peoples and ethnic minorities, trans-boundary issues, Environmental flows and downstream sustainability, regulatory approval, corporate governance Each criterion has its own set of indicators (assessment questions). Section II requires assessment of demonstrated need (assessed in Section I). *Results can inform the decision to approve the project and award (or not award) construction contracts.*
I) Project Implementation Assess quality of construction and social and environmental management programs	A set of 26 criteria (Aspects), 24 of which are repeated from Section II (allowing reassessment). Each criterion has its own indicators. *Results can inform decision to commission (or not commission) projects.*
(IV) Project Operation Assess quality of operational projects	A set of 23 criteria (Aspects), 21 of which are repeated from Sections III or II (allowing reassessment). Each criterion has its own indicators. *Results can inform decisions to allow or modify ongoing operations.*

1.7.2 The Mekong River Commission (MRC) Agreement

The regional agreement is found on *"The Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin (1995)"*(MA95). This agreement was signed on 5 April 2005 by four Mekong riparian countries, namely, the Kingdom of Cambodia, the Lao People's Democratic Republic, the Kingdom of Thailand and the Socialist Republic of Vietnam.

The agreement has set a new mandate for organization to cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin. Signatories to this treaty agree that transfer of the Mekong River and tributary water outside the Mekong River Basin can occur only by consensus among the four country members. The member countries therefore agree to coordinate in water project planning and monitoring of the basin waters.

Also important is to start a process of reasonable and equitable use of the Mekong River System in each country to develop procedures for water utilization. The MRC is supporting a joint basin-wide planning process with the four countries called The Basin Development Plan, which is the basis of its Integrated Water Resources Development Program. The MRC has included the following topics: fishery management, the promotion of safe navigation, irrigated agriculture, watershed management, environmental monitoring, flood management and exploring hydropower alternatives.

The agreement outlinesthree sets of procedures:

1) Procedures for Notification, prior to Consultation and Agreement, requires member countries to alert each other on planned river development that could significantly affect their neighbors, and to provide information regarding the developments, including technical specifications and environmental assessments.
2) Procedures for Water Use Monitoring which can provide a legal basis for awater use monitoring system to be established in the lower Mekong Basin.
3) Procedures for the Maintenance of Flows on the Mainstream.

These agreed procedures provide a definition of water use, covering uses of the Mekong that may have a significant impact on water quality and hydrological regimes on the mainstream of the Mekong.

1.7.3 Relevant Environmental and Social Legislation in Lao PDR

Key organizations and agencies involved in the environmental assessment process for hydropower projects include: the Government of Lao PDR (GOL); the National Assembly; the Ministry of Agriculture and Forestry (MAF); the Water Resources Committee; the Ministry of Energy and Mines (MEM); the Environmental Management Unit of MEM Hydropower Department; the Ministry of Finance; the Ministry of Education and Culture; and the provincial and District Governor(s) of the project location.

Measures for monitoring and managing potential environmental and socio-economic impacts have been developed based on Lao PDR legislation, regulations, decrees, standards and guidelines. The following legislation now in force, and supporting regulations (promulgated or in draft) in Lao PDR are relevant to ensuring environmental and socio-economic issues are addressed during design, construction, and operation of the project.

1.7.3.1 Environment

This guideline can be used in all investment projects identified in the guideline of the ESIA process No. 8030/MONRE and approved agreement that declared a list of investment project whether the project must conduct the IEE or ESIA.

- Category 1: Investment projects which are small or create less impact on environment and society but require initial environmental examination.
- Category 2: Large - sized investment projects which are complicated or create substantial impacts on environment and society but require environmental impact assessment.

- **Regulation on Environment Assessment in the Lao PDR (2000) -** This regulation requires project owner about EA and management matters including;
  - Terms of Reference for EIA and approval of these by MONRE.
  - Feasibility Study EIA and EMP including compensation and resettlement.
  - Environmental Management Monitoring Plan covering project construction, operation and closure phases including budget estimates.
  - Public Involvement of Stakeholders (at least twice).
  - Issuance of environmental certificates by MONRE.
  - Environmental Management and Monitoring Plan (EMMP) by MONRE and MEM throughout project life.

- **MAF Regulation No. 0360/MAF.2003, on Management of National Biodiversity Conservation Areas, Aquatic Animals and Wildlife** provides guidelines on NBCA establishment and zoning and also on restricted activities and development fund establishment and the rights and duties of state agencies in NBCA management.

- **Prime Minister Decree No. 333/PM.2010 on Protection Forest** defines the principles, rules, regulations and measurements on the sustainable management, development, preservation and utilization of protection forest; the aims are as follows: make protection forest and protection forestland more abundant in order to ensure the preservation of environment, water sources, prevention of soil erosion and maintenance of soil quality; safeguard strategic areas for national defense; prevention of natural disasters and protection of the natural environment; ensure forest rehabilitation; promotion, inspection, monitoring and evaluation of implementation to contribute to the overall improvement and livelihood of local ethnic people.

1.7.3.2 Social

- **Prime Minister Decree No. 84/GoL on the Compensation and Resettlement of the Development Project (2016)”** include:

This Decree was replaced the former Decree 192 (promulgated in 2005) which updated principle and guide to implement the compensation and resettlement of development projects with the following principles: (note that the Decree 84 will apply only in the implementation stage since the ESIA was started in 2015).

1. Protection of the rights and legitimate benefits of affected persons;
2. Ensure equality, correctness, transparency, disclosure and fairness;
3. Ensure coordination, consultation and participation between the project owner, affected people, state agencies and other relevant stakeholders.

- **Compensation** - The compensation shall be in the form of land, material or money for the land, agricultural products, livestock and incomes that are affected by development projects based on the compensation value.
- **Resettlement** - Resettlement shall be the resettlement and moving of people including rehabilitation of living conditions of the people affected by development projects. The affected people are moved out from their original living areas to be resettled in new living areas allocated by the development projects based the majority of votes by the affected people.
- **Preparation of compensation plans** - Before project implementation or before the signing of a concession project, the project owner must collaborate with relevant organizations at all levels to collect information on people to be affected including a detail plan of compensation to contribute to the management and monitoring of social and environmental impacts in relation to project implementation. The date of approval of the plan for the management and monitoring of social and environmental impacts shall be deemed as the date of registration of the rights of affected people.

- **Cultural and Archaeology**
  Relevant policy, legal and regulatory framework for archaeology and cultural heritage included Cultural and Natural Heritage in the Lao PDR is controlled by the following laws and regulations:
  - The national Heritage Laws of Lao PDR on the preservation of culture, historical and natural heritage. Complete set of regulations concerning the management of culture, historical and natural heritage was agreed from National Assembly Number 08/NA on dated 09 November 2005.
  - The Decree of the President of the Lao People's Democratic

Republic on the preservation of culture, historical and natural heritage. Complete set of regulations concerning the management of cultural, historical and natural heritage.

- Constitution. Article 19: The management of national heritage is a State study.
- Penal Code. Article 103: Sanction to law offenders in particular in the cases of damage and destruction of cultural sites, export and trade of antiquities.
- Law on the protection of environment. Article 16: Developers must abide by laws and regulations concerning the material culture sites that might be affected by their development projects.
- The Ministry of Information and Culture, on behalf of the council of Ministers implements the National policy on culture and cultural heritage. It is represented at provincial and district level by the Office of Information and Culture of province and district, respectively. Laws and regulations on cultural heritage are enforced under the guidance and control of Ministry of Information and Culture. Lawsuits are filed by Ministry of Information and Culture and transmitted to courts for trials and sanctions against offenders.

In other contractual arrangement use with the Government of Lao PDR (GOL), may guarantees that physical cultural resources (PCR) will be handled properly and in accordance with government of Lao regulations and the World Bank (WB) operational Policy Note (OPN) 11.03 and Operational Policy (OP) 4.11

- **Tourism**

Key issues of the 2005 Law on Tourism related to TBESIA/CIA are as follows:

Article 1: Purposes - The Law on tourism sets the principles, procedures and measures on the establishment, activity and administration of tourism aiming to promote and develop the cultural, historical and eco-tourisms in extending, sustainable ways, transforming to modern tourism industry and contributing the national protection and development, to promotion of mutual understanding, peace, friendship and to cooperate in international development.

Article 2: Tourism - Tourism is the traveling from its resident to other locations or countries for the purpose of visiting, sight seeing, relaxation, entertainment, cultural exchange, sport, health promotion, research study, exhibition, meeting, and others without intention to find works, undertaking of professional carriers in any form of profit making.

Article 4: State Policy towards Tourism - The State centrally and uniformly administers throughout the country on the conservation, protection and development of cultural and historical, eco-tourism in sustainable and participatory manner.

The State considers the tourism as a component of national economy to promote the production, services, increasing of the standing export, creation of works' places, income's generation and improvement of livelihood of Lao ethnical people.

The State and society promote the advertisement's activities, festivals, fairs on culture, fine national traditions, the heroic inheritances of Lao ethnic people to promote domestic tourists and attract foreign tourists.

The State respects, protects legitimate interests including securing the safety of the tourists.

The State pays attention to create the conditions and protect rights and interests of individuals, organizations within the country and abroad that invest in the development and promotion of tourism.

Article 5:The Obligation of Individuals and Organizations - To promote the tourism, individuals and domestic organizations shall have obligations to contribute in conservation, protection, development and promotion of culture, fine traditions, arts, literatures, handicraft that have unique characters, tourism resources, the wealthy and beauty of national natural resources.

The individuals and organization of foreigners entering Lao PDR shall have same obligations to contribute in the protection of the tourism sites, culture and fine tradition of Lao.

Article 6:International Cooperation - The State promotes the internationalcooperation in tourism to exchange lessons, information, building and training of authorities, to attract the assistances, promote the investments, and advertise the Lao tourism promoting the tourism development and providing international standard of tourism's services.

1.8 Dams in the Lower Mekong Basin

1.8.1 Mainstream Dams

There are no dams on the mainstream of the Lower Mekong at this time, but there are at least thirteen being planned, including the PaklayHPP which is the first project plan for Laos, as shown in the Table below. While the MA95 does not preclude mainstream dams, their impacts must be environmentally and socially acceptable. The MRC should act as main dialogue facilitator to promote cooperation and best practices. There must be agreement to prioritize mainstream dams and fish issues.

As stated in their web site (Initiative on Sustainable Hydropower (ISH), the MRC position on proposed mainstream hydropower dams is as follows:

Thirteen hydropower dams are currently being studied by private sector developers for the mainstream of the Mekong. The 1995 Mekong Agreement requires that such projects are discussed extensively among all four countries prior to any decision being taken. That discussion, facilitated by the MRC, will consider the full range of social, environmental and cross-sector development impacts within the Lower Mekong Basin. So far, none of the prospective developers have reached the stage of notification and prior consultation required under the Mekong Agreement. The MRC's position is that it supports *sustainable hydropower development implemented within the framework of the 1995 Mekong Agreement and which serves the joint interests of its member countries. The MRC has already carried out extensive studies on the consequences for fisheries and peoples livelihoods and this information is widely available, see for example a report of an expert group meeting on dams and fisheries. The MRC is undertaking a Strategic Environmental Assessment (SEA) of the proposed mainstream dams to provide a broader understanding of the risks and opportunities of such development. Dialogue on these planned projects with governments, civil society and the private sector is being facilitated by the MRC and all comments received will be considered*[2].

The SEA is due to report its findings in late 2010. It aims to assess and make recommendations on alternative mainstream Mekong hydropower development strategies, including the regional distribution of costs and benefits with respect to economic development, social equity and environmental protection and among different affected interests and sectors. Particular emphasis is given to the importance of looking at the proposed dams as a group and the cumulative impact from an integrated basin-wide perspective through the Basin Development Plan scenarios and other methodologies.

Table 3: Mainstream Dams on the Lower Mekong Basin

No.	Dam	Location	Anticipated Commissioning	Installed Capacity (MW)	Reservoir Area (km2)
1	Paklay	Lao PDR	TBC	855	87
2	Luang Prabang	Lao PDR	TBC	1,122	90
3	Xayabouri	Lao PDR	2019	1,341	49
4	Paklay	Lao PDR	TBC	1,282	108
5	Xanakham	Lao PDR	TBC	660	81
6	Pak Chom	Lao PDR	TBC	1079	74
7	Low Pamong	Lao PDR	TBC	n/a	n/a
8	Lat Sua	Lao PDR	TBC	686	13
9	Ban Koum	Lao PDR	TBC	1872	133
10	Don Sahong	Lao PDR	TBC	240	265 ha
11	Thako	Lao PDR	n/a	50	30 ha
12	Stung Treng	Cambodia	n/a	980	211
13	Sambor	Cambodia	2020	2600	620

[2]http://www.mrcmekong.org/ish/ish.htm (accessed 2 September 2009)

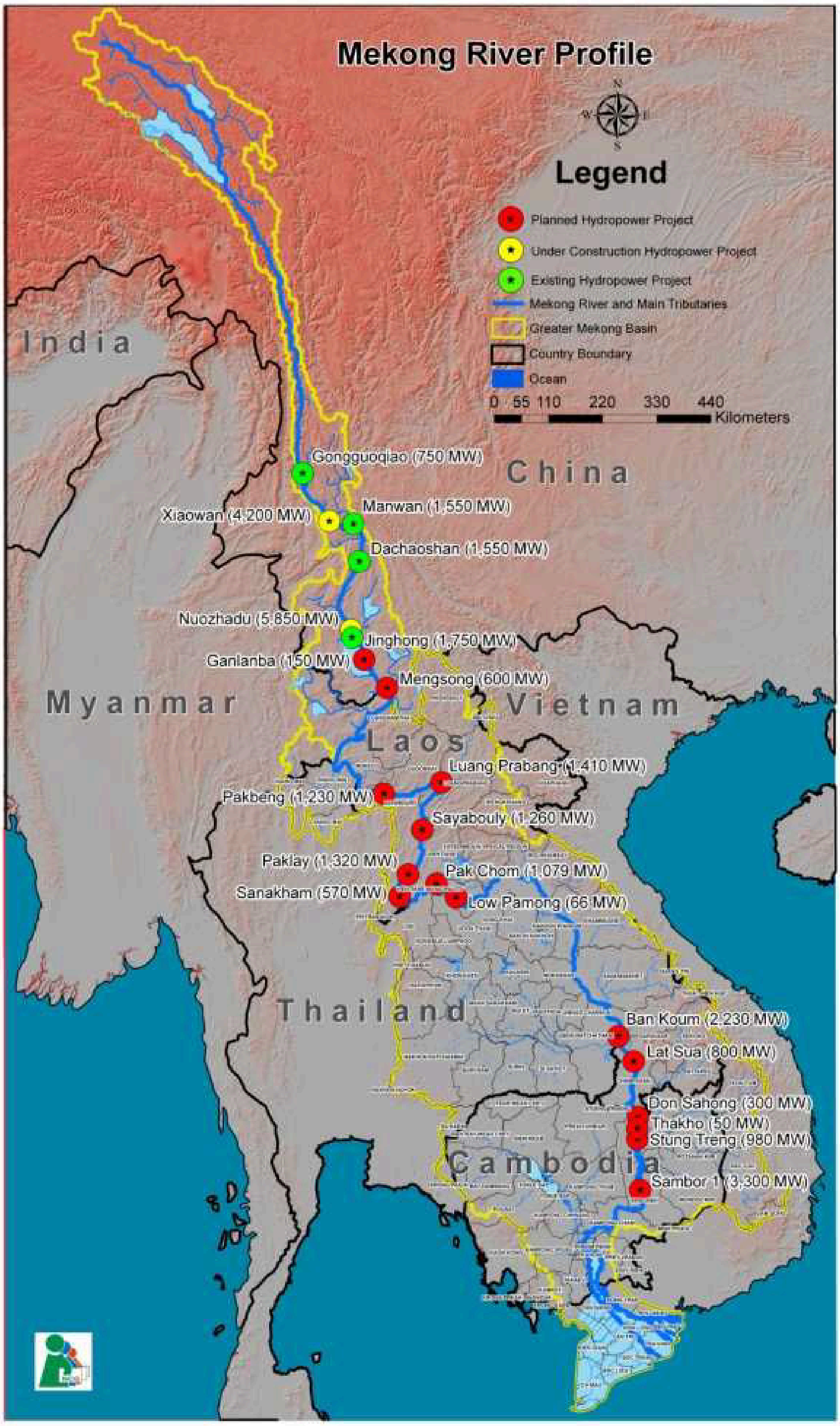


Figure 6: Dams on the Mainstream Mekong

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

According to the Scoping Document[3], the SEA is intended to:

- *Contribute to a shared understanding of the implications of mainstream hydropower development to inform decision processes on whether and how hydropower projects on the Mekong mainstream should best be pursued.*
- *Provide an initial baseline and assessment framework for individual mainstream project EIAs, thereby supporting the implementation of MRC's procedural framework, in particular the Procedures for Notification, Prior Consultation and Agreement (PNPCA).*
- *Serve as a methodological framework for sub-basin hydropower SEAs in the LMB, which will be carried out as inputs to MRC's Basin Development Plan.*
- *Include an element of capacity building to strengthen the respective analytical SEA capabilities in the concerned line agencies of the MRC Member States*.

Unfortunately, this MRC SEA report is not available in time for thisTBESIA/CIA. However, the TBESIA/CIA was developed to the extent possible taking into consideration the vast amount of information available fromthe MRC, and by the general objectives of the SEA.

For example, the MRC is in the process of developing a set of design criteria for assessing the impacts of mainstream dams. These are not yet in the form of guidance, but will address the following issues[4]:

- Effects on the fish resources of the Mekong, the world largest inland fishery, especially with respect to migratory species, fish biodiversity and consequences for peoples' livelihoods.
- Effects on sediment and river morphology, with associated risks to the life of mainstream impoundments, safe operation for dam safety, and effects on long-term bed stability, river bank erosion and channel stability in the downstream reaches.
- Effects of unexpected and possibly rapid changes in water surface level and flow rates downstream due to peaking operations.
- Potential water quality changes, especially with regard to water pollution, both in the impoundments above the dams and localized effects downstream.

The PaklayHPP environmental studies investigate each of these potentialissues.

[3] "Background Scoping Paper For a Strategic Environmental Assessment of Proposed Hydropower Developments on the Mekong Mainstream in the Lower Mekong Basin" Professor John Soussan; Stockholm Environment Institute – Asia; June 2009
[4] Unpublished document: "Design Guidance for Mekong Mainstream Dams in the Lower Mekong Basin; Preliminary Recommendations; Final Discussion Draft"; Mekong River Commission, 30 June 2009

1.8.2 Lower Mekong Dams

Besides the mainstream dams, there are numerous other dams in the LMB. The MRC keeps a list of all dam projects, both existing and proposed. As of this writing there are 137 dams on this list including the 13 mainstream dams and an additional 124 as shown in theTablebelow. Of these, approximately 33 have been commissioned and are operating.

Table 4: Existing and Proposed Projects in the Lower Mekong

No.	MRC Proj. ID Code	Project Name	LOCATION			Commis-sion
			River	Province / District	Country	
1	**T003**	**Nam Pung**	Nam Pung	Sakon Nakhon / Kut Bak	Thailand	1965
2	**T006**	**Ubol Ratana**	Nam Pong	Khon Kaen / UbolRatana	Thailand	1966
3	**L003**	**Xelabam**	Xedon	Champassak /Sanasomboune	Lao PDR	1969
4	**L002**	**Nam Dong**	Nam Dong	Louangpabang / Louangpabang	Lao PDR	1970
5	**L001**	**Nam Ngum 1**	Nam Ngum	Vientiane / Keo oudom	Lao PDR	1971
6	**T005**	**Sirindhorn**	Lam Dom Noi	Ubon Ratchathani / Pibulmangsaharn	Thailand	1971
7	**T001**	**Chulabhorn**	Nam Phrom	Chaiyaphum / Khon San	Thailand	1972
8	**T002**	**Huai Kum**	Nam Phrom	Chaiyaphum/Kasetsombo on	Thailand	1982
9	**V014**	**Dray Hlinh 1**	Sre Pok	Daklak/DakNong	Vietnam	1990
10	**C001**	**O Chum 2**	O Chum	Ratanak Kiri / O Chum	Cambodia	1992
11	**L004**	**Xeset 1**	Xeset	Saravan /	Lao PDR	1994
12	**T004**	**Pak Mun**	Mun	Ubon Ratchathani / Khong Chiam	Thailand	1994
13	**L009**	**Nam Ko**	Nam Ko	Oudomxay/Xay	Lao PDR	1996
14	**L005**	**Theun-Hinboun**	Nam Theun, hinboun	Bolikhamxay	Lao PDR	1998
15	**L006**	**Houayho**	Houayho, Xekong	Attapeu/Samakhixay	Lao PDR	1999
16	**L007**	**Nam Leuk**	Nam Leuk, Nam Ngum	Vientiane /	Lao PDR	2000
17	**T007**	**Lam Ta Khong P.S.**	Lam Ta Khong	Nakorn Ratchasima / Sikhiu	Thailand	2001
18	**V003**	**Yali**	Se San	Gia Lai / Kon Tum	Vietnam	2001
19	**L010**	**Nam Ngay**	Nam Ngay	Phongsaly/Phongsaly	Lao PDR	2002
20	**L008**	**Nam Mang 3**	Nam Mang, NamNgum	Vientiane/Tou La Khom	Lao PDR	2004
21	**V004**	**Se San 3**	Se San	Gia Lai / Kon Tum	Vietnam	2006
22	**V005**	**Se San 3A**	Se San	Gia Lai / Kon Tum	Vietnam	2007
23	**V011**	**Dray Hlinh 2**	Sre Pok	Dak Lak/DakNong	Vietnam	2007
24	**V002**	**Plei Krong**	Se San/ Kroong Po Ko	Kon Tum	Vietnam	2008
25	**V007**	**Se San 4A**	Se San	Gia Lai / Kon Tum	Vietnam	2008

No.	MRC Proj. ID Code	Project Name	LOCATION			Commis-sion
			River	Province / District	Country	
26	**L011**	**Nam Theun 2**	Nam Theun, Xe Bangfai	Khammuane	Lao PDR	2009
27	**L012**	**Xekaman 3**	Houayho, Xekong	Xekong	Lao PDR	2009
28	**L013**	**Xeset 2**	Xe Set	Saravan /	Lao PDR	2009
29	**V006**	**Se San 4**	Se San	Gia Lai / Kon Tum	Vietnam	2009
30	**V009**	**Buon Tua Srah**	Sre Pok/Krong Kno	Daklak/DakNong	Vietnam	2009
31	**V010**	**Buon Kuop**	Sre Pok	Dak Lak/DakNong	Vietnam	2009
32	**V012**	**Sre Pok 3**	Sre Pok	Daklak/DakNong	Vietnam	2009
33	**V013**	**Sre Pok 4**	Sre Pok	Daklak/DakNong	Vietnam	2009
34	**L014**	**Nam Ngum 2**	Nam Ngum	Vientiane	Lao PDR	2010
35	**L015**	**Nam Lik 2**	Nam Lik	Vientiane	Lao PDR	2010
36	**L016**	**Nam Ngum 5**	Nam Ngum	Louangpabang /	Lao PDR	2011
37	**L017**	**Xekaman 1**	Xe Kaman	Attapeu	Lao PDR	2011
38	**L018**	**Xekaman-Sanxay**	Xe Kaman	Attapeu	Lao PDR	2011
39	**V001**	**Upper Kontum**	Se San/ Dak Bla/Dak Nghe	Kon Tum/Quang Ngai	Vietnam	2011
40	**L019**	**Theun-Hinboun expansion**	Nam Theun	Bolikhamxay	Lao PDR	2012
41	**L020**	**Theun-Hinboun exp. (NG8)**	Nam Theun	Bolikhamxay	Lao PDR	2012
42	**L031**	**Xe Kong 3up**	Xekong	Xe Kong/	Lao PDR	2012
43	**L032**	**Xe Kong 3d**	Xekong	Xe Kong/	Lao PDR	2012
44	**L025**	**Nam Tha 1**	Nam Tha	Bokeo/Pha Oudom	Lao PDR	2013
45	**L026**	**Nam Long**	Nam Ma	Luangnamtha/Mouang Long	Lao PDR	2013
46	**L027**	**Xepian-Xenamnoy**	Xepian/Xenamnoy	Attapeu/Samakhixay	Lao PDR	2013
47	**L028**	**Xe Katam**	Xenamnoy	Champassak/Paksong	Lao PDR	2013
48	**L035**	**Nam Ou 1**	Nam Ou	Luangprabang/Pak Ou	Lao PDR	2013
49	**L037**	**Nam Ou 3**	Nam Ou	Luangprabang/Ngoy	Lao PDR	2013
50	**L039**	**Nam Ou 5**	Nam Ou	Phongsaly/Muang Xampan	Lao PDR	2013
51	**L021**	**Nam Ngum 3**	Nam Ngum	Vientiane	Lao PDR	2014
52	**L022**	**Nam Theun1**	Nam Theun	Bolikhamxay	Lao PDR	2014
53	**L029**	**Xekong 4**	Xekong	Xekong/	Lao PDR	2014
54	**L030**	**Nam Kong 1**	Nam kong	Attapeu/	Lao PDR	2014
55	**L036**	**Nam Ou 2**	Nam Ou	Luangprabang/Nam Bak	Lao PDR	2014
56	**L038**	**Nam Ou 4**	Nam Ou	Phongsaly/ Muang Khua	Lao PDR	2014
57	**L040**	**Nam Ou 6**	Nam Ou	Phongsaly/Phongsaly	Lao PDR	2014
58	**L042**	**Nam Lik 1**	Nam Lik	Vientiane/Hin Heup	Lao PDR	2014

No.	MRC Proj. ID Code	Project Name	LOCATION			Commis-sion
			River	Province / District	Country	
59	**L043**	**Nam San 3**	Nam San	Xiengkhuang/	Lao PDR	2014
60	**L048**	**Nam Beng**	Nam Beng	Oudomxay/Paklay	Lao PDR	2014
61	**L023**	**NamNgiep 1**	Nam Ngiep	Bolikhamxay	Lao PDR	2015
62	**L024**	**Nam Ngiep-regulating dam**	Nam Ngiep	Bolikhamxay	Lao PDR	2015
63	**L041**	**Nam Ou 7**	Nam Ou	Phongsaly/Nhod Ou	Lao PDR	2015
64	**L049**	**Nam Feuang 1**	Nam Feuang	Vientiane/	Lao PDR	2015
65	**L050**	**Nam Feuang 2**	Nam Feuang	Vientiane/	Lao PDR	2015
66	**L051**	**Nam Feuang 3**	Nam Feuang	Vientiane/	Lao PDR	2015
67	**C002**	**Battambang 1**	SangKer	Banttambang / Ratanak Mondul	Cambodia	2016
68	**L033**	**Xe Kong 5**	Xekong	Xe Kong/	Lao PDR	2016
69	**L044**	**Nam Pha**	Nam Pha	Luangnamtha/	Lao PDR	2016
70	**L045**	**Nam suang 1**	Nam Suang	Luangprabang/	Lao PDR	2016
71	**L046**	**Nam Suang 2**	Nam Suang	Luangprabang/	Lao PDR	2016
72	**L047**	**Nam Nga**	Nam Ou	Luangprabang/	Lao PDR	2017
73	**C005**	**Lower Se San2+ Lower Sre Pok 2**	Sre Pok	StungTreng / SeSan	Cambodia	2020
74	**C003**	**Battambang 2**	SangKer	Banttambang / Samlot	Cambodia	n/a
75	**C007**	**Pursat 1**	Pursat	Pursat / Veal veng	Cambodia	n/a
76	**C008**	**Pursat 2**	Pursat	Pursat / Kravanh	Cambodia	n/a
77	**C009**	**Lower Se San 3**	Se San	Ratanak Kiri / Voeun Sai	Cambodia	n/a
78	**C010**	**Prek Liang 1**	Prek Liang	Ratanak Kiri / Ta Veng	Cambodia	n/a
79	**C011**	**Prek Liang 2**	Prek Liang	Ratanak Kiri / Ta Veng	Cambodia	n/a
80	**C012**	**Lower Sre Pok 3**	Sre Pok	Ratanak Kiri / Lum Phat	Cambodia	n/a
81	**C013**	**Lower Sre Pok 4**	Sre Pok	Mondul Kiri / Koh Nhek	Cambodia	n/a
82	**C014**	**Stung Sen**	Stung Sen	Preah Vihear / Rovieng	Cambodia	n/a
83	**L060**	**Xe Pon 3**	Xe Banghieng	Saravan /	Lao PDR	n/a
84	**L061**	**Xe Kaman 2A**	Xe Kaman	Attapeu/	Lao PDR	n/a
85	**L062**	**Xe Kaman 2B**	Xe Kaman	Attapeu/	Lao PDR	n/a
86	**L063**	**Xe Kaman 4A**	Xe Kaman	Attapeu/	Lao PDR	n/a
87	**L064**	**Xe Kaman 4B**	Xe Kaman	Attapeu/	Lao PDR	n/a
88	**L065**	**Dak E Mule**	Xe Kong	Xe Kong/	Lao PDR	n/a
89	**L066**	**Nam Khan 1**	Nam Khan	Luangprabang/Xieng Ngeun	Lao PDR	n/a
90	**L067**	**Nam Khan 2**	Nam Khan	Luangprabang/Xieng Ngeun	Lao PDR	n/a

No.	MRC Proj. ID Code	Project Name	LOCATION			Commis-sion
			River	Province / District	Country	
91	**L068**	**Nam Khan 3**	Nam Khan	Luangprabang/Xieng Ngeun	Lao PDR	n/a
92	**L069**	**Nam Ngum 4A**	Nam Ngum	Xiengkhuang/	Lao PDR	n/a
93	**L070**	**Nam Ngum 4B**	Nam ngum	Xiengkhuang/	Lao PDR	n/a
94	**L071**	**Nam Ngum, Lower dam**	Nam ngum	Vientiane Capital/Pak Ngum	Lao PDR	n/a
95	**L072**	**Nam Pay**	Nam ngum	Vientiane/Poun district	Lao PDR	n/a
96	**L073**	**Nam Mang 1**	Nam Mang	Borikhamxay	Lao PDR	n/a
97	**L074**	**Nam Pouy**	Nam Pouy	Xayabuly	Lao PDR	n/a
98	**L075**	**Nam Poun**	Nam Poun	Xayabuly	Lao PDR	n/a
99	**L076**	**Nam Ngao**	Nam Ou	Oudomxay	Lao PDR	n/a
100	**L077**	**Nam Chian**	Nam Ngiep	Xiengkhuang/	Lao PDR	n/a
101	**L078**	**Nam Ngieu**	Nam Ngiep	Xiengkhuang/	Lao PDR	n/a
102	**L079**	**Nam Pot**	Nam Ngiep	Xiengkhuang/	Lao PDR	n/a
103	**L080**	**Nam San 3B**	Nam San	Xiengkhuang/	Lao PDR	n/a
104	**L081**	**Nam San 2**	Nam San	Borikhamxay	Lao PDR	n/a
105	**L082**	**Nam Pok**	Nam Ou	Phonsaly/	Lao PDR	n/a
106	**L083**	**Nam Phak**	Nam Ou	Oudomxay/Mouang La	Lao PDR	n/a
107	**L084**	**Nam Hinboun 1**	Nam Hinboun	Kham Mouan	Lao PDR	n/a
108	**L085**	**Nam Hinboun 2**	Nam Hinboun	Kham Mouan	Lao PDR	n/a
109	**L086**	**Xe Bang Fai**	Xe Bang Fai	Kham Mouan	Lao PDR	n/a
110	**L087**	**Xe Neua**	Xe Bang Fai	Kham Mouan	Lao PDR	n/a
111	**L088**	**Nam Theun 4**	Nam Theun	Borikhamxay	Lao PDR	n/a
112	**L089**	**Nam Mouan**	Nam Theun	Borikhamxay	Lao PDR	n/a
113	**L090**	**Xe Bang Hieng 2**	Xe Bang Hieng	Savannakhet/	Lao PDR	n/a
114	**L091**	**Xedon 2**	Xe Don	Saravan /	Lao PDR	n/a
115	**L092**	**Xe Set 3**	Xe Don	Saravan /	Lao PDR	n/a
116	**L093**	**Xe Bang Nouan**	Xe Bang Nouan	Savannakhet/	Lao PDR	n/a
117	**L094**	**Xe Lanong 1**	Xe Bang Hieng	Savannakhet/	Lao PDR	n/a
118	**L095**	**Xe Lanong 2**	Xe Bang Hieng	Saravan /	Lao PDR	n/a
119	**L096**	**Nam Phak**	Nam Phak	Champassak/	Lao PDR	n/a
120	**L097**	**Xe Nam Noy 5**	Xe Kong	Xekong/	Lao PDR	n/a
121	**L098**	**Houay Lamphan**	Xe Kong	Champassak/Xekong	Lao PDR	n/a
122	**L099**	**Nam Kong 2**	Xe Kong	Attapeu	Lao PDR	n/a
123	**L100**	**Xe Xou**	Xe Kong	Attapeu	Lao PDR	n/a

No.	MRC Proj. ID Code	Project Name	LOCATION			Commis-sion
			River	Province / District	Country	
124	**V008**	**Duc Xuyen**	Sre Pok/Krong Kno	Daklak/DakNong	Vietnam	n/a

2 PAKLAY ENVIRONMENTAL PROJECT DESCRIPTION

Located on the middle Mekong River in Laos, Paklay Hydropower Station is the fourth hydropower station (from upstream to downstream) of the 11 Hydropower Stations planned for the main stream of Mekong River. Xaiyaburi Hydropower Station is located upstream of it while Sanakham Hydropower Station is located downstream. The dam site of Paklay Hydropower Station is located at 1829km (to the estuary) on the main stream of Mekong River, about 31km upstream from Paklay County and about 241km from Vientiane, the capital city of Laos. The control drainage area at the dam site is about 278,400 km^2 for the geographical location of Paklay Hydropower Station.

As a famous international river in Southeast Asia, Mekong River, known as Lancang River within the Chinese territory, is originated from the north piedmont of Tanggula Mountains in China, passes Qinghai, Tibet and Yunan Provinces (autonomous regions) and leaves China at Mengla County, Xishuangbanna Prefecture, Yunnan Province, from where it is called Mekong River, passes Myanmar, Thailand, Laos and Cambodia from north to south and converges in the South China Sea in Ho Chi Minh City, Vietnam.

With a drop of about 480m, Mekong River has a total length of about 2720km and a control drainage area of 621,000 km^2. The mean annual discharge at estuary is 15062m^3/s and annual runoff is 475 billion m^3. According to statistics of relevant data, the reserve of waterpower resources of Mekong River is about 58,000MW in theory, of which the exploitable waterpower resources are about 37,000MW. The exploitable waterpower resources of Mekong River mainly concentrates in Laos and Cambodia, accounting for 51% and 33% respectively, as well as in other countries (Myanmar, Thailand and Vietnam) accounting for 16%. At present, the exploited waterpower resources of Mekong River accounts for only 1% of the total.

In accordance with the *Study on Development of Run-of-River Hydropower Projects on Mekong River Main Stream* released by Mekong River Commission Secretariat in 1994, 11 hydropower stations are planned on the main stream of Mekong River, including five hydropower stations in Laos, namely, Pak Beng, Luang Prabang, Sayaburi, Paklay and Sanakham.

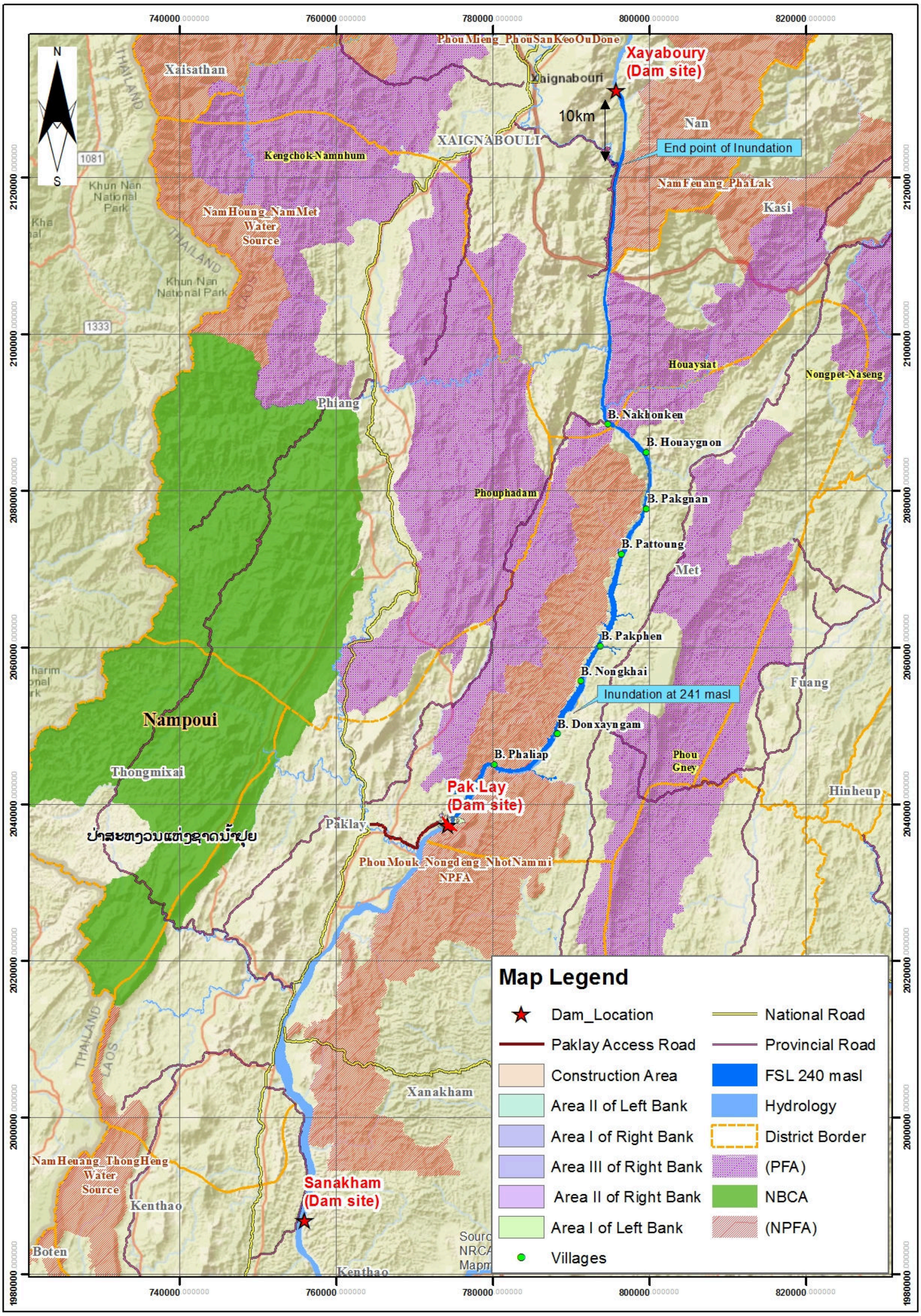


Figure 7: Paklay HPP Location

3 BASELINE OF ENVIRONMENTAL AND SOCIAL CONDITIONS

While dams have provided significant impetus to growth it is well known that dam developments present a number of economic, environmental and social concerns. In the case of mainstream dams on the Mekong such as the PaklayHPP, these issues need to be addressed, and in particular the following aspects require careful analysis:

- Mekong River Flows, and downstream impacts from their modification
- Sedimentation and Erosion
- Fish Migration and Fisheries in the Lower Mekong
- Navigation
- Water Quality
- Dam Safety
- Climate Change
- Socio-Cultural and Economic

Based on the site survey, much information and data have been collected and used in the report. But with the revising of dam design, some information and data may be changed. So, According to the changes of project design and comments from CNR and Instituto Áqua Viva - Brazil, NCG carried out the supplement site survey for information updating and checking from November 2015 to March 2017. Although the design has revised, many basic conditions were still the same as the last survey. So the aim of supplement site survey was to update the changed information and confirm new impacts. The supplement site survey included new data and policies collection, reviewing for impacts, more public participation, consulting with local government, discussion on compensation and resettlement standards, and resettlement sites comparing and selection.

3.1 Mekong River Flows

A basin wide model (actually consisting of several models) has been developed over many years by MRC to assess the impacts to river flows of the numerous existing and proposed dams in the lower Mekong.

3.1.1 General Background

The Mekong River begins its long journey on the Tibetan Plateau at 4,500 or more meters above sea level. From its source, the Mekong River continues south for approximately 4,800 km to the South China Sea, draining a total catchment area of 795,000 km^2 within the six countries namely; China, Myanmar, Lao PDR, Thailand, Cambodia and Vietnam (Table below)[5]. In Yunnan Province in China, the River and its tributaries are confined by narrow, deep gorges (Figure below). The tributary river systems in this part of the basin are small. In the south of Yunnan, in Simao and Xishuangbanna Prefectures, the river changes as the valley opens out, the floodplain becomes wider, and the river becomes wider, more flat and slower.

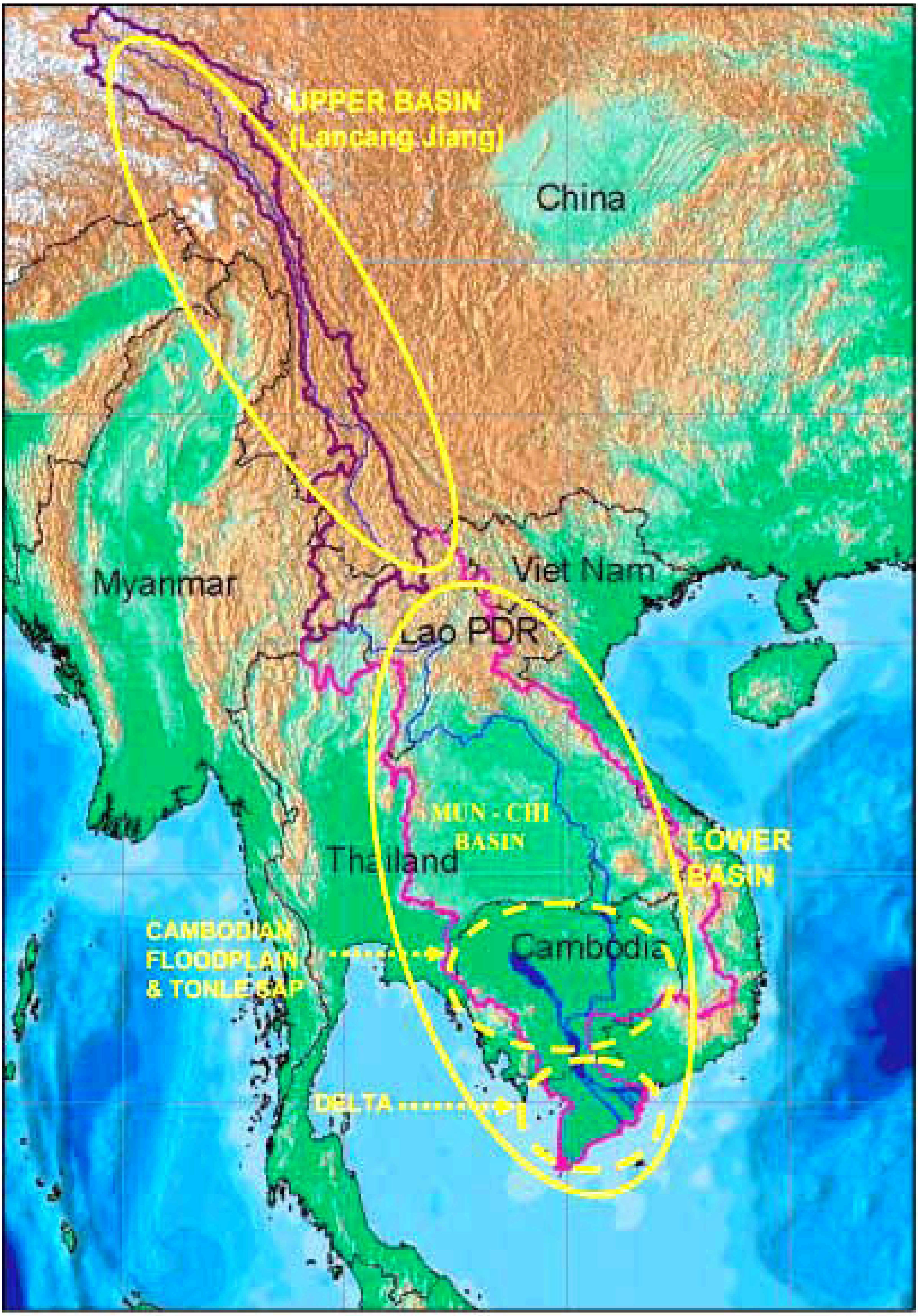
The Greater Mekong can be divided into two parts: the Upper Basin in Tibet and China (where the river is called the Lancang Jiang), and the Lower Mekong Basin from Yunnan downstream from China to the South China Sea (Figure below). The

[5]MRC (2005) Overview of the Hydrology of the Mekong Basin

upper Mekong is a long, narrow valley comprising roughly one-fourth of the total area, cutting through the mountains and plateaus of China. The lower Mekong, below the point where it forms the border between Myanmar and Laos, is a stream 1,485 miles in length that claims the drainage from the Khorat Plateau of Thailand, from the westward slopes of the Annamese Cordillera in Laos and Vietnam, and from most of Cambodia, before reaching the sea through the distributary channels of its Delta in Vietnam.

Table 5: Territory of the six Mekong River Basin countries within the catchment

Description	Countries						Total MRB
	China	Myanmar	Lao PDR	Thailand	Cambodia	Vietnam	
Area (km^2)	165,000	24,000	202,000	184,000	155,000	65,000	795,000
Catchment as % of MRB	21	3	25	23	20	8	100
Flow as % of MRB	16	2	35	18	18	11	100



Source: MRC (2005) Overview of the Hydrology of the Mekong Basin

Figure 8: The Mekong River Basin Broad Geographical Region

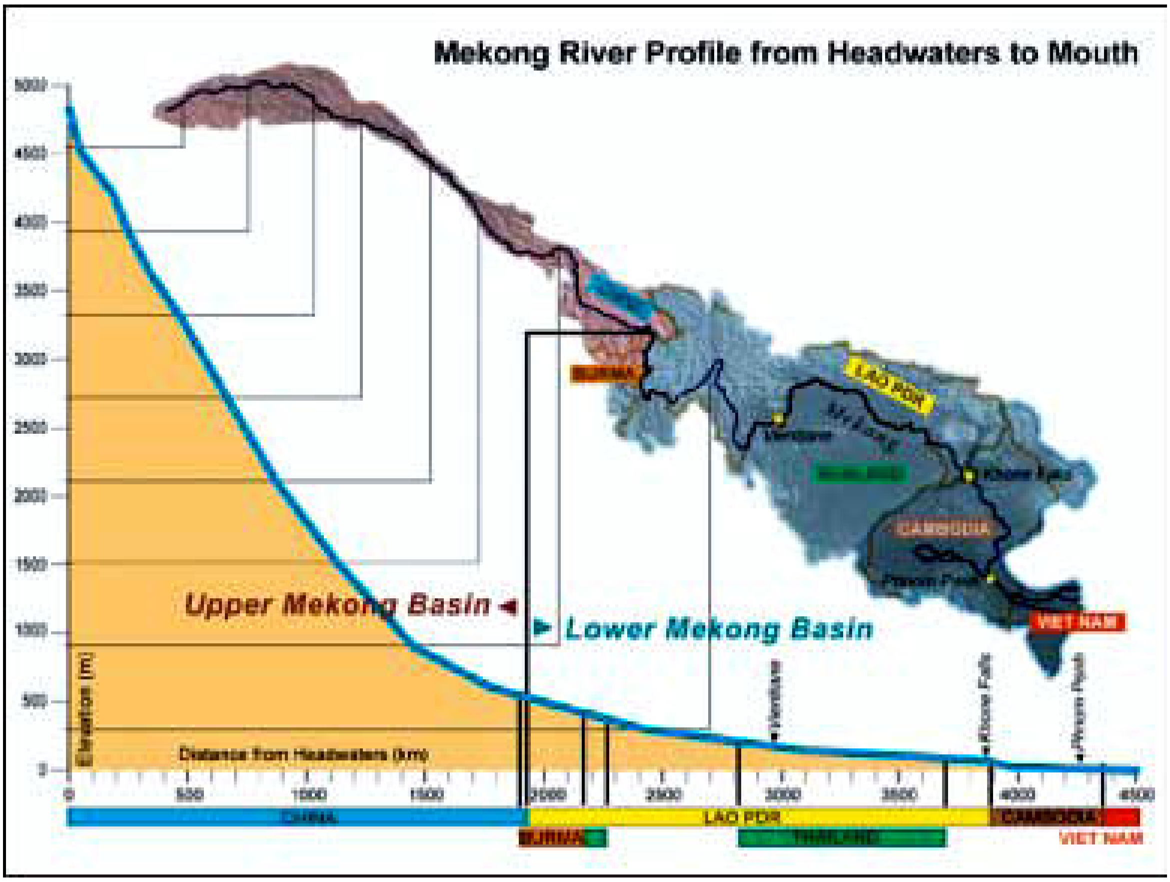


Figure 9: Longitudinal River Profile of the Mekong River from Source to Delta

Major tributary systems of the Mekong River develop in the Lower Basin. These systems can be separated into two groups: tributaries that contribute to the major wet season flows, and tributaries that drain low relief regions of lower rainfall. The first groups are left bank tributaries that drain the high-rainfall areas of Lao PDR. The second groups are those on the right bank, mainly the Mun and Chi Rivers, which drain a large part of Northeast Thailand.

In the Upper Basin, the major source of water flowing into the river comes from melting snow on the Tibetan Plateau. This volume of water plays an important role in the low-flow hydrology of the lower mainstream. Even as far downstream as Kratie,this volume of water makes up almost 30 percent of the average dry season flow.

The mean annual discharge of the Mekong River is approximately 475 km^3 in the rainy season and 79 km^3 in the dry season (Carlos L. Muñoz Brenes, Jonathan B. Mazumdar, 2009). Of this amount, about 16 percent comes from China and only 2 percent from Myanmar. Most of the remainder comes from Lao PDR and the major left bank tributaries, particularly the tributaries that enter downstream of Vientiane-Nongkhai (Table below). The flow of the Mekong River is notably predictable; typically there are relatively small differences in volume between high and low flood years. To outline the water-level cycle, the level of the Mekong River begins to rise in May with the onset of the southwest monsoon and continues until reaching its peak in

August or September in the upper MRB, and in September or October in the lower reaches. At that point the water level declines rapidly until December and then continues to decline, although at a slower rate, until April.

Table 6: Flow Contributions for Mainstream Reaches

River reach	Left Bank %	Right Bank %	Total %
China	16		16
China-Chiang Saen	1	4	5
Chiang Saen-Luang Prabang	6	3	9
Luang Prabang-Chiang Khan	1	2	3
Chiang Khan-Vientiane	0	0	0
Vientiane-Nongkhai	0	1	1
Nongkhai-Nakhon Phanom	20	4	24
Nakhon Phanom-Mukdahan	3	1	4
Mukdahan-Pakse	5	6	11
Pakse-Stung Treng	23	3	26
Stung Treng-Kratie	1	0	1
Totals:	**60**	**16 24**	**100**

Source: MRC Overview of the Hydrology of the Mekong Basin. Mekong River Commission, Vientiane, November 2005. 73pp.

The unifying hydrological feature of the system is the river's flood pulse, which sees the individual rainfall runoff events throughout the catchments coalesce into a stable and predictable hydrograph with distinct hydrological seasons (Figure detail). For the LMB, it is the Mekong flood pulse which drives the river's high levels of aquatic and terrestrial biodiversity and system productivity.

As the Mekong River enters Cambodia over 95% of the flows have already joined the river. From here on downstream the terrain is flat (Figure below) and water levels rather than flow volumes determine the movement of water across the landscape. The seasonal cycle of changing water levels at Phnom Penh results in the unique "flow reversal" of water into and out of the Great Lake via the Tonal Sap River.

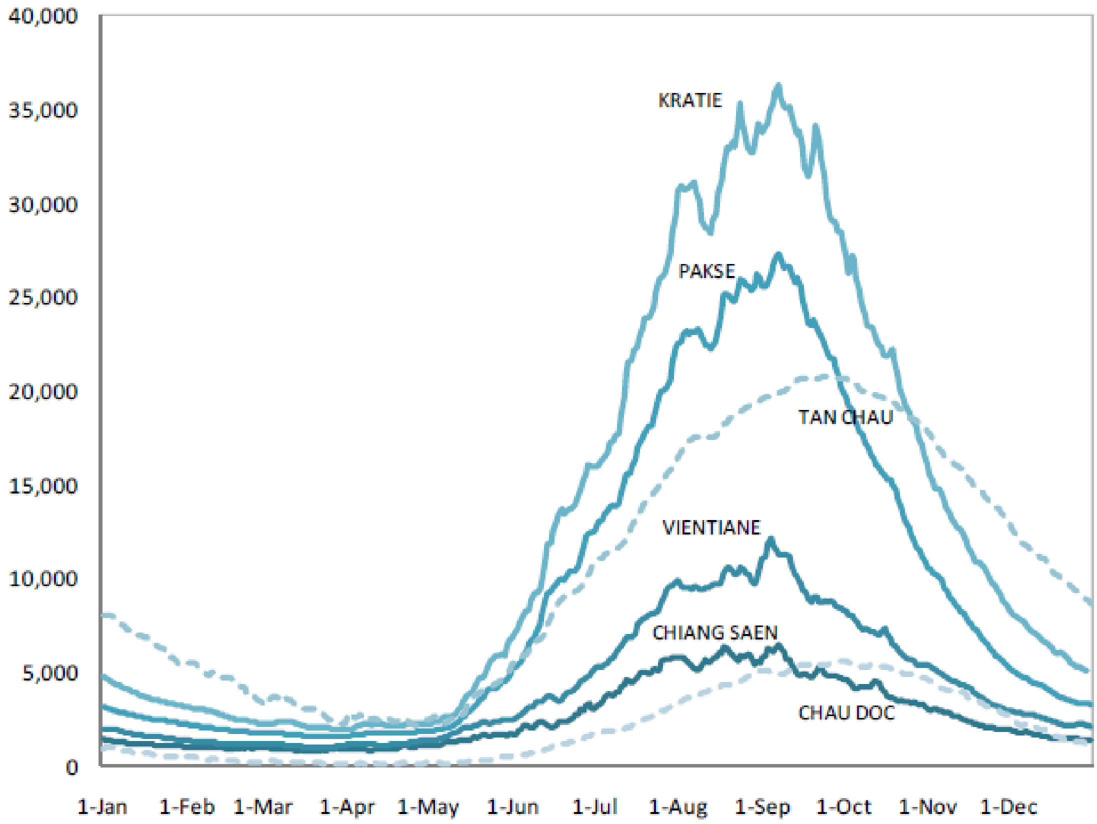


Figure 10: Average Daily Flow Hydrographs for the Mekong River for the MRC Baseline (1986 – 2000)

3.1.2 Flows in the Main Stream

The daily discharge data recorded by 16 hydrologic stations along the Mekong River from Chiang Saen to the Mekong Delta were used to analyze the Mekong's flow regime. Figures 11-44 show the maximum, minimum, and mean monthly discharges and monthly water level for each station. These flow regimes indicate that from Chiang Saen to Nong Khai the minimum flow occurs in March and from Nakhon Phanom to Chau Doc the minimum flow occurs in April. Maximum flow, from Chiang Saen to Khong Chiam and from Pakse to Chau Doc, occurs in August and September, respectively.It implies that the rainy season of Mekong basin shifts from upstream to downstream.

Figure 43 shows the mean monthly discharge at each station. Notice that the flow regimes can be grouped into 3 regions. The first region is from Chiang Saen to Nong Khai. In this region the flow is relatively small because the tributary river systems in this part of the basin are small and have low levels of rainfall. The second region is from Nong Khai to Pakse. This region of flow is relatively high because the tributary river systems in this part of the basin are larger and the amount of rainfall is moderately high. The third region is from Pakse to Chau Doc. In this region the flow is the highest because the tributary river systems in this part of the basin, especially left bank tributaries, drain the high rainfall areas of Lao PDR to the Mekong River. Figure 44-55 shows the rating curve of each station.

Table 7: The mean monthly daily discharge at each station on the Mekong River

Zone	Sta.Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chiang Saen (1960-2005)	1146.96	927.06	832.51	912.94	1329.03	2474.38	4754.69	6431.46	5463.54	3785.96	2487.69	1574.38
	Luang Prabang (1939-2005)	1626.93	1247.51	1044.02	1075.13	1517.60	3043.88	6370.65	9921.05	8787.07	5426.14	3541.78	2240.25
2	Chiang Khan (1965-2005)	1761.81	1302.65	1074.31	1086.35	1706.24	3411.40	7076.01	10605.02	9881.95	6328.29	3962.09	2507.06
	Vientiane (1913-2005)	1752.64	1391.19	1197.84	1211.38	1722.39	3543.84	7108.02	11894.21	11083.71	6832.93	3992.78	2461.86
	Nongkhai (1965-2005)	1792.68	1394.43	1201.52	1238.81	1871.80	3598.56	7372.32	11365.05	11039.91	6563.40	3976.18	2502.55
	Nakhon Phanom (1924-2005)	2375.61	1856.49	1563.34	1546.08	2426.46	6838.98	13438.61	20325.00	19693.76	11132.31	5737.14	3405.49
	Thakhek (1923-2005)	2382.18	1865.10	1575.32	1557.30	2432.68	6781.00	13371.27	20287.08	19672.06	11122.83	5735.05	3411.74
	Mukdahan (1923-2005)	2435.69	1906.82	1612.88	1595.53	2503.26	7339.07	14350.73	21951.83	21182.34	11888.63	6049.59	3542.75
	Savannakhet (1923-2005)	2440.25	1910.65	1616.79	1601.92	2505.61	7340.44	14373.87	22001.64	21240.53	11904.88	6051.10	3540.18
	Khong Chiam (1966-2005)	2833.87	2215.27	1912.90	1852.64	2922.13	7847.52	15405.47	24729.94	24596.41	13301.44	6751.91	3990.71
3	Pakse (1923-2005)	2808.89	2157.35	1812.47	1783.84	2892.87	8798.94	17229.09	27261.59	27632.79	16324.50	8127.33	4300.28
4	Stung Treng (1924-1996)	3593.91	2620.54	2089.17	2011.03	3421.34	11131.63	23278.51	35877.29	38289.99	23529.34	11396.34	5739.39
	Kratie (1924-1970)	3659.75	2664.02	2178.26	2147.05	3457.79	11371.28	25789.61	38742.71	39825.06	25112.42	11837.45	6033.52
	Kompong Cham (1959-1979)	3890.15	2578.42	2046.80	1849.33	2861.52	10503.83	23908.03	34756.13	39714.67	23132.90	11514.67	6601.77
5	Tan Chau (2003-2004)	6123.39	3888.77	2507.26	2144.83	2805.00	7106.67	9813.06	16646.77	19761.67	17612.90	11980.50	7779.52
	Chau Doc (2003-2004)	1186.87	678.25	422.06	345.00	456.24	1300.25	1959.19	3818.87	5524.17	5180.81	2871.67	1570.48

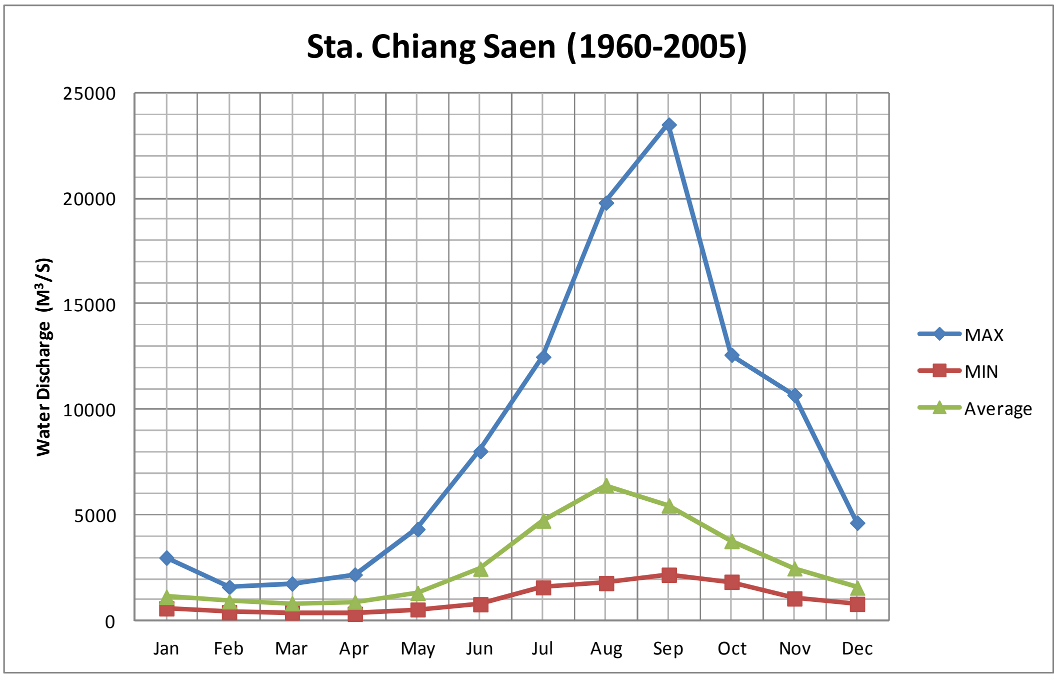


Figure 11: Mekong River's Monthly Flow Regime at Chiang Saen station

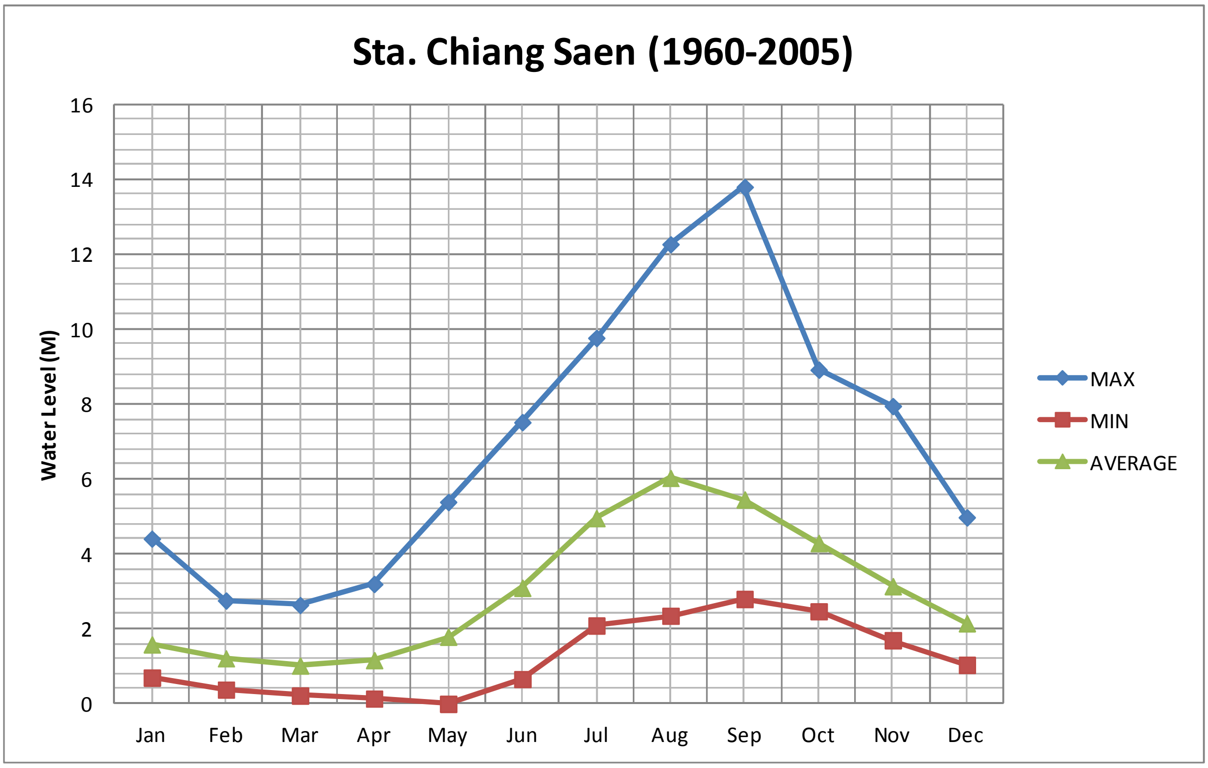


Figure 12: Mekong River's Monthly Water Level Regime at Chiang Saen station

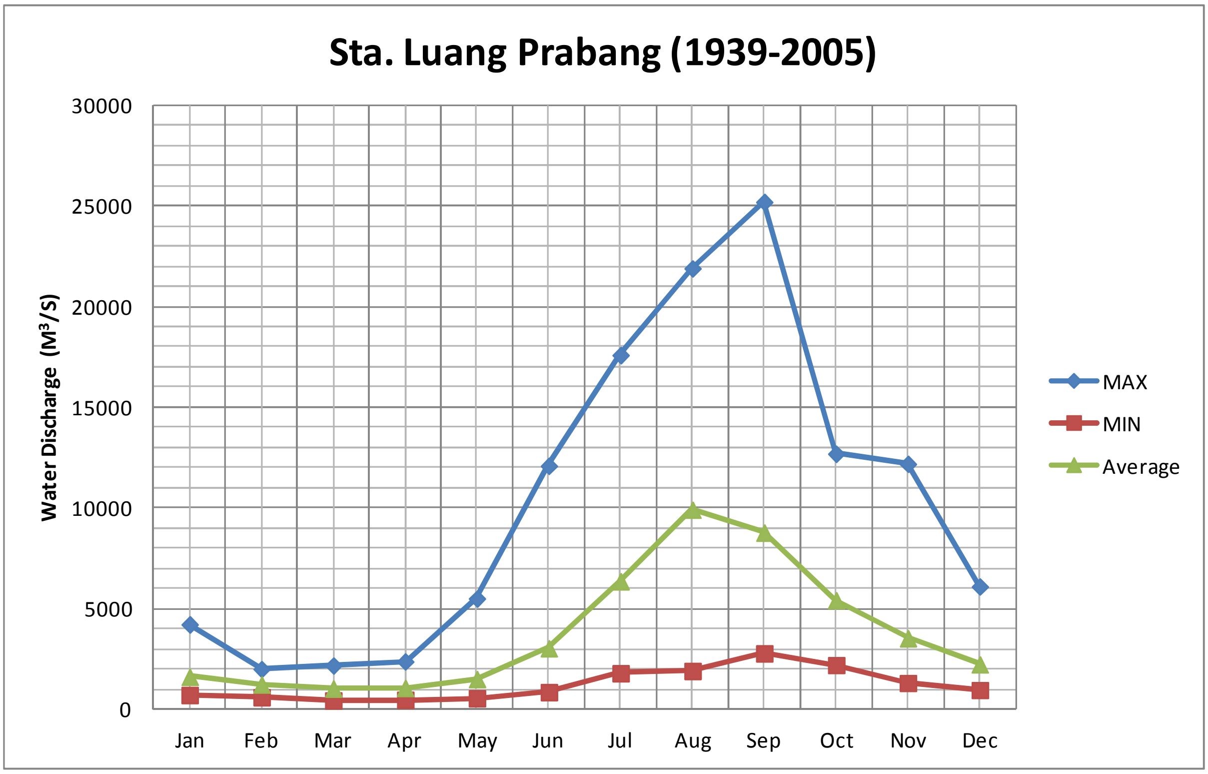


Figure 13: Mekong River's Monthly Flow Regime at Luang Prabang station

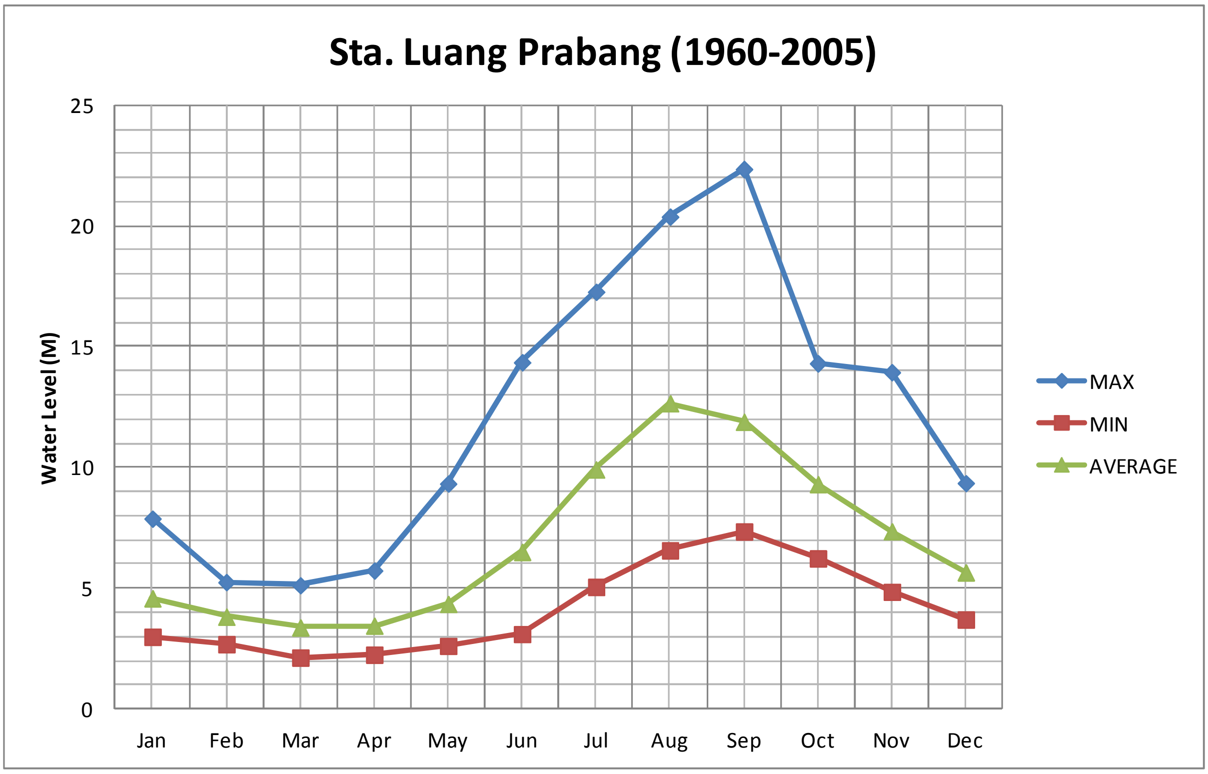


Figure 14: Mekong River's Monthly Water Level Regime at Luang Prabang station

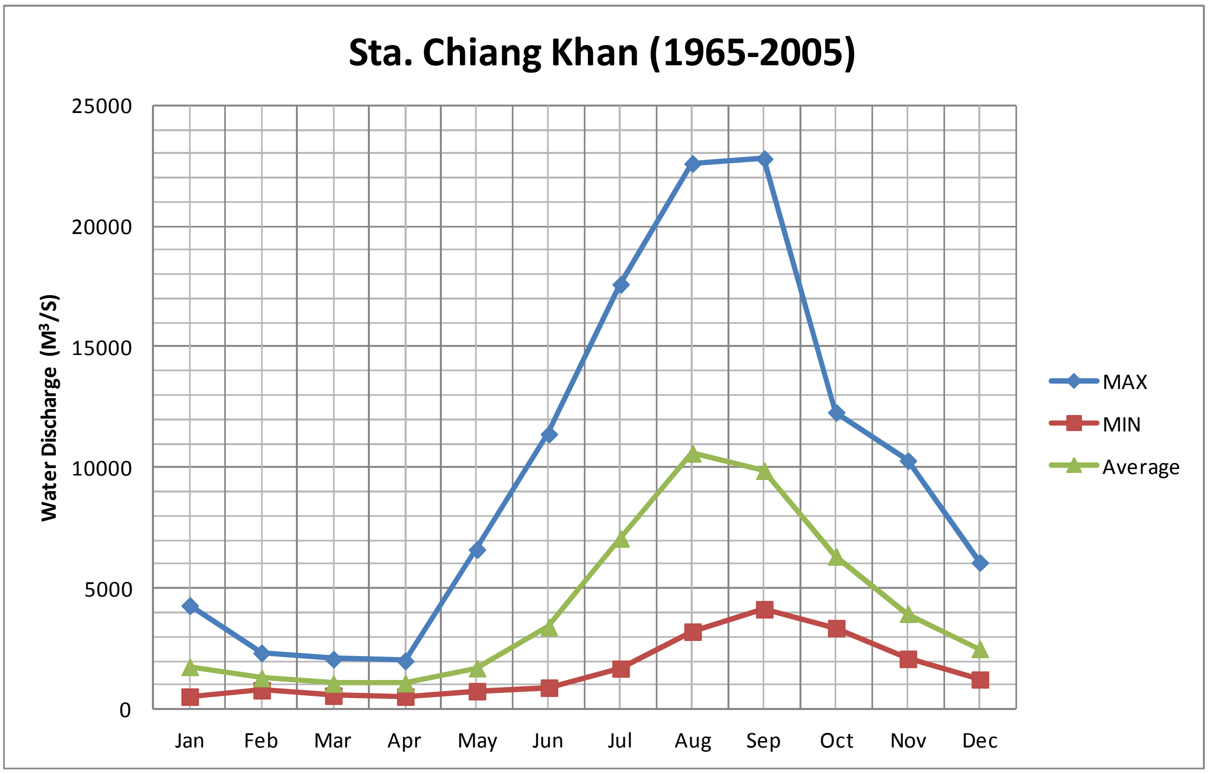


Figure 15: Mekong River's Monthly Flow Regime at Chiang Khan Station

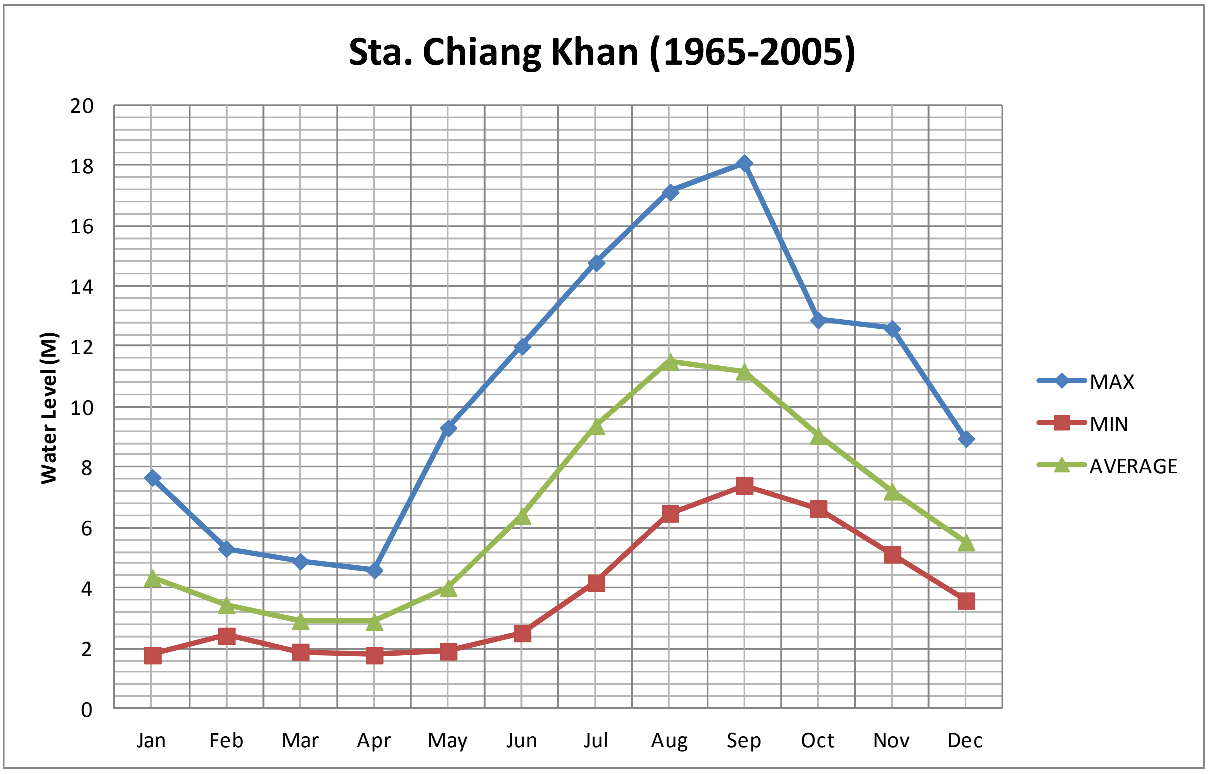


Figure 16: Mekong River's Monthly Water Level Regime at Chiang Khan Station

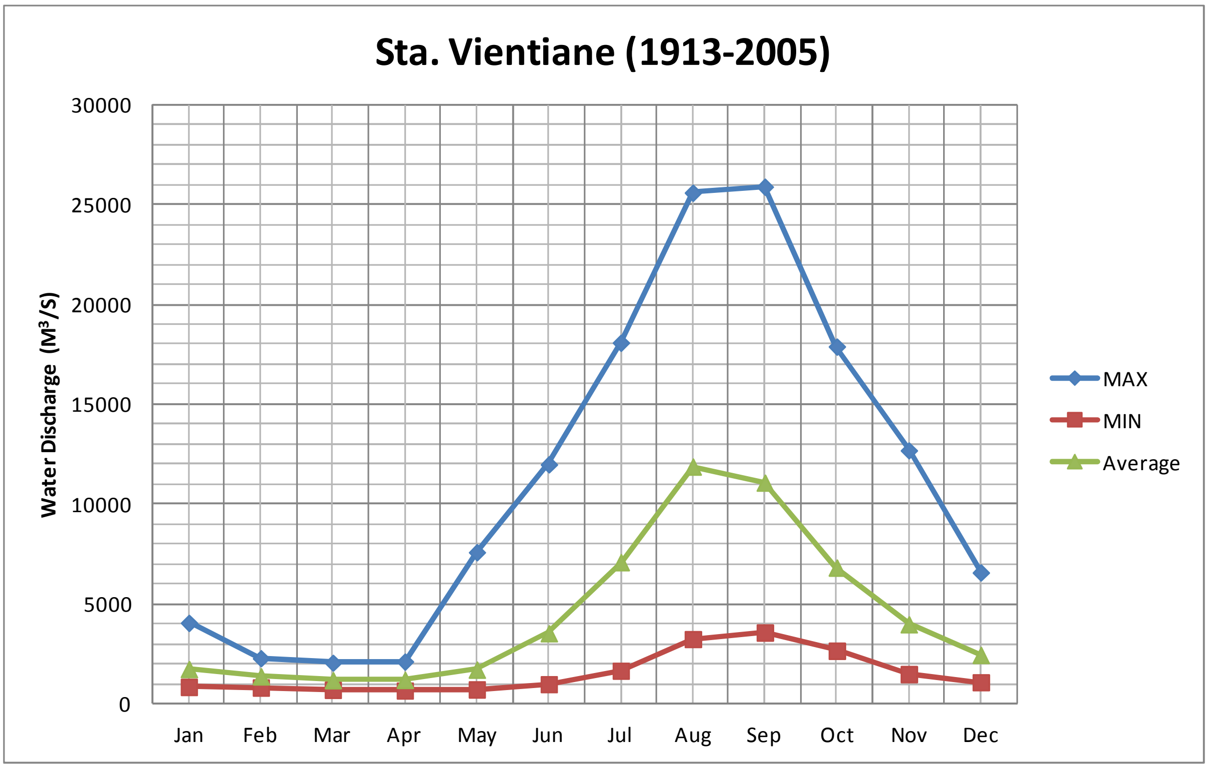


Figure 17: Mekong River's Monthly Flow Regime at Vientiane Station

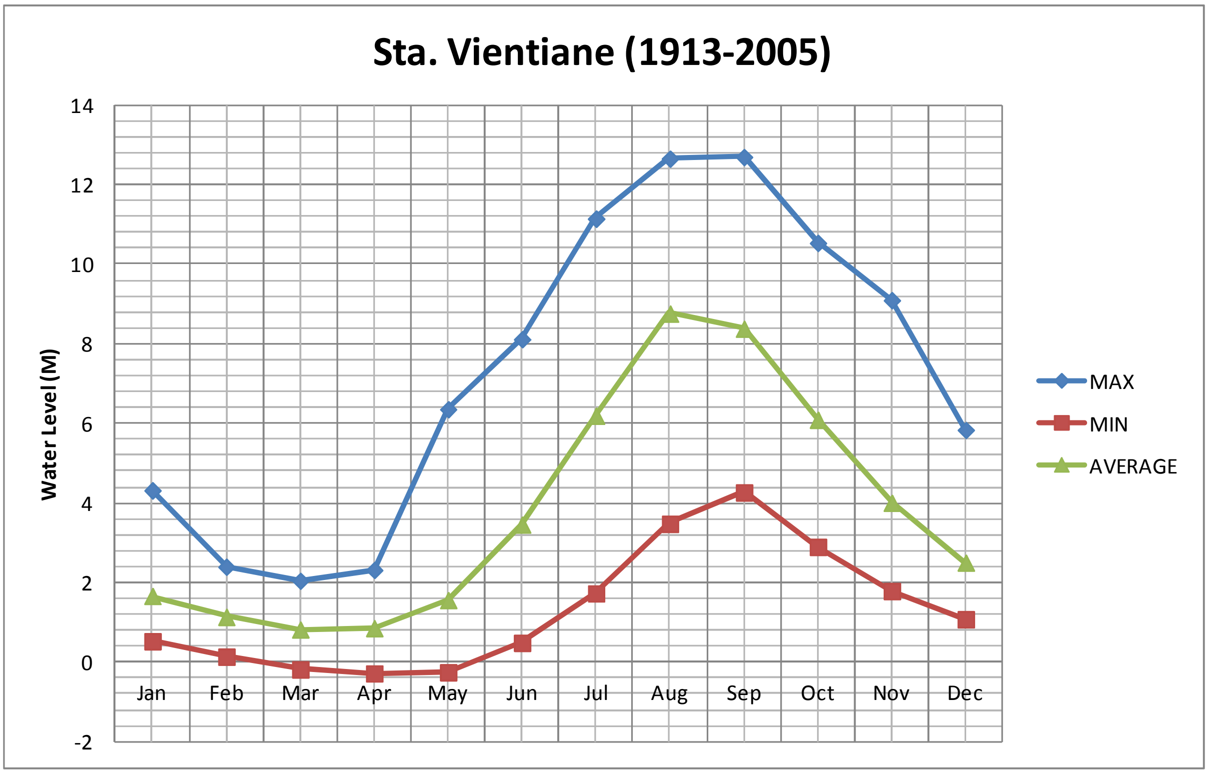


Figure 18: Mekong River's Monthly Water Level Regime at Vientiane station

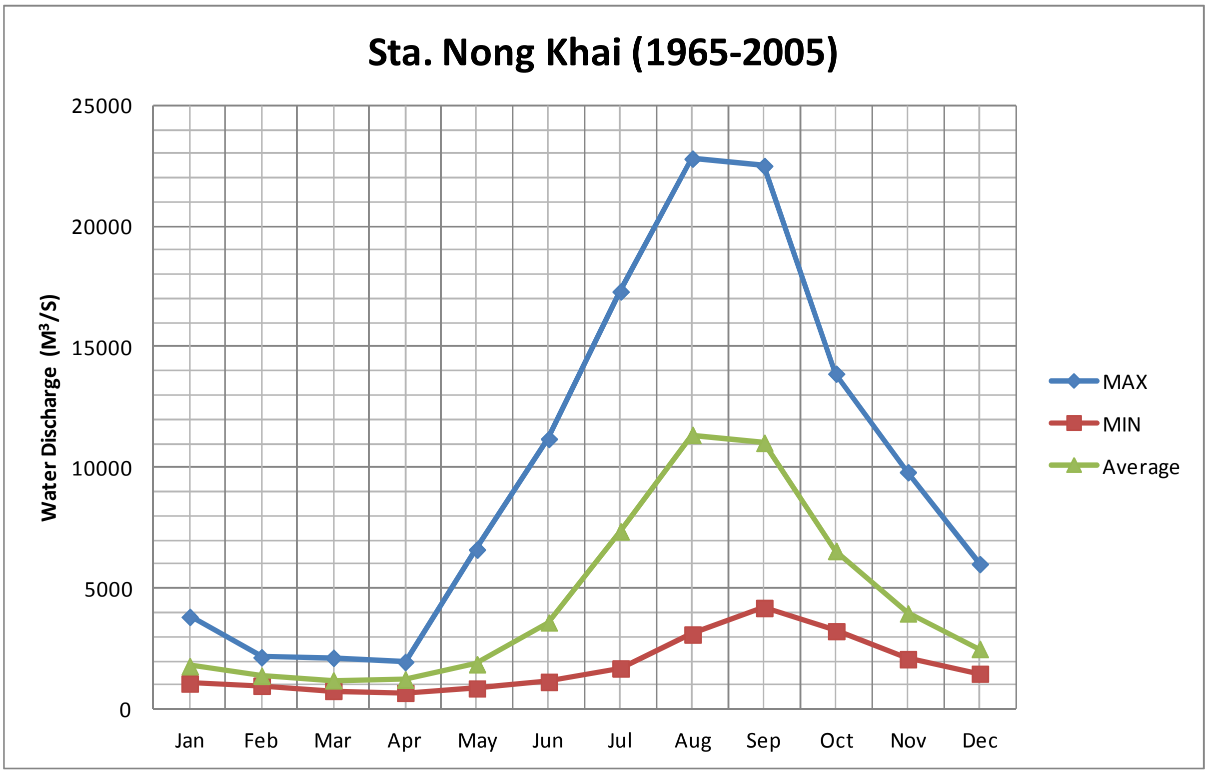


Figure 19: Mekong River's Monthly Flow Regime at Nong Khai station

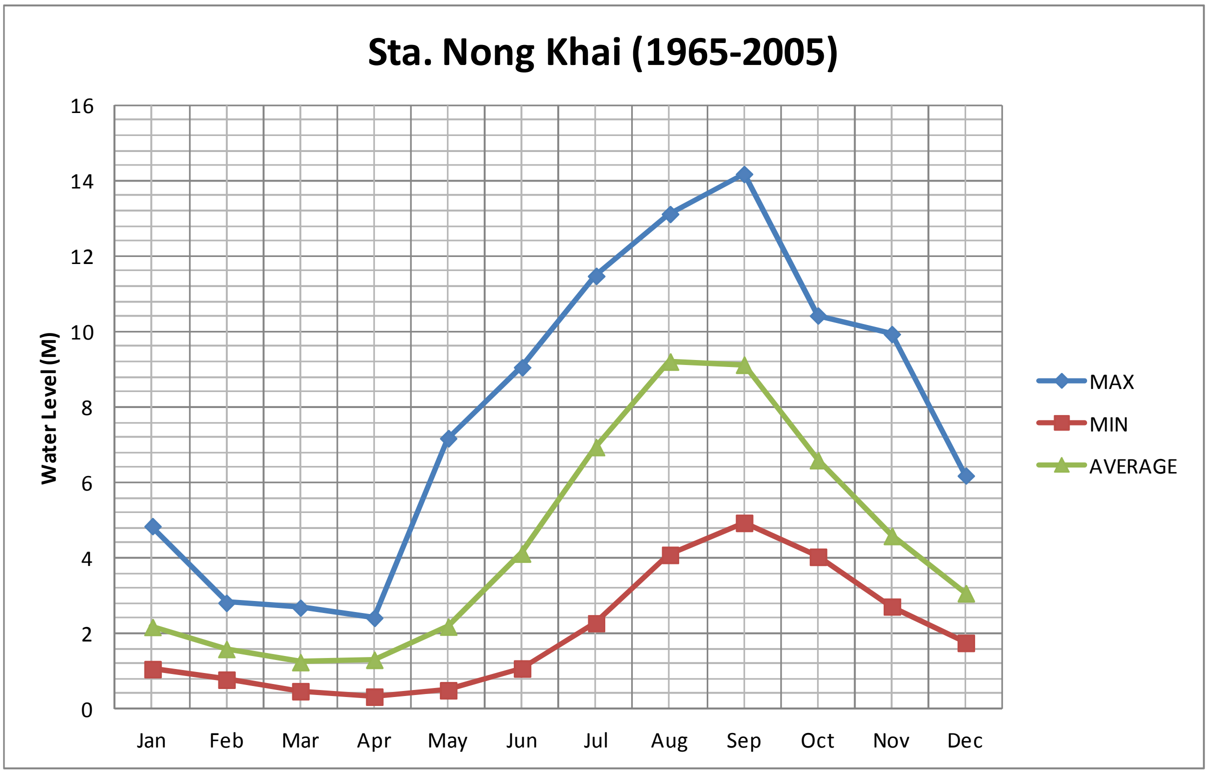


Figure 20: Mekong River's Monthly Water Level Regime at Nong Khai station

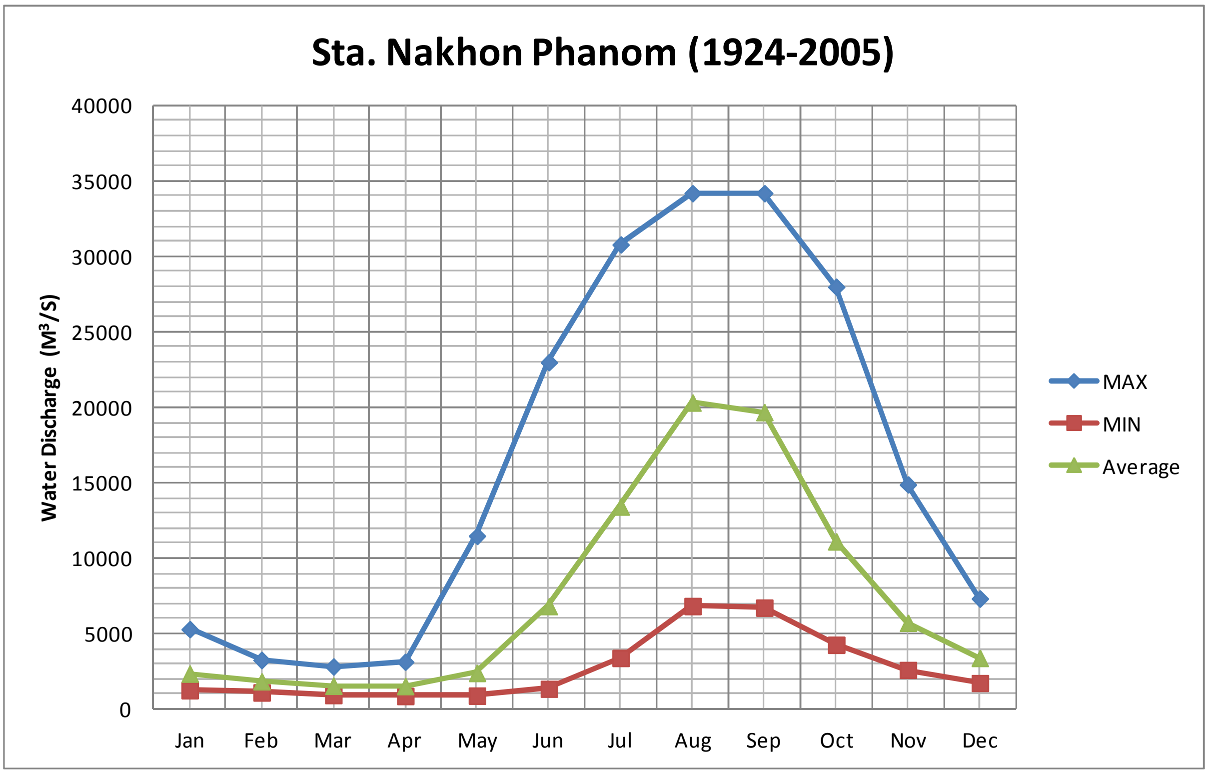


Figure 21: Mekong River's Monthly Flow Regime at Nakhon Phanom station

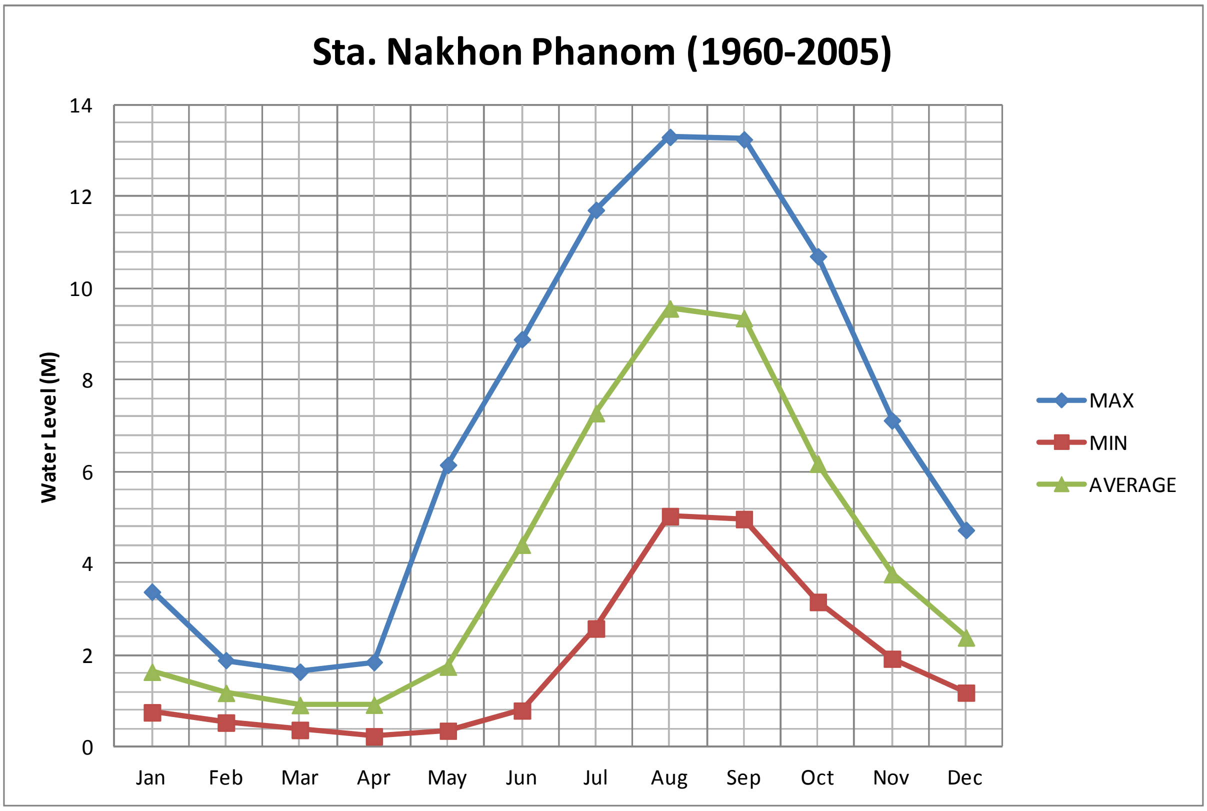


Figure 22: Mekong River's Monthly Water Level Regime at Nakhon Phanom Station

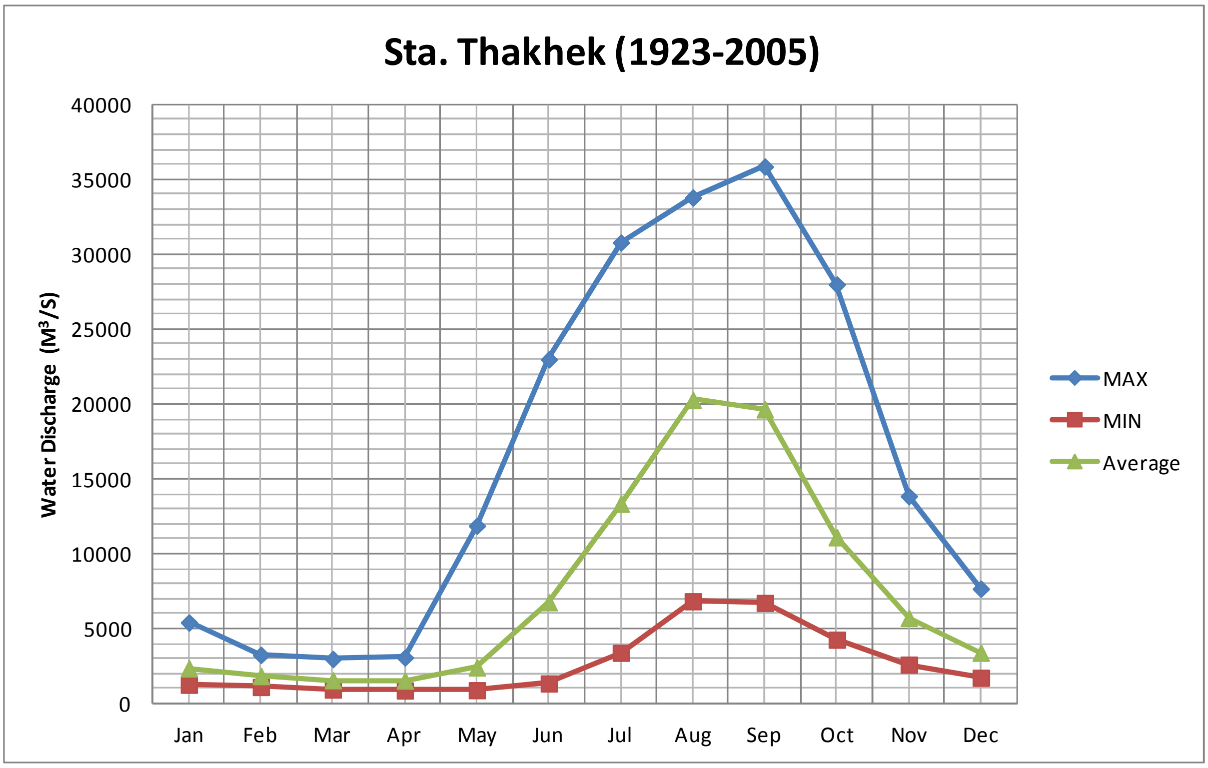


Figure 23: Mekong River's Monthly Flow Regime at Thakhek station

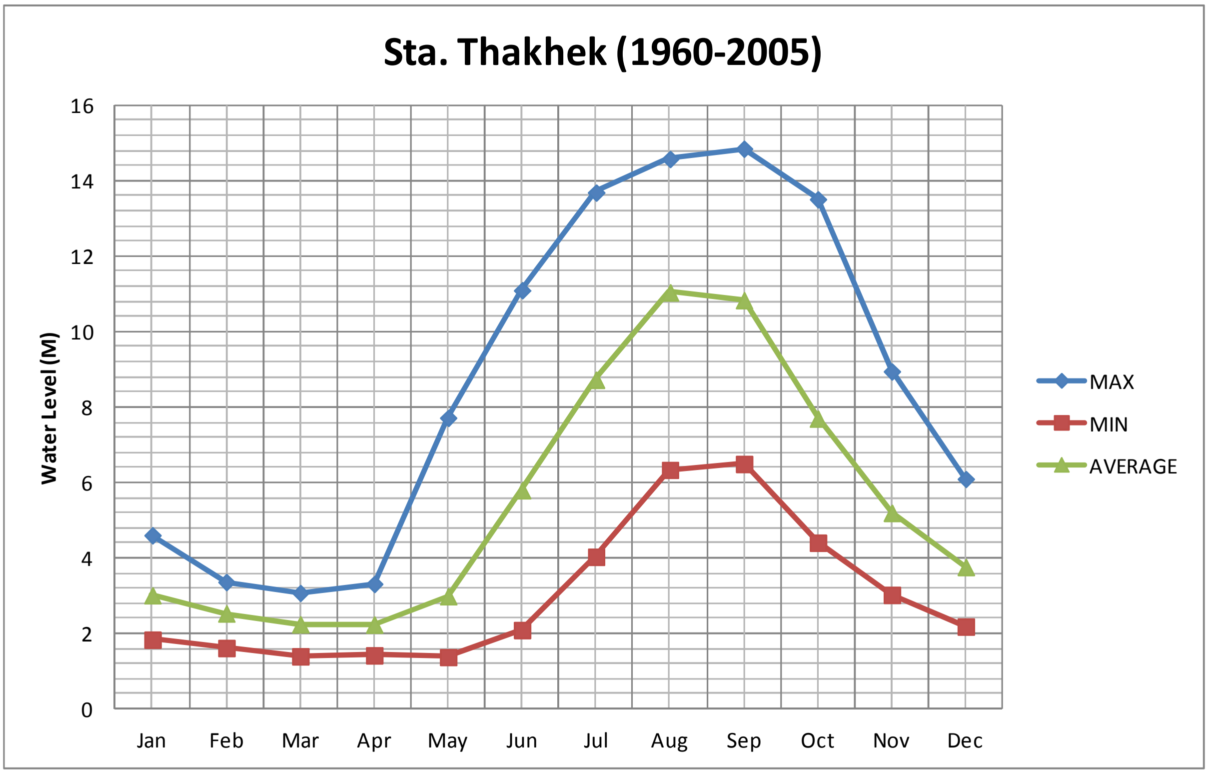


Figure 24: Mekong's Monthly Water Level Regime at Thakhek station

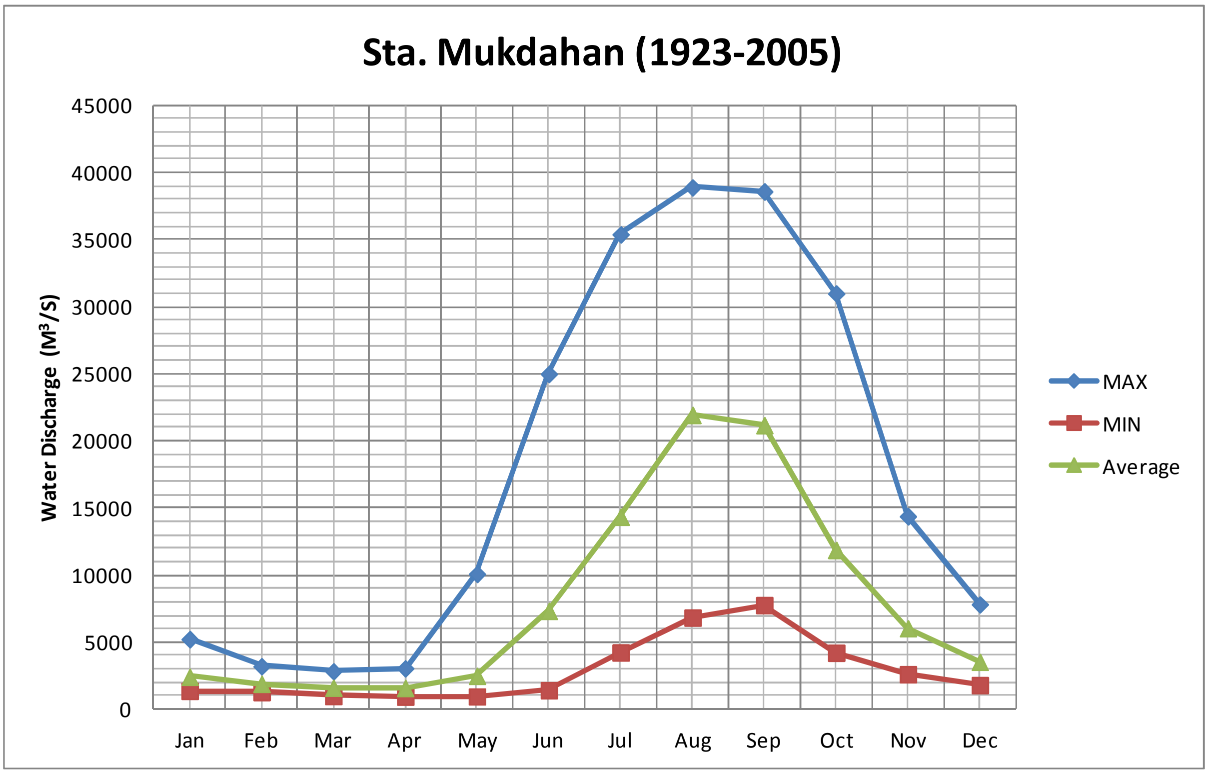


Figure 25: Mekong River's Monthly Flow Regime at Mukdahan station

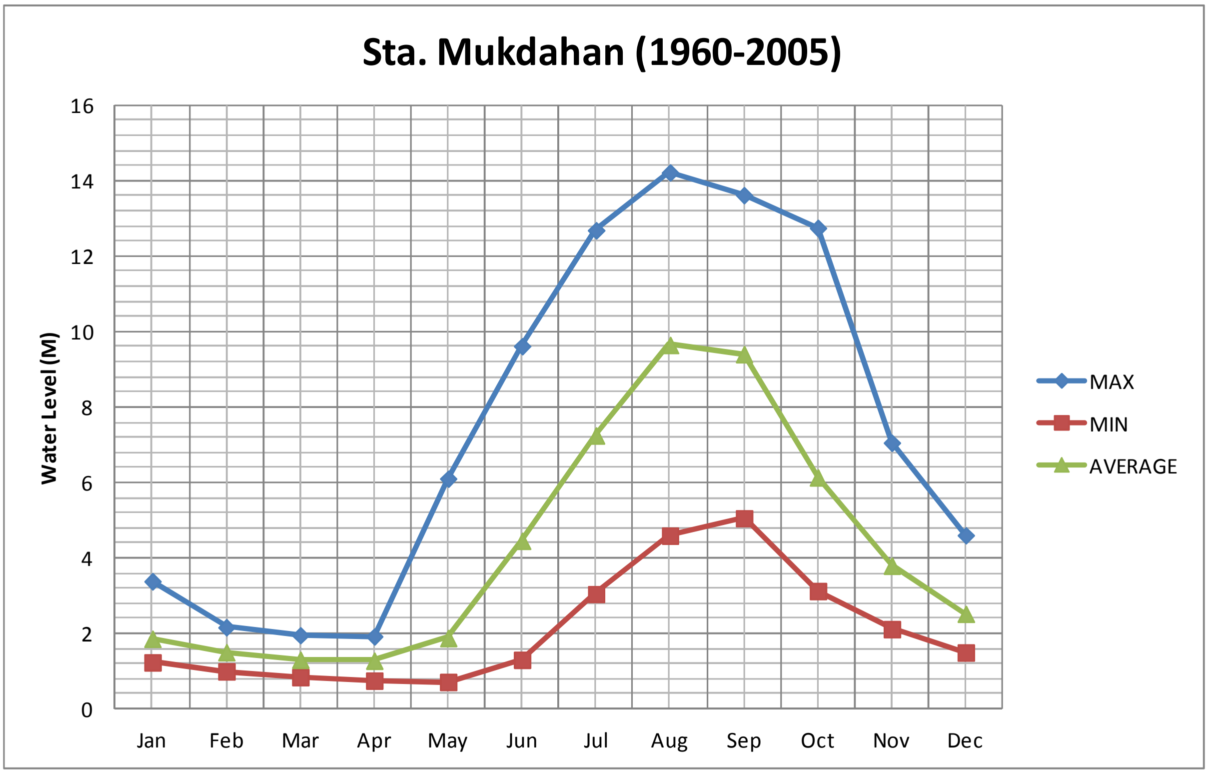


Figure 26: Mekong River's Monthly Water Level Regime at Mukdahan station

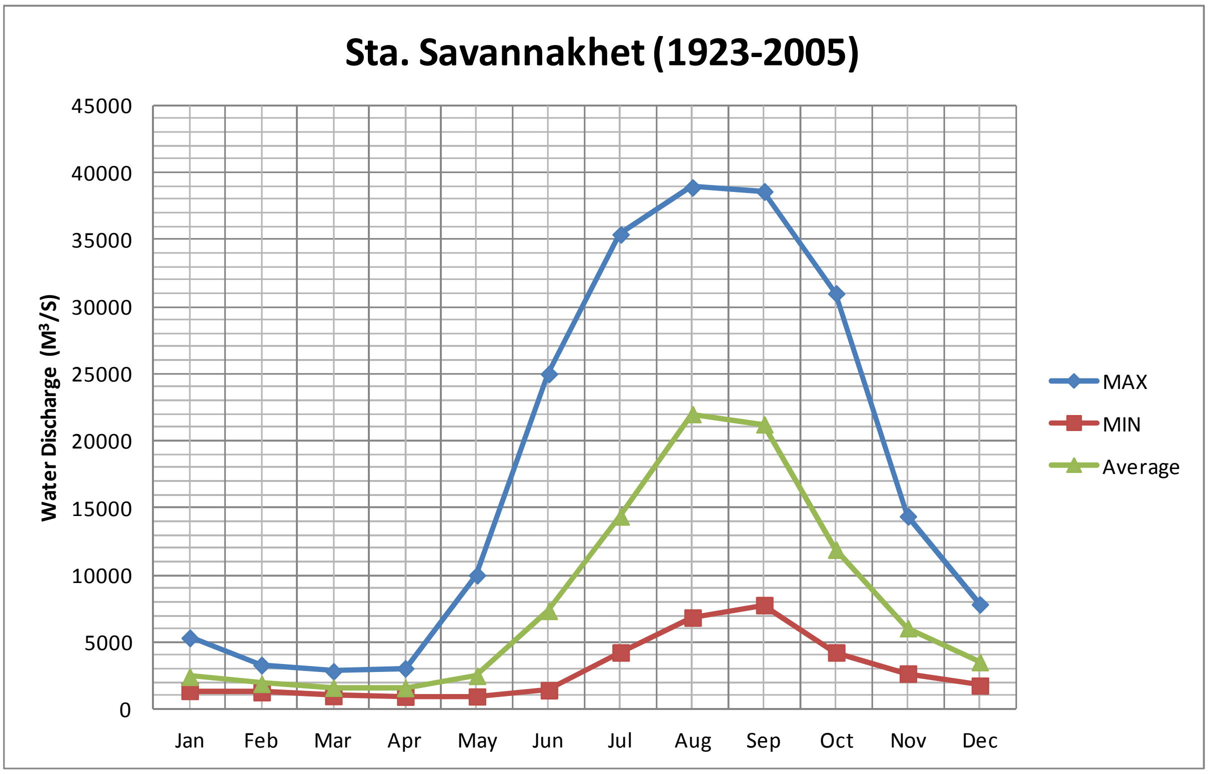


Figure 27: Mekong River's Monthly Flow Regime at Savannakhet station

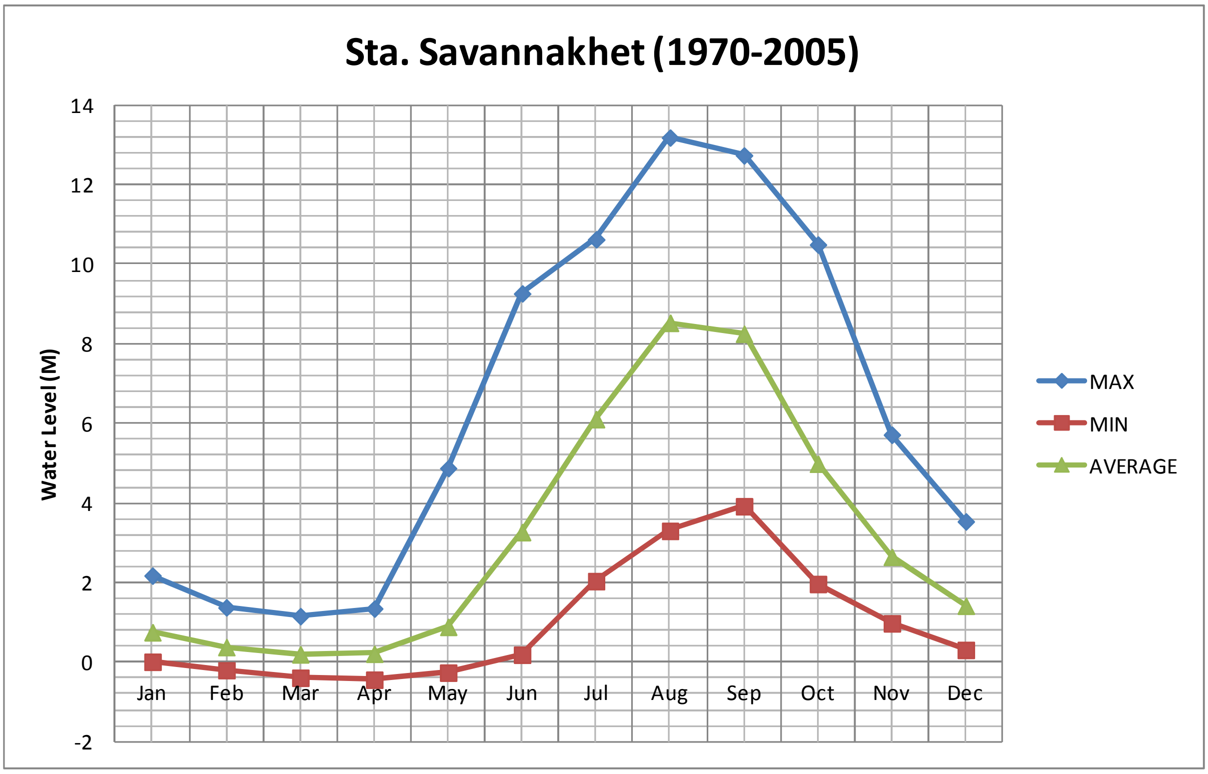


Figure 28: Mekong River's Monthly Water Level Regimeat Savannakhet station

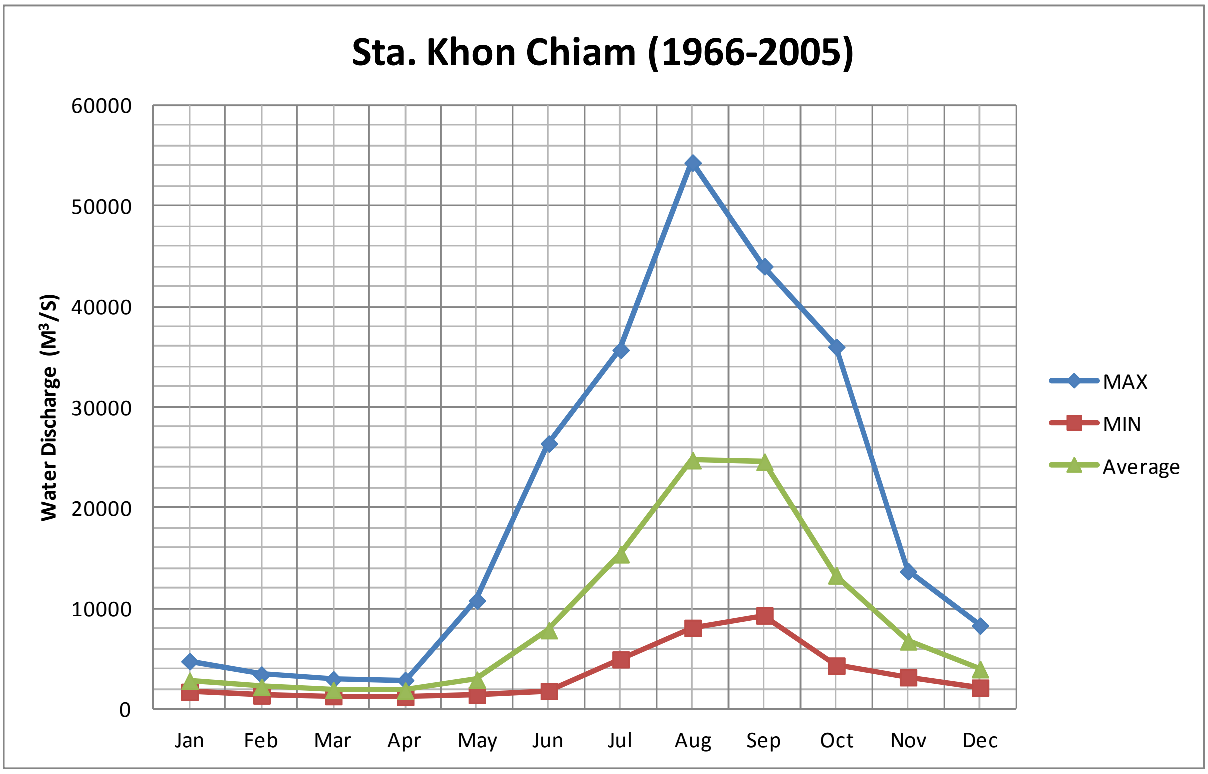


Figure 29: Mekong River's Monthly Flow Regime at Khong Chiam station

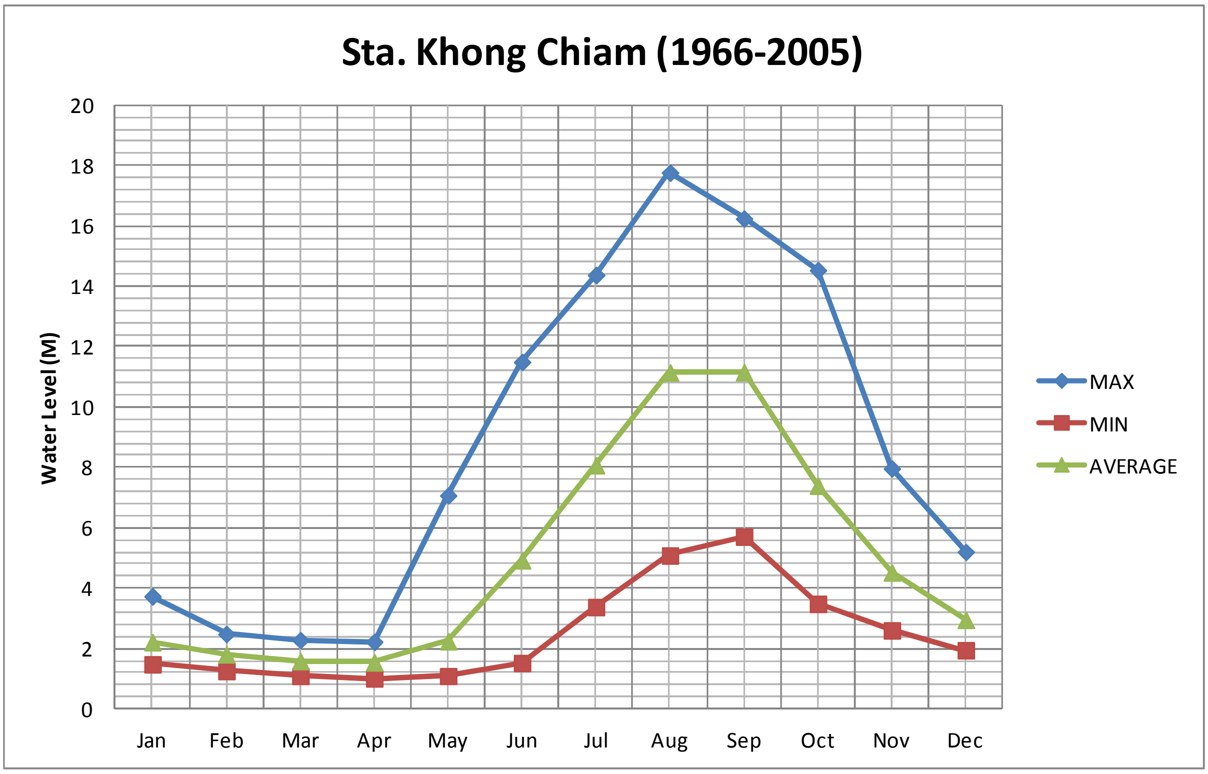


Figure 30: Mekong River's Monthly Water Level Regimeat Khong Chiam station

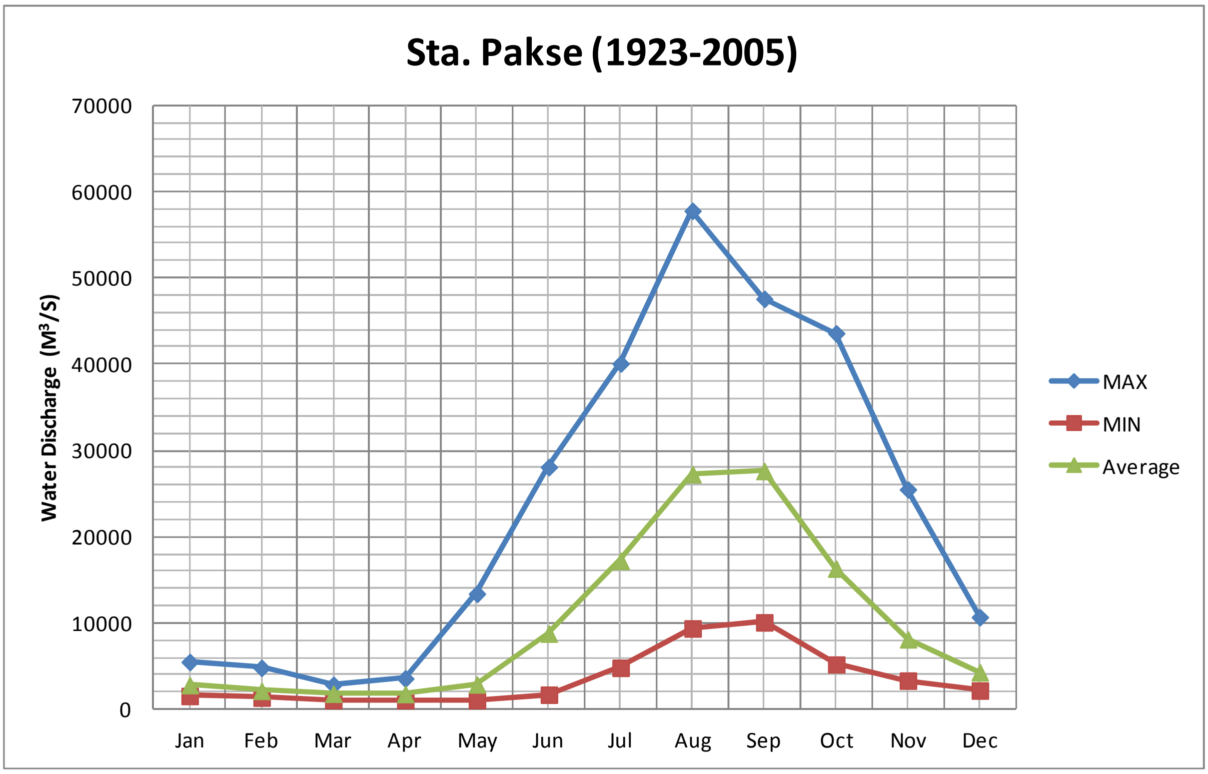


Figure 31: Mekong River's Monthly Flow Regime at Pakse station

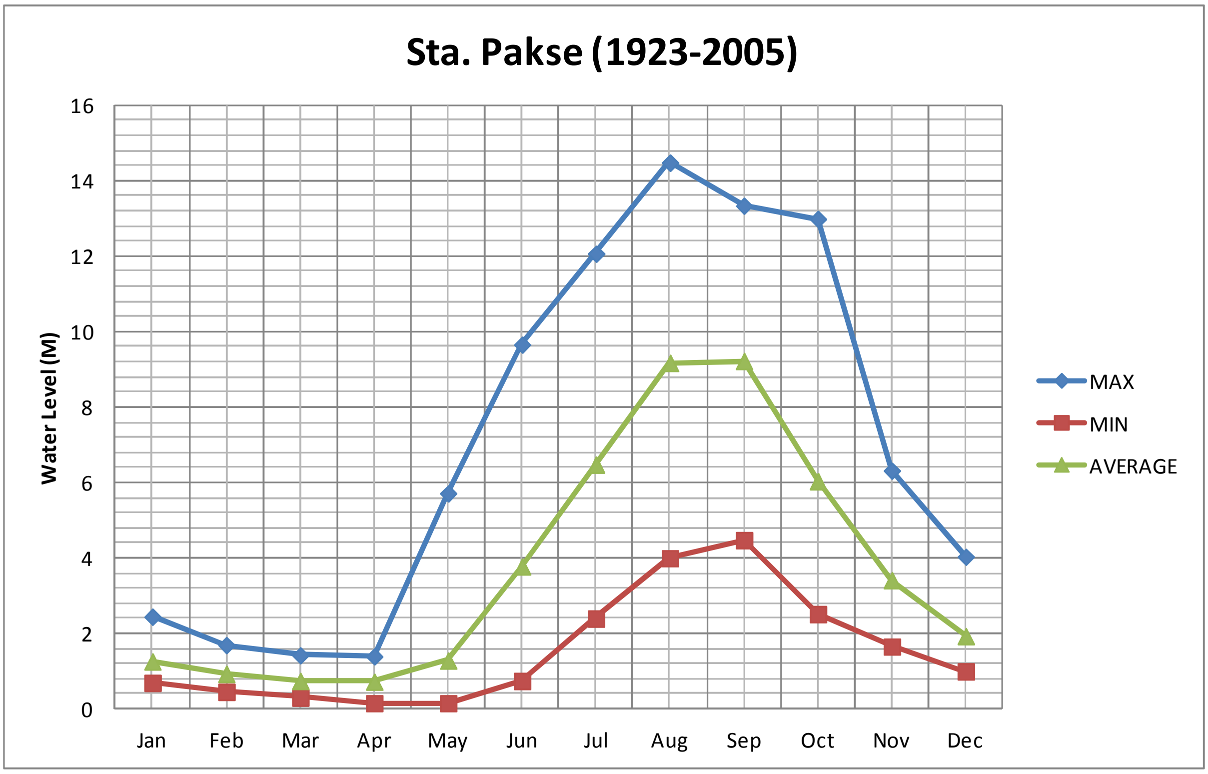


Figure 32: Mekong River's Monthly Water Level Regime at Pakse station

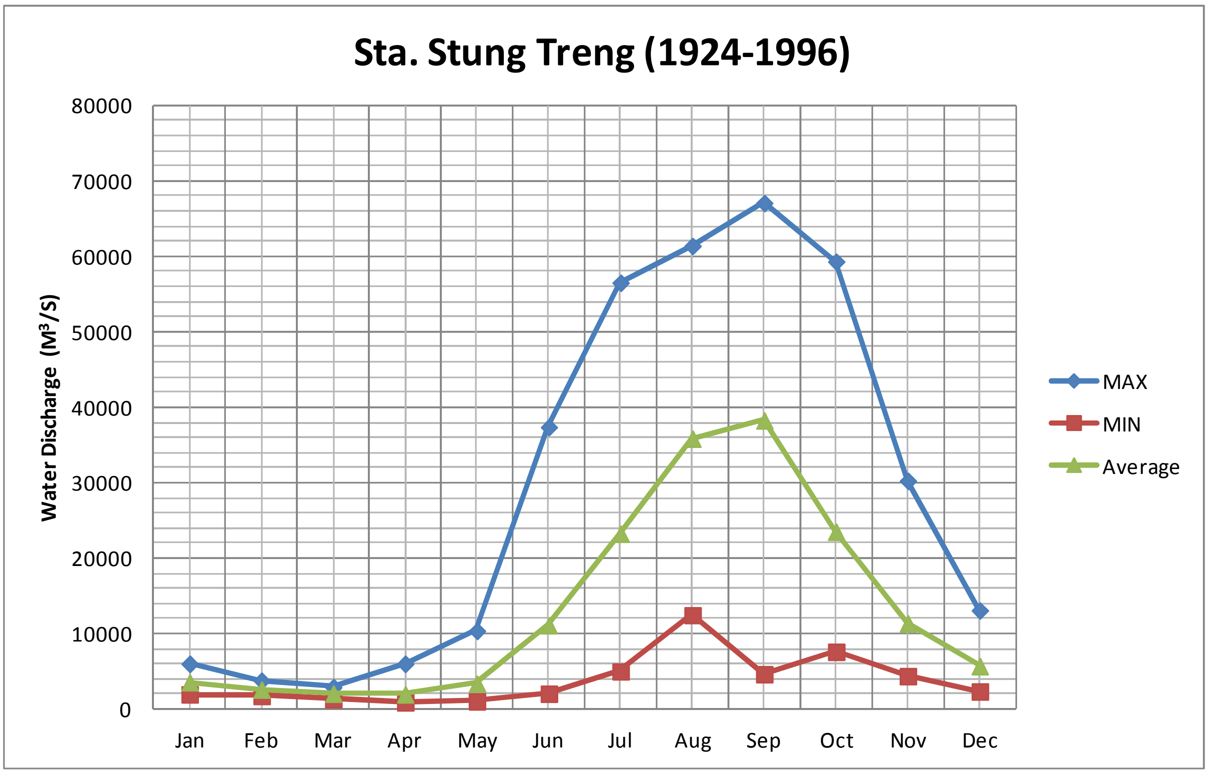


Figure 33: Mekong River's Monthly Flow Regime at Stung Treng station

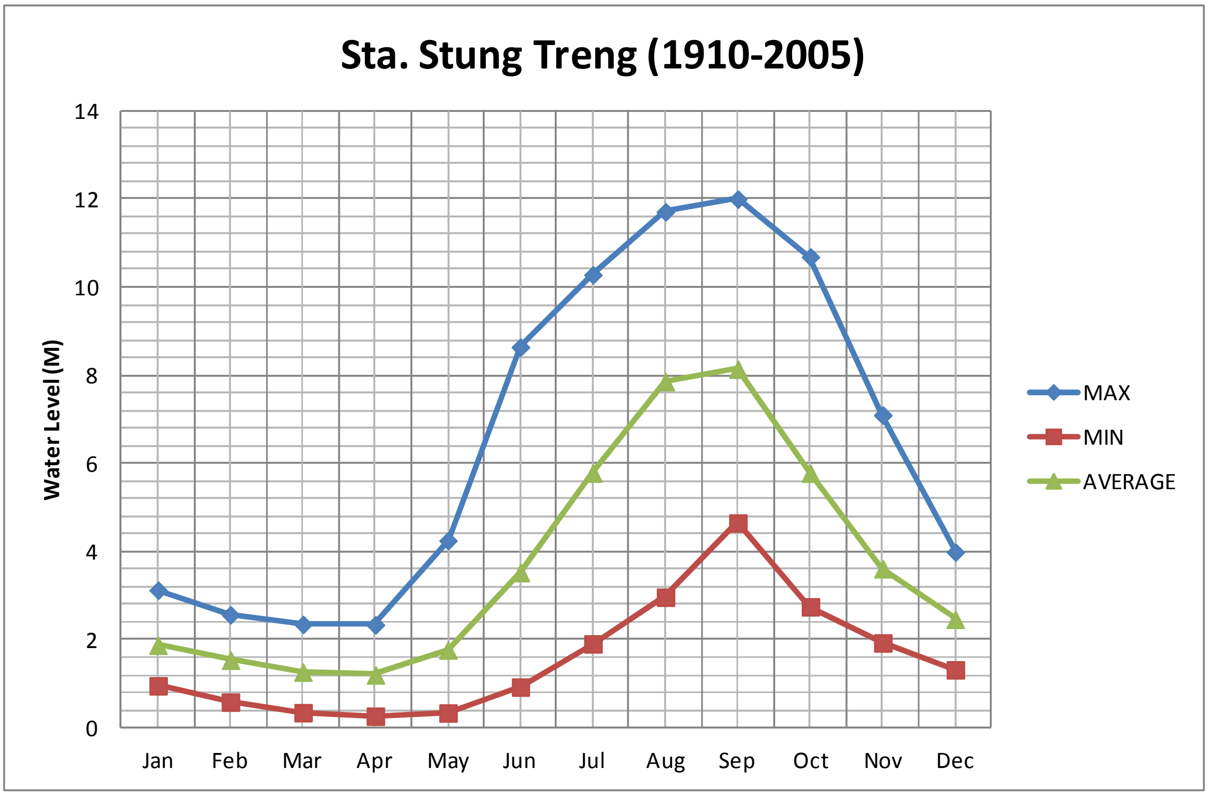


Figure 34: Mekong River's Monthly Water Level Regime at Stung Treng station

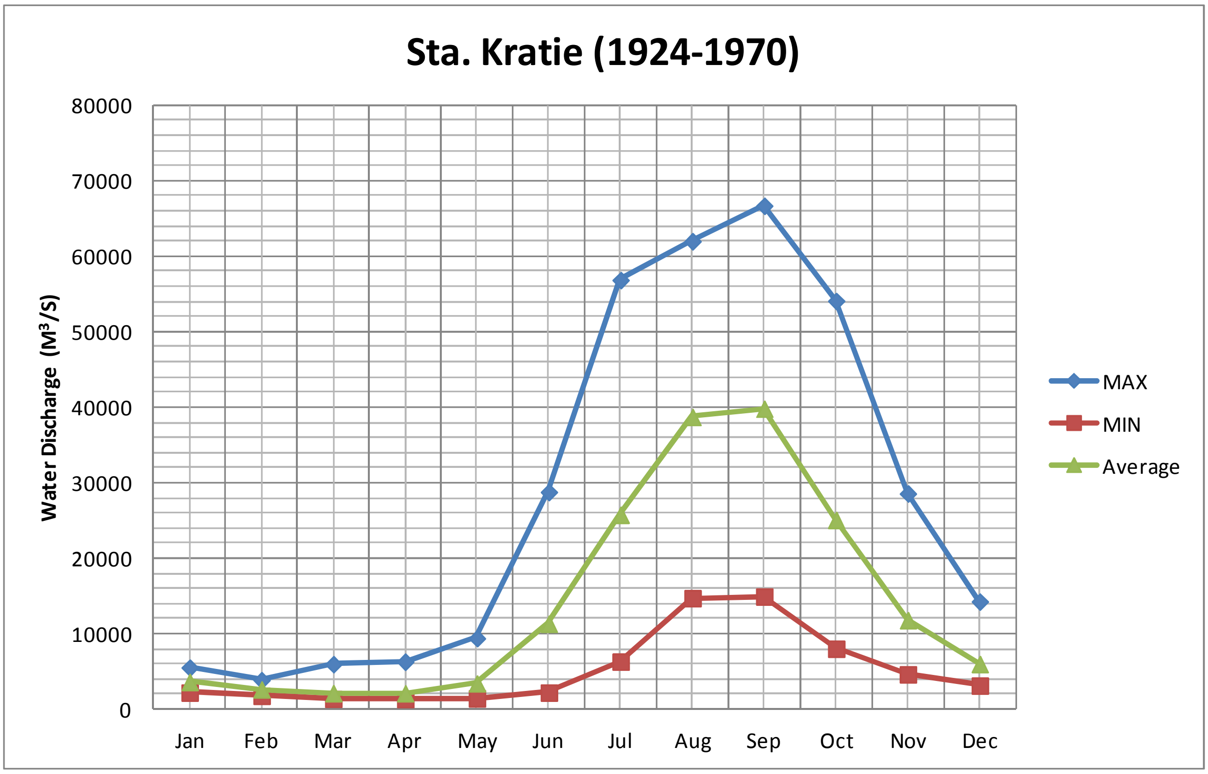


Figure 35: Mekong River's Monthly Flow Regime at Kratie station

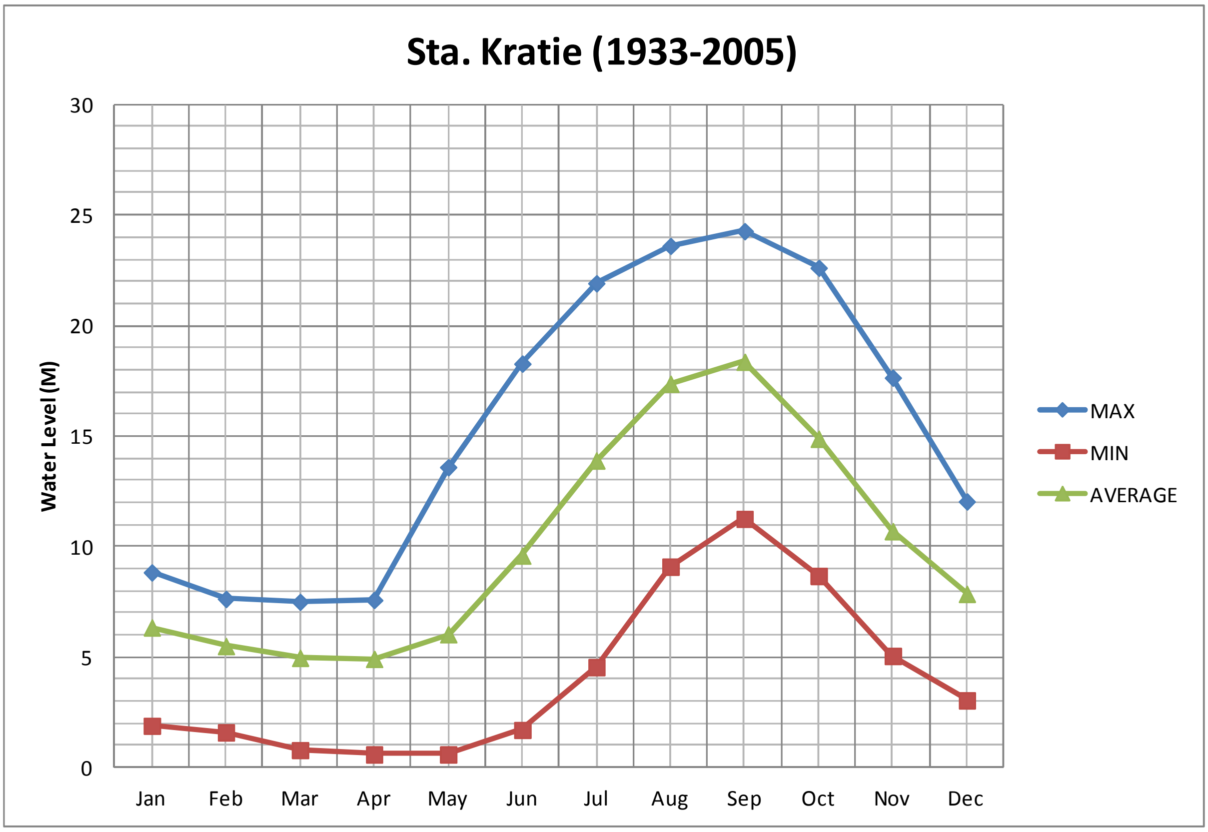


Figure 36: Mekong River's Monthly Water Level Regime at Kratie station

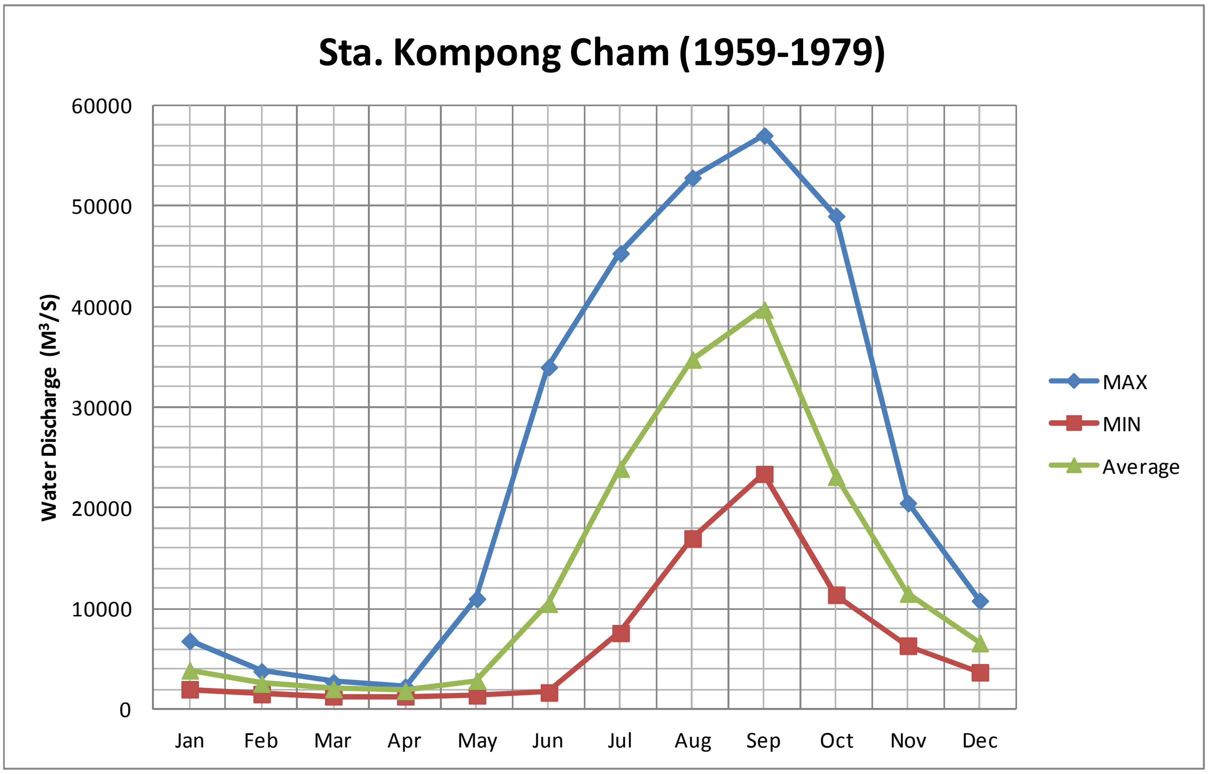


Figure 37: Mekong River's Monthly Flow Regime at Kompong Cham station

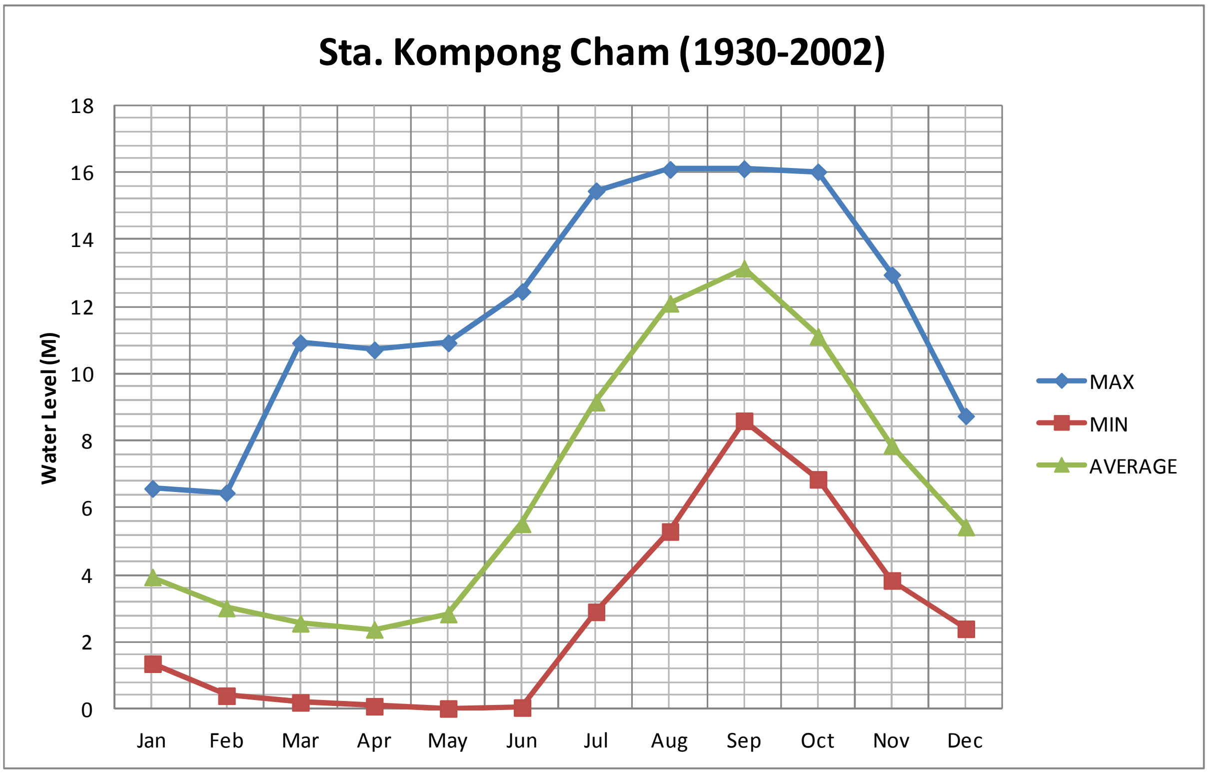


Figure 38: Mekong River's Monthly Water Level Regime at Kompong Cham station

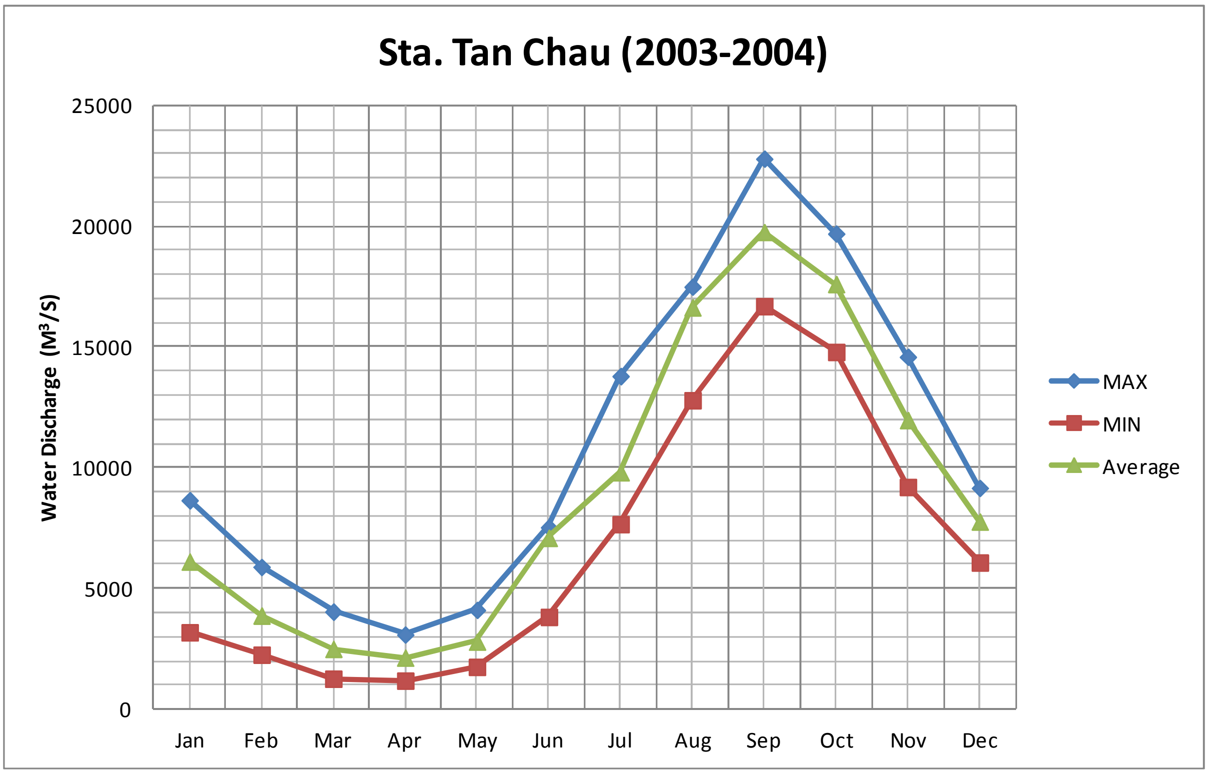


Figure 39: Mekong River's Monthly Flow Regime at Tan Chau station

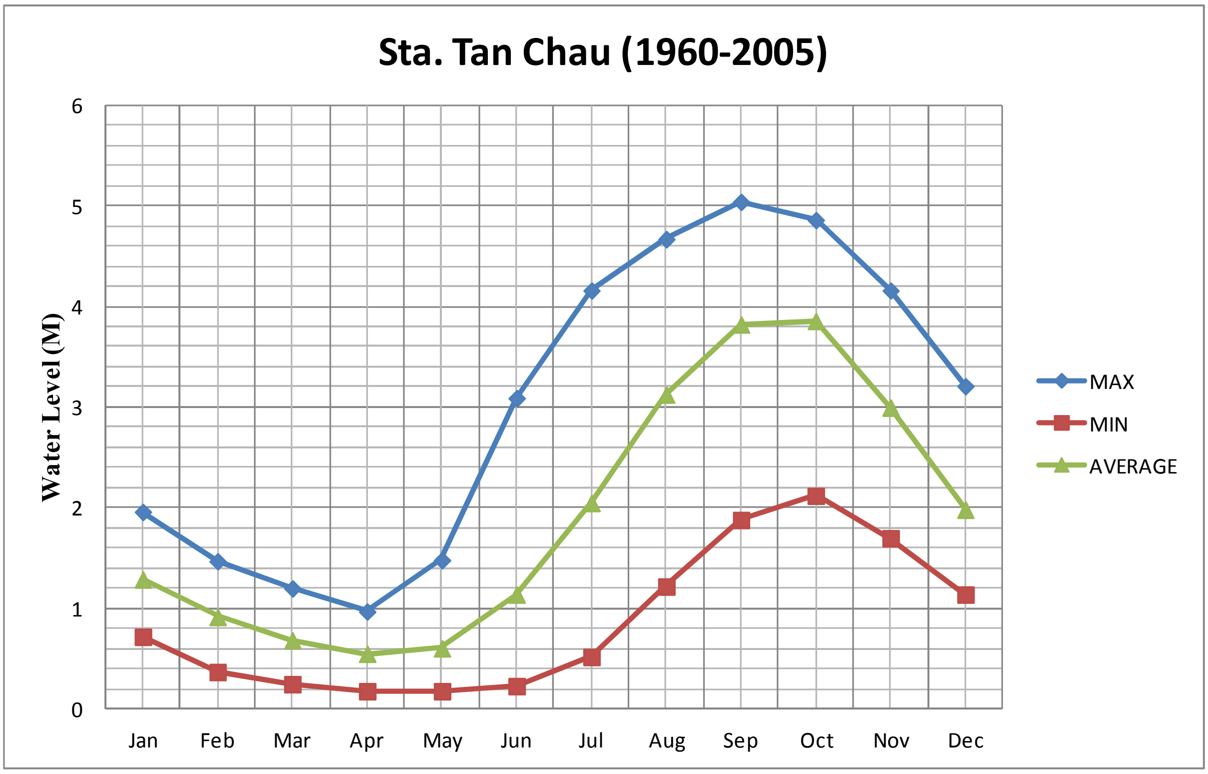


Figure 40: The Mekong River's monthly water level regimeat Tan Chau station

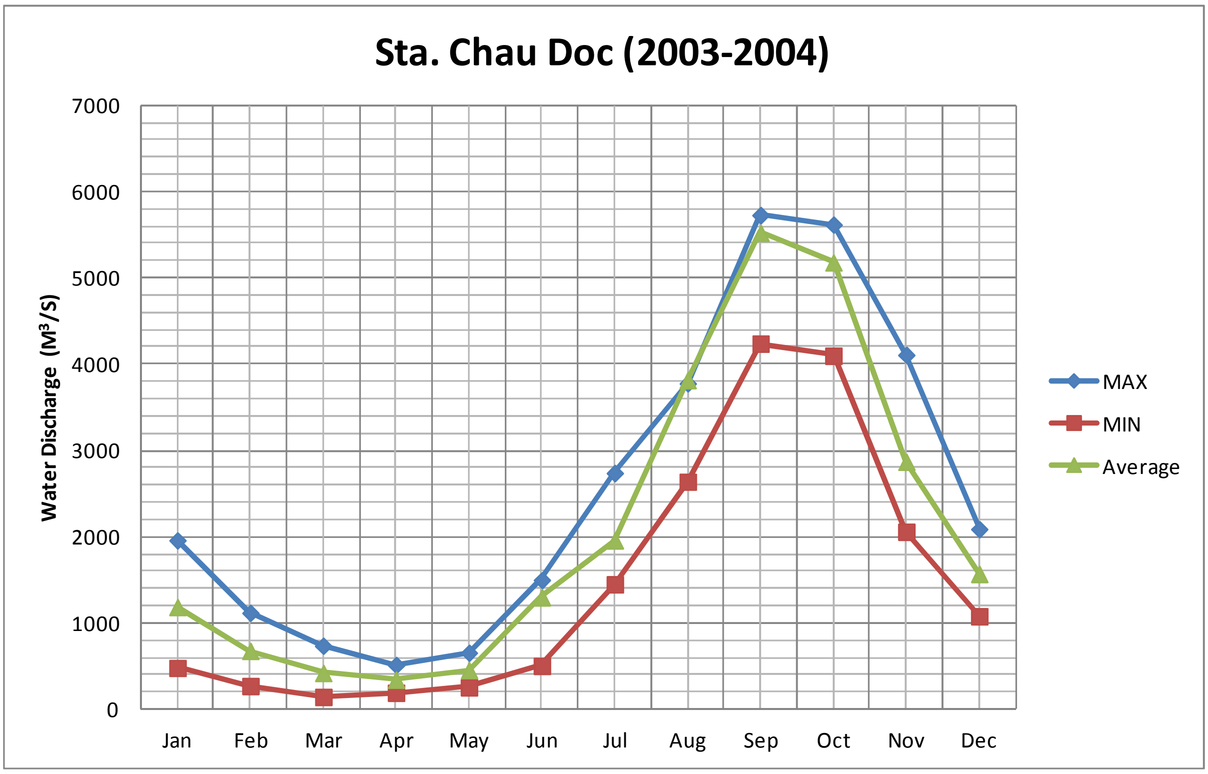


Figure 41: Mekong River's monthly flow regime at Chau Doc station

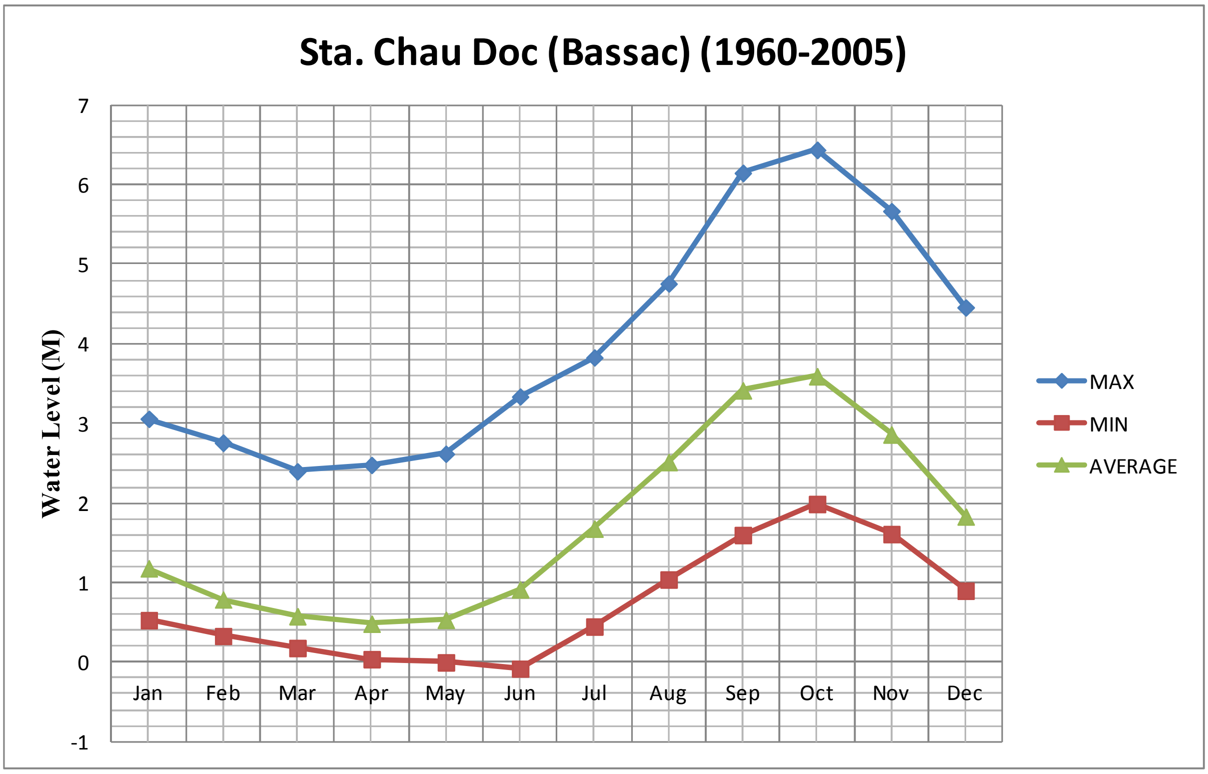


Figure 42: Mekong River's Monthly Water Level Regime at Chau Doc station

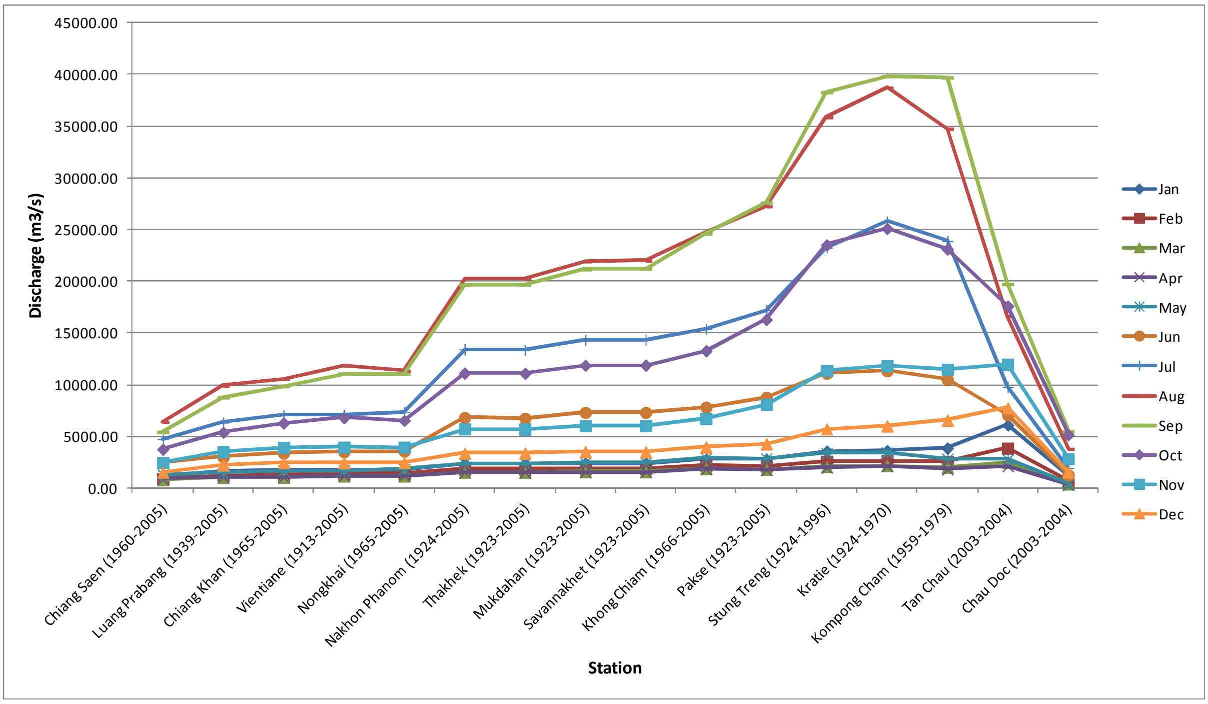


Figure 43: The Mean Monthly Discharge of Mekong River at each station

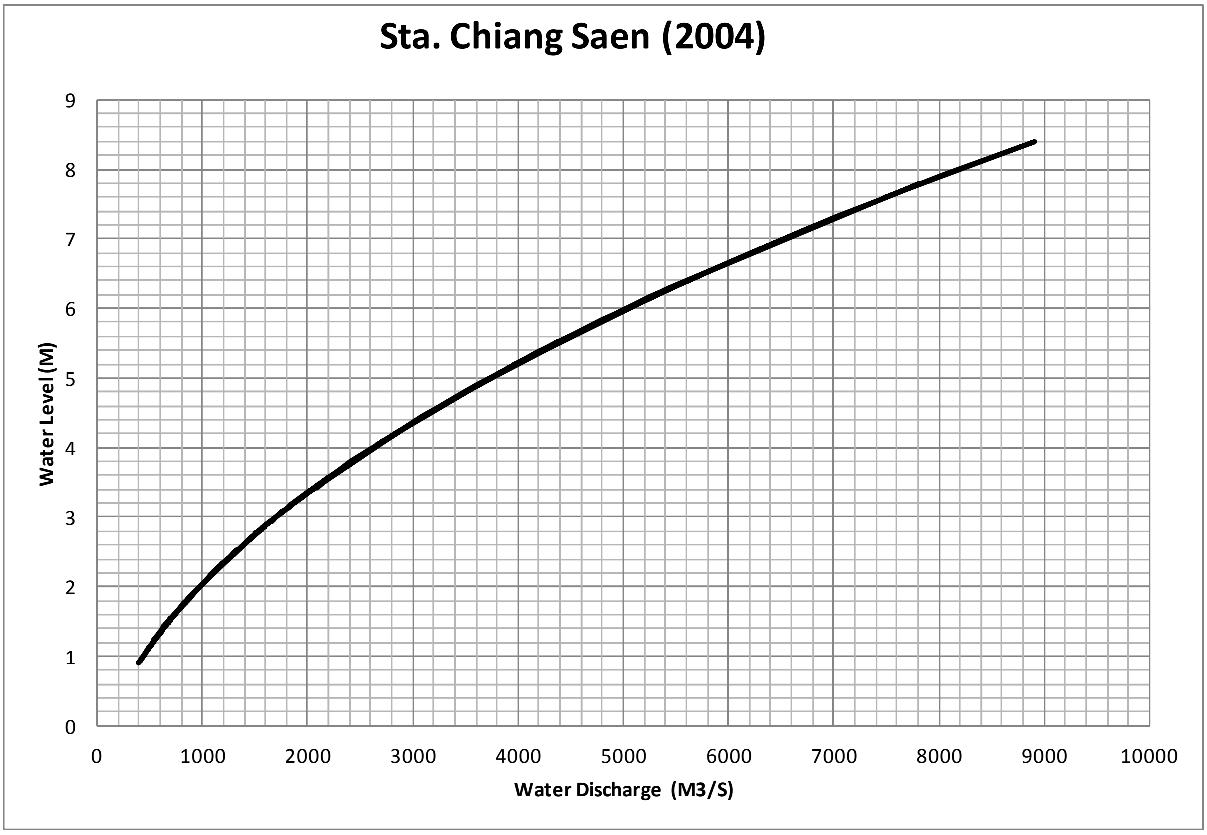


Figure 44: The Rating Curve of Chiang Saen station

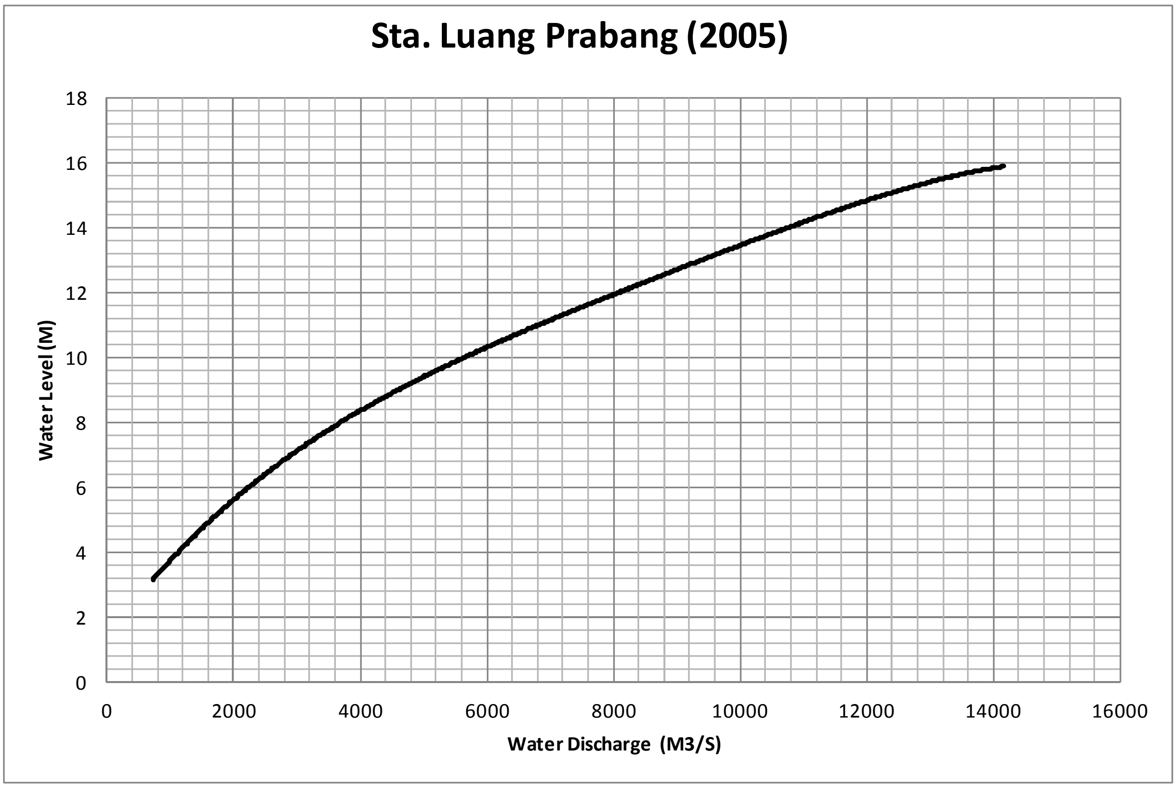


Figure 45: The Rating Curve of Luang Prabang station

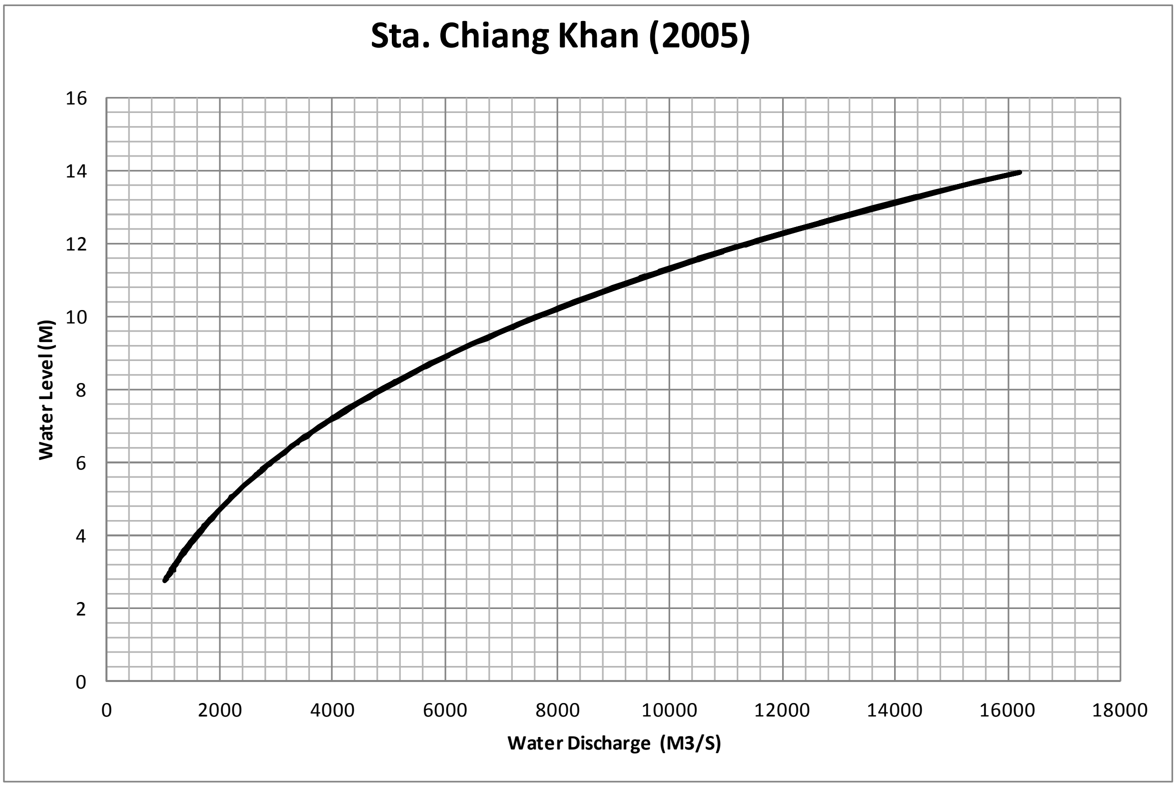


Figure 46: The Rating Curve of Chiang Khan Station

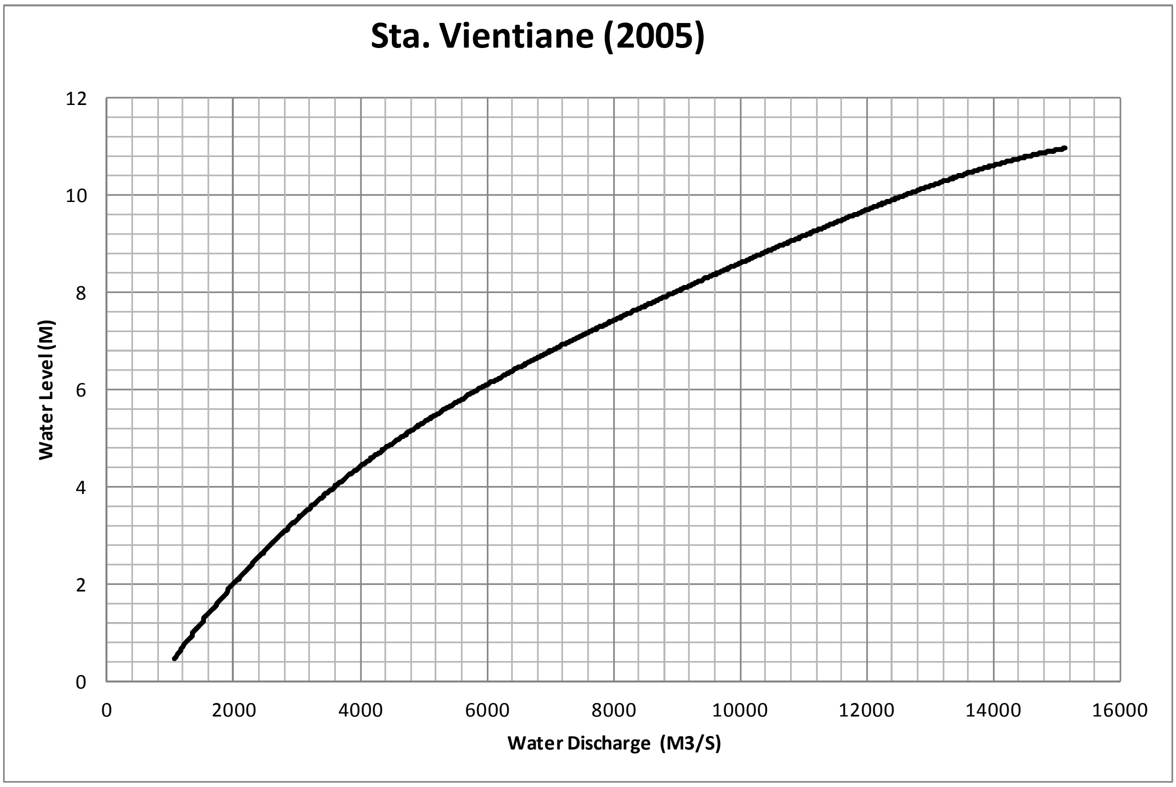


Figure 47: The Rating Curve of Vientiane station

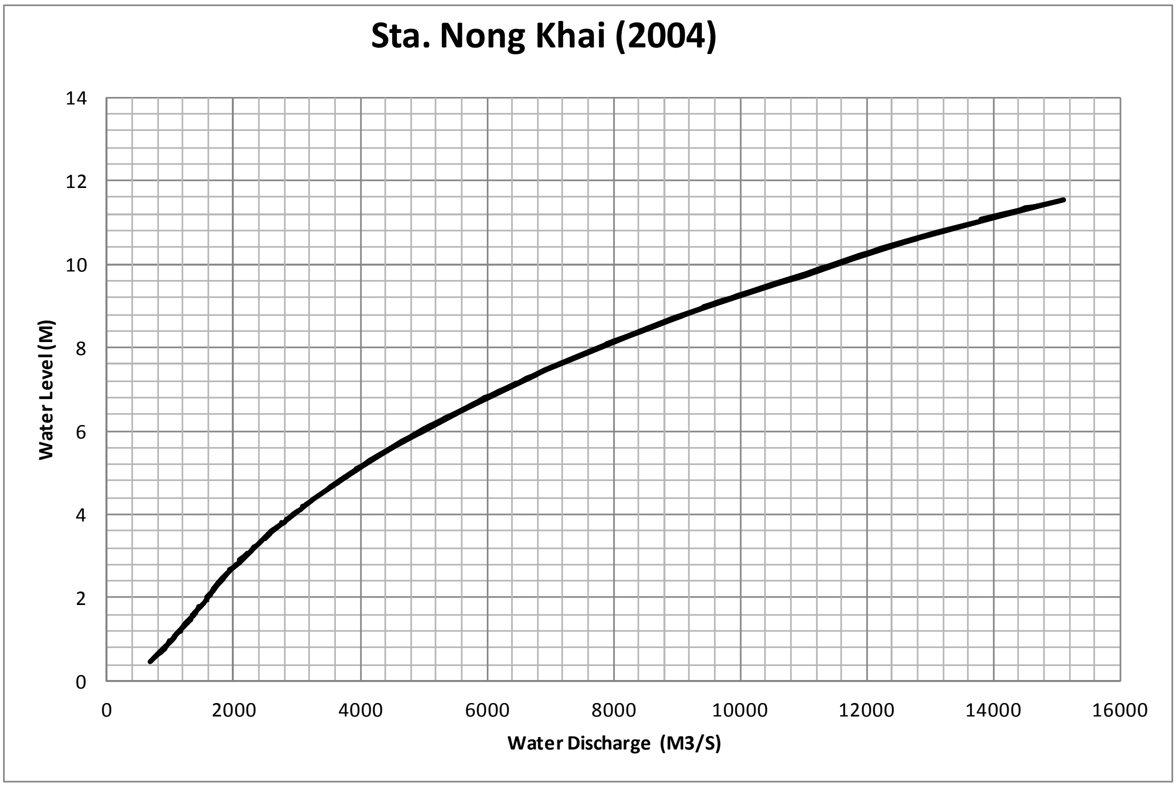


Figure 48: The Rating Curve of Nong Khai station

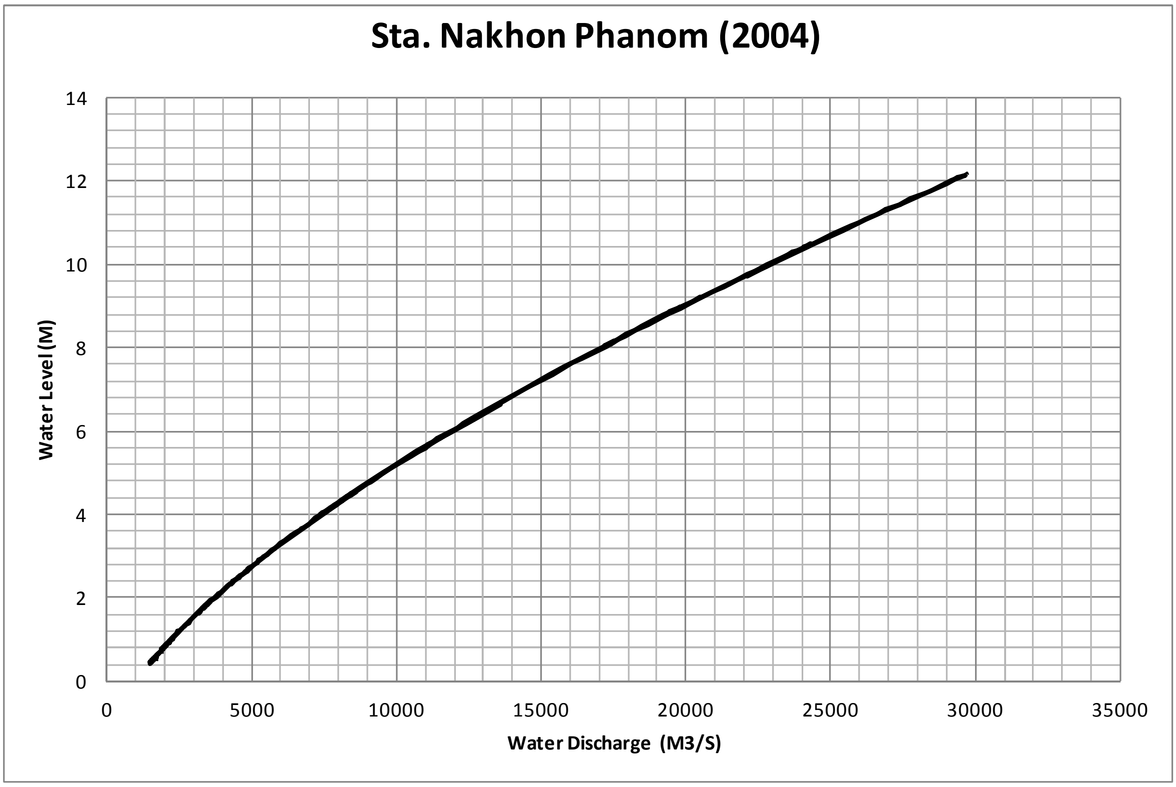


Figure 49: The Rating Curve of Nakhon Phanom station

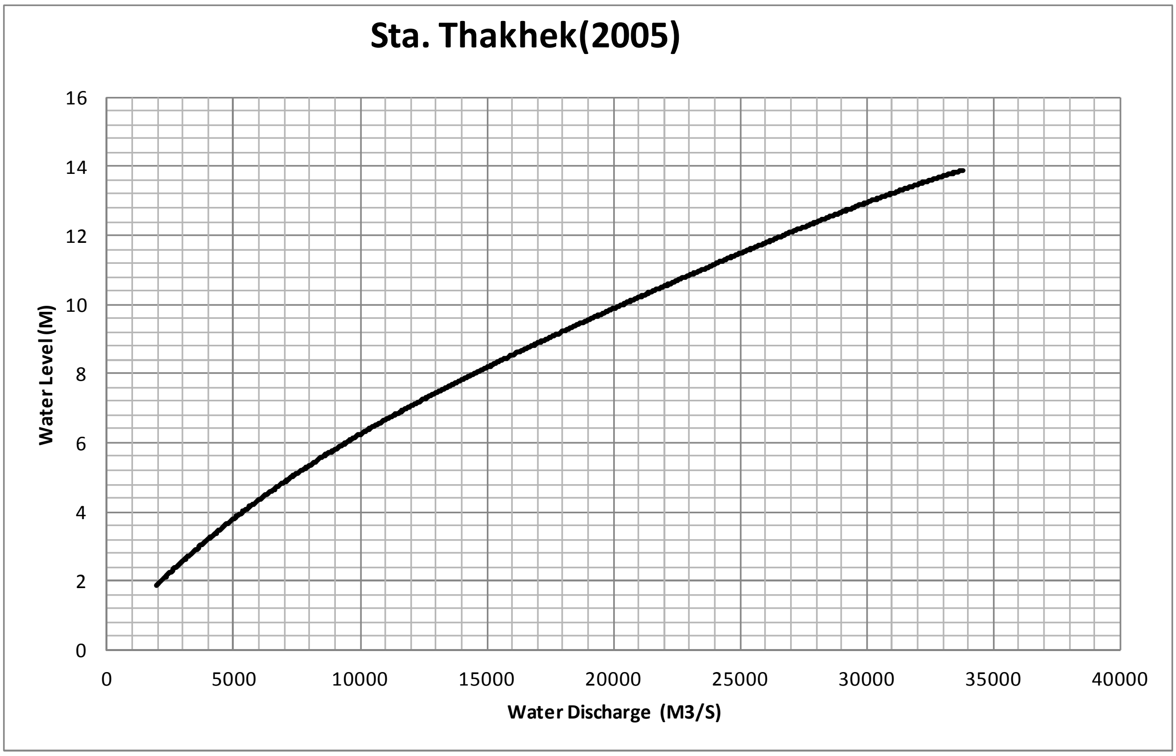


Figure 50: The Rating Curve of Thakhek station

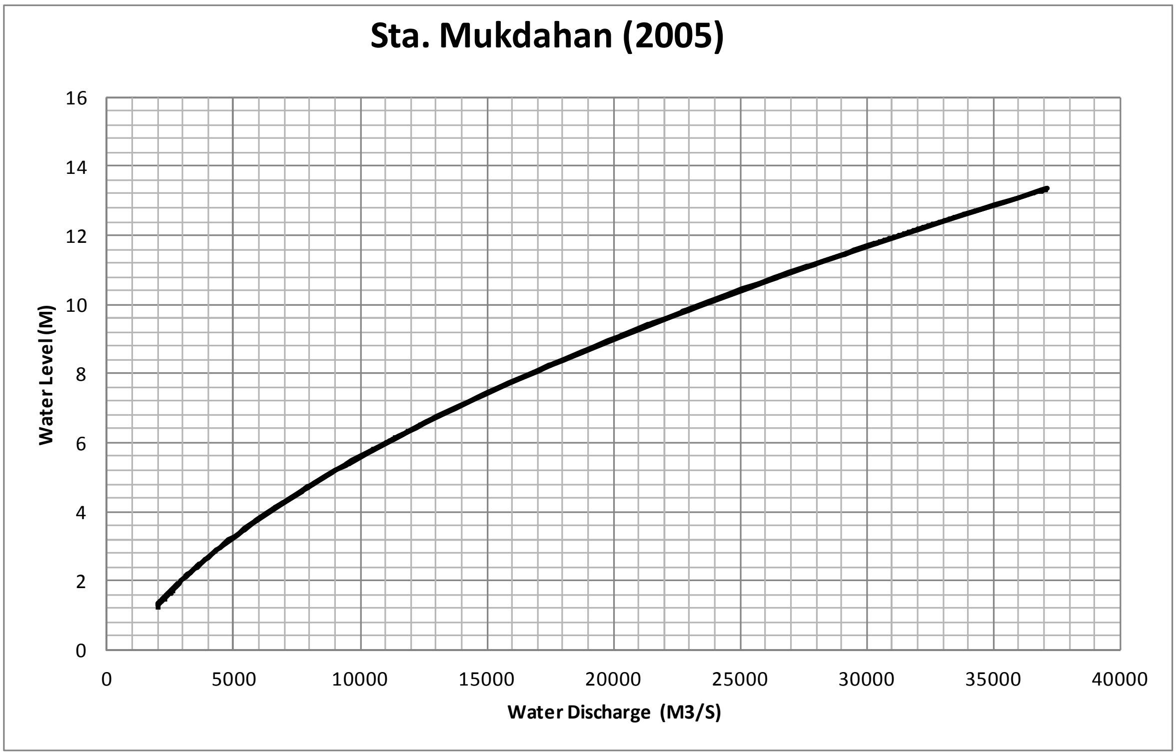


Figure 51: The Rating Curve of Mukdahan station

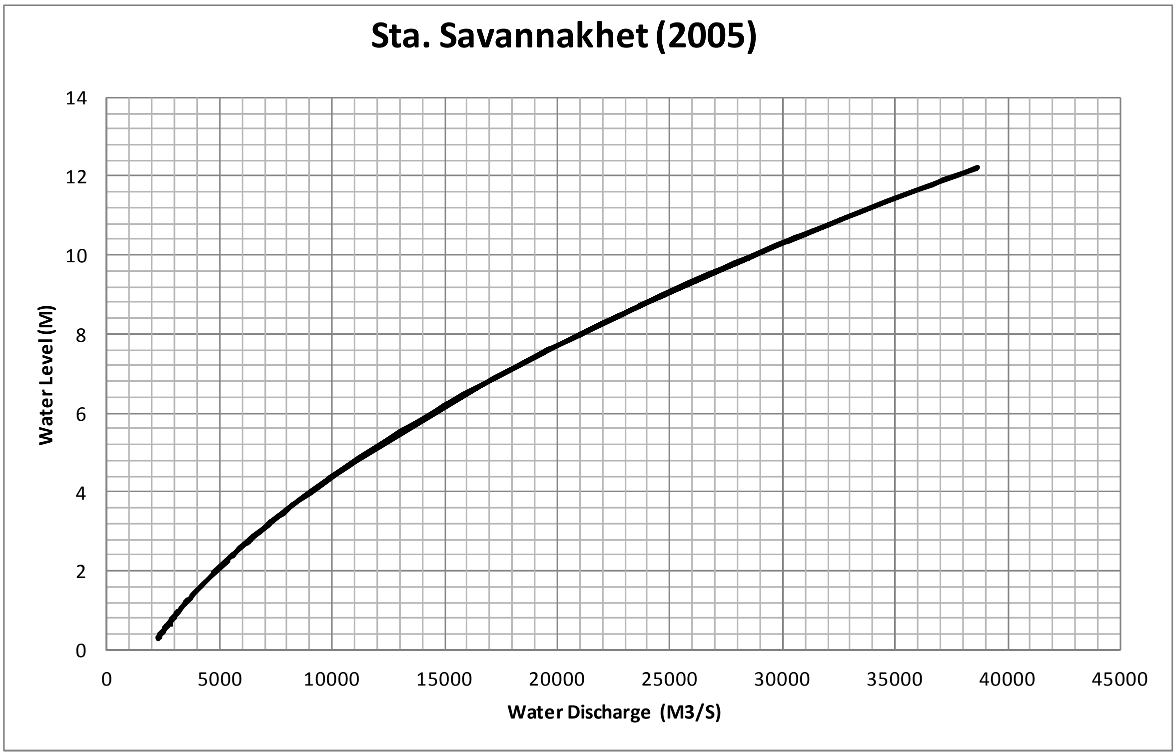


Figure 52: The Rating Curve of Savannakhet station

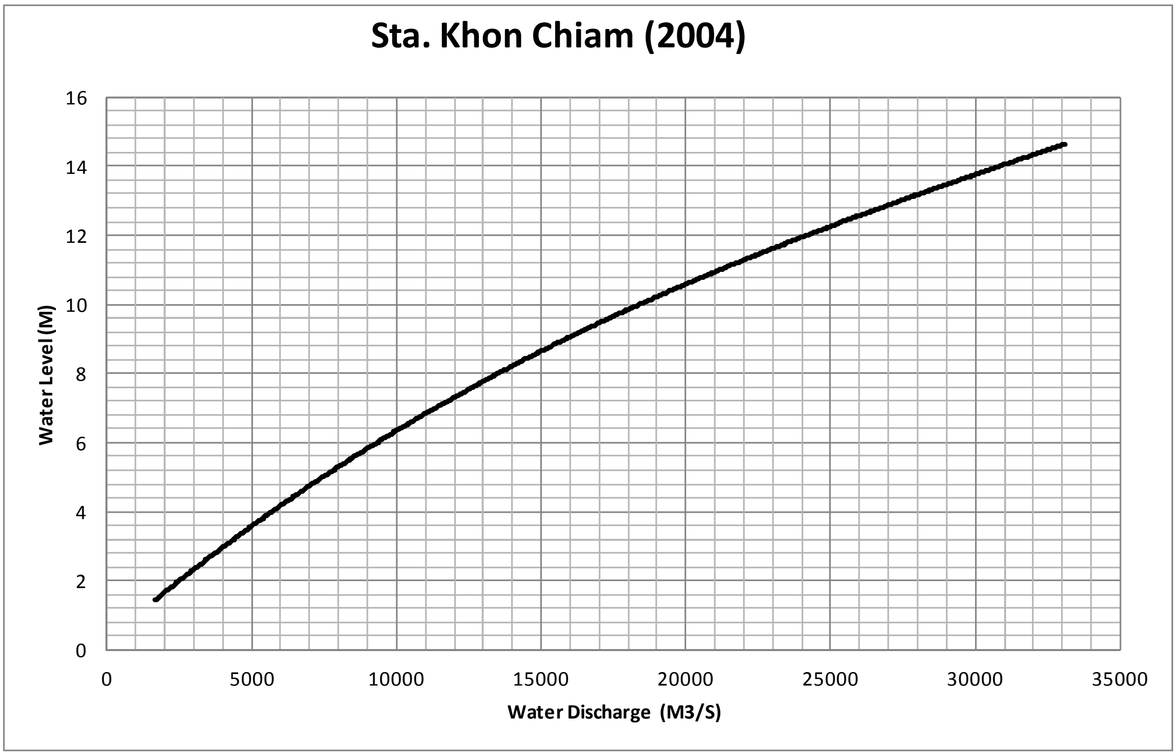


Figure 53: The Rating Curve of Khong Chiam station

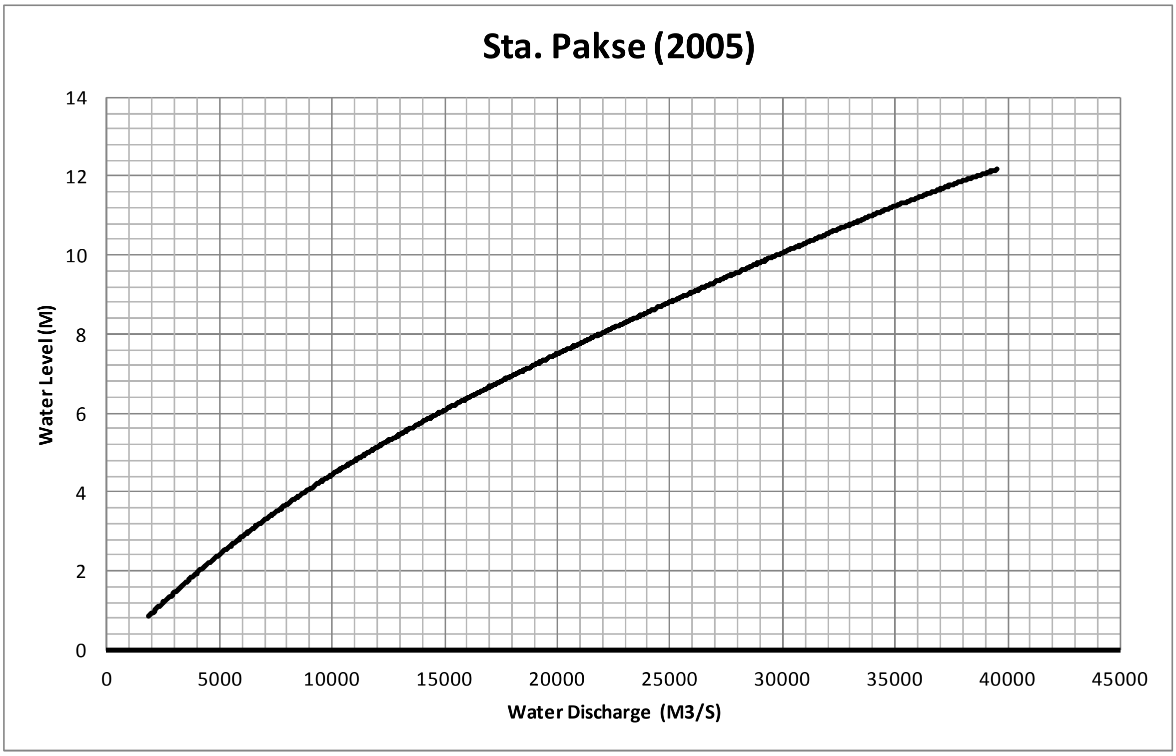


Figure 54: The Rating Curve of Pakse station

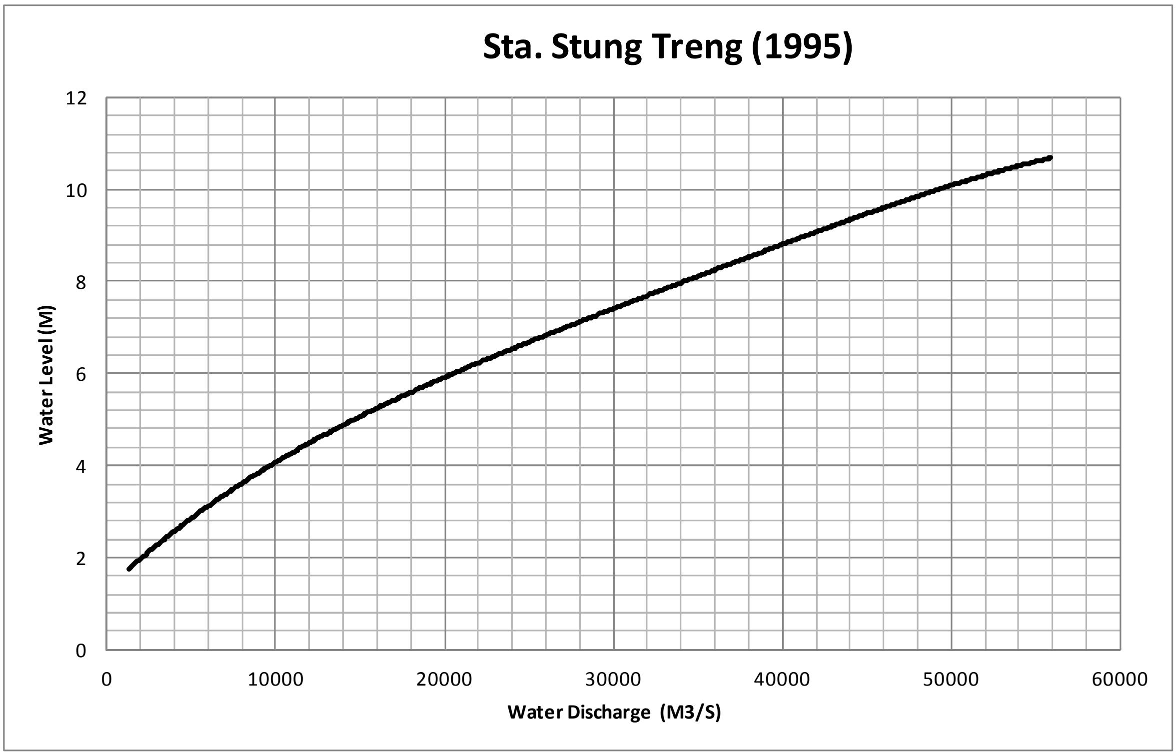


Figure 55: Rating Curve of Stung Treng station

3.2 Sedimentation

This section aims to present the Baseline of Environmental and Social Conditions in terms of sedimentation at the Paklay dam site. It was conducted by reviewing the relevant published research documents and project reports.

3.2.2 Mekong River Basin

The Mekong River is one of the largest rivers in the world. It ranks twenty first in the world in terms of its drainage area (795,000 km^2), twelfth in terms of its length, and eighth in terms of its average discharge, 15,000 m^3/s (Mekong River Commission, MRC,2000). The Mekong River originates in the Tanggula Mountains on the Tibetan Plateau in Tibet, which is approximately 4,975 meters above mean sea level, and flows approximately 4,880 kilometres through the mountains of Qinghai and Yunnan Provinces, China, into the deeply dissected terrain of eastern Myanmar, northern Thailand, and Lao People's Democratic Republic (Lao PDR), before entering the extensive alluvial lowlands of Cambodia and discharging to the South China Sea through its Delta in Vietnam (as shown in Figure 56).

This topographic diversity is paralleled by considerable variability in climate, ranging from the cool temperate conditions in the headwaters, where the high mountains experience permanent snow cover, to the tropical conditions over much of the central and southern parts of the basin. Mean annual precipitation ranges from 2000 - 4000 mm over much of the northern and eastern areas of the basin, and values decline toward the west and the lowland areas to the south to a minimum approaching 1000 mm. The hydrological regime is dominated by the seasonality of the snowmelt runoff from the northern headwaters and the seasonal monsoon over most of the remainder of the basin. The basin generates up to 90% of the annual rainfall during June and October. Over most of the basin, the flow regime is characterized by low flows during the period of February to April and a marked peak in August and September. About 80% of the annual runoff occurs between June and November, with as much as 20%–30% occurring in September (Walling, 2008).

For purposes of analysis the Mekong River Basin is often divided into two sub basins: the Upper Mekong Basin (UMB) and the LMB. The UMBrefers to the area in China and Myanmar and covers about 189,000 km^2accounting for 24% of the total area of the basin. Because of the high rainfall within the middle region of the basin, the high amounts of runoff from the northern areas of the Lao PDR and mountain areas in northern Vietnam, the UMB contributes only around 18% of the total discharge from the basin (Walling, 2008).

The Committee for the Coordination of Investigations of the Lower Mekong Basin (1972) stated that the LMB was defined by the Economic Commission for Asia and the Far East (ECAFE) as part of the Mekong River Basin downstream of Chiang Saen located near the common Burma-Laos-Thailand boundary point. The LMB covers a drainage area of approximately 606,000 km^2 or 76 percent of the Mekong River Basin. It comprises 97 percent of the area of Laos or 202,400 km^2, 86 percent of the area of Cambodia or 154,730 km^2, 36 percent of the area of Thailand which is 184,200 km^2, and 20 percent of the area of Vietnam i.e., the Central Highlands and the Delta region which is about 65,170 km^2.

Altogether, more than 70 million people live in the basin, about 54.8 million in the lower Basin (MRC, 2003). A large part of the lower basin population directly depends on natural ecosystems for their livelihood. Fisheries and croplands are important sources of food and income. For China, the Mekong is especially important as a source of hydropower and for transportation (Makkonen, 2005).

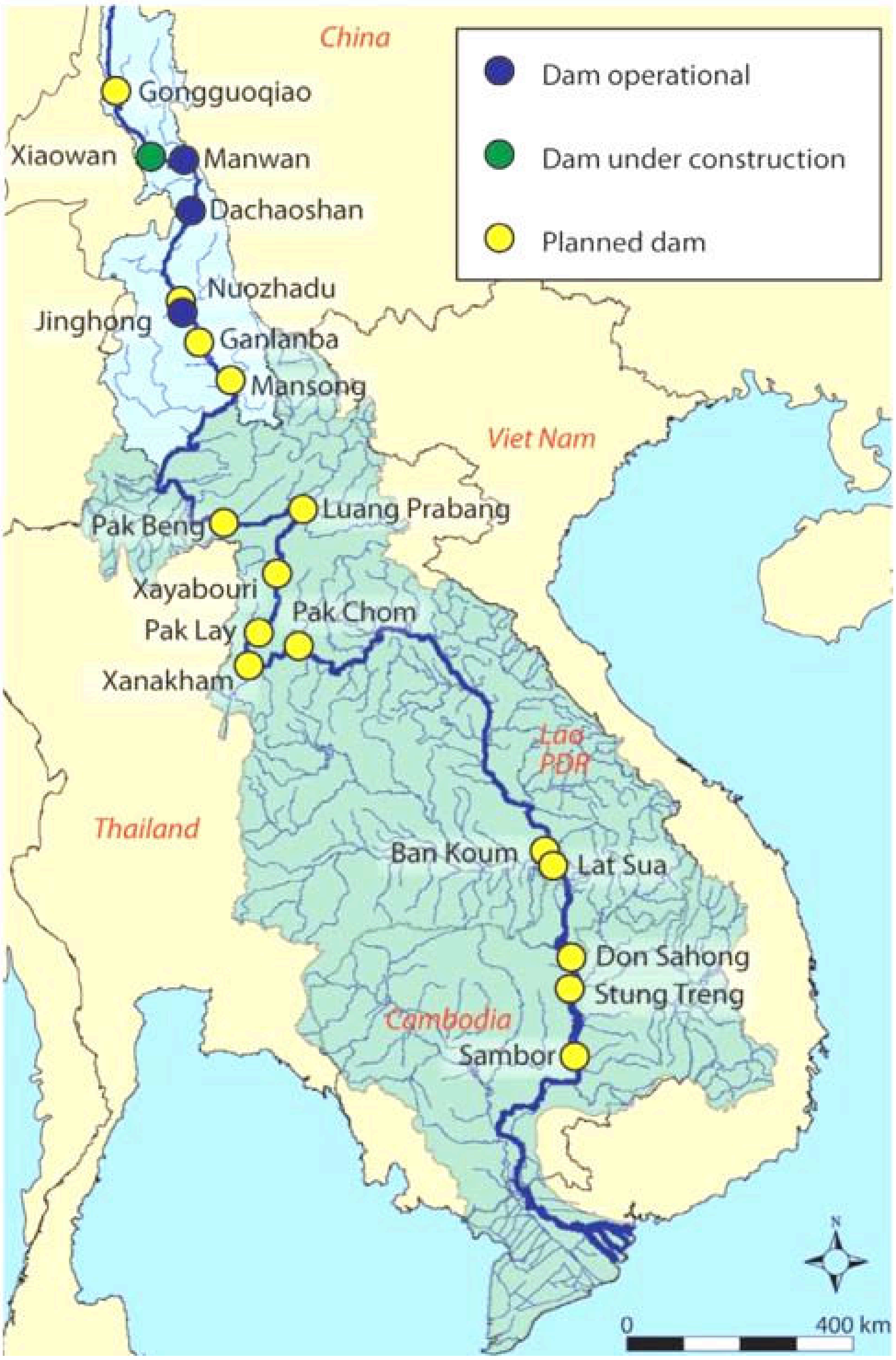


Figure 56: **Map of Mekong River Basin showing the location of cascade dams in the mainstream (Lee and Scurrah, 2009)**

3.2.2 Sidementat Runoff Transport in the Mekong River

Sediment transport rates in the Mekong River are rarely documented and there is no dependable definitive study; a few estimates of transport have been made, without reference to the original data or method (e.g. Milliman and Meade, 1983; Milliman and Syvitski, 1992; Lu and Siew, 2006). The estimated annual sediment flux of Mekong River rangesfrom 150to 170 Mt. In contrast, data from a number of measurement stations on the Mekong River mainstream are available for suspended solid concentrations, starting from the 1960s (MRC, 2004). According to Gupta and Liew (2007) most of the sediment in the Mekong River upstream of Cambodia appears to be stored inside the channel, either on the bed or as insets against rock-cut banks. Unlike certain other large alluvial rivers such as the Amazon, little sediment exchange occurs between channels and flood plains in the Mekong River; except in the Cambodian lowlands and the Mekong Delta in Vietnam, where the river overtops its banks during the rainy season and also has a laterally-shifting channel (Gupta et al., 2002; Gupta and Liew, 2007).

The existing estimate of the mean annual suspended sediment load of the Mekong River reported in the literature such as MRC (Milliman and Syvitski, 1992) is about 160 Mt/yr, and Roberts (2011) has estimated that about 50% of this load is contributed by the upper part of the basin in China. As indicated already, this portion of the basin accounts for about 24% of the total area of the basin and about 18% of its total discharge, and sediment yields in these mountainous headwaters, which have steep, unstable slopes, are clearly substantially higher than those from the remainder of the basin. The dominant role of the annual flood in suspended sediment transport is clear, but there is also evidence that sediment concentrations can be greater during the earlier stages of the flood. This could reflect the remobilization of sediment stored within the channel system, a flushing and exhaustion effect associated with sediment mobilization by erosion as the wet season proceeds, and the contribution of sediment from the upper part of the basin associated with snowmelt floods.

Studies of the sediment deposits in its Delta (Ta, et al., 2002) have suggested that the sediment load of the Mekong River has remained relatively constant over the past 3000 years. Furthermore, there is currently no evidence of the major reduction in sediment load in recent years reported for other large Asian rivers, such as the Indus, Yellow, and Yangtze Rivers (Walling, 2006). However, population growth, land clearance, land-use change, reservoir construction, and other infrastructure development might be expected to have caused some changes in the sediment load of the Mekong River over the past 50 years. For some, if not many, major world rivers, the lack of longer-term sediment measurements precludes meaningful quantitative analysis of recent changes in their sediment loads. In the case of Mekong River, the available data has significant limitations, particularly in terms of the continuity and length of the records, but this data, nevertheless, provides a basis for assessing the likely magnitude and direction of these changes.

Any attempt to assess changes in the sediment load of a river system is clearly heavily dependent upon the availability of sediment load data. This availability in turn reflects the number and location of the measuring stations, the amount of data, the reliability, accuracy, temporal resolution of this data, and the length of the record. In many areas of the world, sediment load data is unavailable. Where sediment data is available, the record length clearly exerts an important constraint on the ability to identify trends, and the reliability of the related analysis will depend heavily upon the nature of the sediment sampling or monitoring program and the accuracy of the resulting load estimates. For most studies aiming to identify trends, emphasis is placed on annual sediment load data. With some measurement programs, sampling frequency is very limited, and the primary aim is to assemble sufficient samples to establish a sediment rating curve that can be used for the overall period. The use of such a rating curve to derive estimates of annual sediment load is unlikely to provide an adequate basis for assessing any trends during that period.

The suspended sediment concentration (SSC) measurements were relatively sporadic, ranging from 1-6 times per month. The sampling frequency varied for different time periods: for instance, between the mid-1970s and 1980s, measurements of sediment concentration were not conducted at several gauging stations due to the political unrest in some of these areas. Sediment sampling procedures generally followed USGS guidelines with special modifications for conditions in the Mekong (Lu and Siew, 2006).

The estimation of suspended sediment flux (i.e. load) is challenging in the Lower Mekong River, given that many gauging stations do not document relatively long term sediment concentration measurements. Due to the scarcity of sediment concentration data, estimates of sediment load were based on discrete, instantaneous measurements of suspended sediment rather than continuous data at regular intervals. Hence it is acknowledged that the frequency of sampling does not ensure that all ranges of the flow were sampled. Various studies on sediment load estimation have noted that irregular sampling intervals, discrete data and the exclusion of the bed load component may result in underestimation of sediment discharge during peak flows (Lu and Higgit, 1999; Phillips, 2004).

3.3 Fish Migration and Fisheries

3.3.1 Fish Migration

3.3.1.1 Fish Species in the Mekong River

The Mekong river covers the length of about 4,900 km)Mekong River Commission, 2010) flowing through six countries: China, Myanmar, Thailand, Laos, Cambodia, and Vietnam.It ends in the South China Sea at the Mekong Delta, Mytho City, Vietnam. There are many tributaries along the Mekong River and with the variations of topography of the Mekong Region the Mekong River Basin is an area of high biodiversity. As reported by the World Fish Center (2011),the abundance of fish species in Mekong River Basin is the second highestin the world with 785 fish species compared to 1,262 species existing in the Amazon river of South America)World Fish Center, 2011, http://www.fishbase.org /search. php). With the 785 species, there are 726 native species, 21 endemic species, 10 introduced species, 26 questionable species and 2misidentifiedspecies.

In accordance with IUCN Red List of Threatened Species, the status of the 785 fish species is as follows:

- 12 species are Critically (CR) endangered species; a partial list is as follows: Mekong giant catfish (*Pangasianodon gigas*), Siamese tiger perch (*Datnioides pulcher*), Giant salmon carp (*Aaptosyax grypus*), Freshwater sawfish orLargetooth sawfish (*Pristis microdon*).
- 19 species are Endangered (EN) species; a partial list is as follows: Mekong stingray (*Dasyatis laosensis*), Isok barb or Julien's golden carp (*Probarbus jullieni*), Thicklip barb (*Probarbus labeamajor*), Dwarf botia (*Yasuhikotakia sidthimunki*), Laotian shad (*Tenualosa thibaudeaui*), Marbled stingray (*Himantura oxyrhynchus*).
- 29 species are Vulnerable (VU) species; a partial list is as follows: Small scale mud carp (*Cirrhinus microlepis*), Mrigal carp (*Cirrhinus cirrhosus*), Mekong tiger perch (*Datnioides undecimradiatus*), *Scaphognathops bandanensis*, Elephant ear gourami (*Osphronemus exodon*), Hairy puffer (*Tetraodon baileyi*).
- 15 species are Near Threatened (NT); a partial list is as follows: Boeseman croaker (*Boesemania microlepis*), Long pectoral-fin minnow (*Macrochirichthys macrochirus*), Great white sheatfish (*Wallago attu*).
- The remaining species are Least Concern (LC): which are fishes found in general or deficient data or not evaluated species (details are in appendix A).

Table 8: List of Endemic species (World Fish Center) and Satus identification by IUCN Redlist

No	Species	Name	Family	Status by IUCN Red list*
1	*Aaptosyax grypus*	Giant salmon carp	Cyprinidae	Critically Endangered
2	*Pangasianodon gigas*	Mekong giant catfish	Pangasiidae	Critically Endangered
3	*Probarbus labeamajor*	Thicklip barb	Cyprinidae	Endangered
4	*Schistura bolavenensis*		Balitoridae	Endangered
5	*Scaphognathops bandanensis*		Cyprinidae	Vulnerable
6	*Tenualosa thibaudeaui*	Laotian shad	Clupeidae	Vulnerable
7	*Tetraodon baileyi*	Hairy puffer	Tetraodontidae	Vulnerable
8	*Balitora elongata*		Balitoridae	Not Evaluated
9	*Cobitis laoensis*		Cobitidae	Not Evaluated
10	*Cyprinus longipectoralis*		Cyprinidae	Not Evaluated
11	*Hemisilurus mekongensis*		Siluridae	Not Evaluated
12	*Henicorhynchus lobatus*		Cyprinidae	Not Evaluated
13	*Henicorhynchus ornatipinnis*		Cyprinidae	Not Evaluated
14	*Lobocheilos thavili*		Cyprinidae	Not Evaluated
15	*Probarbus labeaminor*	Thinlip barb	Cyprinidae	Data Deficient
16	*Pseudobagarius subtilis*		Akysidae	Not Evaluated
17	*Schistura magnifluvis*		Balitoridae	Not Evaluated
18	*Schistura melarancia*		Balitoridae	Not Evaluated
19	*Serpenticobitis octozona*		Cobitidae	Not Evaluated
20	*Tetraodon suvattii*		Tetraodontidae	Not Evaluated
21	*Thryssocypris tonlesapensis*		Cyprinidae	Not Evaluated

Source: World Fish Center. http://www.fishbase.org

* IUCN Red List of Threatened Species. Version 2011.1.www.iucnredlist.org

Of 785 fish species, there are 21 endemic species (see Table 8) which are categorized as following:

- 2 species of Critically endangered species (CR); Giant catfish (Pangasianodon gigas) and Giant salmon carp) (*Aaptosyax grypus*) (Figure57).
- 2 species of endangered species (EN) which are Thicklip barb (*Probarbus labeamajor*) and *Schistura bolavenensis* (Figure58).
- species of Vulnerable species (VU); *Scaphognathops bandanensis*,Laotian shad) *Tenualosa thibaudeaui* (and Hairy puffer)*Tetraodon baileyi*((Figure 59)
- For the rest of 14 species, 1 species was data deficiency and other 13 species were not evaluated.

Source:http://www.gillhamsfishingresorts.com/fish_library/mekong_catfish/mekong_catfish.html

a) Mekong giant catfish (*Pangasianodon gigas*)

Source: http://www.fishesfishing.com/talk/index.php?topic=1060.10

b) Giant salmon carp)*Aaptosyax grypus*)

Figure 57:Critically endangered species

Source: http://www.siamfishing.com/board/view.php?tid=49192&begin=25

a) Thicklip barb (*Probarbus labeamajor*)

Source: http://www.asiafinest.com/forum/lofiversion/index.php/t265795.html

b) *Schistura bolavenensis*

Figure 58: Endangered species

Source: http://www.fishing4you.com/webboard/index.php?topic=4606.15

a) *Scaphognathops bandanensis*

Source: http://fishbase.org.cn/summary/speciessummary.php?id=1599

b) Laotian shad) *Tenualosa thibaudeaui*(

Source: http://en.wikipedia.org/wiki/File:Baileyi.jpg

c) Hairy puffer (*Tetraodon baileyi)*

Figure 59:Vulnerable species

In addition, of 785 species there are 726 native species which are divided into following species.

- 10 species critically endangered species (CR). For example: Siamese tiger perch (*Datnioides pulcher*), Giant pangasius (*Pangasius sanitwongsei*), Largetooth sawfish (*Pristis microdon*), Giant barb (*Catlocarpio siamensis*), etc.
- 15 species of Endangered species (EN). For example: Mekong stingray (*Dasyatis laosensis*), Freshwater whipray (*Himantura chaophraya*), (*Probarbus jullieni*, etc.
- 24 species of Vulnerable species (VU). For example:*Bangana behri*มปลา Mekong tiger perch (*Datnioides undecimradiatus*), *Tetraodon cambodgiensis*, etc.

Details of fish species are presented in Table 9, the rest of 677species are categorized as 15 Near Threatened species (NT), 83 Least Concern:species (LC), 13 data deficient species, and 566 not evaluated species.

Table 9: List of Native species(World Fish Center) and Status Identification by IUCN Redlist

No	Species	Name	Family	Status by IUCN Red list*
1	*Datnioides pulcher*	Siamese tiger perch	Datnioididae	Critically Endangered
2	*Epalzeorhynchos bicolor*	Redtail sharkminnow	Cyprinidae	Critically Endangered
3	*Pangasius sanitwongsei*	Giant pangasius	Pangasiidae	Critically Endangered
4	*Pristis microdon*	Largetooth sawfish	Pristidae	Critically Endangered
5	*Scaphognathops theunensis*		Cyprinidae	Critically Endangered
6	*Schistura spiloptera*		Balitoridae	Critically Endangered
7	*Schistura tenura*		Balitoridae	Critically Endangered
8	*Sewellia breviventralis*	Butterfly Loach	Balitoridae	Critically Endangered
9	*Catlocarpio siamensis*	Giant barb	Cyprinidae	Critically Endangered
10	*Ceratoglanis pachynema*	Club-barbel sheatfish	Siluridae	Critically Endangered
11	*Balantiocheilos*	Tricolor sharkminnow	Cyprinidae	Endangered
12	*Dasyatis laosensis*	Mekong stingray	Dasyatidae	Endangered
13	*Himantura chaophraya*	Freshwater whipray	Dasyatidae	Endangered
14	*Himantura oxyrhyncha*	Marbled whipray	Dasyatidae	Endangered
15	*Himantura signifer*	White-rimmed stingray	Dasyatidae	Endangered
16	*Laubuca caeruleostigmata*	Leaping barb, Flying	Cyprinidae	Endangered
17	*Luciocyprinus striolatus*		Cyprinidae	Endangered
18	*Oreoglanis siamensis*	Siamese bat catfish	Sisoridae	Endangered
19	*Pangasianodon*	Striped catfish	Pangasiidae	Endangered
20	*Poropuntius bolovenensis*		Cyprinidae	Endangered
21	*Probarbus jullieni*	Isok barb	Cyprinidae	Endangered
22	*Schistura bairdi*		Balitoridae	Endangered
23	*Scleropages formosus*	Asian bonytongue	Osteoglossid	Endangered
24	*Sewellia patella*		Balitoridae	Endangered
25	*Yasuhikotakia sidthimunki*	Dwarf botia	Cobitidae	Endangered
26	*Amblypharyngodon*		Cyprinidae	Vulnerable
27	*Bangana behri*		Cyprinidae	Vulnerable
28	*Bangana musaei*		Cyprinidae	Vulnerable
29	*Betta splendens*	Siamese fighting fish	Osphronemi	Vulnerable

No	Species	Name	Family	Status by IUCN Red list*
30	*Cirrhinus microlepis*	Small scale mud carp	Cyprinidae	Vulnerable
31	*Crossocheilus reticulatus*		Cyprinidae	Vulnerable
32	*Datnioides undecimradiatus*	Mekong tiger perch	Datnioididae	Vulnerable
33	*Epalzeorhynchos munense*	Red Fin Shark	Cyprinidae	Vulnerable
34	*Hypsibarbus lagleri*		Cyprinidae	Vulnerable
35	*Mystus bocourti*		Bagridae	Vulnerable
36	*Nemacheilus banar*		Balitoridae	Vulnerable
37	*Osphronemus exodon*	Elephant ear gourami	Osphronemi	Vulnerable
38	*Oxygaster pointoni*		Cyprinidae	Vulnerable
39	*Pangasius krempfi*		Pangasiidae	Vulnerable
40	*Poropuntius speleops*		Cyprinidae	Vulnerable
41	*Pseudohemiculter dispar*		Cyprinidae	Vulnerable
42	*Schistura cataracta*		Balitoridae	Vulnerable
43	*Schistura personata*		Balitoridae	Vulnerable
44	*Schistura tubulinaris*		Balitoridae	Vulnerable
45	*Serpenticobitis cingulata*		Cobitidae	Vulnerable
46	*Sewellia lineolata*		Balitoridae	Vulnerable
47	*Tetraodon cambodgiensis*		Tetraodontid	Vulnerable
48	*Tor ater*		Cyprinidae	Vulnerable
49	*Yasuhikotakia splendida*		Cobitidae	Vulnerable

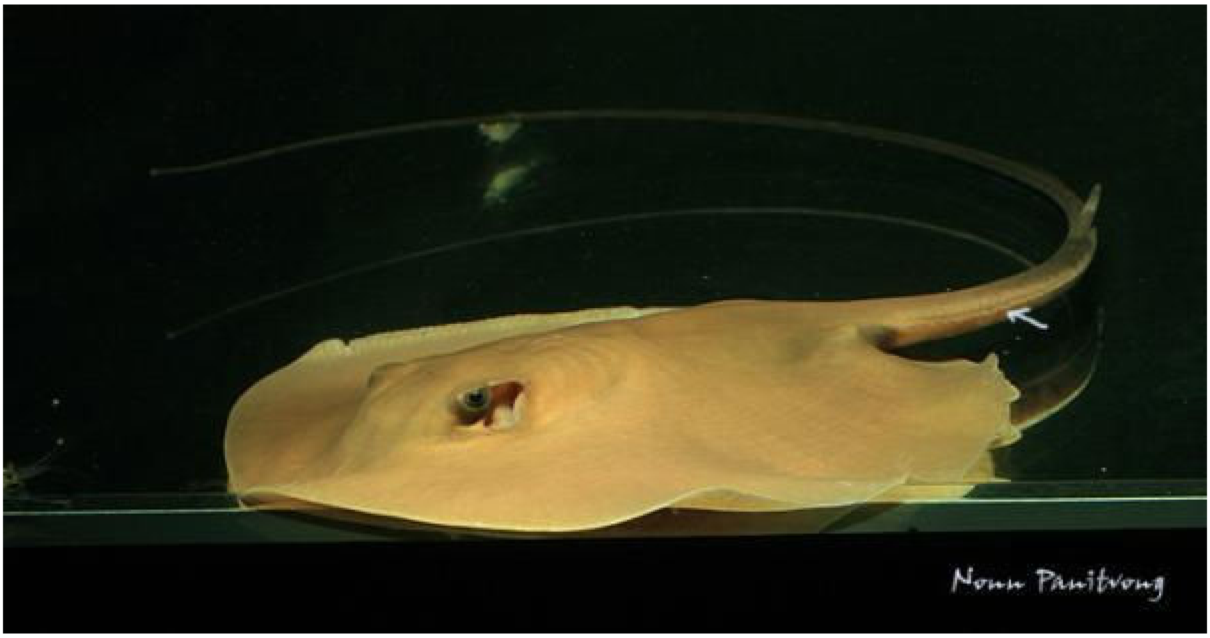
Source: World Fish Center. http://www.fishbase.org [Search on October, 31 2011]

Based on the State of the Basin Report 2010 by the MRC, it indicated that among the species of fish caught in the Mekong River, 2 are critically endangeredand 4 are endangered species. These are:

- Giant catfish (*Pangasianodon gigas*) – CR.
- Freshwater sawfish orLargetooth sawfish (*Pristis microdon*) – CR (Figure 60).
- Mekong stingray (*Dasyatis laosensis*) EN (Figure 61)
- Isok barb or Julien's golden carp (*Probarbus jullieni*)- EN (Figure 62).
- Laotian shad (*Tenualosa thibaudeaui*) EN.
- Marbled stingray (*Himantura oxyrhynchus*) –EN (Figure 63)

Source: http://th.wikipedia.org/wiki/%E0%B9%84%E0%B8%9F%E0%B8%A5%E0%B9%8C:
pristis_microdon.jpg

Figure 60: Freshwater sawfish or Largetooth sawfish (*Pristis microdon*)



Source: http://www.siamensis.org/taxonomy/term/1509/0

Figure 61: Mekong stingray (*Dasyatis laosensis*)

Source: http://www.jjphoto.dk/fish_archive/warm_freshwater/probarbus_jullieni.htm

Figure 62: Isok barb or Julien's golden carp (*Probarbus jullieni*)

Source: http://www.siamensis.org/taxonomy/term/1894/0

Figure 63: **Marbled stingray (*Himantura oxyrhynchus*)**

Based on the report:"Fish Migration of the Lower Mekong River Basin, implications for development, planning and environmental management) Poulsen A.F. et al 2002)", published by thr MRC, the habitat of fish in the Mekong River Basin are as follows:

- Floodplains are areas plentiful with nutrients that can be habitat for fish in the wet season. The important floodplain in the Lower Mekong River Basin for very high fish catchesis Tonle Sap(Great Lake) in Cambodia and the Mekong Delta.
- Dry season refuge habitats. With low flow in the dry season, fish will migrate to an area where there is still water such as permanent floodplains, pools, streams or the Mekong River itself. Deep pools located along the Mekong Riverare important fish habitats such as from Kratie toKhone Falls in the north of Cambodia, Kammoune Province in Laos, Nakon Panom Province, and the Loei River to Luang Prabang.
- Spawning habitats for migratory fish. These habitats include rapids or deep pools along the Mekong River as well as floodplains. Species include pangasiid catfishes, cyprinids e.g. *Cyclocheilichthys enoplos*, *Cirrhinus microlepis*, and *Catlocarpio siamensis*, etc.

3.3.1.2 *Fish Migration*

There are many factors affecting fish migration including water level, rainfall, lunar cycle, color and turbidity of water, and insects in wate (Baran E, 2006). Most of fish in the Mekong River migrate; many species migrate for long distancesincluding transboundary migration (Poulsen A.F. et al, 2002). During the seasonal migration, people reside along the Mekong River are able to catch fish for food and earn a living.

Migration of fish is divided into black-fishand white-fish (Poulsen A.F. et al, 2002). Black-fish inhabit lakes and ponds on the floodplains connected to the Mekong River. This Blach-fish group has no migration but they move by the season for short distances between permanent habitats and nearby areasdepending on the season, particularly at the beginning of the monsoon season. Example of Black-fish are Climbing perth (*Anabas testudineus*), Philippines catfish (*Clarias batrachus*), Striped snakehead fish (*Channa striata*). Migration of fish is for spawning at the floodplain in Tonle Sap, and then back when the water level at Tonle Sap fallsbetween November and January. This fish group is evidently seen at the Lower Mekong River Basin, Mekong Delta to Panomphen and Tonle Sap.

White-fish migrate in the monsoon season from May to July and will migrate back to their habitat in the main river at the end of wet or monsoon season. Fish species of this group are in the Cyprinidae familye.g. *Cyclocheilichthys enoplos* and *Cirrhinus microlepis*. Also in the Pangasiidae family. Migration of this white fish group is longer than the Black-fish group. Migration of the Giant Mekong River fish is belongs to this White-fish group.

There is another fish group categorized as Grey-fish. This group migrates the short distance between the floodplain and the adjacent river or may permanently migrate by season between water sources (Chanh et al. 2001; Welcomme2001).

Migration of fish in the Mekong River is divided into 3 sections; upper,

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

middle and lower sections as shiwn in the Fugure below:

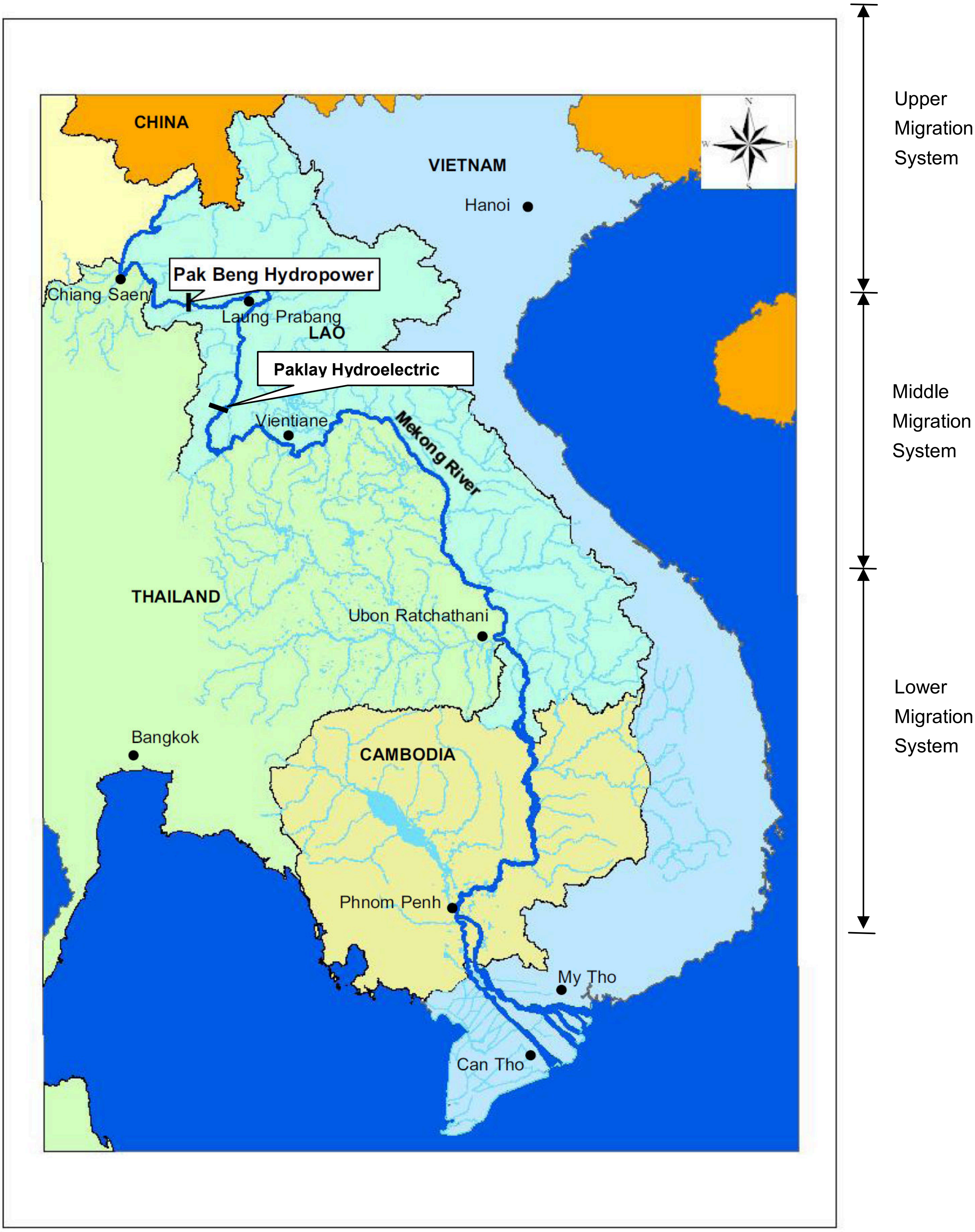


Figure 64: Migration Section of Fish in the Lower Mekong Basin

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

1) *Lower Mekong migration system (LMS)*

This covers the Lower Mekong Basin covering Cambodia and Vietnam, containing the area from Khone Falls downward to the Mekong Delta in Vietnam.In the dry season, migratory fish from the Mekong Delta move north, but in the Tonle Sap area fish move downward to lower sections. In the rainyor flood season (May-June), fish migration occurs in the opposite direction to the dry seasondue to changes in flow direction. The migration pathway is from the upper section of the Mekong River downsouth to the Mekong Delta and northeast to Tonle Sap.

In the flood season, adult fish (male and female), migrate to reproduce and spawn in the floodplains along the Mekong River, particularly Tonle Sap and the Mekong Delta. The fingerlings will live and grow in the floodplains for 4-5 months until the end of the rainy season. Then, when the water level is lower,usually in November,they migrate out of the floodplains to the Mekong River (Figure 65). In addition, the juveniles also migrate or feed in the floodplains. Fish migration in the flood period is due to the stimulation of new water seasons. The richness of nutrients creates an abundance of fish in the Mekong Delta and Tonle Sap.

Fish species which have this migration characteristic are in the family of Henicorhynchus, which are an important fish species in the Lower Mekong Basin, e.g.Tonle Sap. Other large fish having the same migration characteristics are the Giant barb (*Catlocarpio siamensis*), Small scale mud carb (*Cirrhinus microlepis*), *Cyclocheilichthys enoplos,*Isok barb (*Probarbus jullieni*), Mekong giant catfish(*Pangasianodon gigas*) and fish in the family of Pangasiidae. Most white-fish spawn in the upper section of the Mekong River in the Lower Mekong Basin, from Kratie to Khone Falls.

Similarly, the study of Sverdrup-Jensen.S (2002) explains that fish migration in the Lower Mekong Basin starts from Khone Falls going downstream to Tonle Sap in the south of Cambodia and in the Mekong Delta in Vietnam. Water levels increasing at the beginning of the flood season induce fish migration from their habitat at the lower side of Khone Falls (e.g. deep pools between Stung Treng to Kratie) to head south to the floodplains of the Mekong River, whichare rich in nutrients.

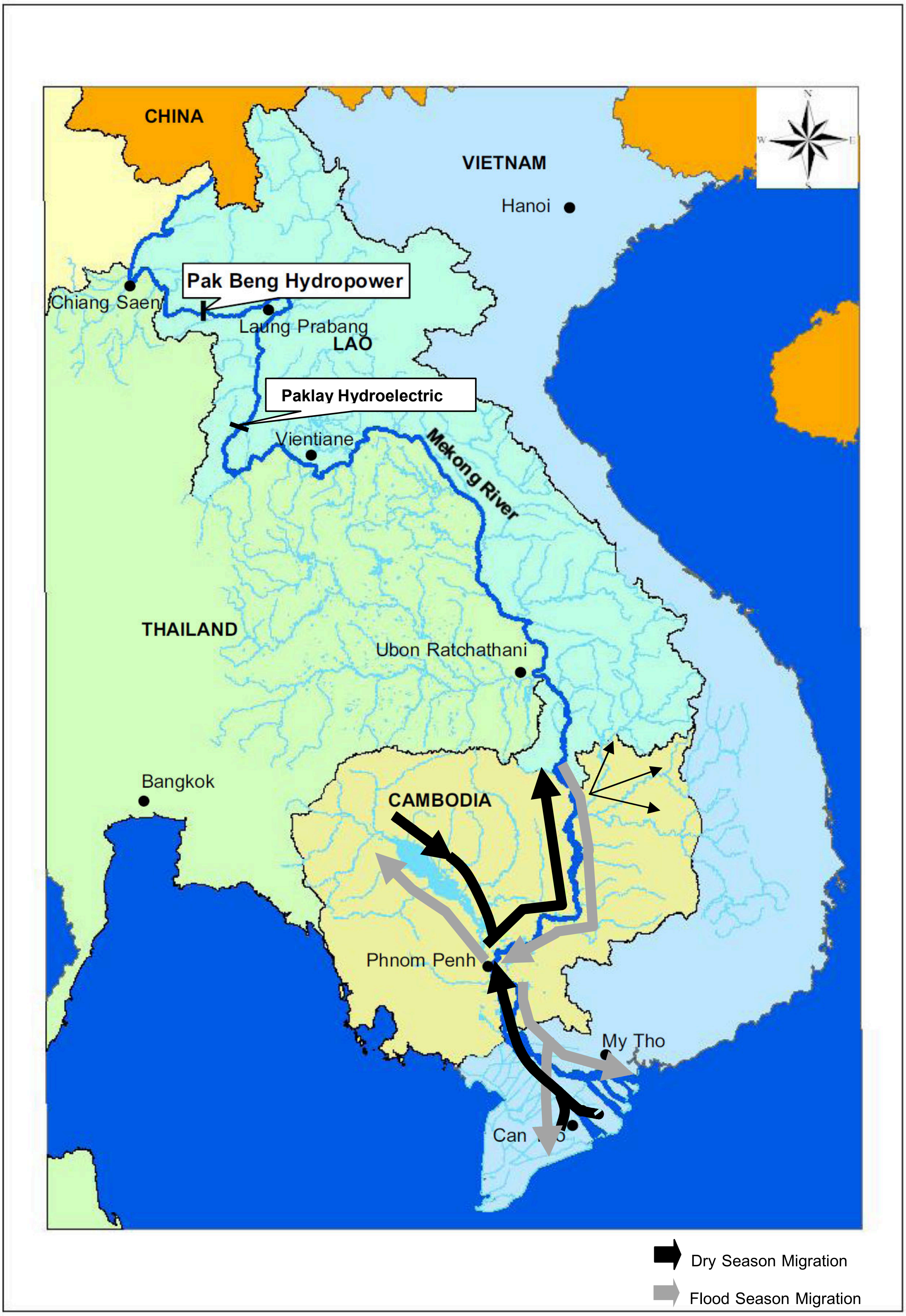
2) *Middle Mekong Migration System (MMS)*

The Middle Mekong River Basin covers Thailand and Laos and goes from Khone Falls to Loei in Thailand. Migration of fish in this middle section isconnected tothe tributaries including the Mun River, the Srisongkam River in Thailand, the Xe Bang Fai River, the Hinboun River in Laos and other tributaries. Fish migrate according to the seasons. At the beginning of the rainy season, fish migrate from the main river to the tributaries for reproduction and spawning as well as feeding in appropriate habitats. Thefish will then migrate back to the main Mekong River after the monsoon season (Figure 66). Some fish species have a combination of migration systems: at the fingerling stage they belong to the lower migration system and at the adult stage they become part of the middle migration system. Examples of fish species showing this migration characteristic are*Cyclocheilichthys enoplos*, and small scale mud carb (*Cirrhinus microlepis*).The same migration characteristic is evident in Thailand - fish from the Mekong River migrate to the tributaries, e.g. the Srisongkam River, andto floodplains in the monsoon season and then migrate back to the Mekong River at the end of the monsoon season.

3) *Upper Mekong migration system (UMS)*

The upper Mekong River Basin starts from the mouth of the Loei River in Thailand and moves upstream toward the boundary of Laos and China. It is a floodplain area but without connection to tributaries (unlike the Middle Mekong River basin), except some river sections connected with the Ing River in the north of Thailand.

Migration starts at the beginning of the flood season. Fish migrate from dry areas in the main river to spawn upstream (Figure 67). In addition, some fish species migrate from downstream rapids and deep pools to spawn in the Mekong River upstream. An example of fish species in this migration system is the Mekong giant catfish (*Pangasianodon gigas*). In the past, upstream migrating fish could be caught at the end of April to May every year, which isat the beginning of the new water season or monsoon season. At Had Krai in Thailand,Mekong giant catfish caught in this period are mature fish, having eggs and sperm ready for spawning. In addition, some fish species (e.g. *Henicorhynchus* sp.) migrate atthe beginning of the monsoon season to the tributaries (e.g. the Ing River)to spawn feed and then go back to the main river at the end of monsoon season.



Source: Poulsen A.F. *et Al.*, 2002

Figure 65: Migration System in Lower Mekong Basin

Source: Poulsen A.F.*et al*, 2002

Figure 66: Migration System in the Middle Mekong Basin

Source: Poulsen A.F. et al, 2002

Figure 67: Migration Sytem in the Upper Mekong Basin

Based on the study of Baran E (2006) employing the data of World Fish Center in2004, there are768 species of fish divided into 165 speicies of migrating fish (21%), 24 species of non-migrating fish (3%), and no data for 579 fish species (76 %). Of 165 migarting fishes, 30 species are known for the factors causing migration (Details are in Appendix B). These are:

- Pangasiidae (shark catfishes), 11 species: *Pangasianodon gigas*, *Pangasianodon hypophthalmus*, *Pangasius polyuranodon*, *Pangasius macronema*, *Pangasius bocourti*, *Pangasius conchophilus*, *Pangasius krempfi*, *Pangasius kunyit*, *Pangasius larnaudii*, *Pangasius pleurotaenia*, *Pangasius sanitwongsei*.
- Cyprinidae (minnows or carps), 9 species: *Paralaubuca typus*, *Cyclocheilichthys enoplos*, *Bangana behri*, *Barbonymus gonionotus*, *Labeo chrysophekadion*, *Mekongina erythrospila*, *Cyprinus carpio carpio*, *Macrochirichthys macrochirus*, *Parachela oxygastroides*.
- Siluridae (sheatfishes),3 species: *Hemisilurus mekongensis*, *Micronema bleekeri*, *Wallago leerii.*
- Bagridae (bagrid catfishes): *Hemibagrus filamentus*
- Clupeidae (herrings, shads, sardines, menhadens): *Tenualosa thibaudeaui*
- Cobitidae (loaches): *Botia modesta*
- Engraulidae (anchovies): *Lycothrissa crocodiles*
- Nandidae (Asian leaffishes): *Pristolepis fasciata*
- Notopteridae (featherbacks or knifefishes): *Chitala blanci*
- Osphronemidae (gouramies): *Osphronemus exodon*

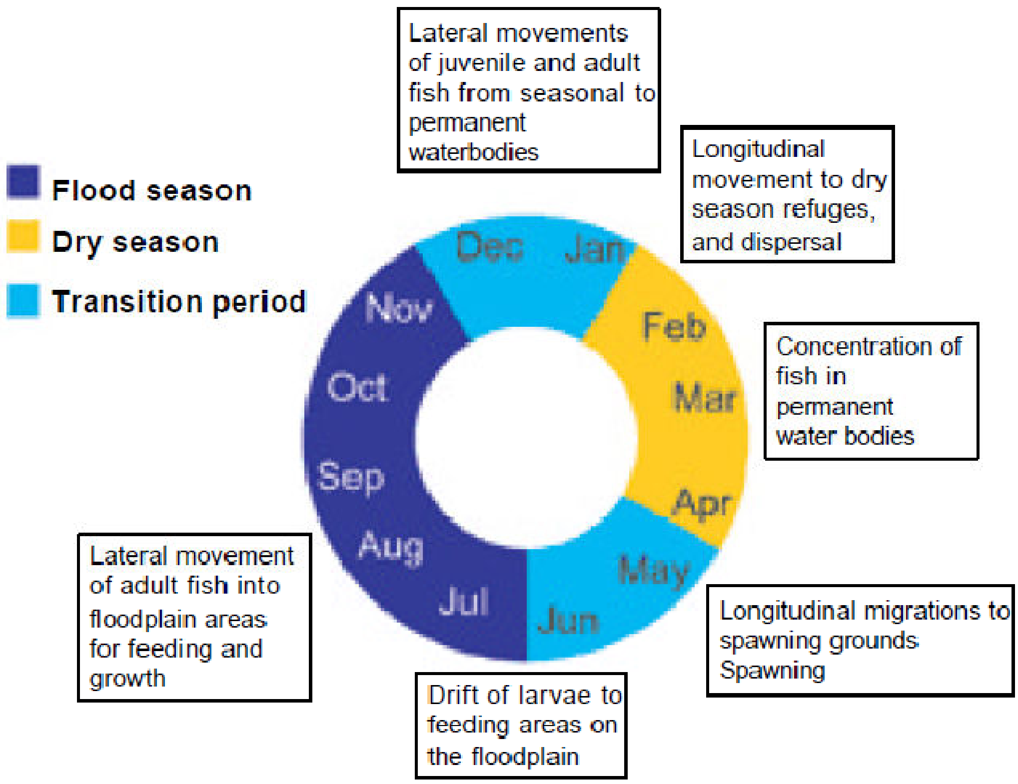
The study of fish species of the Lower Mekong River from Chiang Kan to Pakchom was done by the River Organization for Life. The study included basic information of fish species, ecosystem, local fishery tools, agriculture along the Mekong River, plant species in the Mekong River, and the socio-culture of fishermen. The study area covered the Hueng River mouth, Tha Demhee, Pak Tom Sub-district, Chiang Kan Province down road to Huai Tiam Village, Had Kampee Sub-district, Pak Chom District, Loei Province;adistance of 110 km. The findings were 270 species of aquatic organisms, of which 89 species were non-scaled fish and 181 scaled fish. This study found more species than the Villager Researh of Indigenious Knowledge of Fish species in the Mekong River. The latter studied from Kon Pee Long, Ching Kong District down to Pha Dai, Wiang kaen District, Chiang Rai (August 2003- June 2004) and found 96 species of aquatic organism.

Based on the mentioned study, the villagers could catch alot of fish in 2 periods: between February and April when small sized scaled and non-scaled fishes migrate to sprawn; and May - the beginning of rainy season. This is when the water level starts increasing with turbidity that enables large sized scaled and non-scaled fish migrating to sprawn in the tributaries. In August or September, the water level has increased up to the river bank, which villagers call the up-fish period. However, the most up-fish period is in the red water or flood period between May and June. Most fish caught are the non-scaled fish; for example; Asian Redtail Catfis(*Hemibagrus wyckioides*), Dwarf

Goonch(*Bagarius bagarius*, *Pangasius conchophilus*, *Pangasius bocourti*, Twisted-Jaw Catfish (*Belodontichthys truncate*, *Micronema micronema*, *Henisilurus mekongensis*).The fish caught in the dcreasing water level period from October to April are small fish, mostly scaled; for example, *Sikukia gudgeri*, *Tenualosa thibaudeaui*, *Epalzeorhynchos frenatum*.

3.3.1.4 Migration Period of Fish

The period of migration studied by Sverdrup-Jensen, S.) 2002), life cycle of fish during seasonal periods is depicted in Figure below:



Source: Sverdrup-Jensen, S.,

Figure 68: Life Cycle of Fish Migration in Lower Mekong River Basin

- Dry season during February to April: there is migration of fish along the river. It is the period of higest concentration of fish in the Main River or permanent water bodies.
- Flood season during July to November: there is the migration of adult fish to the flood plains for feeding and growth.
- Transition period: there are 2 periods which are December to January and May to June. December-January involves the migration of juvenile and adult fish from seasonal habitats to permanent water bodies. May to June involves migration of fish to spawning grounds and by June the drifting of larvae to feeding areas on the floodplain.

From the report of the River Organization for Life and Villager Network of

Pak Chom- Chiang Kan the migration of fish species in the Mekong River takes place in 2 periods.Increasing water levels in May- September allow large fish migrate to spawn along the tributaries of the Mekong River. In addition, increasing water quantity in the streams due to seasonal rain also supports both large scaled and non scaled fishmigrating to spawn at the suitable ecosystem. The villagers call this the up-fish period. The large fish will migrate back to their habitat when the water level starts decreasing in October-November. It is the period the villagers call the down- fish period or dcreasing water level period. Approximately by the end of February, a big group of both small scaled and non-scaled fish migrate in a conter-current of the stream direction.

3.3.1.5 *Investigation Result of Fish Speciesand Migration in the Study Area*

Investigation by the study team of this project was performed on 3-4 of December 2011 both upstream and downstream of the proposed dam site of Paklay from Ban (village) Kae, Ban Muong Nea, Ban Pone Sai, Paklay District, Chaiyaburi Province (Figure below). In addition, interviews with the people and fish sellers at the market at Ban Na Sawang (Paklay town) were conducted. To obtain reliable data of fish species in the area, pictures and name lists of fish wereshown to interviewees (mostly village leaders and old age villagers who have lived in that area for along time) together with observation of fish sold in the market. Fish species prevalent in the area are shown in the Table below.

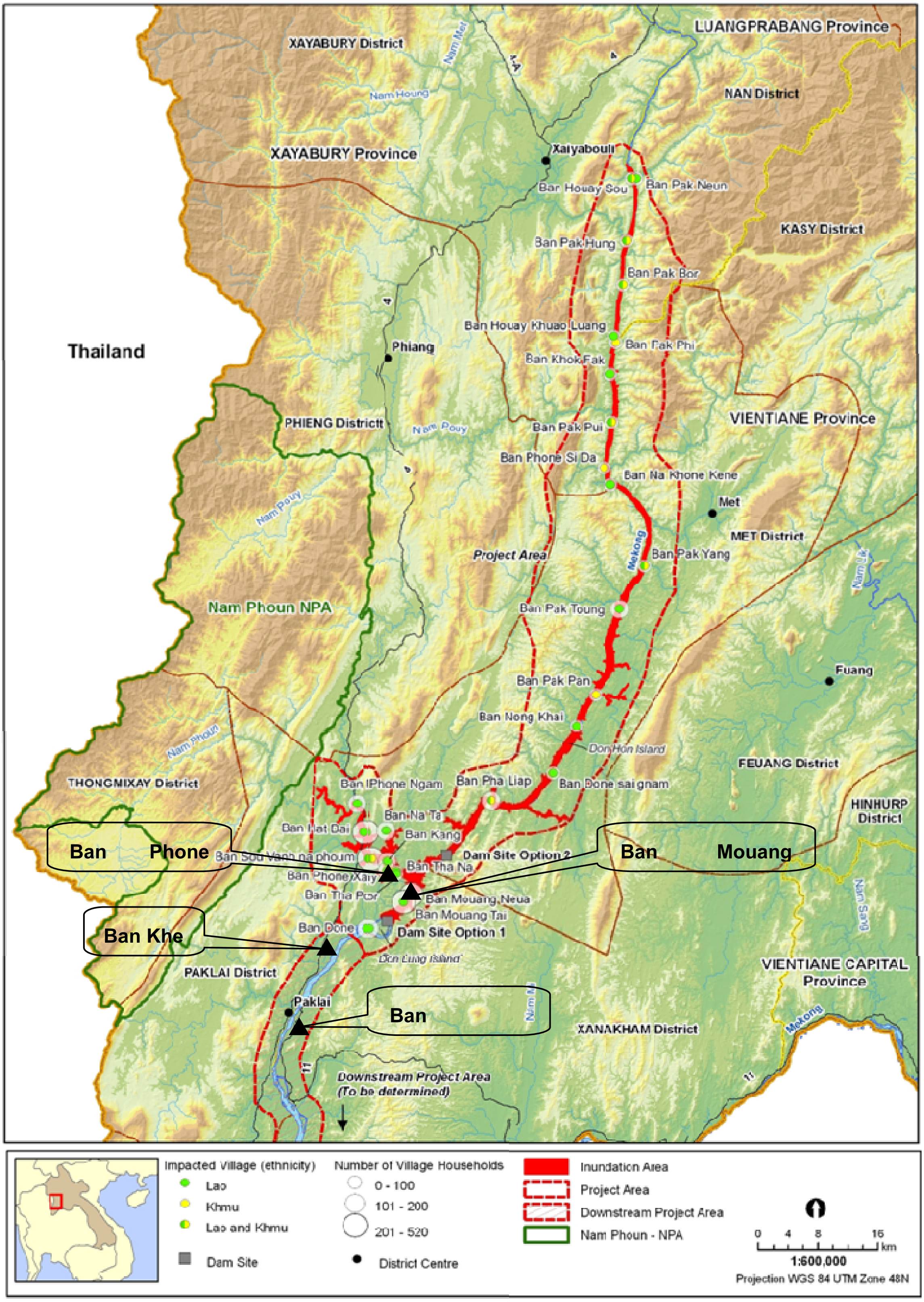


Figure 69: Study area by the study team of TBESIA project

e) Ban Na Sawang

b .Ban Kae

c .Banm Muong Nuea

d(Ban Phone Sai)at the Pool stream)

Figure 70: Investigation of fish species found in the Mekong River in study area

Table 10: Investigation result by study team

No.	Scientific Name	Common Name	Area*				Status by IUCN Red list*
			1	2	3	4	
1	*Aaptosyax grypus*	Giant Salmon Carp	X	X	X	X	Critically Endangered
2	*Acantopsis choirorhynchos*		✓	✓	✓	✓	Not Evaluated
3	*Amblypharyngodon chulabhornae*		X	X	X	X	Vulnerable
4	*Amblyrhynchichthys micracanthus*		✓	✓	✓	✓	Least Concern
5	*Anguilla marmorata*	Giant mottled eel	X	X	X	X	Not Evaluated
6	*Arius maculatus*	Spotted catfish	X	X	X	X	Not Evaluated
7	*Auriglobus nefastus*		✓	✓	X	X	Least Concern
8	*Bagarius bagarius*	Devil Catfish	✓	✓	✓	✓	Near Threatened
9	*Bagarius yarrelli*	Goonch	✓	✓	✓	✓	Near Threatened
10	*Bagrichthys obscurus*	Flase lancer catfish	✓	✓	✓	X	Not Evaluated

No.	Scientific Name	Common Name	Area*				Status by IUCN Red list*
			1	2	3	4	
11	*Bangana behri*		✓	✓	✓	✓	Vulnerable
12	*Bangana sinkleri*		✓	✓	X	X	Data Deficient
13	*Barbonymus altus*	Red tailed tinfoil	✓	✓	✓	X	Least Concern
14	*Barbonymus gonionotus*	Java Barb	✓	✓	✓	✓	Not Evaluated
15	*Belodontichthys truncatus*	Twisted-Jaw Catfish	✓	✓	✓	✓	Not Evaluated
16	*Boesemania microlepis*	Boeseman croaker	X	X	X	X	Near Threatened
17	*Brachirus harmandi*		✓	X	✓	✓	Not Evaluated
18	*Brachygobius mekongensis*	Mekong Bumblebee Goby	✓	✓	✓	✓	Not Evaluated
19	*Carcharhinus leucas*	Bull Shark	X	X	X	X	Near Threatened
20	*Catlocarpio siamensis*	Giant barb	✓	✓	✓	✓	Critically Endangered
21	*Channa limbata*	Red-tile Snakehead	✓	✓	✓	✓	Not Evaluated
22	Channa striata	Snakehead	✓	✓	X	✓	Least Concern
23	*Chitala blanci*	Royal knife fish	✓	X	✓	✓	Near Threatened
24	*Chitala lopis*	Giant Featherback	✓	✓	X	X	Not Evaluated
25	*Chitala ornate*	Spotted featherback	✓	✓	✓	✓	Not Evaluated
26	*Cirrhinus caudimaculatus*		✓	✓	X	✓	Not Evaluated
27	*Cirrhinus microlepis*		✓	✓	✓	✓	Vulnerable
28	*Cirrhinus molitorella*		✓	✓	✓	✓	Near Threatened
29	*Clarias gariepinus*		X	X	X	X	Not Evaluated
30	*Clupeichthys aesarnensis*	Thai river sprat	✓	X	X	X	Not Evaluated
31	*Cosmochilus harmandi*		✓	✓	✓	✓	Not Evaluated
32	*Cyclocheilichthys armatus*		✓	✓	✓	✓	Least Concern
33	*Cyclocheilichthys enoplus*	Soldier river barb	✓	✓	✓	✓	Not Evaluated
34	*Cyclocheilichthys furcatus*		✓	✓	✓	X	Not Evaluated
35	*Cynoglossus feldmanni*	River tonguesole	X	X	X	X	Not Evaluated
36	*Cyprinus carpio*	Carp	✓	✓	✓	✓	Vulnerable
37	*Dangila siamensis*		✓	X	X	✓	Least Concern
38	*Dasyatis laosensis*	Mekong stingray	✓	X	✓	X	Endangered
39	*Datnioides pulcher*	Siamese tigerfish	X	✓	✓	✓	Critically Endangered
40	*Datnioides undecimradiatus*	Northeastern Siamese	✓	X	✓	X	Vulnerable
41	*Discherodontus ashmeadi*		✓	X	✓	✓	Not Evaluated
42	*Epalzeorhynchos frenatum*		✓	X	X	✓	Not Evaluated
43	*Esomus metallicus*	Flying barb	✓	X	✓	✓	Not Evaluated
44	*Garra cambodgiensis*	Cambodian logsucker	X	X	X	X	Not Evaluated
45	*Garra fascicauda*		✓	✓	X	✓	Not Evaluated
46	*Glyptothorax lampris*		✓	X	X	✓	Not Evaluated
47	*Gyrinocheilus aymonieri*		X	X	X	X	Not Evaluated
48	*Gyrinocheilus pennocki*		✓	✓	✓	✓	Least Concern
49	*Hampala macrolepidota*	Hampala barb	✓	X	✓	✓	Least Concern
50	*Helicophagus waandersii*		✓	X	X	X	Not Evaluated
51	*Hemiarius verrucosus*		✓	X	X	✓	Not Evaluated
52	*Hemibagrus filamentus*		✓	✓	✓	✓	Not Evaluated
53	*Hemibagrus nemurus*	Asian Redtail Catfish	✓	✓	X	✓	Not Evaluated
54	*Hemibagrus wyckii*	Crystal eye Catfish	✓	✓	X	✓	Not Evaluated
55	*Hemibagrus wyckioides*		✓	✓	X	✓	Not Evaluated
56	*Hemisilurus mekongensis*		✓	✓	✓	X	Not Evaluated
57	*Henicorhynchus siamensis*	Siamens mud carp	✓	✓	X	✓	Not Evaluated
58	*Heteropneustes fossilis*	Stringer Catfish	✓	✓	X	X	Least Concern
59	*Heteropneustes kemratensis*		X	X	X	X	Not Evaluated
60	*Himantura chaophraya*	Giant freshwater whipray	X	X	X	X	Endangered
61	*Himantura oxyrhyncha*	Marbled whipray	X	X	X	X	Endangered
62	*Hypophthalmichthys molitrix*		✓	✓	✓	X	Near Threatened
63	*Hypostomus plecostomus*	Sucker	✓	✓	✓	✓	Not Evaluated
64	*Hypsibarbus malcolmi*	Goldfin tinfoil barb	✓	✓	✓	X	Least Concern
65	*Hypsibarbus vernayi*		✓	✓	✓	✓	Not Evaluated
66	*Hypsibarbus wetmorei*	Goldenbelly Barb	✓	X	✓	✓	Not Evaluated
67	*Ictalurus punctatus*	Channel catfish	X	X	X	✓	Not Evaluated
68	*Kryptopterus cryptopterus*		✓	✓	X	✓	Not Evaluated
69	*Labeo dyocheilus*		X	X	X	X	Least Concern
70	*Lates calcarifer*	White perch	X	X	X	X	Not Evaluated

No.	Scientific Name	Common Name	Area*				Status by IUCN Red list*
			1	2	3	4	
71	*Leiocassis siamensis*	Siamese rock catfish	X	X	X	X	Not Evaluated
72	*Leptobarbus hoevenii*	Mad carp	✓	X	X	✓	Not Evaluated
73	*Lobocheilus cf. quadrilineata*		✓	✓	✓	✓	Not Evaluated
74	*Luciosoma bleekeri*	Apollo shark	✓	✓	✓	✓	Not Evaluated
75	*Macrochirichthys macrochirus*	Sword Minnow	✓	✓	X	X	NearThreatened
76	*Macrognathus semiocellatus*		✓	✓	X	X	Not Evaluated
77	*Mastacembelus armatus*	Tire Track Eel	✓	✓	✓	✓	Least Concern
78	*Mekongina erythrospila*		✓	✓	✓	X	Near Threatened
79	*Micronema bleekeri*		✓	✓	✓	✓	Not Evaluated
80	*Morulius chrysophekadion*		✓	✓	✓	✓	Not Evaluated
81	*Mystacoleucus ectypus*		✓	✓	✓	X	Not Evaluated
82	*Mystus singaringan*		✓	X	X	✓	Not Evaluated
83	*Notopterus notopterus*	Bronze featherback	✓	✓	X	✓	Least Concern
84	*Ompok bimaculatus*	Butter catfish	✓	✓	✓	X	Near Threatened
85	*Opsarius koratensis*		X	X	X	X	Not Evaluated
86	*Opsarius pulchellus*	Stream barilius	✓	X	X	✓	Not Evaluated
87	*Oreochromis niloticus*	Nile Tilapia	✓	✓	✓	✓	Not Evaluated
88	*Oryzias songkhramensis*	Songkhram River ricefish	✓	✓	X	X	Not Evaluated
89	*Osphronemus goramy*	Giant Gourami	✓	✓	✓	✓	Not Evaluated
90	*Osphronemus exodon*	Elephant ear gourami	✓	✓	✓	✓	Vulnerable
91	*Osteochilus microcephalus*		✓	✓	X	✓	Not Evaluated
92	*Pangasius gigas*	Mekong Giant Catfish	X	X	X	X	Critically Endangered
93	*Pangasius bocourti*		X	X	X	X	Not Evaluated
94	*Pangasius conchophilus*		✓	✓	✓	X	Not Evaluated
95	*Pangasiushypophthalmus*	Striped catfish	X	X	X	X	Endanger
96	*Pangasius krempfi*		✓	✓	✓	X	Vulnerable
97	*Pangasius larnaudii*		✓	✓	✓	X	Not Evaluated
98	*Pangasius macronema*	Siamensis pangasius	✓	✓	✓	✓	Least Concern
99	*Pangasius polyuranodon*		✓	X	X	X	Not Evaluated
100	*Pangasius sanitwongsei*		X	X	X	X	Critically Endangered
101	*Parambassis siamensis*	Asiatic glassfish	✓	✓	✓	✓	Not Evaluated
102	*Phalacronotus apogon*		X	X	X	X	Not Evaluated
103	*Poropuntius laoensis*		✓	✓	✓	✓	Not Evaluated
104	*Probarbus jullieni*	Seven-striped barb	✓	✓	✓	X	Endangered
105	*Probarbus labeamajor*	Thicklipped barb	✓	✓	X	✓	Endangered
106	*Probarbus labeaminor*	Thinlip barb	✓	✓	X	X	Data Deficient
107	*Pseudolais pleurotaenia*		X	X	X	X	Not Evaluated
108	*Puntioplites falcifer*		✓	✓	✓	✓	Least Concern
109	*Puntioplites proctozystron*		✓	✓	✓	✓	Least Concern
110	*Puntius orphoides*		✓	✓	X	✓	Not Evaluated
111	*Puntius stoliczkanus*	Stoliczkae's Barb	X	X	X	X	Least Concern
112	*Raiamas guttatus*	Burmese trout	✓	✓	✓	✓	Least Concern
113	*Rasbora borapetensis*	Redline rasbora	X	X	X	X	Not Evaluated
114	*Rasbora septentrionalis*		✓	X	✓	✓	Not Evaluated
115	*Rasbora trilineata*	Scissor-tailed rasbora	X	X	X	X	Not Evaluated
116	*Scaphognathops bandanensis*		✓	✓	✓	✓	Vulnerable
117	*Scomberomorus sinensis*	Chinese seerfish	X	X	X	X	Not Evaluated
118	*Sikukia gudgeri*		✓	✓	✓	✓	Not Evaluated
119	*Tenualosa thibaudeaui*	Freshwater herring ,Laotian shad	X	X	X	X	Vulnerable
120	*Tetraodon abei*		X	X	X	X	Not Evaluated
121	*Tetraodon baileyi*	Hairy puffer	X	X	X	X	Vulnerable
122	*Tetraodon cambodgiensis*		X	X	X	X	Vulnerable
123	*Tetraodon cochinchinensis*		X	X	X	X	Not Evaluated
124	*Tetraodon suvatti*	Arrowhead puffer	✓	✓	✓	✓	Not Evaluated
125	*Thynnichthys thynnoides*	White lady carp	✓	✓	X	X	Not Evaluated
126	*Tor tambroides , T. sinensis*	Greater Brook Carp	✓	✓	✓	X	Not Evaluated
127	*Toxotes microlepis*		X	X	X	X	Least Concern
128	*Trichogaster microlepis*		X	X	X	X	Not Evaluated
129	*Trichopsis schalleri*	Threestripe gourami	✓	X	✓	✓	Not Evaluated
130	*Wallago attu*	Great white sheatfish	✓	✓	✓	✓	Near Threatened
131	*Wallago micropogon*	Black Sheatfish	✓	X	✓	✓	Data Deficient

No.	Scientific Name	Common Name	Area*				Status by IUCN Red list*
			1	2	3	4	
132	*Xenentodon cancila*	Freshwater garfish	✓	✓	✓	✓	Least Concern
133	*Yasuhikotakia modesta*	Yellow tailed botia	✓	✓	X	✓	Least Concern
134	*Yasuhikotakia morleti*	Skunk loach	X	X	X	✓	Least Concern
135	*Yasuhikotakia nigrolineata*		X	X	X	X	Not Evaluated
136	*Yasuhikotakia sidthimunki*		X	X	X	X	Endangered

Remark: * Investigation area, ✓found, X not found

1. Interview people and survey morning marketat Ban Na Sawang,Paklay District, Chaiyaburi Province
2. Interview village leaders and people at Ban Kae,Paklay District, Chaiyaburi Province
3. Interview people at Ban Muong Nuea, Paklay District, Chaiyaburi Province
4. Interview people at Ban Pone Sai (at the Poon stream),Paklay District, Chaiyaburi Province

Identification of fish species as endemic species and native species by focusing critically endangered species or Endangered species or Vulnerable species according to IUCN Redlist, they are described as follows.

1. Endemic species and Critically endangered species or Endangered species or Vulnerable species) , total of 7 species are categorized as follows.

   - Fish species were not found in every area are:
     - Mekong giant catfish (*Pangasianodon gigas*), Giant salmon carp (*Aaptosyax grypus*) which are critically endangered species. The interviewees stated that they had never found this fish species.However, the villagers at Ban na Sawang said that currently they could catch Mekong giant catfish (*Pangasianodon gigas*)but the size was small, weighing about5 kilograms.
     - Laotian shad (*Tenualosa thibaudeaui*) and Hairy puffer (*Tetraodon baileyi*) which are vulnerable species.
   - Fish species found in some area included Thicklip barb (*Probarbus labeamajor*) which is an endangered species. Interviewees indicated that this species was still found except at Ban Muong Nuea.
   - Fsh species found every where at present were *Scaphognathops bandanensis* which is a Vulnerable species.
   - Fish species that had insufficient data were *Schistura bolavenensis*, which is an Endangered species.

2. Native species either critically endangered, endangered or vulnerable comprise a total of 49 species, can be divided into the following:

   - Fish species not found in the area:
     - Giant pangasius (*Pangasius sanitwongsei*) which is a critically endangered species.
     - Freshwater whipray (*Himantura chaophraya*), Marbled whipray (*Himantura oxyrhyncha*) which are Endangered species.
     - *Tetraodon cambodgiensis*) which is Vulnerable species.

   - Fish species found in someparts of the area:
     - Siamese tiger perch (*Datnioides pulcher*) which is critically endangered species.

- Mekong stingray (*Dasyatis laosensis*), Isok barb (*Probarbus jullieni*) which are endangered species.
- Mekong tiger perch (*Datnioides undecimradiatus*) which is a Vulnerable species.

▪ Fsh species found every where at present:

- Giant barb (*Catlocarpio siamensis*) which is a critically endangered species. From interviewing, this species could be caught everywhere, but in small numbers. The market survey at Ban Na Sawang saw Giant barb. It was a big fish with the length of 80 centimetersand 13 kilogram in weight (Figure below). Also *Bangana behri*which is a vulnerable species.

Figure 71: Fish sold in the morning market at Paklay City

In addition, the alien species, Sucker (*Hypostomus plecostomus*)was found every investigation area.

Other aquatic organisms found were tiny shrimps (0.5 cm body size, 3-4 cm length) habitated along the Mekong River bank in the flood period. Some species of shell were also found but not many; for example, single valve shell (Class Gastropoda)and bivalve shell (Class Pelecypoda or Bivalvia).

3.3.2 Fisheries

3.3.2.1 Type of Fishery

Due to high biodiversity in the Mekong River, diversity of fish species and fisheries can be seen along the Mekong River. Fisheries in the Mekong River can be divided into 2 types.

1) Fisheries for occupation. This type is fish caught for selling which is evidently seen at Tonle Sap in Cambodia and in the north of the Mekong Delta of Vietnam. Both areas are important fishery areas of the Nekong River Basin.
2) Fishery for household consumption or income supplementation. This fishery type is generally found in the villages along the Mekong River in Thailand and Lao PDR.

3.3.2.2 Quantity of Fishery

In *State of the Basin Report Summary 2010*, the MRC reported the following:

"The inland fisheries of the Mekong Basin are among the world's largest, with total production of about 3.9 million tonnes in 2008, comprising 1.9 million tonnes from captureand 2 million tonnes from aquaculture. The total economic value of the Mekong fisheries is estimated at US$3.9–7.0 billion per year".

The IEE of the Paklay Hydropower Project*(Earth Systems Lao/Norconsult 2009)* indicated aquatic organismstotaled about 0.21 million tonnes per year, which can be divided into 0.17 million tonnes of fish per year and 0.04 million tonnes of other aquatic organisms per year.

Fisheries as a food source are highly significant to over a million inhabitants in the Mekong River Basin.In addition, there are fishery related occupations such as fish product transformation, food shops, fishery equipment shops, etc. The economical value of fisheries in the Mekong River is considered an important base of household economy. For Lao PDR, more than 50% of households earn 20% of their income from fishery related activities. Fisheries in the southern region of Lao PDR are very important: about 80% of households have fishery related occupations. Income from fisheries is used to buy seeds for rice cultivation.

Fisheries in the Mekong River and tributaries are performed in rainy season which is the migration period of aquatic organisms. In dry season, fish are caught in places the deep river where is migration mean of some fish species

Fish species in the GMS countries (Lao PDR, Thailand, Vietnam, Cambodia) which are the most abundant 'very large' species in catches are Great white sheatfish (*Wallago attu),* Blue barb(*Cosmochilus harmandi*), Snail-eating catfish) *Pangasius conchophilus*(Goonch) *Bagarius yarrelli*(Spot pangasius

)*Pangasius larnaudii* (Boeseman's croaker) *Boesemania microlepis*. See details in Table 11.

Based on the report of Sverdrup-Jensen, S. (2002), there were 40 million fishermen in the Lower Mekong River Basin. They catchfish and other aquatic organisms measuring about 2 million ton/year of which 1.5 million ton/year are caught from natural resources and 0.26 million ton/year from aquaculture. The value of aquatic organism was 1,400 million US$.

Moreover, the IEE of PaklayHPP assesses impact of the dam construction on fishes and other aquatic organism from Luang Pra Bang, Lao PDR to Chiang Kan, Loei Provincde, Thailand - a distance of 290kilometers in length and 300 meters in width. The potential impact area would be 87,000,000square meters or 8,700hectare. The approximation of the quantity of fish and other aquatic organism is classified into 3 levels:

- Low level approximation based on fish is about 20 kg/ha/year and other aquatic organism 5 kg/ha/year, total fish and other aquatic organism is approximately 217.5 ton/year or 750 kg/km.
- Medium level approximation based on fish is about 40 kg/ha/year and other aquatic organism 10 kg/ha/year, total fish and other aquatic organism is approximately 435 ton/year or 1500 kg/km.
- High level approximation based on fish is about 60 kg/ha/year and other aquatic organism 25 kg/ha/year, total fish and other aquatic organism is approximately 913.5 ton/year or 3,100 kg/km.

However, this report did not summarize the quantity of fish and aquatic organism in the actual condition of the area.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

Table 11: Summary of the most abundant 'very large' species in catches

Species	English name	Total Weight (t)	Max. Length (cm)	Max. Weight (kg)	Max. length recorded in literature (cm)
Wallago attu	Great white sheatfish	20.18	135	35.0	200
Cosmochilus harmandi	Blue barb	4.15	88	11.7	100
Pangasius conchophilus	Snail-eating catfish	3.91	84	8.8	120
Bagarius yarrelli	Goonch	3.65	134	34.2	200
Pangasius larnaudii	Spot pangasius	2.02	65	6.0	150
Boesemania microlepis	Boeseman's croaker	1.91	86	6.0	100
Netuma thalassina	Giant sea-catfish	1.18	50	1.0	185
Hemibagrus wyckioides	Red-finned catfish	1.06	120	17.0	138
Pangasianodon hypophthalmus	Sutchi catfish	1.04	95	8.0	150
Pangasius bocourti	Bocourt's catfish	0.91	82	9.0	100
Pangasius elongatus	Slender catfish	0.72	66	4.0	100
Cyprinus carpio	Common carp	0.54	85	7.0	120
Probarbus jullieni	Isok barb	0.46	100	15.0	165
Probarbus labeamajor	Thicklip barb	0.44	107	23.0	150

Source: MRC

Besides economic value, fisheries provide food stability and nutrition for inhabitants in the Mekong River basin. The consumption of fish and other aquatic organisms from the Mekong River is high as 41-51 kg/per capita/year which is very high consumption in the world terms (MRC, 2010), as presented in Table below.

Table 12: Approximation of fishery products consumption in the Lower Mekong River Basin in 2008

Country	Inland (x1000 tonnes)			Marine Products*	Total Aquatic (x1000 tonnes)
	Fish	OAAs	Fish plus OAAs		
Cambodia	555	121	676	13	689
Lao PDR	185	45	230	3	232
Thailand	740	196	937	134	1070
Vietnam	746	173	920	140	1059
Total	**2226**	**535**	**2752**	**294**	**3051**

*fish and other marine species imported into the LMB and sold in markets.
Values are fresh weight (x 1000 tonnes (kt) per year) (Hortle 2007).
Note that actual consumption is less due to losses in processing.
OAAs – other aquatic animals

Fisheries in the Lower Mekon River Basin are mostly small scale local fisheries. From the MRC report (2010), fishermen catch less fish continuously and fish sizesaresmaller on averagethan in the past as well as the big meat fishes are lower in catch. The monitoring of fish catches in Tonle Sap by lift netin the past 12 years indicate that fish numbers have not decreased, but the cause of smaller fish catchesareincreased overcatches, which also may explain less catches of big meat fish and higher catches of small fish.

The MRC report (2010) about a 3 year study on fisheries for commerce along the Mekong River concluded fish catchesare not affected by seasons but dependent on fish migration phenomena that are related to the water level and flow in the river. In addition, seasonal flood cycles have induced spawning and high number of fingerlings on the floodplains. Flooding is beneficial to spawning stimulation, accessibility to floodplains, migration between normal habitat and floodplains.

Fishery equipment used in the Mekong River as stated in the MRC report (2010) include the following:

- Lao PDR: grill net or cast net.
- Thailand: grill net, cast net, seine net, hook,line.
- Cambodia: grill net, seine net,lift net, cast net.
- Vietnam: push-net,trap-net, trawl-net, dai.

3.3.2.3 Fisheries in the Study Area

Based on the study of fishery activity reported in the IEE of PaklayHPP, there arefish catches upstream of Don Lung and between Don Lung (Ban Mouang Tai),Paklay District. Fish can be caught all year round, but the high fish catches are in the dry season. Fish migration season in the main river and tributaries is during May-Junewhich is the beginning of the flood season. After that, the fishermen catch less fish due to high water levels in the Mekong River.People residing along the Mekong River mostly catch fish for a living and food. Their main occupations are upland cultivation. Fisheries are carried out at the beginning of the monsoon season (end of April - May) and the ending of the monsoon season (October-November).

From the preliminary data, there are some occupations in fisheries, but data is not evident. General data could be used for the impact assessment of Pak Beng dam construction. In addition, a survey of fishpen aquaculture along the Mekong River should be made in order to assess the impact on this activity.

3.4 Navigation

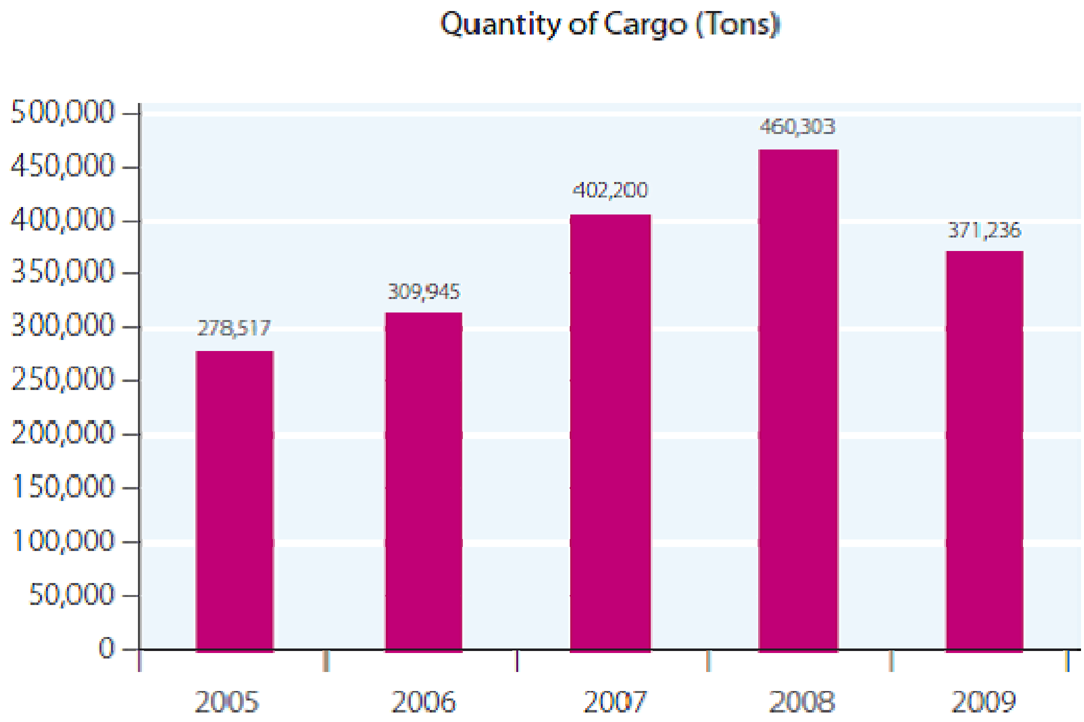
3.4.1 Waterway Transport

The Mekong River is used for traveling and cargo transhipping has a long history.This is confirmed by the record of Chou Ta-kuan who traveled by ship to Angkor Watfor a trading dialogue between China and Cambodia via the Mekong River and Tonle Sap prior to the city (Briggs, 1951). Presently, the Mekong River is still a significant route for cargo transportation and communication of people of the GMS countries.In addition, travelling along the Mekong River is for tourism as well.

Transportation of goods along the Mekong River in the past has employed small boats connecting communities. Presently, it has become an important trade connecting route among 6 countries in the GMS and other countries (MRC, 2010). The transhipping route along the Mekong River is from Kunming to Chingsaen dock, Chiangsaen District, Chiangrai Province, Thailand. Then goods are transported to Bangkok by big trucks. Advantages of transhipping are reasonable cost particularly over a long distance; and the high capability to accommodate a large amount of goods compared to land transportation.

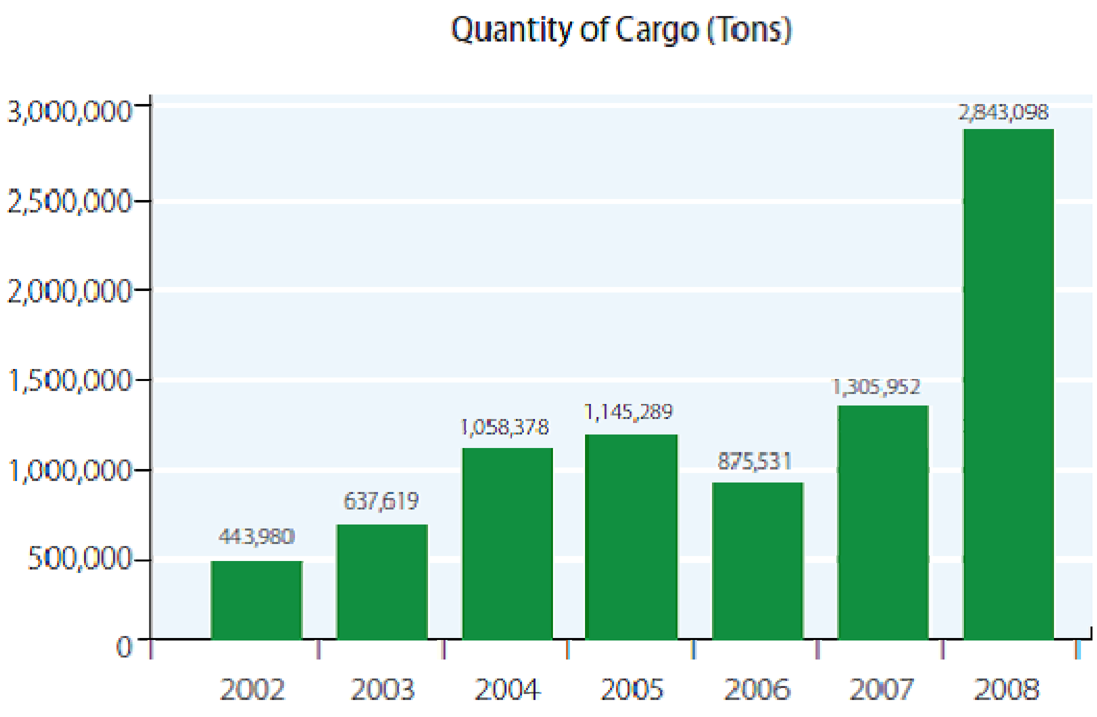
The Mekong River Basin Report 2010 Executive Summary (MRC 2010) indicates that despite the difficulty of transhipping along the Mekong River, due to difference of seasonal water levels in the magnitude of 15m for each time period of the year, approximately 300,000 tons of goods are transshippedannually between Kunming (China) and Bangkok (Thailand). From 2005-2008 this trade has doubled in volume. The major cargo transhipped from Thailand to China are wood, agricultural products, and construction materials such as cement. The most common Cargo transhipped from China to Thailand are garlic, onions, and fertilizer.

Besides cargo transshipping between China and Thailand, trading through transshipping between Vietnam and Cambodia has evidently increased as well. The MRC (2010) reports that the number of cargo transshipped via the dock at Panomphen has almost doubled from 278,000 tons in 2005 to 430,000 tons in 2009. Cargo transhipping in the triangle area of the Mekong Delta of Vietnam has substantially increased from 1,145,000 tons in 2005 to 2,843,000 tons in 2008 (Figures72 and 73).



Source: MRC, 2010

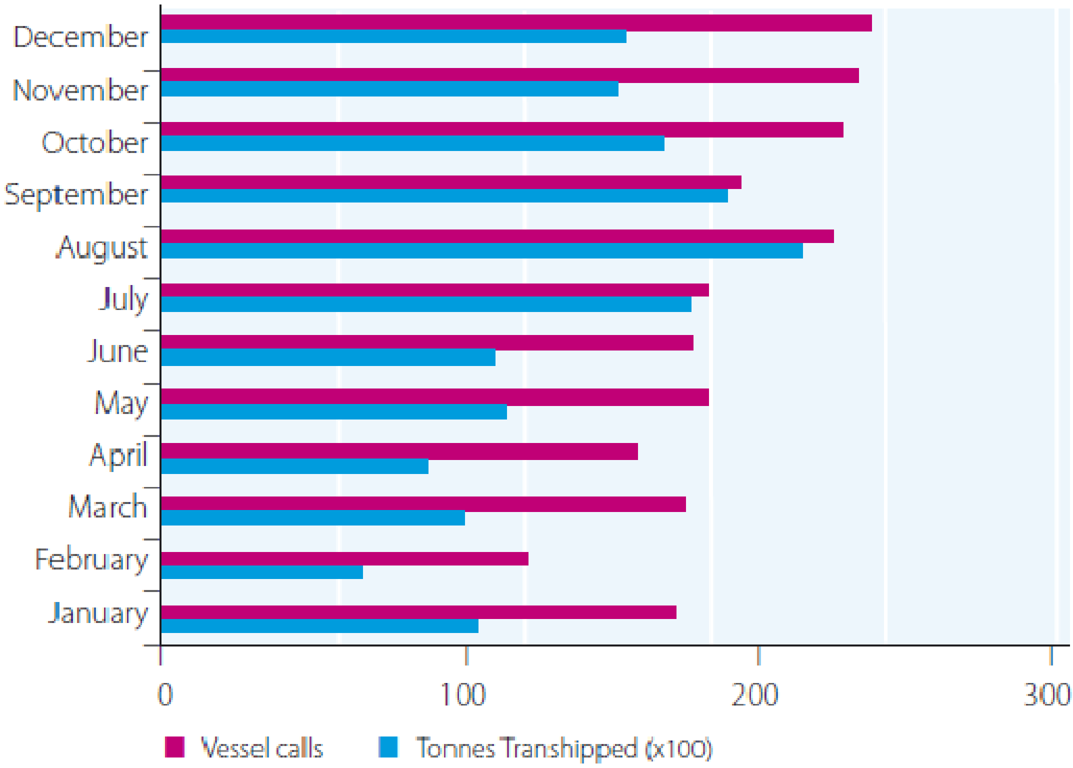
Figure 72: Quantity of Cargo at Panompenh Dock



Source: MRC, 2010

Figure 73: Quantity of Cargo at Can-Tho Dock

In Thailand, there are a number of docks for cargo transshipping, particularly Chiangsaen dock, located at the border of Lao PDR, Burma and Thailand. The MRC report (2010) indicates transshipping is high during the flooding season but lowers by 50% in January-June (Figure below).



Source: MRC, 2010

Figure 74: Averaged Monthly of Cargo Quantity between 2005-2008 Transhippedthrough Chiangsaen Dock, Thailand

See Page 5-126 to 5-188, details of Navigation could be found in the section of Project Layout and Main Structure in FS approved in March 2017 as attached in this report.

3.4.2 Transhipping Route and Period

The important transshipping routes are as follows:

- Kunming (China):Chiangsaen Dock (Thailand) Cargo transhippingusing Chinese ships, of which the vessel size is 300-500 DWT, 8 m in width and 50 m in length, requiring a waterway of 2.0-2.5 m. Goods from China are vegetables, fruits, etc. Goods from Thailand are sugar, fuel oil, etc.
- Vietnam- Panomphen route: Ships used in this route are large sized vessels of 500 DWT to 5,000 DWTwith a draft of 8 m.
- Cambodia: The dock at Phnom Penh is capable of accommodating a vessel of 5,000 DWT. Goods shipped are textiles, agricultural products and construction materials.

- Vietnam: A vessel sized 10,000 DWAT can transship through theBassac River. Cantho dock can connect to the South China Sea. Most of goods transhipped are rice, vegetables and wood products.
- Huai Sai (Lao PDR):Chiang Khong dock (Thailand) route. There are both passenger boats and cargo ships. Passenger boats are small vessels carrying about 10 passengers/trip. For cargo vessels, most goods are transported on land by vans or trucks through Bo Ten District, Luang Namta Province, Lao PDR, then to Huai Sai dock toward Chiang Khong dock by ferry.

Transshipping in Lao PDR is mostly for passengers traveling along the Mekong River to important spots and goingto Thailand. The routes are as follows:

- Distance from Huai Sai to Paklay 126 km (Km.2314 - Km.2188).
- Distance from Paklay to Luang Prabang 178 km (Km. 2188-Km.2010)
- Distance from Luang Prabang to Vientiane 426 km (Km.2010-Km. 1584).
- Distance from Vientiane to Savanakhet 459 km (Km.1584-Km. 1125).
- Distance from Savanakhet to Pakse 256 km (Km.1125-Km. 869).

The travel route between Huai Sai-Paklay-Luang Prabangis not onlyfor passenger transportation, but also for tourism. Passenger boats have 85-100 seats, with a size of 2.5m in width, 35 m in length, which require a deep waterway of 0.60 m.

In addition, there is transshipping of goods from Ching Khong dock (Thailand) to Luang Prabang (Lao PDR). The dock at Luang Prabang can accommodate a vessel of 300 DWTl. Goods transshipped to Luang Prabang are construction materials, cement, etc. There is also the transshipping of goods (mostly agricultural and wood products) back to Ching Khong dock. There are 2-3 cargo shipments each month.

Due to the distance of the Mekong River and the existence of a high number of outcrops and different water levels along the river sections, the sizes of vesselsdiffer accordingly. The size of vessels that can pass through different river sections is shown in Figure below.

Transshipping periods differ depending on the purpose of transshipping. Passenger transshipping occurs year round. Cargo transshipping with a large vessel can only be done duringthe rainy or monsoon seasons (May-Oct) when the water level is high.

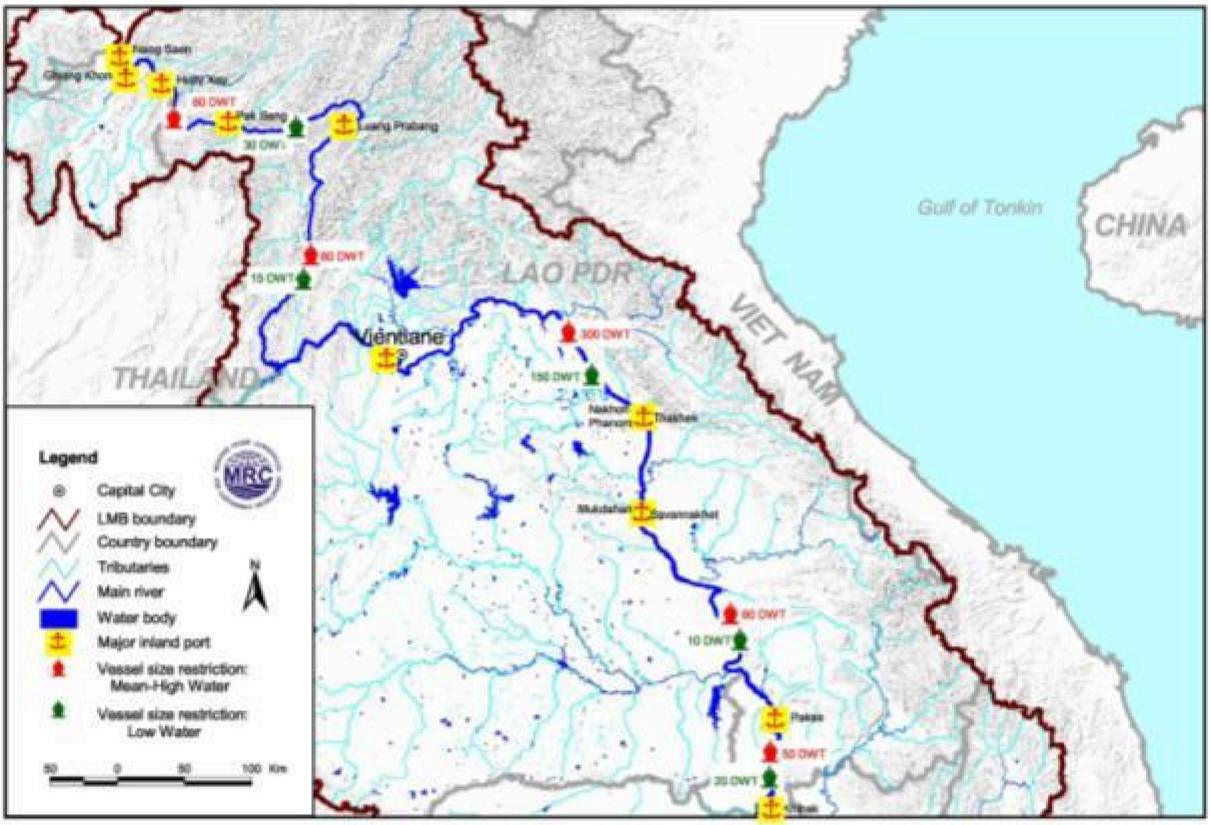


Figure 75: Carrying Capacity of the Mekong in terms of Vessel Size (DWT)

3.4.3 Probems Encountered and Future Development

As mentioned above, the water level and outcrops/rapids are factors affecting cargo transshipping. In the LMB, transshipping along the Mekong River and its major tributaries occurs the whole year round. Transshipping is more convenient in the monsoon season with high water levels. The exception is at the boundary of Cambodia and Lao PDR i.e. the Khone Falls area (within a distance of 14 km). Rapids and dunes along the river section Luang Prabang to Pakse are detailed in Appendix C.

Based on the statistical data of transshipping in the LMB (MRC 2010), it is evident that the construction of more docks is needed to accommodate a substantial increase of cargo transshipping. The construction of Cai Mep dock at Ba Ria-Vung Tao Province, in the south of Hochimin, Vietnam, is an example. It is the first deep-water dock in Vietnam designed to transship cargo to Europe or the USA. This dock can accommodate marine ships of 10,000DWT.

3.4.4 Agreementsfor Transhipping between Countries

Because the Mekong River flows through or along international boundaries, it is necessary to set agreements for transshipping which are very important for the development of transshipping on the Mekong River. Some examples of agreements are as follows:

- Agreement between China and Lao PDR on Freight and Passenger Transport along the Lancang–Mekong River was adopted in November 1994.
- Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin, Article 9, Freedom of Navigation, 5 April 1995, Chiang Rai states. "*On the basis of equality of right, freedom of navigation shall be accorded throughout the mainstream of the Mekong River without regard to the territorial boundaries, for transportation and communication to promote regional cooperation and to satisfactorily implement projects under this Agreement. The Mekong River shall be kept free from obstructions, measures, conduct and actions that might directly or indirectly impair navigability interfere with this right or permanently make it more difficult. Navigational uses are not assured any priority over other uses, but will be incorporated into any mainstream project. Riparians may issue regulations for the portions of the Mekong River within their territories, particularly in sanitary, customs and immigration matters, police and general security"*

In addition, there is an agreement for construction of new hydropower that facilitates transshipping by enabling ships to pass through, such as;

- Hanoi Agreement between Cambodia andVietnam on Waterway Transportation, 13 December 1998.
- Agreement between and among the Governments of the Lao PDR, the Kingdom of Thailand, and the Socialist Republic of Vietnam for Facilitation of Cross border Transport of Goods and People(amended at Yangon, Myanmar), signed in Vientiane, 26 November 1999.
- Agreement on Commercial Navigation on Lancang–Mekong River among the governments of the People's Democratic Republic of China, the Lao People's Democratic Republic, the Union of Myanmar and the Kingdom of Thailand, adopted at Tachileik, 20 April 2000.
- Phnom Penh Agreement between Cambodia and Vietnam on the Transit of Goods, 7 September 2000.
- New Agreement on Waterway Transportation between Vietnam and Cambodia, facilitated by MRC, signed in Phnom Penh, 17 December 2009.

3.4.5 Transhipping in the Norhtern Part

From the survey of transshipping by the study team between Huai Sai District, Bokeo and between Pak Beng-Pak Ngei-Luang Prabang, two types of transshipping can becharacterized as follows.

1) Passenger transshipping

The major transshipping route is Huai Sai-Luang Prabang. The docks for passenger boats are at Luan Prabang, Pak Beng and Huai Sai (Figure 76). Characteristics of the boats are described as follows:

a) General passenger boat

There is one trip starting from Huai Sai dock about 11.00 am. The boat has 85-100 seats, 2.50 m. in width, 35 m. in length and requires a deep waterway 0.60 m. Travel time from Huai Sai to Luang Prabang takes more than one day - from Huai Sai to Pak Beng 6-7 hours and stay overnight at Pak Beng, then travel 7-8 hours to Luang Prabang the following day. The passenger boats are used by passengers and tourists. There are high numbers of Pak Beng, 100 boats at Luang Prabang and 50 boats at Huai Sai. In addition, travel to Huai Sai dock from Thailand is through Chiang Khong dock by a using small boat

b) Speed Boat

With this speed boat, Huai Sai- Luang Prabang takes about 7 hours divided into Huai Sai-Pak Beng 3 hours, parking at Pak Beng dock 1 hour, and Pak Beng-Luang Prabang 3 hours.

c) Mekong River Cruise

This is used for tourism activity, of which the time spent depends on the agreement of tourism purpose, possibly 4- 6 days or more. The boat size is 40 m. in length, 7.5 m in width and requires a deep waterway 0.90 m.

Presently, after January 2012 there will be a traveling route between Chiangsaen and Luang Prabang by speed boat with 50 seets capacity, departing from Chiang Saen early morning and arriving at Luang Pra Bang about late evening. This kind of trip does not to stay overnight on the way at Pak Beng. It is expected to be a favorite to the tourists.

Beside the transhipping tourism along the Mekong River in Lao PDR or between Chiang Rai, Thailand and the Lao PDR, there is tourism to China by boat. The size of the boat is 58 seats capacity, maximum speed is 60 km/hour (see Figure detail). The tourist route starts from Chiang Saen to Chiang Roong, Yunan, China for about 8 hours. Then, tourism is taken place at Chiang Roong, Sip Song Panna. This trip will take about 4 days. Another tourist alternativestarts crossing the Mekong River from Chiang Kong dock, Thailand to Huai Sai, Bo Keo, Lao PDR, and transport by bus to Luang Namtha- Bo Ten- La City- Chiang Roong. Then, spend days at Chiang Roong and Sip Song panna before traveling back by boat from Chiang Roong along the Mekong River through Lao PDR and Thailand at Chiang Saen. The boat is serviced by Chinese captain and crews.

2) Cargo transshipping

From the field survey on cargo transshipping by the study team, the major docks are as follows:

- Chiang Saen dock, Chiang Saen District, Chiang Rai Province, Thailand, which is the responsibility of the Harbor Department of Thailand. It is used only for cargo transshipping between Kunming in China and Chiang Saen in Thailand (Figure detail). Cargo transhipping mostly uses Chinese ships sized 300 - 500 DWT.

- Chiang Khong dock (Buck dock), Chiang Khong, Chiang Rai Province, Thailand. It is the responsibility the Harbor Department of Thailand. It is used only for cargo transshipping (Figure 83). It's located far from Chiang Saen dock - about 55 km. The transhipping route is divided into two types.
    - Chiang Khong dock-Luang Prabang dock - the cargo is mainly construction materials and cement.
    - Chiang Khong dock-Huai Sai dock at Borkeo, Lao PDR. Goods are transported by vans or trucks through to Bo Ten city to Huai Sai dock and then on ferry to Chiang Khong dock.

a) Luang Prabang Dock

b) Pak Beng Dock

b) Huai Sai Dock

Figure 76: Docks for Passengers

Figure 77: Boats Transportation between Huai Sai-Paklay-Luang Prabang

Figure 78: Small Boats Transported between Chiang Khong-Huai Sai

Figure 79: Speed Boat Transported between Huai Sai-Paklay-Luang Prabang

Figure 80: Mekong River Cruise

Figure 81: Chiang Saen Dock Transhipping between China-Thailand

Figure 82: Ferry Carrying Trucks from Huay Sai to Chiang Khong

Figure 83: Ching Khong Dock Transhiiping between Thailanf-Lao PDR

Figure 84: Huai Sai Dockin Lao PDR

3.4.6 Transhipping in the Study Area

Based on the investigation of transportation in the study area by the study team, there is no cargo transhipping along the route Ban Kae, Ban Muong Nea, and Ban Pone Sai, Chaiyaburi Province, as land transportation is more convenient. However, there are some tourism cruises along various routes by passing PaklayCity (http://www.cruisemekong.com/routes/) including:

- o Vientiane- Luang Prabang route starts from Vientiane-Paklay-Tha Deus-Kuang Si- Luang Prabang, which takes 6 - 8 days.
- o Golden Triangle- Vientiane route starts from Chiang Saen- Huai Sai-Pak Tha- Pak Beng- Pak Ou- Luang Prabang- Kuang Si- Tha Dea- Paklay-Vientiane, which takes about 10 - 12 days.

This transshipping is rather for tourism than for cargo purposes. It employs cruise boats with facilities that accommodate tourists. However, it is not yet popular among tourists as it takes too long a time.

3.5 Water Quality

3.5.2 Overview of water quality of the Lower Mekong Basin

In general, the water quality of the Mekong River is considered good except at some locations situated nearby communities, agriculture areas and particularly at crowded aquaculture areas. Toxic substances such as Organo-chlorine and heavy metals were found in very low concentrations and did not cause any water quality problems. Similarly, nutrient contents were mostly lower than the designated values, except at the monitoring stations in some areas where high nutrient contents were found due to the high density of communities located there that earned their living from agriculture. Ammonia content in the Mekong River was lower than the standard value. However, it has increased, particularly in the section of the river where the main river joins with tributaries from Vientiane in the Lao PDR, and the Bassac River in Cambodia.

Figure 85 displays the monitoring stations on the Mekong River. The Interim Mekong Committee established the water quality monitoring network in 1987 to monitor alterations in water quality and also to protect and rehabilitate water quality. A total of 87 monitoring stations were established before 2009 and since then the number has been reduced to 55 stations. Of these 55 monitoring stations:

- 23 stations are primary stations located at significant basin wide transboundary locations including 17 stations on the Mekong mainstream and 6 stations on the Bassac River.
- 32 monitoring stations are secondary stations.

Figure 85: **Monitoring Stations along the Mekong River and Tributaries(MRC, 2010)**

3.5.3 Further water quality details are as follows

* **Dissolved oxygen (DO):** at acceptable levels, the concentrations were within the standard value of 5-6 mg/l. The lowest DO contents were found at the monitoring stations downstream at Ta Khmau and Koh Khel stationslocated on the Bassac River downstream of Phnom Penh.

* **Chemical oxygen demand (COD):** the period of 4 year monitoring from 2004-2008 indirectly indicate organic content in the river. The COD slightly increased from upstream to *downstream* in the Mekong River (see stations 1-17 in Figure below). In addition, COD contents in the Bassac River in Cambodia (in the Lower Mekong Basin) had a higher COD than the *upstream* stations 1-17. However, the concentrations of COD of these monitoring stations did not exceed the standard of 10 mg/l, and were considered as excellent water quality.

* **Nutrients:** Nitrate and Nitrite concentrations were not significantly different in 2000-2008. Similarly nitrogen and phosphorus increased a little in the Mekong Deltaand at

the Mekong River at Vientiane. Some nutrient hotspots were found in tributaries of the Mekong Delta such as the Tein and Hau Rivers where high organics, nutrients and microorganisms were found due to waste discharge from industries, aquaculture and agriculture. In addition, at the Chau Doc River in Vietnam, at some flooding locations, the content of phosphorus was almost at the level that causes eutrophication algal bloom. Flushing water into such areas might reduce this algal bloom problem. Development of water resources and activities upstream of the basin impact on downstream water (MRC, 2010).

* **Persistent organic pollutants (POPs):** Presently, the data on POPs is not complete or clearly defined. Most study results mention the presence oforganochlorines such as DDT and PCB. Table 3.5-1 presents contamination of POPs in aquatic organisms including phytoplankton, crustaceans and fish. DDT was found in such a way that it can be assumed the contamination comes from sediment; sediment downstream of urban areas was contaminated with DDT and PCB in higher levels than in rural and agriculture areas, which indicates that urban areas are the main discharging points (MRC, 2007).

* **Trans-boundary water pollution**: At present, there is no distinct evidence about transboundary impacts between Lao PDR and Thailand, Lao PDR and Cambodia, and Cambodia and Vietnam (MRC, 2008). However, increasing nitrogen content in the Upper Mekong Basin likely indicates there will be transboundary affects of pollutants to the Lower Mekong Basin. In addition, sediment transport along the Mekong River causes transport of nutrients to the lower reaches of the Mekong River that can potentially enhance high productivity in the Tonle Sap Great Lake. This implies a positive impact rather than the negative impact due to the nutrients. However, the nutrient contents should not be high enough to stimulate eutrophication. Monitoring on nutrient and fishery productivity has to be carried out in order to balance these aspects.

* **Heavy metals** and other trace elements were found at high levels in areas with a lot of navigation or with a high density of population such as downstream of Panompenh, in the Mekong Delta and the border area of China and the Lao PDR.

The figures/tables below (Figures 86-88, Table13) present the details of water quality monitored.

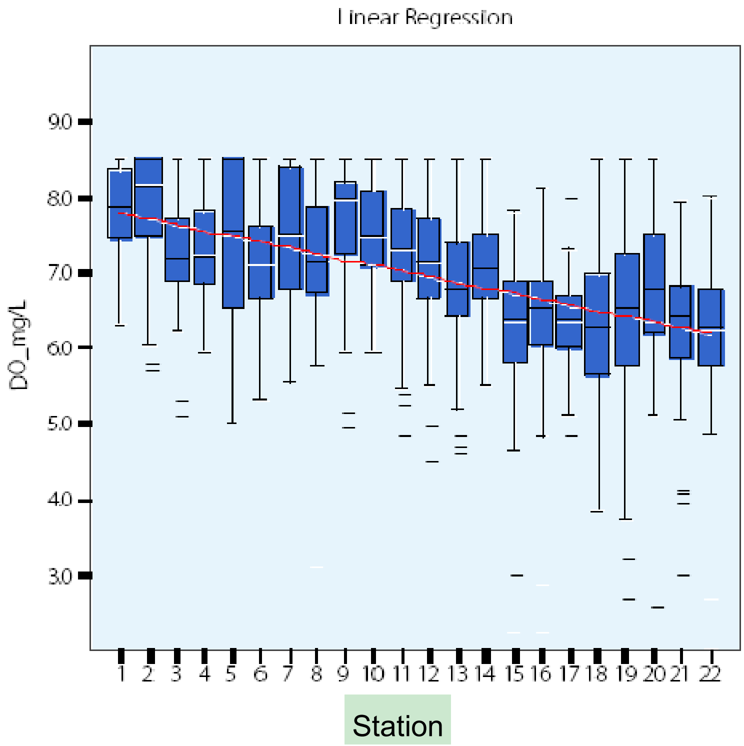


Figure 86: DO Profile at Stations 1-17 in the Mekong Riverand Stations 18-22 in the Bassac River

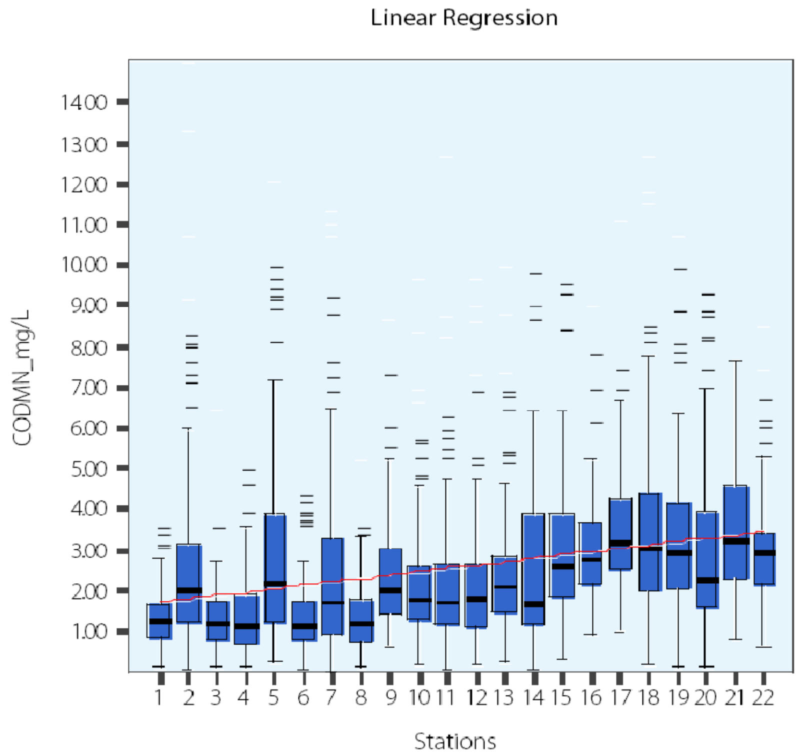


Figure 87: COD Profile at Stations 1-17 in the Mekong Riverand Stations 18-22 in theBassac River

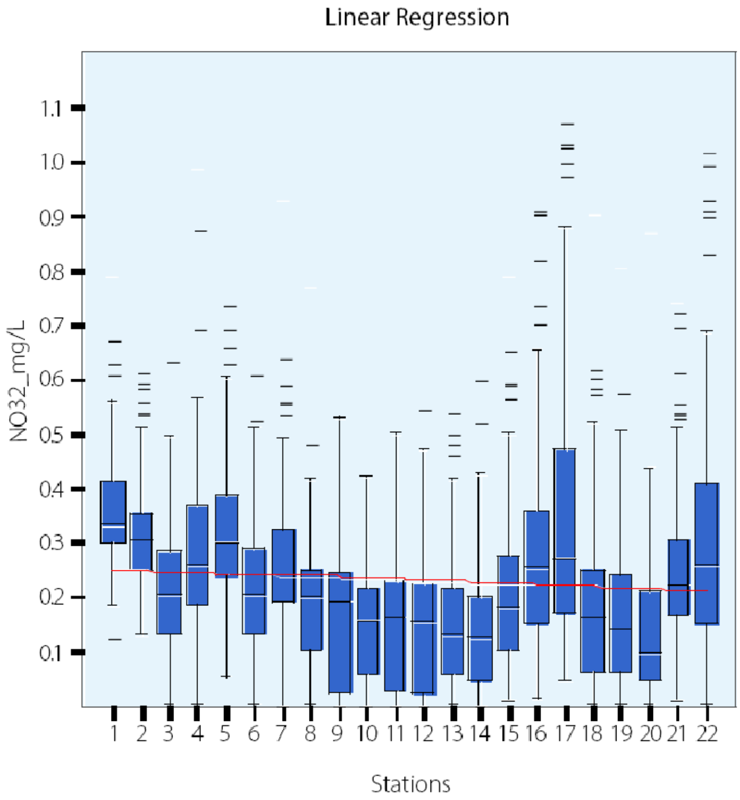


Figure 88: Nitrite and Nitrate Profile at Stations 1-17 in the Mekong River and Stations 18-22 in the Bassac River

Table 13: Concentration of Persistent Organic Pollutants (POPs) in the Mekong Delta(MRC, 2010)

Species	Number of samples	Lipid (%)	Moisture (%)	PCB[3]	DDT[3]	CHL[3]	HCH[3]	HCB
Phytoplankton[1]	1	0.07	96.20	0.02	0.06	0.00	0.00	0.00
Crustaceans[1]	33	2.97	72.62	2.12	5.32	0.16	0.01	0.04
Fish[1]	18	2.02	77.43	4.25	8.00	0.27	0.03	0.03
Sediments[2]	24			0.98	5.50	0.77	0.12	0.02

[1]ng/g wet weight in whole organisms from Mekong River mainstream, Can Tho 2004 (modified from Ikemoto et al. 2008b); [2]ng/g dry weight from Mekong River (Hau River) 2003–2004 (Minh et al. 2006); [3]Figures represent the sum of all components found.

3.5.4 Water Quality in the PaklayHPP Area

Water quality in the proposed Paklay dam site area was reviewed in the EIAof the PaklayHPP. This EIA study collected water samples both in the dry (February) and rainy(September) seasons at 7 stations including 3 stations upstream, 1 station at the proposed damsite location, and 3 stations downstream of the proposed dam site

(Figure below. These stations were as follows:

- Station 1: Mekong mainstream at Ban Pha Liap 0797144 E , 2048706N
- Station2: Mekong mainstream , (Pak Nam Pa) down the confluence with Nam Pha 0776326 E, 2039918 N
- Station 3: Dam site (upperstream option) 0770534 E, 2032337 N
- Station 4: Mekong mainstream, confluence with Nam Phoun, at Ban Moung Nua 0770562 E, 2032420 N
- Station5: Dam site (lowerstream option) 0769061 E, 2032399 N
- Station6: Nam Xong, confluence with Mekong mainstream, 0758122 E, 2021689 N.
- Station7: Paklay, confluence with Mekong mainstream. 0755083 E, 2017323 N.

Figure 89: **Sampling Stations at PaklayHPP area**

3.5.4.1 Surface Water quality of Paklay HPP Area in Dry season

Overall the results of the study show that the surface water quality in Mekong mainstream from the area of Ban Pha Liap, upstream and downstream of PakLay town is good with no heavy metal contents over acceptable limits. The most important concerns are the values of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) which were very high at all stations. These need to have mitigation measures to prevent the problem of water deterioration in the future. The dumping of organic matterfrom any sources should be prohibited. Total phosphate and some nitrates concentration were found at lower values than in the wet season and are in an acceptable standard of surface water.

The surface water quality of the Mekong River from the seven sampling sites in the project area shows a good quality of class three for fresh surface water; it's suitable for irrigation supply, aquatic biota (NEAP , 2000, STEA), and human consumption after a normal treatment process.

3.5.4.2 Surface Water quality of Paklay HPP Area in Rainy Season

The results of surface water quality tests in the rainy season are presented in Table 15. The DO levels in the river were generally found to be at high levels (6 mg/L). In each sampling, horizontal distribution of DO between stations seemed to be consistent with the level of primary producers (phytoplankton) and high water turbulence in rapid areas. pH found ranged between 7.49-7.98.

Total Solids are high in concentration due to the influence of high water flows. Nitrate is in a high range of 1.87-4.28 mg/l while ammonia is 0.07-0.52 mg/l. The water in this area showed the contamination of coliform bacteria. Total coliform bacteria are in range of higher than 230MPN/100 ml and faecal coliform bacteria are higher than 23 MPN/100 ml in all stations. There were no significant concentration of heavy metals found in this area except for iron which show high dissolved concentration in the water at Ban Pha Liap (station 1).

BOD values of the water in the study area were in the range of 3.7-5.4 mg/L while COD values were high within the range of 4.2-6.8 mg/L.

The surface water quality of Mekong River from seven sampling sites in Paklay hydropower project area shows a good quality but levels of BOD and COD were higher than the surface water standard, The medium quality water suitable for irrigation supply and aquatic biota and human consumption after normal treatment process for contaminated bacteria (NEAP, 2000).

Table 14: Surface Water Quality in Study Area of PaklayHPP in Dry Season

(Paklay HPP –Sampling in November)

Parameters	unit	Sampling station							Surfacewater	Standard of
		1	2	3	4	5	6	7	Standard	Lao Water supply
water temperature	°C	21.8	22.4	21.7	23.3	21.7	22	25.3		
Transparency	cm	40	50	40	40	40	40	10		
Turbidity	NTU	40.4	8.4	48.0	39.0	27.4	39.3	204		5
Total Suspended Solids	mg/l	53.0	12.0	64.5	43.5	82.0	118.5	418.5		
Total Dissolved Solids	mg/l	164.0	203.0	176.0	146.0	155.0	174.0	328		500
Conductivity	µS/cm	292.7	346.7	293.4	250.3	291.4	258.9	410.4		
pH	unit	7.9	8.1	7.9	7.8	7.8	8	8.1	05-Sep	
Total hardness	mg/l as $CaCO_3$	152.0	181.0	150.0	244.0	100.0	132.0	220		500
Dissolved Oxygen	mg/l	8.1	7.9	8	7.4	7.9	7.1	8.6	6	
COD	mg/l	1.8	1.8	2.3	2.5	1.3	1.5	2.7	5	
BOD	mg/L	3.2	2.7	1.5	1.5	1.5	1.1	1.5	1.5	5
Nitrate ion (NO3-)	mg/l	2.49	3.53	4.28	2.55	3.68	1.87	3.38	<0.5	50
Ammonia ion (NH4+)	mg/l	0.18	0.09	0.18	0.15	0.12	0.25	0.53	0.2	0.5
Total Phosphate (T.P)	mg/l	0.8	0.3	0.8	0.7	0.8	0.8	2.2		
Total Cromium (Cr)	mg/l	5.982	8.8	7.257	8.73	16.42	16.01	16.01	0.05 (CR^{6+})	0.05
Nickle (Ni)	mg/l	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	0.1	0.05
Iron (Fe)	mg/l	0.630	0.220	0.910	0.900	0.530	0.800	3.060		0.3
Manganese (Mn)	mg/l	0.060	ND <0.03	0.080	0.090	0.050	0.070	0.340	1.00	0.1
Lead (Pb)	mg/l	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02	0.05	0.05
Arsenic (As)	mg/l	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	0.01	0.05
Mercury (Hg)	mg/l	ND <0.0005	ND <0.0005	ND <0.0005	0.001	0.001	ND <0.0005	ND <0.0005	0.002	0.001
Zinc (Zn)	mg/l	ND <0.05	ND <0.05	ND <0.05	ND <0.05	ND <0.05	ND <0.05	ND <0.05	1	5
Copper (Cu)	mg/l	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	0.1	1
Aluminum(Al)	mg/l	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	1.460	0.270		0.24
Cadmium (Cd)	mg/l	ND <0.01	ND <0.01	ND <0.01	ND <0.01	ND <0.01	ND <0.01	ND <0.01	0.005	0.01
Faecal Coliform	MPN/100 ml	>23	>23	>23	>23	>23	>23	>23	1000	0
Total Coliform	MPN/100 ml	>230	>230	>230	>230	>230	>230	>230	5000	2.2

ND = Non Detection, MPN = Most Probable Number

Table 15: Surface Water Quality in Study Area of PaklayHPP in Rainy Season
(Paklay HPP –Sampling in Septemper)

Parameters	unit	Sampling station							Surfacewater	Standard of
		1	2	3	4	5	6	7	Standard	Lao Water supply
water temperature	^{o}C	26.7	28	26.5	25.3	26	26.8	28		
Transparency	cm	30	35	25	22	31	30	30		
Turbidity	NTU	96.0	71.0	212.0	75.0	202.0	15.0	144		5
Total Suspended Solids	mg/l	2.0	3.0	12.0	3.3	0.3	11.0	11.0		
Total Dissolved Solids	mg/l	62.9	130.0	85.7	91.4	167.1	228.6	228.6		500
Conductivity	µS/cm	197.0	213	195	171	191	381	288		
pH	unit	7.49	7.58	7.61	7.57	7.78	7.98	7.93	6-9	
Total hardness	mg/l as $CaCO_3$	110.0	110.0	80.0	76.0	110.0	178.0	140		500
Dissolved Oxygen	mg/l	5.96	6.63	6.17	6.24	6.13	6.09	4.35	6	
COD	mg/l	4.2	6.1	4.9	5.3	4.2	4.2	6.8	5	
BOD	mg/L	4.0	5.4	3.7	4.5	3.9	3.7	5.2	1.5	5
Nitrate ion (NO3-)	mg/l	2.49	3.53	4.28	2.55	3.68	1.87	3.38	<0.5	50
Ammonia ion (NH4+)	mg/l	0.16	0.42	0.28	0.2	0.3	0.07	0.52	0.2	0.5
Total Phosphate (T.P)	mg/l	0.88	0.62	0.79	0.62	0.88	0.49	0.92		
Total Cromium (Cr)	mg/l	5.982	8.8	7.257	8.73	16.42	16.01	16.01	0.05 (CR^{6+})	0.05
Nickle (Ni)	mg/l	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	0.1	0.05
Iron (Fe)	mg/l	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02		0.3
Manganese (Mn)	mg/l	0.180	ND <0.03	ND <0.03	ND <0.03	ND <0.03	ND <0.03	0.080	1.00	0.1
Lead (Pb)	mg/l	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02	ND <0.02	0.05	0.05
Arsenic (As)	mg/l	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	ND < 0.005	0.01	0.05
Mercury (Hg)	mg/l	ND <0.0005	ND <0.0005	ND <0.0005	ND <0.0005	ND <0.0005	ND <0.0005	ND <0.0005	0.002	0.001
Zinc (Zn)	mg/l	ND <0.05	ND <0.05	ND <0.05	ND <0.05	ND <0.05	ND <0.05	ND <0.05	1	5
Copper (Cu)	mg/l	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	0.1	1
Aluminum(Al)	mg/l	0.760	0.100	0.140	ND<0.1	ND<0.1	ND<0.1	0.270		0.24
Cadmium (Cd)	mg/l	ND <0.01	ND <0.01	ND <0.01	ND <0.01	ND <0.01	ND <0.01	ND <0.01	0.005	0.01
Faecal Coliform	MPN/100 ml	>23	>23	>23	>23	>23	>23	>23	1000	0
Total Coliform	MPN/100 ml	>230	>230	>230	>230	>230	>230	>230	5000	2.2

ND = Non Detection, MPN = Most Probable Number

3.6 Dam Safety

A comprehensive dam safety concept is used for projects with a large damage potential

1) Flood Design

According to provisions of Classification & Design Safety Standard of Hydroproject(DL5180-2003), for structures such as concrete water retaining structure, water releasestructure and water retaining type powerhouse, design standard of flood control for normalapplication is based on 500-year return period and that for special application is based on2000-year return period For energy dissipation and anti-scour structures, design standard offlood control for normal application is designed as 50-year return period. Flood controlstandard for downstream lead wall and retaining wall should be kept consistent with that ofthe energy dissipation and anti-scour structures.

2) Earthquake Safety

According to LAO PDR: Natural Hazard Risks published in March, 2011 byOCHA-ROAP and World Map of Active Tectonics, Nuclear Power Plants, Major Damsand Seismic Intensity, and with reference to Thailand Natural Disaster Profile (the upper& lower dam sites are 45km and 35km respectively west of the borders of Laos & Thailand)published in January, 2005 by Thailand's Ministry of Energy & Mining, the basic seismicintensity of the dam sites is determined as VI degree. After comprehensive considerationand analysis combined with the materials such as seismotectonic characteristics described above, the peak ground acceleration (PGA) of the dam site with 50-year exceedanceprobability of 10% is temporarily determined as $0.8m/s^2$; In addition, there is no activefault distributed within 5km of the two dam sites, earthquake magnitude "M" within thearea is less than 5. According to Technical Specification for Regional Structure StabilityInvestigation of Hydropower & Water Conservancy Engineering, the regional structure isgood in stability.

According to (DL5073-2000) Specifications for Seismic Design of Hydroproject, theseismic intensity of the permanent water retaining structures of the Project is designed as 6degree.

3) Monitoring of the project during operation (by the proponent)

a) Monitoring Design Purpose

1) Conduct monitoring to each important structure and each key part to master the pattern change, to find out the abnormality timely and to take remedial measures to avoid accidents and ensure the project safety.

2) Check the correctness of the design proposal and the construction process to underlie the optimization of the design proposal, the improvement of the construction process and the determination of the design parameters.

3) Monitor and master the change tendency and stability process of the rock mass of the geotechnical works to make timely evaluation to its stability and safety degree

4) Provide measured data for feedback analysis and accumulate data for safety evaluation and scientific study of the project.

b)Monitoring System and Its Composition

Safety monitoring system of Paklay Hydropower Station mainly consists of various sensors, detecting units (monitoring-floor equipment) arranged at each observation station and equipment in the monitoring center. Main monitoring items include:

a) Deformation monitoring includes: horizontal displacement monitoring, vertical displacement and slope monitoring, dam body deflection monitoring, dam foundation deformation monitoring, structural and construction joints monitoring etc.

b) Seepage flow monitoring includes: foundation uplift pressure monitoring, seepage pressure monitoring, monitoring of seepage flow around the dam, overall leakage monitoring etc.

c) Stress-strain and temperature monitoring includes: concrete stress-strain monitoring, temperature monitoring of dam body and dam foundation, reinforcement stress monitoring, stress monitoring of prestressed anchor cable etc.

d) Slope monitoring includes: surface and internal horizontal displacement monitoring, surface and internal vertical displacement monitoring, underground water level monitoring, anchor stress monitoring, anchor cable stress monitoring etc.

e) Other monitoring includes: environmental variables, silting monitoring, seismic monitoring etc.

c) Safety Monitoring Design Principle

According to design characteristics of hydroproject structures of the Project and combining specific situations of the Project scale, structure level etc. 8 monitoring sections are provided for water retaining dam and powerhouse, 2 for ship lock sluice chamber, 1 for dam abutment slope on the right bank and 3 for dam abutment slope on the left bank.

Dam horizontal displacement and deflection monitoring: monitoring is carried out by adopting plummet + tension wire system, accompanied by artificial measurement (horizontal displacement monitoring network measurement).

Dam vertical displacement and slope monitoring: automatic monitoring technical scheme of hydrostatic leveling + bimetal bench mark is adopted, accompanied by artificial measurement (leveling).

Ship lock deformation monitoring: horizontal displacement monitoring is performed by adopting collimation line + direct and inverted plumb line system. The surface vertical displacement monitoring is performed by means of geometric leveling.

Slope deformation monitoring: fourteen and six horizontal displacement monitoring points are set respectively on the slope berms on the left and right banks. Horizontal displacement observation is performed by adopting the combined method of triangulation and trilateration, taking monitoring network as working standard; slope vertical displacement measuring point and intersection measuring point are arranged at the same level. Vertical displacement observation is performed by adopting third order leveling method or trigonometric leveling by electro-optical distance measurement combined with third order leveling method.

Stress-strain monitoring of dam concrete: strain gauge group and non-stress meter are provided inside the concrete at dam heel and dam toe.

Slope supporting structure monitoring: one monitoring section is provided respectively for each dam abutment slope on the left and right banks. Anchor stress monitoring and anchor cable stress monitoring etc. are included.

Temperature monitoring: some concrete thermometers have been provided according to monitoring requirements of ordinary concrete temperature field; one group of dam surface temperature measuring points have been arranged at one place on the overflow surface at spillway affected by sunshine. Three thermometers are arranged in the characteristics of temperature gradient change.

Joint surface and structural joint monitoring: an amount of joint meter has been provided at joint surface of concrete and bedrock at steeper part; joint meters have been provided in groups at expansion joints near monitoring sections.

Bedrock deformation monitoring: Bedrock displacement meter is arranged at dam heel and dam toe on determined horizontal monitoring section. One group of thermometers are provided on the pull rod (in the vertical borehole) of bedrock displacement meter so that temperature correction can be performed to bedrock displacement meter and temperature variation in dam foundation can be observed.

Prestressed pier monitoring: two intermediate piers and one abutment pier are selected for monitoring in order to perform monitoring on stressed state of prestressed pier. Monitoring items mainly include: tensioning control tonnage monitoring, prestress loss and stress variation monitoring.

Longitudinal and transverse joints monitoring during powerhouse construction: to provide relevant parameter data for joint grouting construction and to monitor the state and variation after joint grouting, an amount of joint meter, reinforcement meter and thermometer have been provided on and near those joints.

Uplift pressure monitoring: a piezometer tube is provided at each dam section along the dam longitudinal foundation gallery. Besides, one group of piezometer tubes (3 - 5 tubes for each group) are provided at different dam sections along horizontal foundation gallery, forming vertical and horizontal uplift pressure monitoring sections.

Seepage discharge monitoring: six sets of measuring weir plant are temporarily considered to be provided at inlet of drainage sump and where the flow is concentrated at each dam section.

Monitoring of seepage flow around the dam (underground water level): ten holes for seepage flow around the dam (underground water level) are respectively provided for dam abutments on the left and right banks for long-term monitoring of seepage flow around the dam.

A group of 6 surface thermometers are provided on concrete surfaces on upstream side of the A8-A8 monitoring section of the left non-overflow section to monitor reservoir water temperature.

Water level monitoring pipes are embedded at suitable part at upstream and downstream sides of concrete dam. A set of special water level automatic monitoring devices are provided.

Special small-scale meteorological station is provided at suitable part of dam abutment to monitor environment variables, such as temperature, precipitation, humidity.

Observation sections are arranged at suitable positions in front of the dam and at downstream to periodically or as required observe silting in front of the dam and downstream scouring and silting.

3.7 Climate Change

In a narrow sense, hydro-electricity itself produced by dams is considered climate friendly, as there are avoided emissions, compared to alternative sources of electricity such as coal and oils.

Climate change relates to dam development in two ways: dams contribute to climate change and are impacted by climate change. In general, the process of development causes land use change which can contribute to increased greenhouse gases that warm the earth; other activities causing change are mostly related to urbanization and agriculture. Dams can cause forest covers to decrease - thus, emitting greenhouse gases (GHGs), among which carbon dioxide is the major gas. But on the positive side, electricity produced by hydro sources replaces fossil fueled electricity, thus generating "avoided GHGs emissions".

The estimated emissions from construction and operation of PaklayHPP are necessary to arrive at the net emissions of **Greenhouse Gases (**GHGs), specifically that of carbon dioxide and methane. The *real* final emissions nevertheless depend on the management of forest clearing, necessary to increase the commercial value of to-be-submerged forests and to reduce methane emissions.

With estimated 50% of the biomass being carbon, the total carbon emissions can be estimated at 1,188.4 ton carbon dioxide. Being a one-time release, it is a very small amount of carbon dioxide to be released compared to the amount of avoided emissions calculated above. That is, this figure is small compared to the nearly 67 million ton carbon dioxide avoided. This calculation is done with a set of assumptions, but the results, though partial, are convincing enough to lend support to Paklay project. The avoided emissions modestly estimated are far out-weighting the emissions considered from biomass clearing activity alone. This positive result can also be enhanced with careful biomass clearing, already called for by the Laos government in its guideline.

3.8 Social Baseline Condition

3.8.1 Social Overview of the Study Area and LMB Countries

3.8.1.1 General Information

Four countries are located in the LMB: Lao PDR, Thailand, Cambodia, and Vietnam. All signed the Mekong Agreement in 1995 which is primarily concerned with sustainable development, water conservation, resource utilization and management, and transboundary related resources of the basin.

The LMB has an area of 622,585 km^2 and includes Lao PDR and Cambodia (about 90% each) while in Thailand and Vietnam the LMB covers about 26.6% and 21.0% of these countries respectively (Table 16). The population of the LMB has increased from 54.7 million in 2000 to 62.4 million in 2010 - an increase of 14%. In 2010, the riparian population who live within a 5 km corridor along either side of the Mekong was 24.5 million or approximately 39.3% of the total LMB population. The southern provinces of Vietnam and the flood plains of Cambodia together have around 21 million or 85.6% of the total 5 km corridor population (Table below).

Table 16: Information on Area of LMB, Country and 5 km Corridor

Name of Country	*Whole country area (km^2)*	*Area in the LMB (km^2)*	*% of area the n LMB*	*Study area in 5 km mainstream corridor (approx. km^2)*
Lao PDR	236,800	207,313	87.5	12,420
Thailand	513,115	187,932	36.6	4,160
Cambodia	181,035	158,851	87.7	10,010
Vietnam	325,490	68,489	21.0	6,180
TOTAL	***1,256,440***	***622,585***	***49.5***	***32,770***

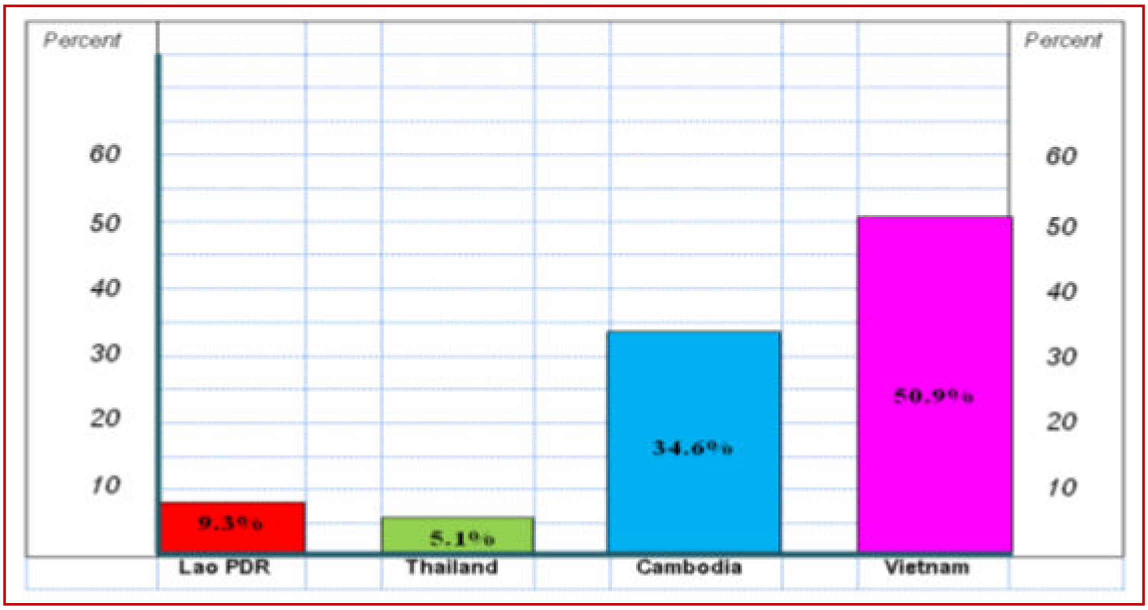
Source: prepared by the study team

Table 17: Population in Country, LMB and in the 5 km Corridor

Name of Country	*Whole country population (million persons)*	*Population within LMB (million persons)*		*2007 Population in 5 km mainstream corridor (persons)*	*2010 Population in 5 km mainstream corridor [Persons (%)]*
		2000	***2010***		
Lao PDR	6.5	4.9	5.5	2,135,497	2,284,982 (9.3%)
Thailand	67.0	23.1	23.7	1,192,212	1,251,823 (5.1%)
Cambodia	13.4	9.8	13.8	8,092,245	8,466,107 (34.6%)
Vietnam	90.0	16.9	19.4	12,079,681	12,487,310 (50.9%)
TOTAL	***176.9***	***54.7***	***62.4***	***23,499,636***	***24,490,222 (100.0%)***

Source: prepared by the study team

Out of the total of about 24.5 million people residing in the 5 km corridor, Figure 90 shows that 9.3% (2.3 million) are Lao, 5.1% (1.3 million) are Thai, 34.6% (8.4) are Cambodian and 50.9% (12.5 million) are Vietnamese. The largest density is in the Delta provinces.



Source: prepared by the study team

Figure 90: People Living in the 5 km Corridor on the Mekong River

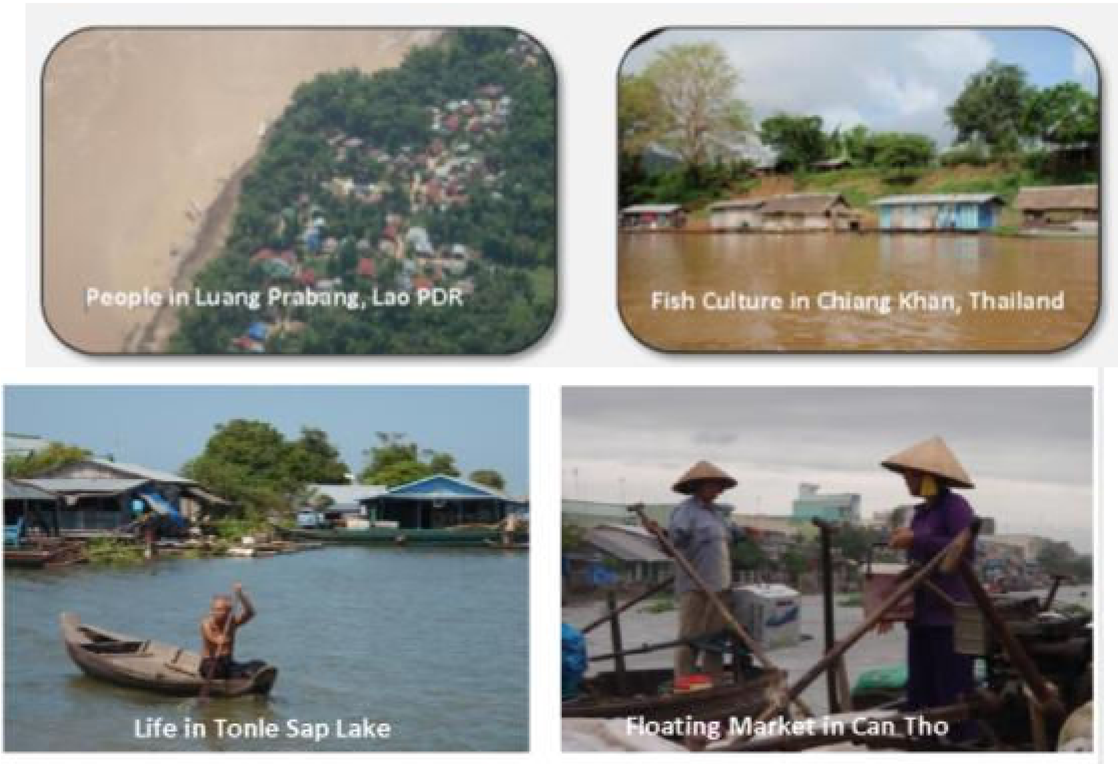


Figure 91: Photos of People Living in the 5 km Corridor on the Mekong River

In general, the LMB countries are considered diverse in terms of language, culture, economy and political administration. Compared to the rapid industrialization and economic growth found in Thailand and Vietnam, Lao PDR and Cambodia have experienced slower economic or GDPgrowth; this is due to a smaller population and generally more marginal socio-economic development.

Lao PDR:the Lao PDR is a landlocked country with 5.5 million people living in the LMB (2.3 million are living within a 5 km corridor along the Mekong River). Agriculture, mostly subsistence rice farming, dominates the economy, employing an estimated 75% of the population and producing 29% of GDP. Domestic savings are low, forcing the Lao PDR to rely heavily on foreign assistance and concessional loans as investment sources for economic development.

Thailand: this country has more advanced development compared to other LMB riparian countries despite the severe economic crisis in 1997. Thailand has successful health care policies such as family planning and low cost health care for people; this can be seen in the rising life expectancy of its people. With regards to education the latest constitution mandates at least 12 years of free education (9 years are compulsory) and the year 2010 started with provision of 15 years of free education. However, the political conflicts between the “Red Shirt” and “Yellow Shirt” factions and the severe floods in 56 provinces (2010/2011) were wide spread and intense; this has slowed down the country’s socio-economic development.
Cambodia: for Cambodia, from 2001-2010, the economy expanded by, on average, 8% per year, with the garment sector and the tourism industry driving the growth, and inflation remaining relatively low. The onset of the global recession led to a 0.1% contraction in 2009, but growth resumed in 2010 at 5.95%. The economy is heavily dollarized; the dollar and riel can be used interchangeably. Cambodia remains heavily reliant on foreign assistance with about half of the central government’s budget depending on it.

Vietnam: rapid economic development has been seen in Vietnam since it started employing a market oriented economy approach. Now Vietnam is a net exporter of agricultural products which includes mainly rice but also coffee (robusta), pepper (spice), cashews, tea, rubber, wood products, and fisheries products.More industrialized efforts can also be found in Vietnam and its industrial production has grown and contributed 41% of GDP in 2010.

Individual country profiles of Lao PDR, Thailand, Cambodia, and Vietnam are presented the following Sections respectively.

3.8.1.2 Problems Related to Transboundary Resources

For transboudary resources, many concerns have been raised about the environmental problems in the LMB. These include:

- The increase in population from 54.7 million to 62.4 million,a 14% increase.
- Environmental degradation such as less forest in the Mekong watershed.
- Less fish from overfishing and using electric shock/illegal fishing gears.
- Bank erosion on both banks of the Mekong River.
- Water quality changes from direct discharge of solid and liquid waste especially in area near big riparian cities/towns.
- Increasing transboundary impacts from a variety of development projects.

3.8.2 Social Condition in Zone 1

3.8.2.1 Population, Ethnicity and Culture

Population:

From Pak Tha (KM 2281) to Pak Heuang (KM 1736), the Mekong River runs through northern and central parts of Lao PDR provinces and there are five mainstream hydropower projects currently in the planning stage. These projects can be listed in Table below:

Table 18: Mekong Mainstream Hydropower Project in Zone 1

Project	*Distance to estuary (km)*	*Operating level (masl)*	*Installed capacity (MW)*	*Annual power generation (GWh/yr)*
1. Paklay	2,189	340	855	4,846
2. Luangprabang	2,036	310	1,122	5,321
3. Xayaburi	1,930	275	1,341	6,160
4. Paklay	1,818	245	1,282	6,255
5. Sanakham	1,737	220	660	3,696

The Mekong River in this zone is situated within five provinces of the Lao PDR, namely, Bokeo, Oudomxay, Xayaboury, Luang Prabang and Vientiane. All right bank communities belong to six districts of Xayaboury Province. On the left bank, the Mekong passes through a district of Bokeo, three districts of Oudomxay, three districts of Luang Prabang, and two districts of Vientiane. The total population living in the 5 km corridor along the Mekong River is estimated at approximately 183,000 households with a population of 900,000 (Table 19).

Table 19: Population in the 5 km Corridor of Zone 1

<table>
<tr><th>Zone</th><th>Provinces</th><th>Districts</th><th>No. of Population</th></tr>
<tr><td rowspan="2">Zone 1</td><td>Left bank
1) Bokeo
2) Oudomxay
3) Luang Prabang
4) Vientiane</td><td>9 Districts
• Paktha
• Paklay, Hoon,Nga
• Pak Ou, Luangprabang, Nan
• Met, Sanakham</td><td rowspan="2">Total Households:
182,798
Total Population:
913,990</td></tr>
<tr><td>Right Bank
1) Xayaboury</td><td>6 Districts
• Khop, Ngeun, Hongsa, Xayaboury, Paklay, Kenthao</td></tr>
</table>

Source: prepared by the study team

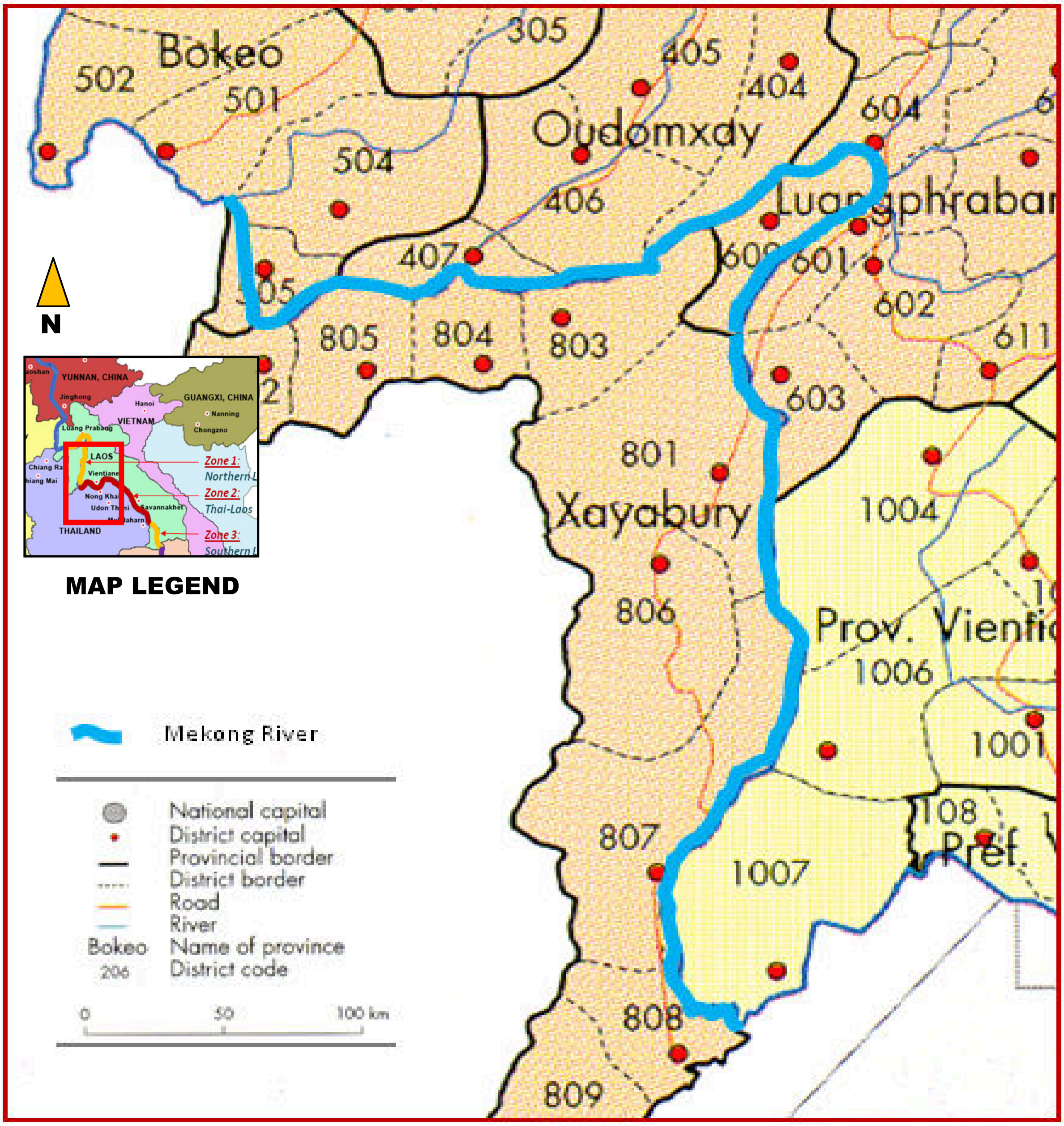


Figure 92: Zone 1 Pak Tha (KM 2281) to Pak Heung (KM 1736)]

Ethnicity and Culture:

The ethnicity and culture of Zone 1 is a mix of culturescomprised of the 4 main language groups: namely, Tai-Lao, Mon Khmer, Sino-Tibetan and Hmong-Ewmien.In zone 1 the Lao ethinicity of the Tai-Lao group are the majority estimated at 70% of total population while the Khmu of the Mon Khmer group and the Hmong of Hmong-Ewmien group comprise around 20% and 10% respectively.

- <u>**Lao Ethnicity**</u>

Characteristic of Lao ethnicity - Introduction

The Lao typically live in the lowlands of Laos along the Mekong River Valley, which makes up about 30% of the land of the country. The lowlands are great for rice paddy farming, which is what the vast majority of the culture does for a living. Wet or sticky rice is a center of the culture, and main source of food. It is prepared steamed and eaten as a hand food. Usually it is accompanied with a vegetable, meat, or soup to be dipped in. Because Lao people have a farming culture, food production is self-sufficient. The construction of Lao homes reflects the focus of rice farming. The homes are built up on wooden posts that raise the house up by about two meters in case of flooding from the rice paddies. The homes use the extra height as a cooling technique as well because it allows a better breeze than it would if it was on the ground. The area under the house is also used to keep livestock. Another feature of a typical home is a rice granary, a storage place for the rice. It is built on posts, like the rest of the house. The dimensions of a typical house are eight by twelve meters. Most homes have a porch on the longer side of the house. This is where the family primarily visits with guests. Inside the houses, floor mats are used as bedding, and a bamboo table is used for eating meals.

The family in each household usually consists of a married couple, and their unmarried children. Occasionally a husband and wife and their children will live with the one of their parents. Once a couple gets married they move to the home village of the bride. People of the town help build frames of a new home, and then the groom usually takes over from there. It will take a few weeks for the house to be finished. Polygamy was practiced at one time but is rarely practiced anymore. Either husband or wife initiates divorce. The families will get involved, and even elderly villagers will be involved before a divorce will occur. Chores around the home are secluded to gender. Usually women cook, clean, and care for the young. Women are primary buyers and sellers of smaller goods in nearby markets. Men will usually take care of the buying and selling of cattle, pigs and machines.

The main religion of Laos is Buddhism. 60% of the people of Laos are practicing Buddhists. Religion plays a big role in their culture. Usually most villages have three or four monks. Every village has a Buddhist temple, typically called a “Wat”. Because a village’s “Wat” is typically the only structure large enough to hold the entire village, town meetings are held in them as well. The “Wats” are typically the center of action in villages. Religious festivals (“Bouns”) are held in them as well. Often the Lao also believe in spirits called phi. They celebrate yearly for the phi ban, a village deity. These celebrations were in order to ensure good fortune in the upcoming year, and to show the importance of their village as its own social unit. Animal sacrifice practices did not stop until the early 90’s in these ceremonies.

Before 1975 the Lao villagers were led by village chiefs called either “pho ban or nai ban”. Now the leaders are called village presidents or “Pathan Ban”. They are elected by the popular vote of the Lao villages. The village presidents don’t have much say in what is done in each village because many of the things that are decided within each village is done at a town meeting by the villagers. The president will make a decision if the town people don’t come to a total agreement on an issue the village president will delay the discussion until a later date.

- **The National Flower**

The Frangipani is the emblem flower of Laos. It is said that this small tree is immortal as even un-rooted, it continues to produce flowers and leaves. The flower is commonly used during traditional ceremonies. The frangipani blooms most abundantly before the rainy season but it generally also does so all year long. It's flowers have a strong and very pleasant perfume. This tree normally is planted near the temples.It enters in the composition of many recipes of traditional Lao medicine. At a very early age, the Laotians learn the song "Dok Champa" in nursery schools as this song speaks about the beauty and the extraordinary perfume of this flower.

- **The Traditional Musical Instrument**

The Khene is the traditional musical instrument of Laos. It's in the family of the piped/flute instruments. It is a kind of mouth organ going back to the Bronze Age. It is made of two parallel lines of bamboo. A true cultural symbol, the khene is played on many occasions. It draws its name from the particular species of bamboo (in the Lao `May Khene') from which it is manufactured. It is made of sonorous tubes in bamboo, with, in the inside, some small strips of metal acting as free reeds. The bamboo are assembled in pairs of identical length in an order of decreasing magnitude, in the center they are connected with the help of hollow wooden piece in which the air is insufflated. The Khene is used in traditional music as well as in modern music. It is played solo, with an orchestra or, in its most traditional form, as an accompaniment for improvising singers, the Molan (the player of the Khene is called Mokhene). A type of performance is called the "Lam" which is an improvised song of feelingssuch as joy or the torments of love.

- **The Baci**

Baci" or "Soukhouan" is a ceremony which aimsto recall of the souls. Some Animists think that the body is composed of 32 parts having each one a soul. These souls can escape, be stolen or quite simply be lost with changes such as a disease, a strong emotion or sadness.The purpose of the ceremony of the Baci is thus to bring back these souls to our body. It is a traditional rite which one finds in all to life's stages including marriage, welcome ceremonies, birth of a child, visit of an important person or construction of new house. One invites the family, the friends and the neighbors. It is generally officiated by a monk having left the order. The ceremony starts with the call to the souls, then come the wishes and to conclude, the attachment of cotton cords to the wrists of the guests, used to imprison the wandering souls.

These cords must be kept on at least 3 days. The Baci is held around a "Phakouan", a tray made up in its center with leaves of a banana tree on which are pricked flowers. Then all around are laid out rice, Lao Lao (traditional Lao alcohol) and sweets. They will be used as a meal for the souls and encouragement the souls to return.

<u>**Hmong**</u>

- **Kinship and Marriage System**

The Hmong Khao in Zone 1 within the Luang Prabang Province follow the clan (*Xeem*) system of lineage, which is traced and followed through patrilineal or the male line and the children belong to the same clan as their father. The clan is strictly exogamous; this system prohibits marriage between members of the same lineage. Marriage must be with members of another clan. The exogamous rule is followed with remarkable rigor, and it even pertains to preor extra marital sexual relations. However a person's primary loyalty is always towards other members of his own clan, irrespective of village or region of residence.

The solidarity of the Hmong is expected from clans men and presence of actual genealogical relatives, called "Chao Kok Chao Laao" in Lao language. These are the people who directly traced escent from the common ancestor and represent the characteristics of alarge extended family, of which the ancestor may still bealive. Because of the migratory way of life of the Hmong, genealogical is alineage seldom goes back more than three generations. A man will turn to relatives for economic help, practical assistance and consolation, if a man wishes to move his household to another location, he will almost in variably have relatives there, and they should be prepared to sponsor his entry into the new location by giving him land, loans of rice or money, and helping him build his house.

Because of the importance and prestige attached to marriages in unilineal societies like that of the Hmong, there is a tendency for the bride price to increase gradually. The rules and their under lying principles are a good illustration of the function of the bride price in a patrilineal society. The bride price is compensation for the productive and reproductive capacity and potential of a woman. Her labor and fertility are paid for by the household acquiring these assets to the household that relinquishes them.

Divorce is rare among the Hmong. If a wife misbehaves badly, becoming addicted to opium and working poorly or not at all, or committing adultery, the man has the right to divorce and insist on the return of the bride price. A woman can leave her husband at any time. If she can show before a court composed of village leaders and members of both clans involved in the marriage, evidence of cruelty without reasonable cause, no bride price is repaid and divorce is immediate. She would return to her original clan. Custody of children in divorce or separation normally goes to the man. In exceptional circumstances, however, they can go to the innocent party. Divorced women able to prove their innocence usually have no trouble finding another husband. Indeed, any children she might bring with her into the new husband's family, plus the reduced bride price likely to be required, sometimes adds to her attractiveness.

- **Housing**

Houses of Hmong can vary greatly in size, depending on composition and wealth. A house can be enlarged as a family grows in number; more usual, however, is for news leeping chambers to be made within the existing structure and to leave house size adjustment until a new house is essential. The house is not raised on poles but built on the ground, the floor being simply leveled, packed earth. The roofis supported by a number of pillars, as manya s fifteen for a large house, one of which is the central house post, the abode of one of the most important spirits of the house. The walls are usually made of split bamboo, but occasionally of timber. The roof is that ched with woven mats of large leaves, but sometimes with split bamboo or wooden slats.

The inside layout of the house shows individual variations, but common features are the altar or altars on the wall opposite the main door, a cooking hearth in the middle of the main room, one or more walled bedroom for the married couple of the household, one or more open sleeping plat forms along the walls for visitors, and a ceremonial hearth to one side of the altars. This heart his constructed of dried mud and its foundation is alarge iron pot. The space under the roof serves as a storage loft, and over the cooking fire ears of maize and chunks of meat are hung to dry. In some houses the granaries are built along one of the gable walls, while others have erected separate rice barns close to the house. The selection of a site to build a house is determined both by practical and geomantic considerations. Proximity to the fields, sources of water, and to kins men and other neighbors are taken into consideration.

When a site has been selected a divination ceremony is performed. One method of divination is to dig a small hole in the place of the proposed central house post and erect a small pyramid of uncooked rice in the hole. The pyramid is covered overnight, an difitremains in tact the next morning, the site is approved by the spirits. Another method is to cut a fresh stick of wood, measure its length and drive it into the ground in the place of central post. If the stick has grown longer overnight, the proposed site is accepted.

- **Clothing styles**

  The traditional clothes are still made by women and largely worn by all. Hmong Khao's women may wear e laborate silver ornaments, trousers and a blue or white apron infront and behind not a skirt like the Hmong Lay. Some women as similated to the Hmong Lay wear trousers but with a vest with ornate green or fabric arm rings. For dairy work, trousers tend to be more popular among women than skirts.

- **Religious Practice and Traditional Cultural Beliefs**

  The Hmong Universe is in habited by alarge number of different spirits. Hmong people believe in animistic spirits. The most important categories of spirits are those presiding over the household, the spirits of medicines,the spirits of nature, and the shamanistic spirit. The household spirits include a number of highly specialized spirits and these spirits are worshipped by members of the household according to customs of the clan. The most important spirit of the house is that which ensures the wealth of the household and the safety of its members, and whose altar, is placed on a small shelf in the wall opposite the main door. The altarc onsists of a rectangular sheet of paper painted with gold. Major traditional festival of the Hmong people are the Boon KinChiang or Hmong New Year Festival which is celebrated after the crop harvest, mainly on the fifteenth day of the first month of every year. This is a time of great celebration and feasting. This is also an important time for courting between young people. At New Year, a chicken or a pig is sacrificed to this spirit and blood is daubed on the altar. Before entering the house, the visitor must first ask permission. If he or she enters directly without permission, the household spirit may be offended and cause illness in the household.

The Hmong also believe that the ancestral spirits of the male line of the family live inside the pillars of the house. This is another reason why care must be taken when entering another personal house.

The spirits of medicines are called upon for assistance by a person who has learnt to perform magic and employ herbal medicines to exorcize the spirit causing illness. Such a person may be a man who performs magical acts to drive away the spirits, such as blowing water or swinging knives over the sick personor it may be a woman who attempts to cure by means of herbal medicines, very often in combination with massage.

The spirits of nature live in wild and uncultivated land spots.They are not inherently malicious, but they are likely to attack if disturbed, and they constantly look for wandering human souls to capture. Every human being possesses a number of souls. Some of these souls may wanderduring sleep and sometimes they get lost. As a result, the person gets sick. The ritual "huplig" is performed to bring back wandering souls. It is often performed for a sick person and for a new born baby on third day after birth to transform the new born into a proper human being. It is also always performed for a new bride on the third day after marriage for securing the fragile soul of the new bride and for connecting them to the spirits of her husband's clan and household.

Shamanism is an existing aspect of the socio-medico-religious life of the Hmong. In case of the illness, the services of shaman may have to be called upon. A person becomes a shaman by the bidding of the shamanic spirits "Dab Neeb". The ir wish is usually conveyed to the shaman by means of an illness with fever and hallucinations, and when the person recover she enters atrance with the ability to cure other people with the help of DabNeeb. The equipment of the shaman included an altar for the "Dab Neeb", apaper-covered shelf on the wall, a bronze gong, a pair of finger bells and a metal ring with bells, a blackhood to cover the face and a bench to ride on the journey to the spirits. Shamans are generally male, but there are also female shamans.

Khmu

- **Introduction**

In the 5-km corridor of Zone 1, the Khmu system is a well marked matrilineal system. Exogamicpatrilineages have emblematic names but their significance is losing ground. The habitat is patrilocal and the household is generally composed of the restricted family.

The basic economic unit is composed of the restricted family.The budget is held by the manor woman depending on the family.When several families share the same house, only paddy production and housekeeping activities are undertaken together. The family's diversified activities of ten constitute the only chance of economic success among the shifting cultivators, ensuring the family's food and material self-sufficiency. The rest of essential requirements such as clothes, shoes, plates, matches, oil lamp, lamp petroleum, torches, batteries, salt and nails do not require a substantial budget.

- **Kinship and Marriage System**

The Khmu live in nuclear families.Traditionally, marriagewas arranged by the parents. At present, the young can bring their own views. Monogamy is the pre dominant form of marriage today, but polygamy was common among the wealthier Khmu men. The customary exogamouspatrilineal relationship is losing ground. Residence is not clearly differentiated, but generally the man works in the wife's family for 1 to 3 years before moving to an ewhouse or to his own parent's house. Courtship between the Khmu is relatively free. Negotiations between parents about the bride price often begin when the girl is pregnant. Premarital relationships are traditionally forbidden. However, a boy caught red handed must pay a fine to the girl's parent. The pre parathions are discussed and formerly 3 to 5 buffaloes are given to the girls' parents. The wedding meal is organized and financed by the boy's parents, and must include a large pig "of 5 fists" and a jar of rice wine. The bride prices are presented to the girl's parents before the meals tarts. On the following day, another meal is organized at the house of girl's parents. The bride price presented the day before, as well as a piece of Pakhom textile for each of the girl's female cousins are offered by the boy's family. The girl then takes a package prepared by her mother and moves to her parent-in-law's house. On the following day, to clean the *Bluesaly* (Pastsins), the young couple goes to the river with a fish net, the husban with a knife, and a basket. In the case of marriage against the girl's will, the ceremony is different and relates more to kidnapping. Kidnapping is authorized and negotiated before hand between both families, but the ceremonies are not very courteous. Divorce is not authorized formally. However if the first wife is sterile, she is charged to find a second wife for her husband. Both wives then live in the same house.

- **Housing**

The Khmu prefers to build their houses on low wooden stilts, about 1to1.5 meters above the ground. A poor family contents itself with a bamboo mat walled house with no windows and a roof made of that chor bambootiles.Wood is only for used for the piles, the cross beams and the main floor and roof frames. A short bamboo ladder leads to a small porch or directly to the entrance door. A single public living room is accessible through an entry stair and is not separated from the bed rooms.The sleeping mats are rolled up in the day time. The kitchen and fire place is usually separated from the public livingroom, although frequently it may be in one of the room.In that case, the fire place and kitchen ware are in the main livingroom which has a bamboo shelf over the fire to dry the food. Firewood, tools, basket work ,rice pounder, tiles and construction wood are placed between the piles of the house, while the rafters provide a storage area for baskets of dried food, seed rice and valuables; thea nimal pens may also beerected under, or beside the house. The buffaloes are sometimes kept under the house during the land preparation period between May and June.

Visitors to the house will be allowed to stay in the outer room. During day time, a taboo states that raw meat can not be carried into the house without wrapping it first. Khmu people celebrate the building and renovation of their homes during festivals or smaller ceremonies featuring local rice wine.

The Quality and size of the Khmu house depends on the wealth of the family. For poor families, small bamboo houses are built on small and poorly work piles.Disadvantaged families, widows without children, divorced opium addicts, elders and orphans, live in small huts built at ground level. The floor and walls are made of bamboo and the roof of thatch. There is generally a single room and the fire place is situate din the middle, a little to the back.The number of traps, nets, snaresforrodents, frog baskets and crustacean net shanging at the entry of the house are indicators of these families' standard of living.

Currently, many ethnic people with sufficient income may build their house with more stable construction materials and adopt the house style to the mainstream culture, but they still keep the traditional interior layout.

- **Clothing styles**

The Khmu have never had more than very limited weaving skills and buy most of their cloths from Phouan and Lao in their vicinity. The festive ress of Khmu woman includes along- sleeved dark vest open the front, often with redhems,a dark based sarong with many colored strings or motifs and akerchief. On ordinary days, Khmu women wear Lao-styled sarong and ordinary blouses, preferably with amultitude of bright colors.The older women weara heads carf, the younger women weartheir hair bound up in abunand leave it uncovered. They decorate themselves with silver and copper bracelets.Tattoos of geometric figures can be found on the arms and legs of older Khmu women especially among the Nguan subgroup. Traditionally, Khmu men wear trousersor loincloths and longsleeved jackets, which are embroidered along the hems and fastened atoneside of the neck. Today, the Khmu buy cheap, factory-made garments in the Local markets.

- **Religious Practice and Traditional Cultural Beliefs**

Traditional Khmou belief centers in various inanimate and animate spirits, similar to most Mon-Khmer indigenous people. The practice of sorcery by certain families and the presence of media having trances are particular to Khmu. The Khmu believe in several protecting spirits,which should be respected. Any fault committed against them should be excused through a ceremony or ritual. The guilty person is subject to reprisals that are some times targeted against his family oragains this village. Spirit gates are erected over the entrances of the villages. A special house is built to makes a crifices to the honor of these spirits. However, the spirits have to be satisfied with chicken, rice, whiskey and occasionally a pig.The Khmu practice a form of ancestor worship. Every village has a shaman and several sorcerers. The sorcerers are considered as excellent religious practitioners: boths exesareable to fulfill this role. They can describe which spirit is causing the illness or calamity and prescribe the necessary sacrifices. The Khmu follow the agrarian cycle and practice several ceremonies for a good harvest. The Khmu main spirits “Rroi”are:

The house spirit “Rroi gang” is the most important. It is not the most feared, but it possesses a spiritual value which naturally commands veneration. Its presence was symbolized by an altar fixed to the pole of the house, but most often by two small amulets or charms. The charms, made of packed yeast in banana leaf, were hung above the fireplace, respectively representing the spirits of the man and woman. They still exist in some isolated villages. The evil spirit “Rroi poop” is guided by a malevolent person, who may possess the body of its victims. The victim must often pass through a session of exorcism practiced by an experienced practitioner with power superior than the malevolent person. It is thought that the persons with magic power are able to change objects into crabs and leeches to eat the victims, who have been rendered ill beforehand. The victims often act irrationally as their unconscious behavior is dictated by the evil spirit. The “Rroi pong” or “Rroi suu”, like the Rroi poop is feared as it is able to possess persons. Often symbolized by a large bat, it appears only at night spitting fire from its mouth. Once such a spirit takes possession of a body, that person will spit fire. A person is recognized as being possessed by this spirit when he or she goes out at night to feed themselves with frog and chicken excrements.

The Kade Poliyeul specialist hangs a cloth belonging to the patient or to a member of his family above a bowl of paddy rice. Then he asks the house spirit whether it is involved. If the cloth moves, it is really him. Otherwise, the question is made to another spirit until it is identified. The Kade Khatong is the most popular spirit specialist. He identifies the spirit from the impurities and visible signs in the yolk of a broken egg. He is also equipped with candles, a bunch of rags, a bracelet and flowers.

The Kade Khaal chooses a wood branch that he cut into ten pieces, corresponding to the ten series of khmu days. The practitioner chooses a spirit and counts the pieces again. If the same number is found, the spirit is identified, otherwise, he starts again which another spirit who is suspected. Once the spirit is identified, the practitioner must define which animal is required by the spirit and also the site of sacrificial ceremony and prayers. For the water spirit, it will be at the river or the source, for the termite mound spirit, it will be on a termite mound, etc. The Table 4-9 below shows the percentage of different beliefs of the population of the interviewed households in the project area.

- **Language and Present Language Usage:**

  Lao PDR not only has a rich diversity of ethnic groups but languages from four major linguistic families are spoken in the country, each being represented by a number of languages and dialects. Approximately, 35-40% of the present population speaks Tai Lao or Lao, the national language, as a first language. Most do not have knowledge of other languages but some may have a passing knowledge of other TaiLao dialects. The Lao language is the only one that is expanding interms of use as the “first language”as more parents teach their children Lao and more indigenous people change from being bilingual to being primarily Lao-speakers.

- **Cultural Heritage:**

  Declared by UNESCO, Luang Prabang is the only official cultural heritage site. Luang Prabang is an outstanding example of the fusion of traditional architecture and Lao urban structures with those built by the European colonial authorities in the 19th and 20th centuries. Its unique, remarkably well-preserved townscape illustrates a key stage in the blending of these two distinct cultural traditions. The town is situated on a peninsula formed by the Mekong River and its tributaries in a clay basin surrounded by limestone hills that dominate the landscape. According to legend, the Buddha smiled when he rested here for a day during his travels, prophesying that it would one day be the site of a rich and powerful capital city.

  Another legend attributes the choice of the site to two hermits, attracted by its natural beauty, who gave it the name of Xieng Thong.

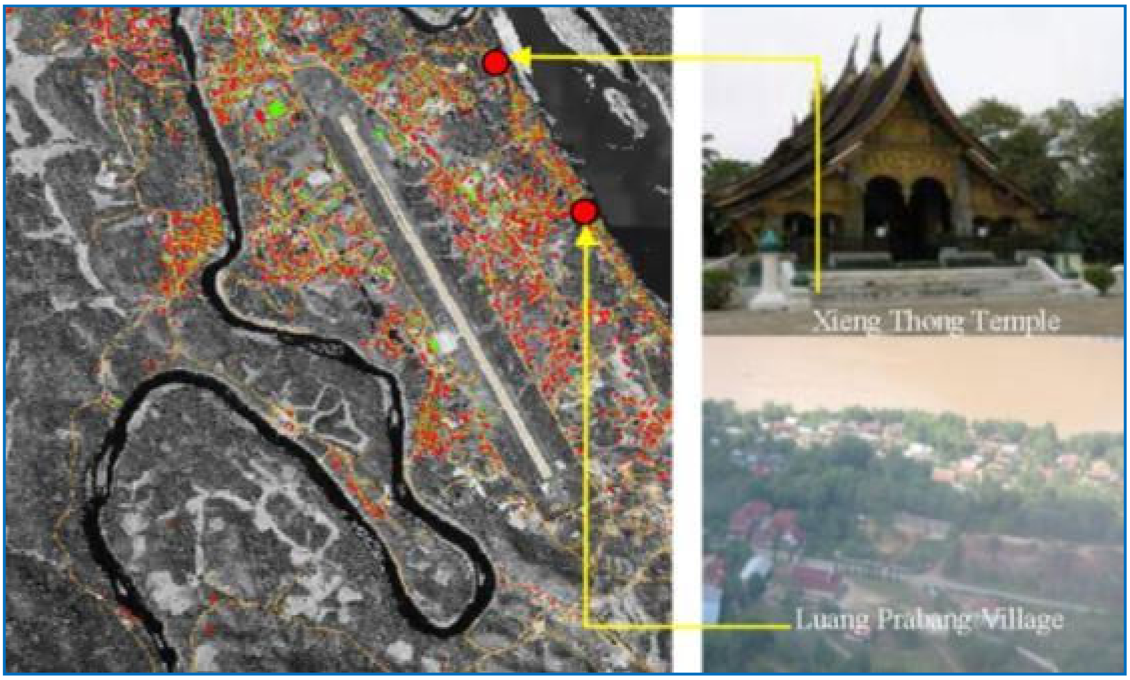


Figure 93: Luang Prabang Village and Xieng Thong Temple

It was known under this name at the end of the 13th century AD. A few decades later it became the capital of the powerful kingdom of Lang Xang, whose wealth and influence can be attributed to the location of its capital at a crossroads on the Silk Route, as well as the centre of Buddhism in the region. It remained the capital until 1560, when this title passed to Vientiane. It was at this time that it received a new name, Luang Prabang, the name of the famous Buddha image brought earlier from Cambodia.

The towns in Laos conformed to the European urban of defended royal administrative complexes with adjacent temples and monasteries. Around them clustered a number of distinct village communities, supplying their needs but not integrated into a single administrative entity. The villages acted as commercial center, not the town as such, which did not have the large mercantile communities to be found at the time in Thailand or Cambodia.

On the death of King Sourigna Vongsa at the end of the 17th century a serious political crisis ensued. The Lan Xang kingdom was divided first into two independent realms, those of Vientiane and Luang Prabang, and then into three, with the creation of the kingdom of Champassak. Luang Prabang retained its role as the royal capital until 1946, when Vientiane took over as administrative center.

The political and religious centre of the town is the peninsula, with its royal and noble residences and religious foundations. This is defined by a defensive wall built from one river bank to the other, sealing off the peninsula at its base. The majority of the buildings are, following traditions, built from wood (part of the temples are in stone). The colonial element of the town is characterized by one- or two-storey terraced houses built from brick: they often have balconies and other decorative features in wood.

The commercial buildings are grouped along the Mekong, interspersed with private houses. The temples and royal residences line one side of Avenue Pavie, which runs the length of the peninsula, the other side being occupied by traditional and colonial houses. The administrative buildings are for the most part at the crossroads with Rue Gernier. The monasteries generally consist of: the cult buildings (shrine, chapel, library, stupa, stone post), ancillary buildings and buildings for inhabitants or visitors (monastic communal buildings, cells, refectory, etc.). Most are simple shrines with three aisles and a single porch. Their interior furnishings comprise a pedestal or throne for the main Buddha image, a pulpit, a terrace and a lamp. Most are elaborately decorated with carved motifs but the wall paintings are relatively simple. The Luang Prabang chapels are simple structures for housing images; they may be open or walled.

The traditional Lao wooden houses are basically divided into spaces: the private rooms and the public terraces. They are usually raised on wooden piles, giving a space beneath for working and for shelter for both men and animals. Walling may be of planks or plaited bamboo on a wooden frame. A developed form of this house makes use of brick, following the French introduction of this material, but conserving the general layout and appearance of the traditional house. Finally there are the administrative buildings, which more or less successfully blend traditional elements with European materials, techniques and uses.

3.8.2.2 Socio-Economic Livelihood

Bokeo Province:

The Provincial Government of Bokeo faces many challenges in meeting poverty alleviation targets and is working overtime to improve the living standards of the 6,480 households in the province classified as poor. Approximately 3 to 10 billion kip from the central government has beenused for repairing irrigation systems, installation of artesian wells, and the construction of medical dispensaries and schools in remote villages.

The province is home to 188 villages and many are located in remote areas that are difficult for officials to access in order to develop infrastructure and improve services. Out of 188 villages, 91 are classified as poor.

Provincial officials are focusing particularly on improving the living standards of people in Meung and Pha-oudom districts which are on the government's list of the 47 poorest districts nationwide. Work is in process to develop infrastructure in these districts, including roads, dispensaries, clean water supply systems and more schools.

The interviews with senior public administrators revealed that the living standards of people in the province have improved over the years because of improvements to infrastructure, and 67 percent of villages now have access to electricity. Roads access to all villages is also a priority because it will make it easier for people to transport their produce to sell at nearby markets, therefore encouraging farming families to boost crop yields.

Most remote villagers in Bokeo province are farmers and many still use traditional techniques to cultivate their crops. This has resulted in lower yields, so officials are promoting the use of modern farming methods to boost productivity. People in Bokeo province are planting a variety crops both for sale and family consumption, including rice and sweetcorn, as well as breeding poultry, goats and cattle.

Per capita average annual income in the province now stands at more than 8 million kip.The province will not reach the government's target of alleviating basic poverty this year, although the number of poor families continues to decrease.

Provincial officials need more funds and assistance from the government and international organizations to achieve poverty alleviation targets by 2015. It is estimated that only 40 percent of the province's population will be classified as poor by 2015, and that all poverty will be eradicated by 2020.

Oudomxay Province:

Development in Oudomxay Province is obstructed by poor infrastructure. More funding is required from the government, international organizations and the private sector if the provincial government is to achieve basic poverty alleviation by 2015. The province is striving to reach poverty alleviation targets as fast as possible, while the government is trying to develop the country and improve the quality of life for all people to leave the list of Least Developed Countries (LDCs) by 2020.

According to a report from the Poverty Reduction Fund, in 2008-09 the living conditions of many Lao people improved and the number of poor people dropped to 26.7 percent of the total population. More than 80 percent of the people, families, villages and districts categorized as poor are located in remote areas. The challenge of this is the poverty alleviation targets and improving the living standards of the 14,445 families classified as poor.

The province is mountainous and considered difficult to access remote villages, so infrastructure development is a top priority in the efforts to improve villagers' living conditions. These include provision of sealed roads, electricity, water, more schools and improved health care facilities.

By 2010 average annual per capita income had reached more than 5 million kip. Seven districts, Namor, Nga, Beng, Houn and Paklay, are on the list of the 47 poorest districts nationwide as listed by the government.

Xayaboury Province:

The Xayaboury Province comprises 10 districts, of which Xayaboury and Xienghone are on the government's list of 47 poorest districts nationwide. Locals have been farming for many centuries and district officials believe combining local knowledge with modern farming techniques is the key to poverty reduction.

Although the number of poor families is steadily declining year by year the district cannot achieve basic poverty alleviation this year because some people still live in poor conditions and are waiting for assistance. However, district officials are confident they will be able to declare basic poverty reduction by 2012.

The district has more 3,000 hectares of rice fields and 2,600 hectares of Job's tears which are expected to increase in the future as villagers boost production for sale. Villagers compete to grow Job's tears to sell to a Chinese-owned factory in the district.

A Chinese company also has a concession of about 4,500 hectares to grow rubber trees, which provides local people with employment. It is believed that infrastructure development and teaching new farming methods to poor families helped them to expand their farming and animal husbandry activities, and are important factors in improving their living standards.

But the provincial government has difficulty getting farmers to move away from using old fashioned techniques that result in low yields, though they continue to educate locals about improved agricultural practices. The district has only two markets so the provincial government has set up eight groups who go directly to villages to buy surplus crops so villagers can be sure to sell all of their produce.

It is found that some 6,036 families living in the district, 1,328 are still living below the poverty line, he added. All villages in the district can be accessed by road but only 30 percent can be accessed all year round. District officials are hoping eight remote villages will be connected to the electricity grid this year. So far 27 villages in the district are hooked up and all villages are slated to have electricity by 2013.

The average annual income in the province now stands at more than 5 million kip, and is expected to rise in the near future. The government's Poverty Reduction Fund has so far invested 500 million kip in improvements to basic infrastructure.

Luang Prabang Province:

Recently, provincial GDP has had a high annual growth of 9.4% totaling 3,000 billion kip with an average per capita income of US $ 821. In the next five years provincial socio-economic development plan (2011-2015), Luang Prabang will focus on how to improve the living standards of all people and help the nation achieve the UN's Millennium Development Goals by 2015. This requires local authorities to continue disseminating the resolution of the 9th Party Congress.

Concerned authorities must ensure all children, including those from poor families, have access to education, as well as boost public health, socio-culture and welfare activities, especially in relation to Order No 03 of the Political Bureau of the Party Central Committee on building villages to be development units and building big villages to be urban centers in rural areas.

The national defense and public security are also required to be strengthened, while improved attempts are to be made in building up cooperation and relationships with foreign countries in both the region and the world. Some advice will be made for local people to focus on growing more commercial crops and raising animals for sale and family consumption. As Luang Prabang is a cultural world heritage tourist destination, the local authorities expect to draw 500,000 tourists to the region by 2015 by implementing its 5-year provincial socio-economic development plan.

Vientiane Province:

The Vientiane Province's fourth five-year development plan (2011-2015) focused on the development of the agricultural processing industry, and to create prerequisite factors for rural development in order to make a comprehensive change by focusing all efforts on families and villages as centres for development. Economic development progress in the past five years has seen average annual per capita income increase from approximately US$330 to over US$750. The value of the province's exports reached US$30 million, 24 percent increase over that of five years ago, while imports were valued at US$14 million this year, an increase of 14 percent over the previous year's same period. There are now 5,968 poor families in 88 villages of Vientiane Province, accounting for 7.2 percent of the total provincial population.

3.8.2.3 Livelihood and Proverty

The poverty is linked with geographical area. Districts located in border-trade area with Thailand have moved away from poverty, such as Kenthao and Sanakham. Other areas near Luang Prabang City, the popular tourist site, also have higherincome levels above the poverty line. The mostly poor riparian districts are found in Oudomxay and Xayaboury. The high priority poor districts include Paklay, Hoon and Nga in the Oudomxay Province and Xayabury District in the Xayaboury Province. Met District of Vientiane Province is also identified as poor.

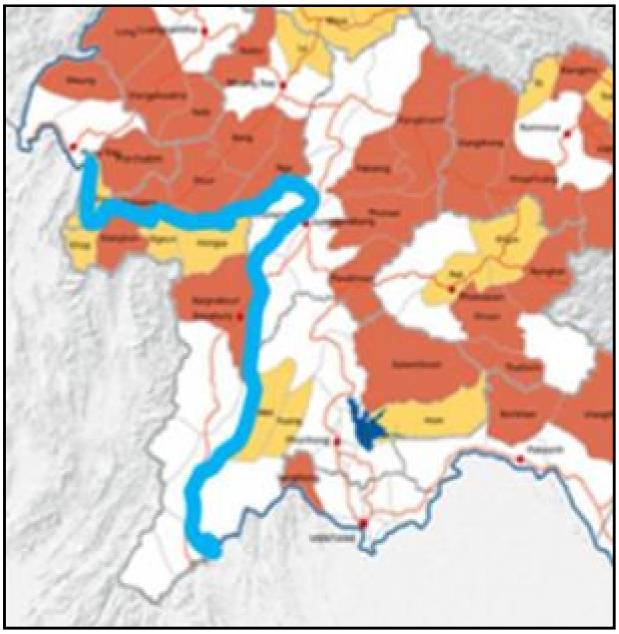


Figure 94: Map of Poor Districts in Zone 1

3.8.2.4 Selected Village Represented the Livelihood of Zone 1

To examine key livelihood issues that reflect the way of life of people residing within the 5 km corridor from the Mekong Mainstream, four villages have been selected. These are:

(1) Luang Prabang Province – Khokkham Village in Pak Ou District

(2) Oudomxay Province – Bor Village in Nga District

(3) Vientiane Province -Don Sok Village in Sanakham District

(4) Xayaboury Province – Veunkham Village in Kenthao District

Profile of the villages are as follows:

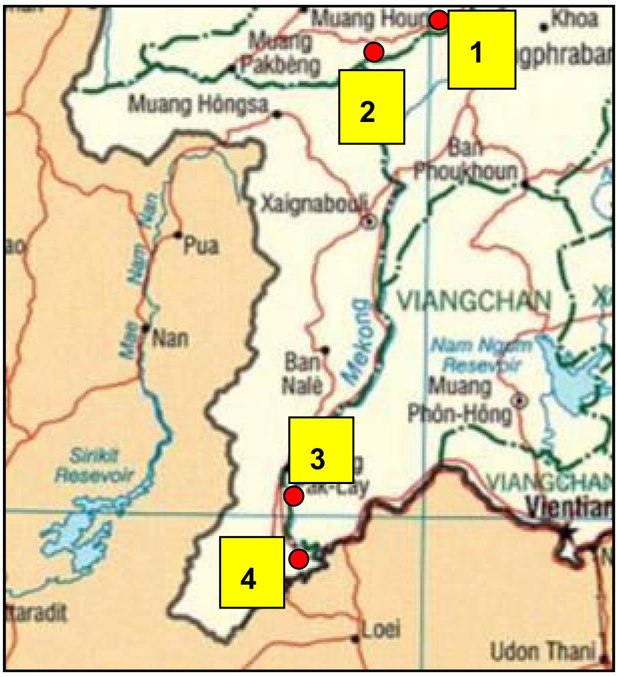


Figure 95: Location Map of Selected Villages

Table 20: Livelihood Profile of Selected Villages

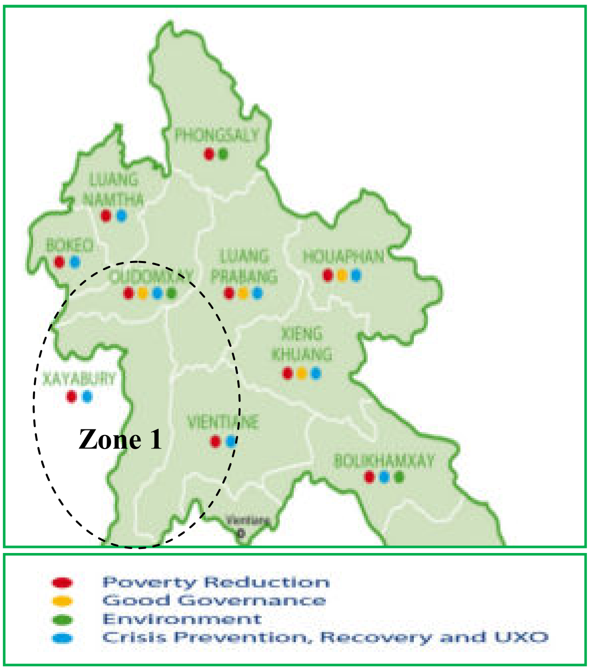
Description	***Luang Prabang Province***	***Oudomxay Province***	***Vientiane Province***	***Xayaboury Province***
Village Name	Khokkham	Bor	Donsok	Veunkham
Location ○ District ○ Km no. ○ River bank	 Pak Ou 2039 Left bank	 Nga 2103 Left bank	 Sanakham 1764 Left bank	 Pak Ou 1736 Right bank
Population ○ Total ○ Female	 263 136	 444 223	 155 73	 263 136
Main Occupation	Agriculture	Agriculture	Agriculture	Agriculture
Gross family income (US $)	1,563	1,262	1,655	4,897
Health Condition ○ Nutrition ○ Keyhealth problem ○ Sanitation	 Poor Flu, Diarrhea, Dengue Poor	 Poor Malaria, Diarrhea, Poor	 Poor Flu, Diarrhea, Poor	 Poor Flu, Diarrhea Poor

Source: prepared by the study team

Livelihood conditions of people relying on agriculture are influenced by rice farming and livestock rearing which are key income generation activities. Some trading activities are found in Veunkham (near Thailand Border) while tourism service related activities are observed in Khokkham (the village located near Pak Ou River mouth in Luang Prabang). Most livelihood activities are performed within 5 km radius from the Mekong River. Most livelihood activities are performed within a 5 km distance from the Mekong River. Fishing activities were also observed but fish catches were limited. In turn, family income depends on economic opportunity within the village location. Most villages have poor health and nutrition/sanitation conditions because of their eating and environmental health behavior. Key health problems are associated with communicable diseases such as flu and diarrhea. Some other diseases such as Dengue and Malaria are also found in the remote villages.

3.8.2.5 Foreign Assistance in Socio-Economic Development in Zone 1

There are a number of foreign agencies that have supported development in Zone 1.



The United Nations Development Programme (UNDP) has been supporting the Government of Lao PDR to achieve the overarching national goal of lifting the country from the ranks of LDCs by 2020. *During the period 2007 to 2009, the UNDP has contributed a total of USD 40.8 million to the Lao PDR's development through policy advice and dialogue, capacity development, creation of an enabling environment, and knowledge building and sharing. Of this total, USD 15.9 million was contributed from UNDP's core resources, and USD 24.9 million was from resources mobilized by the donor community. In 2009, the UNDP delivered USD 16.3 million in development assistance, up from USD 13.8 million in 2008.(Source: UNDP 2010)*

Figure 96: UNDP Support to Lao PDR

3.8.2.6 Public Health

a) Bokeo Province

Bokeo Provincial Health Office consists of one Provincial hospital with 70 beds which is located in Houayxay district, the capital of the province.There are five district hospitals with a total of 65 beds. Under the District Health Office (DHO) and district hospital there are a total of 31 health centers with 95 beds; there are also 666 village health volunteers, 198 midwifes and 225 village drug kits which cover 80.35% of villages in the Province.

There are 334 health staff in the province, working in different health services: at the provincial level122 (36.52%); at the district level 133 (39.8%); and athealth centers 79 (23.6%). The categorization of staff can be classified such as 6 specialists/ postgraduate, 45 medical doctors, 135 medical assistant and 146 nurses.

According to recent statistics collected from the Bokeo Provincial Health Office (PHO) , the ten most common diseases and causes of illness and death in Bokeo Province are as follows:

Top ten causes of illness of Out Patientsin Bokeo Province

No.	*Causes of illness*	*Numbers*	*Percentage*
1	*Minor surgery Pneumo-brongitis*	*3,427*	*9.9*
2	*Common cold (Influenza)*	*3,334*	*9.6*
3	*Tonsillitits, pharyngitis*	*3,258*	*9.4*
4	*Neuvous system non-psychiatric*	*3,082*	*8.9*
5	*Pneumo-Bronchitis*	*2,695*	*7.7*
6	*Diarrhea*	*2,020*	*5.8*
7	*Hypertension Road accident*	*600*	*1.7*
8	*Trauma, all others of body*	*549*	*1.6*
9	*Helminthes parasites*	*465*	*1.3*
10	*Malaria*	*442*	*1.2*

- Top ten causes of illness of In patients in Bokeo Province

No.	*Causes of illness*	*Numbers*	*Percentage*
1	*Acute Watery Diarrhea*	*1,191*	*10.9*
2	*Pneumo-brongitis*	*935*	*8.5*
3	*Tonsillitits, pharyngitis*	*770*	*7.0*
4	*Dengue Fever Malaria*	*560*	*5.1*
5	*Neuvous system non-psychiatric*	*545*	*5.0*
6	*Common cold*	*364*	*3.3*
7	*Trauma, All other*	*353*	*3.2*
8	*Road traffic injury*	*275*	*2.5*
9	*Malaria*	*211*	*1.9*
10	*Hypertension*	*210*	*1.9*

- The causes of death in Bokeo Provincial Hospital

No.	*Causes of illness*	*Numbers*	*Percentage*	*< 5 years old*	
1	*Severe watery diarrhea*	*2*	*1.2*	*1*	*4.7*
2	*Severe Acute Respiratory Infection (SARI)*	*8*	*5.0*	*5*	*23.4*
3	*Severe Dengue (DSS)*	*1*	*0.6*	*0*	*0.0*
3	*Other causes*	*35*	*21.8*	*4*	*18,7*

b) Xayaboury Province

Xayaboury Province Health Office is comprised of 6 health services sections, o1 provincial hospital (40 beds) located in the Provincial Capital of Phongsaly, 6

DHOs and 6 district hospitals (a total of 95 beds), 24 Health Centers with a total of 72 beds, 466 Village Health Volunteer and 466 village drug revolving funds which cover84% of the villages in the Province. There are 378 health staffs in the province: 53 (14%) are working in varioussectors at the provincial level; 61 (16%) at the Provincial Hospital; 192 (50%) at the district level; and 72(20%) at health centers; and a large proportion of the village health volunteers (1388) are working at village levels. The categorization of staff can be classified as 7 specialists/ postgraduate, 31 medical doctors, 111 medicine assistants, 214 nurses and 15 other staffs.

Indicators of provincial health situation include the fertility rate (5,1%); life expectancy 60 for male and 63 for women;<1 year old mortality rate (64/1000);<5 years old mortality rate (88/1000);and the maternal mortality rate (690/100.000). The ten most common diseases and causes of illness and death in Xayaboury Province are summarized as follows:

- Top ten causes of illness of Out Patients(OPD) in Xayabury Province

No.	*Causes of illness*	*Numbers*	*Percentage*
1	*Common cold (Influenza)*	*7,603*	*10.3*
2	*Tonsillitits, pharyngitis*	*6,285*	*8.5*
3	*Neuvous system non-psychiatric*	*5,305*	*7.2*
4	*Minor surgery*	*4,481*	*6.1*
5	*Diarrhea*	*3,396*	*4.6*
6	*Pneumo-brongitis*	*3,340*	*4.5*
7	*Trauma, all others of body*	*2,005*	*2.7*
8	*Hypertension*	*1,312*	*1.8*
9	*Road accident*	*1,275*	*1.7*
10	*Malaria*	*918*	*0.8*

Top ten causes of illness of In patients in (IPD) Xayaboury Province

No.	*Causes of illness*	*Numbers*	*Percentage*
1	*Tonsillitits, pharyngitis*	*1,220*	*7,7*
2	*Severe watery Diarrhea*	*1,015*	*6,4*
3	*Pneumo-brongitis*	*975*	*6,1*
4	*Road accident*	*648*	*4,1*
5	*Neuvous system non-psychiatric*	*611*	*3,8*
6	*Hypertension*	*443*	*2,8*
7	*Trauma, All other*	*371*	*2,3*
8	*Common cold*	*306*	*1,9*
9	*Malaria*	*170*	*1,1*
10	*Severe Manutrition*	*133*	*0,8*

The causes of death in Xayabury Provincial Hospital

No.	*Causes of illness*	*Numbers*	*Percentage*	*< 5 years old*	
1	*Severe watery diaarrhea*	*3*	*0.8*	*1*	*2.5*
2	*Severe Acute Respiratory Infection (SARI)*	*15*	*4.2*	*15*	*38.1*
3	*Other causes*	*120*	*33.3*	*26*	*66.1*

c) Oudomxay Province

The infrastructure of public health of Oudomxay Province is comprised of the PHO and6 DHOs. There is one provincial hospital with a total 85 beds, located in Oudomxay, the capital of the province. In each of the other six districts there is a district hospital with a total of 90 beds. Under the DHO and district hospital there are a total of 44 health centers with a total of 88 beds. There are also 335 village drug kits which cover 100% of total villages in the Province.

There are 551 health staff in the province; more than half are women. Staff work at various levels: at the provincial level, 227 (41,19%); at the district level 226 (41%); atthe health centers 98 (17,78%); and a large number of village health volunteer (700). The categorization of staff can be classified as 21 specialists/ postgraduate, 88 medical doctors, 184 medical assistants, 237 nurses and 21 other staffs.

Accordinf to statisticsfrom Oudomxay PHO, the ten most common diseases and causes of illness and death in the province are as follows:

- Top ten causes of illness of Out Patients (OPD) in Oudomxay Province

No	***Causes of illness***	***Numbers***	***Percentage***
1	*Pneumo-Bronchitis*	*1,311*	*9.0*
2	*Common cold (Influenza)*	*1,057*	*7,3*
3	*Neuvous system non-psychiatric*	*884*	*6.1*
4	*Diarrhea*	*845*	*5.8*
5	*Tonsillitits, pharyngitis*	*627*	*4.3*
6	*Trauma, all others of body*	*431*	*3.0*
7	*Road accident*	*426*	*2.9*
8	*Minor surgery*	*381*	*2.6*
9	*Helminthes parasites*	*275*	*1.9*
10	*Hypertension*	*189*	*1.3*

- Top ten causes of illness of In patients in (IPD) Oudomxay Province

No	***Causes of illness***	***Numbers***	***Percentage***
1	Pneumo-brongitis	840	16.7
2	Severe watery Diarrhea	600	12.0
3	Road accident	174	3.5
4	Malaria	149	3.0
5	Trauma, All other	145	2.9
6	Neuvous system non-psychiatric	86	1.7
7	Common cold	70	1.4
8	Tonsillitits, pharyngitis	70	1.4
9	Helminthes parasites	69	1.4
10	Hypertension	57	1.1

- The causes of death in Oudomxay Provincial Hospital

No	*Causes of illness*	*Numbers*	*Percentage*	*< 5 years old*	
1	*Severe watery diaarrhea*	*4*	*1.4*	*2*	*4.8*
2	*Severe Acute Respiratory Infection (SAR)*	*6*	*2.1*	*3*	*7.2*
3	*Malaria*	*1*	*0.3*	*0*	*0.0*
3	*Other causes*	*79*	*27.1*	*14*	*33.7*

3.8.2.7 Nutrition

The 2005 health survey statistics indicated that Lao still has high maternal and child mortality rates. The current maternal mortality rate is 400 per 100,000 live births, while the mortality rate of infants aged below five years is 70 per 1,000 live births and of infants aged less than one year is 70 per 1,000 live births.The high child mortality is also related to malnutrition, with some 40 percent of Lao children less than five years of age suffering from stunted growth due to malnutrition.

It is believed that the high infant mortality rate in the Lao PDR is related to inappropriate breast-feeding and complementary feeding practices. Micronutrient deficiencies are also an important nutritional problem. Recent statistics indicated 95% of school-age children were at risk or were suffering from iodine deficiency disorders, and 65% had severe iodine deficiency disorders.

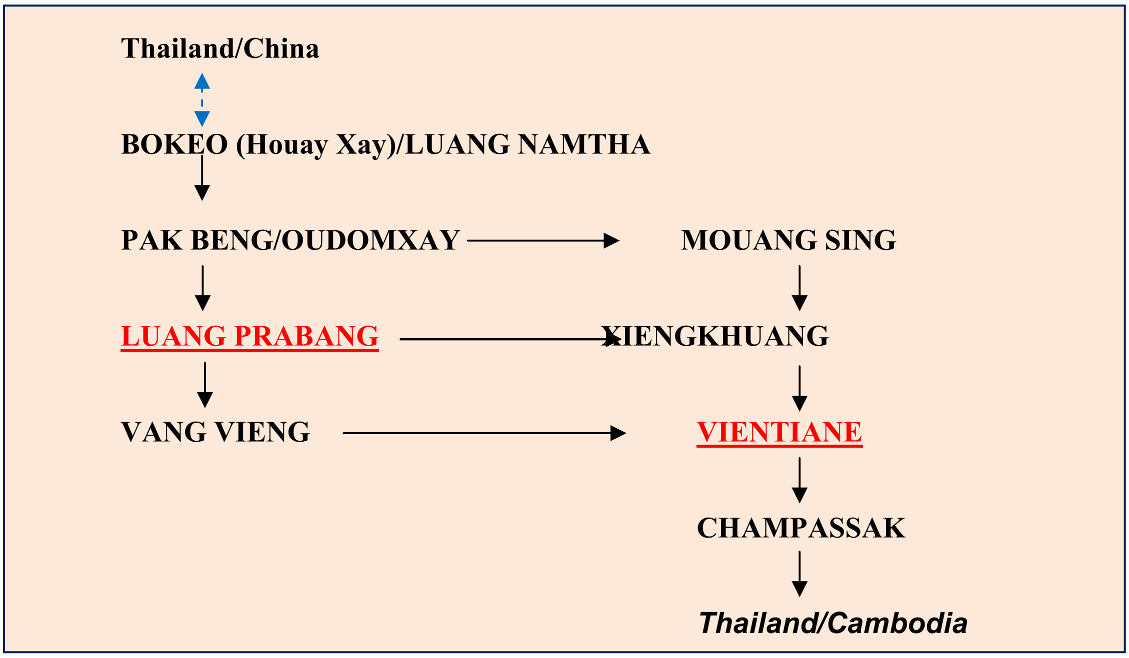
In zone 1, the 2005 health survey revealed that 50.2% of women breast fed their babies.

3.8.2.8 Tourism

3.8.2.8.1 Tourism System

Zone 1 is part of the Northern/Central Lao touristsystem that connects tourists from three countries, namely, the Lao PDR, Thailand and China. The Mekong River in this zone plays a major role in tourism.

a) **Tourism Linkage between Houay Xay (Capital OF Bokeo Province) and Luang Prabang of Lao PDR** - in this part Houay Xay is the main international tourist pier for waterway tourism from China and Thailand to Luang Prabang. The survey found that everyday there are 150 speedboats (maximum capacity 6 persons/boat) and 10 slow boats (maximum capacity 50-100 persons/boat) serving tourists along this route. The cost for s slow boat per person is 100,000 kip from Hoay Xay to Paklay and another 100,000 kip from Paklay to Luang Prabang, with each trip taking 6-8 hours. Each boat carries some 50 to 100 passengers (depending upon the loading capacity of the boat).



Source: prepared by the study team

Figure 97: The Tourism System in Zone 1

Paklay sits midway between Huay Xai and Luang Prabang. As the Mekong was once the only major transport route in the country, Paklay developed as an overnight stop for both cargo and passenger ferries. As this route down the Mekong is so spectacular, it remains a popular transport route, and Paklay is flourishing. Paklay is connected by a sealed road with Oudomxai along the Nam Beng River. The town is a major stop for the boats traveling from Luangprabang to Huay Xay; the slow boats which run between Huay Xay and Luang Prabang over a period of two days spend the night moored in Paklay.

There are several small guesthouses that usually have attached restaurants, a sauna, and many local hilltribes living close by. Groceries can be purchased for when you want to continue down the Mekong. The Paklay had its main road paved in 2005, and recently completed its Hydropower station down river. Before then all facilities and houses had their own electrical generators if any electricity at all. Many backpackers can expect quiet evenings there, as most places close by 10 p.m. There is a small temple found in the hills not far from the village. It is a very quaint example of a Buddhist temple from the former Lanna Kingdom. Many of the old temples have been destroyed during wars with the Thai Kingdom 300 years before.

b) **Spot Tourism** –a combination of overland tourism to Mouang Xay and Mouang Sing to Paklay for touring on the Mekong River.

c) **From Luang Prabang to other provinces** – many international tourists extended their journey to Vang Vieng/Xieng Khouang and Vientiane then to southern Lao, especially Champassak

3.8.2.8.2 Number of Visitors

The National Tourism Statistics showed that the number of visitors in Zone 1 was 0.79 million, which accounted for about 40% of the country's visitors. Luang Prabang, Vientiane and Bokeo are significant destinations of international tourists. It should be noted that Bokeo is the main gateway of waterway tourism.

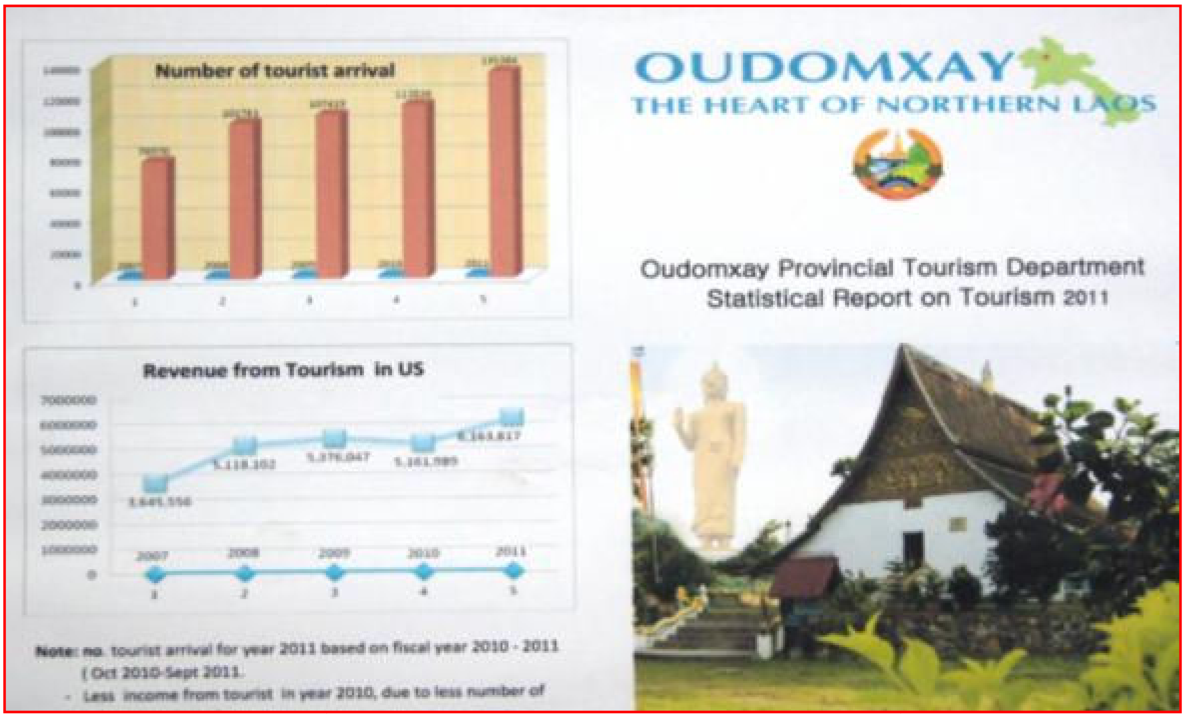
3.8.2.8.3 Tourism Service and Market

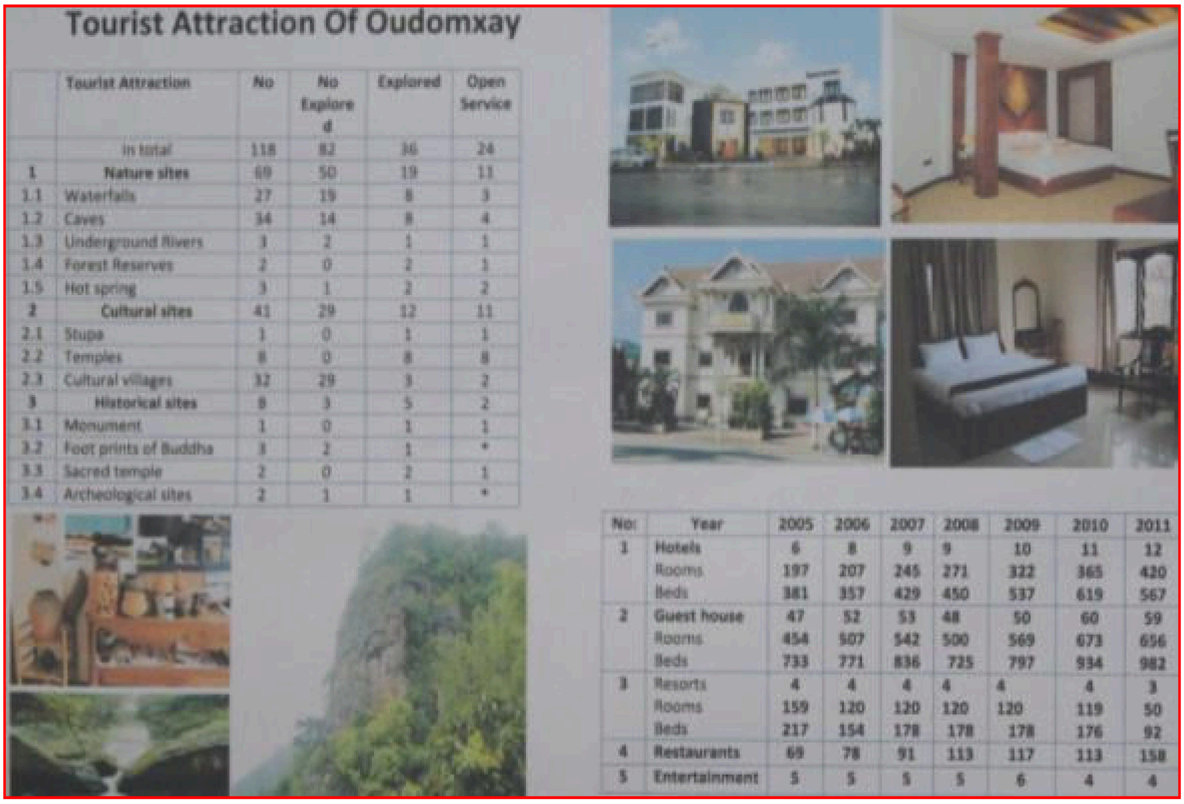
The statistics by Lao National Tourism Authority (LNTA) indicated that 80% of visitors to Luang Prabang, the center of tourism in this Zone, were from Asia, the Pacific and the Americas.

Table 21: Tourist Market in Zone 1

No.	*Market*	*No. of Visitors*	*Share*
1	Asia and Pacific	93,785	39.45%
2	Europe	92,617	38.97%
3	The Americas	46,703	19.65%
4	Africa and Middle East	4,578	1.93%
Total		***237,683***	***100.00%***

Near to Paklay HPP, according to the Oudomxay Tourism Authority, the main activities were waterway tourism given that Paklay is the mid-way point of the tourist route from Bokeo to Luang Prabang. Some overland tourism can be observed linking Southern China and Oudomxay. The template below shows that the number of tourist arrivals in Oudomxay is estimated at 135,384 which generated an income of approximately US$ 6 million per year.





Tourist Attraction Of Oudomxay

	Tourist Attraction	No	No Explored	Explored	Open Service
	In total	118	82	36	24
1	**Nature sites**	69	50	19	11
1.1	Waterfalls	27	19	8	3
1.2	Caves	34	14	8	4
1.3	Underground Rivers	3	2	1	1
1.4	Forest Reserves	2	0	2	1
1.5	Hot spring	3	1	2	2
2	**Cultural sites**	41	29	12	11
2.1	Stupa	1	0	1	1
2.2	Temples	8	0	8	8
2.3	Cultural villages	32	29	3	2
3	**Historical sites**	8	3	5	2
3.1	Monument	1	0	1	1
3.2	Foot prints of Buddha	3	2	1	*
3.3	Sacred temple	2	0	2	1
3.4	Archeological sites	2	1	1	*

No:	Year	2005	2006	2007	2008	2009	2010	2011
1	Hotels	6	8	9	9	10	11	12
	Rooms	197	207	245	271	322	365	420
	Beds	381	357	429	450	537	619	567
2	Guest house	47	52	53	48	50	60	59
	Rooms	454	507	542	500	569	673	656
	Beds	733	771	836	725	797	934	982
3	Resorts	4	4	4	4	4	4	3
	Rooms	159	120	120	120	120	119	50
	Beds	217	154	178	178	178	176	92
4	Restaurants	69	78	91	113	117	113	158
5	Entertainment	5	5	5	5	6	4	4

Figure 98: Tourism Situation in Oudomxay

3.8.3 Social Condition in Zone 2 (Thai-Laos)

In Zone 2 (Pak Heuang at KM 1736 to Ban Woenbuk at KM 904), both Lao and Thai riparian communities have a similar culture based on lowland Buddhism. But the provincial product is considered bigger in the Thailand's provinces. Three international friendship bridges were constructed and operated. The first one at Nongkhai-Vientiane, the second is Mukdahan-Savanakhet and the last one recently opened on the 11/11/11 at Nakhon Phanom near Thakhek. These three bridges provided convenient communication and trading between the two countries.

In total, the riparian communities include:

- Left Bank (Lao PDR) - 5 provinces and 17 districts;
- Right Bank (Thailand) - 7 provinces and 24 districts.

Figure 99: Zone 2 [(Pak Heuang (KM 1736) to Ban Woenbuk (KM 904)]

3.8.3.1 Population, Etnicity and Culture

The left bank in Lao has a 5 km wide corridor population of approximately 0.91 million people while more population on the right-bank in Thailand estimated at 1.25 million (Table 6). Key big cities include Vientiane Capital, Pak Xane, Thakhek, and Savannakhet (in Lao on the left bank) and Chiang Khan, Nong Khai, Bueng Kan, Nakhon Phanom, and Mukdahan(in Thailand on the right bank).

Table 22: Population in the 5 km Corridor of Zone 2

Zone	***Country/ Provinces***	***Districts***	***No. of Population in 5 km Corridor***
Zone 2	**Left bank (Lao PDR)** *1) Vientiane* *2) Vientiane Capital* *3) Borikhamxay* 4) *Khammouane* 5) *Savannakhet*	***17 Districts*** ○ *Sanakham, Meun* ○ *Sungthong, Chanthabuly, Sikhottabong, Sisattanak, Hadsaifong* ○ *Thapphabath, Pakxane, Pakkading* ○ *Thakhek, Mahaxay, Nongbok* ○ *Kaysone, Songkhone, Champhone, Xaybuly*	Total Households: **182,798** Total Population: **913,990**
	Right Bank (Thailand) *1) Loei* *2) Nong Khai* *3) Bueng Kan* *4) Nakhon Phanom* *5) Mukdahan* *6) Amnat Charoen* *7) Ubon Ratchathani*	***24 Districts*** ○ *Chiang Khan, Pak Chom* ○ *Sangkhom, Si Chiangmai, Thabo, Mueang Nongkhai, Phon Phisai, Rattana Wapi* ○ *Pak Khat, Mueang Buengkan, Bueng Khong Long, Bung Khla* ○ *Tha Uthen, Mueang Nakhon Phanom, That Phanom* ○ *Wan Yai, Mueang Mukdahan, Dontan* ○ *Chanuman* ○ *Khemarat, Natan, Phosai Si Mueang Mai, Khong Chiam, Sirindhorn*	Total Households: **312,955** Total Population: **1,251,823**
	Total *(Lao PDR and Thailand)*		***Total Households: 495,753*** ***Total Population: 2,615,813***

Source: prepared by the study team

3.8.3.2 Socio-Economics and Livelihood

3.8.3.2.1 Left Bank (Lao PDR)

There are 2 types of socio-economic livelihoods on the left bank – urban, and rural. Most big urban communities are found at Vientiane Capital City, Pak Xane City, Thakhek and Savanakhet. The urban communities have better basic infrastructure such as electricity, water works including paved road. The remaining communities are rural livelihoods that have poorer basic infrastructure.

As an example, we selected 2 provinces, Vientiane (Sanakham and Meun Districts) and Khammouane (Thakhek District) as representative characteristics of socio-economic livelihoods of people residing in 5 km corridor on the left bank of the Mekong, as presented below.

a) Vientiane*(Sanakham and Meun Districts)*

In the Vientiane area, six left-bank villages (Phalat, Pak Phang, Juansavanh, Tak Dad, Siphoum, Sanakham) belong to Sanakham District of Vientiane Province. While another six villages (Pak Sao, Don Hieng, Vang, Namhi, Konekham, Khokmued, Pakchan) reside in Meun District of Vientiane. Most people are Lao ethnicity; only a few villages in Meun District have mixed ethnicity with some Khmou people.

Electricity is available in most villages. Telephone services especially mobile phone are available but regular phone is very limited. Clean water is found only in the district civic center.

Table 23: Basic Infrastructures of Left-Bank Selected Villages

No.	*Basic infrastructures*	*Villages in Sanakham*	*Villages in Meun*
01	River front high way	None	Yes
02	Roads linking major towns	Limited	Limited
03	Water works	Available in district center	Available in district center
04	Electricity	Available	Available
05	Telephone	Available	Available

Source: Surveys by study team

Table 24: Location and Population of Selected Communities in Vientiane Province

Item	*Population*						*Coordinate*	
	Name of Village	*Fam.*	*HH.*	*Pop.*	*Female*	*Ethnic*	*X*	*Y*
01	Phalat	179	170	751	366	Lao	17.52.18.1	101.34.13.2
02	Pak Phang	870	627	3,072	1,519	Lao	17.53.33.5	101.36.40.5
03	Juansavanh	75	75	379	195	Lao	17.54.00.7	101.38.09.9
04	Tak Dad	135	128	604	307	Lao	17.54.03.7	101.39.06.7
05	Siphoum	194	182	844	417	Lao	17.54.21.0	101.39.54.1
06	Sanakham	642	625	3,242	1,702	Lao	17.54.37.5	101.40.33.5
07	Pak Mee	380	345	1,653	834	Lao	17.55.06.0	101.41.23.9
08	Pak sao	57	58	298	157	Lao	18.01.20.5	101.45.12.4
09	Don Hieng	90	98	406	212	Lao	18.04.36.0	101.47.10.8
10	Vang	180	185	836	416	Lao	18.03.03.9	101.51.11.7
		8	8	36	18	Khmou		
11	Namhi	111	109	517	254	Lao	18.02.23.3	101.53.28.3
12	Konekham	159	162	924	430	Lao	18.04.47.8	10155.45.3
		88	88	541	253	Khmou		
13	Khokmued	150	131	644	314	Lao	18.06.25.0	101.57.11.5
		4	3	34	15	Khmou		
14	Pakchan	235	234	1,464	717	Lao	18.09.17.9	101.01.06.9
		226	225	1,411	690	Khmou		

In terms of educational services, primary schools are notavailable in all villageswhile secondary/high schoolsare available only in the main district towns.

Table 25: Educational Services in Left-Bank Selected Villages

No.	*Types of Educational Facilities*	*Sanakham*	*Meun*
01	Public primary schools	23	18
02	Public secondary schools	3	3
03	Public high school	2	1
04	Private schools	-	-
05	Religious Buddhist schools	-	-
06	Village reading centers	-	-
07	District library	-	-
08	Pre-school development center	-	-
09	Primary school (up to grade 4)	9	-
Total		***37***	***24***

Source: Surveys by study team

In terms of the household economy, the household gross income of downstream riparian villages of Sanakham and Meun is estimated at $585and$499respectively which areabove the poverty line index of Lao PDR. The main gross income is from agriculture (cropping and livestock rearing) which is estimated at 63% to 72% of total household income for Sanakham and Meun villages respectively. Downstream villages in Sanakham have more opportunity in income generation from trading, employment and services.

Table 26: Estimated Average HH Income of Villages in Sanakham District

District	*Sources of Income*	*(Kip/month)*	*(Kip/year)*
Sanakham	1) From Agriculture	2,600,000	31,200, 010
	2) Livestock	410,000	4,930,000
	3) Sale of Forest Product	425,000	5,100,100
	4) Trading	516,666	6,200,000
	5) Services	351,670	4,220,040
	6) Laboring /Salary	181,500	2,178,005
	7) Handicraft	96,300	1,156,402
	8) Other	92,000	1,100,800
Total monthly income/HH (Kip)		***4,673,779***	***56,085,357***
Total monthly income/HH (US $)		***585***	***7,010***

Source: Surveys by study team

Table 27: Estimated Average HH Income of Selected Villages in Meun District

District	*Sources of Income*	*(Kip/month)*	*(Kip/year)*
Meun	1) From Agriculture	2,450,000	29,400, 000
	2) Livestock	427,500	5,130,000
	3) Sale of Forest Product	166,692	2,000,310
	4) Trading	341,691	4,100,300
	5) Services	177,420	2,129,040
	6) Laboring /Salary	267,667	3,212,005
	7) Handicraft	103,850	1,246,202
	8) Other	225,066	2,700,800
	Total monthly income/HH (Kip)	***3,993,221***	***47,918,657***
	Total monthly income/HH (US $)	***499***	***5,989***

Source: Surveys by study team

Most of villages on the Lao side practise river-bank gardening. The main crops are vegetables such as onion, chili, peanuts, etc. Some sweet corns and maize are observed in the Phalat village in Sanakham. The average size for each village for this is ranged from 5,000 m^2 to 10,000 m^2 depending on slope and land availability. Bank erosions are normally observed in the area.

b) Thakhek (Khammouane Province)

Five villages are selected to represent socio-economic livelihoods of people living in the 5 km corridor on the left Bank of the Mekong River. They include Ban Thangam, Ban Mouangsoum, Ban Donmalai, and Ban Thadua. The village profiles are as follows.

- ***Ban Thangam***

Ban Thangam situates at the elevation of 146 m about 5 km southwest of the proposed processing plant. It has 319 HH (329 families, 1,988 persons, 552 are female). No village lands are acquired by the project. Livelihood of Thangam’s inhabitants is based on rice farming. The average per capita income is estimated at 2,500,000 Kips/person/year. All families havemoved away from the poverty line. However, vulnerable households are headed by females of which there are 80. The village has an electricity supply and the use of a deep well and drinking water is bought. The village also has a clinic and a primary school and is near Highway No. 13B.

Figure 100: General Views of Ban Thangam

- ***Ban Mouangsoum***

The Mouangsoum village with an area of 322.5 ha locates at the elevation of 141 m (ASL), approximately 9 km northwest of the proposed potash plant. It has 289 HH (309 families, 1,612 persons, 839 are female). No village lands are acquired by the project. The village livelihood is basedon livestock. The income of the people is from rice followed by livestock with an average per capita income of 2,500,000 Kip/person/year. Nearly all families havemoved away from the poverty line. The village is considered a center of the Sikhot Social Group. Thereis a secondary school, a primary school and a clinic. Importantly the village has 3 temples and a valuable archaeological stupa namely Phathat Sikhottabong.

Figure 3.8-12: View of Ban Mouangsoum

- ***Ban Donmalai***

Settled in 1920, the Donmalai Village near Highway 13 B at the elevation of 142 m (ASL), approximately 7 km west of the proposed potash plant. It has 144 HH (152 families, 844 persons, 442 are female). No village lands are acquired by the project. It has a temple and a primary school. Llivestock and rice farming are the main economic activities generating an average per capita income of 5 million Kip per person per year.

- ***Ban Thadua***

Ban Thadua is also the riparian village on the Mekong left bank. It has a population of 263 HH (270 families, 1,609 persons, 853 are female). The economy of the village is based on livestock (more than 1,000 heads of cattle and buffaloes) with an average per capita income of 3.7million Kip/person/year. The village has a temple and a primary school. It is noticed that this village has very high number of femaleheaded families of 150.

Figure 101: General Views of Ban Thadua

- ***Ban Nongphue***

A small riparian community with a population of 70 HH (75 families, 366 persons, 189 are female). The village has a temple and a primary school. Its economy depends on livestock with an average per capita income of 3.7 million kip per person per year.

Figure 102: General Views of Ban Nongphue

3.8.3.2.2 Right Bank (Thailand)

Two districts, Chiang Khan and Pak Com are selected as representative of socio-economic livelihoods on the right bank as shown below.

- **Chiang Khan District**
  - Location: 17°53′54″N, 101°39′54″E
  - Chiang Khan (Loei Province) is a border district connecting with Sanakham District of Lao PDR to the north and connecting with Kenthao District of

Lao PDR on the west (Heung River is the Thai-Lao border line with a distance of 12 km).

- The district area of 940.5 km^2 is covered with 60% of medium flood plain/hill terrace, and with 40% of mountains.
- There are 5 main rivers in Chiang Khan which include Loei River, Heung River, Houy River, Mi River, and Souay River. All of these drain into the Mekong River.
- the Chiang Khan has 9 sub-districts, 82 villages with the total population of 59,732 people (29,600 female). The average density is 63 persons per km^2.
- 16 villages are identified as Mekong riparian villages that may be indirectly affected by the Mekong mainstream hydropower projects. (see next sections)

- **Pak Chom District**
  - Location: 18°1′18″N, 101°53′18″E
  - The district area of 945 km^2 is covered with 60% of medium flood plain/hill terrace, and with 40% of mountains.
  - Pak Chom has 3 rivers namely Chom River, Mang River, and Sa Ngao River which all drain into the Mekong River.
  - The statistic showed that Pak Chom has 6 sub-districts, 50 villages with the population of 38,845 people (19,065 female). The average density is 41persons/km^2.
  - 14 villages are found to be the Mekong riparian villages. (see also next sections)

The two districts have served with paved roads, waterworks, electricity, and telecommunications. The main road linking Chiang Khan and Pak Chom called River-front Highway (HW) Number 211 which also links other major towns HWs 201, 2108, 2249, 2194, 2186, and 2108.

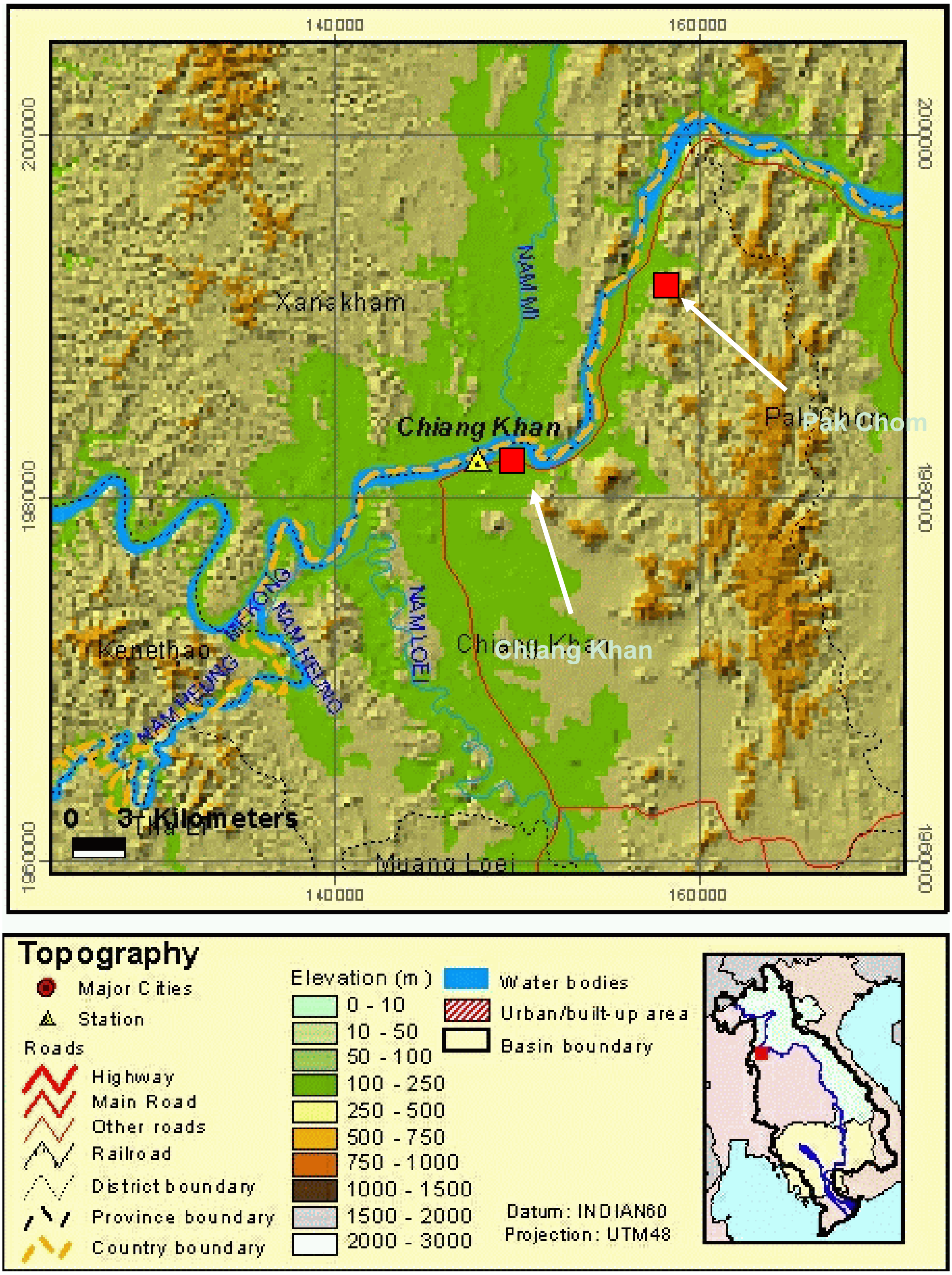


Figure 103: Map of Selected Right-bank Districts

Table 28: Basic Infrastructure in Selected Districts (Zone 2 – Right Bank)

No.	Basic Infrastructures	Chiang Khan	Pak Chom
01	River-front highway	HW 211	HW 211
02	Highway linking major towns	HWs 201, 2108, 2249, 2194, 2195	HWs 2186, 2108
03	Waterworks	68 Stations	32 Stations
04	Electricity	Available	Available
05	Telephone	Available	Available

Source: Surveys by study team

Thai standard primary/secondary/high schools and other educational services are available in these two districts including Buddhist religious schools and a number of pre-school development centers. The undergrad schools are served at Rajaphat University, and Buddhist University which is located in the Loei provincial town. Higher vocational schools are also available in Loei.

Table 29: Educational Facilities in Selected Districts (Zone 2 – Right Bank)

No.	Type of Educational Facilities	Chiang Khan	Pak Chom
01	Public primary schools	41	36
02	Public secondary schools	4	3
03	Private schools	1	-
04	Religious Buddhist schools	2	8
05	Village Reading Centers	82	36
06	District Library	1	1
07	Pre-school development centers	35	12
Total		**166**	**96**

Source: Surveys by study team

Like other remote provinces in Thailand, the health care is available for a cost of only 30 Bath for any health treatment cases. There are also private clinics available but higher cost per case. A number of private clinicswerefound in Chiang Khan.

Table 30: Public Health Facilities in Downstream Villages (Thailand)

No.	Type of Health Care Facilities	Chiang Khan	Pak Chom
01	District hospital (30 beds)	1	1
02	Health administration	1	1
03	Public health clinic	14	10
04	Private health clinic	18	3
05	Dispensaries/drug store	7	4
06	Public Physicians	3	3
07	Public Dentists	1	1
08	Public Pharmacists	3	2
09	Public Nurses	51	29

Source: Surveys by study team

It was observed that every village has a solid waste management system operated by the Municipality Office and by the Sub-district Administration Office. All houses have bathroom/ toilets, 3% are flush latrine, 94% are mould latrine and 3% mixed flush and mould latrines.

3.8.4 The demography of riparian 5 km

The demography of riparian villages in 5 km corridor in the selected districts on the right bank indicated that there are 15 villages within the Chiang Khan District and 14 villages in the Pak Chom District. The general demography of these villages is as follows:

Figure 104: View of Chiang Khan Town

- Total households: 6,109
- Total population: 20,847
- Female population: 10,532 (50.57% of total population)
- Average household size: 3.41

Table 31: Location and Population of the Selected Right-bank Villages

No.	***Village Name***	***No. of HH***	***No. of Pop.***	***No. of Female***	***Location on MRRB***	***Distance from Dam***
1. Chiang Khan District						
01	Tha Di Mi	247	993	502	KM 1736.0	5.5 km
02	Khok Ngiu	159	575	291	KM1732.7	8.8 km
03	Na Chan	123	531	269	Nam Heung	6.5 km
04	Khok Mat	146	544	275	KM1725.5	16.0 km
05	Chiangkhan Moo 2	144	675	341	KM 1116.5	24.0 km
06	Chiangkhan Moo 1	208	498	252	KM1117.0	24.5 km
07	Noi	211	729	369	KM1712.8	28.7 km
08	Pha Baen Moo 8	158	703	355	KM1709.0	32.5 km
09	Pha Baen Moo 6	288	1,058	534	KM1708.0	33.5 km
10	Pha Baen Moo 11	251	462	233	KM1707.0	34.5 km
11	Wattana Phirom	70	278	141	KM1705.0	36.5 km
12	Buhom Moo 1	320	1,223	618	KM1703.5	38.0 km
13	Buhom Moo 9	118	510	258	KM1703.0	38.5 km

14	Khok Lao Tai	195	930	469	KM1708.5	44.0 km
15	Khok Lao Nua	206	871	440	KM1700.0	51.5 km
	Total	***2,844***	***10,580***	***5,347***		
2. Pak Chom District						
16	Hat Bia	143	473	242	KM1687.5	54.0 km
17	Khok Phai	171	566	267	KM1681.0	60.5 km
18	Pakchom Moo 10	173	551	267	KM1679.0	62.5 km
19	Pakchom Moo 1	791	1,848	950	KM1678.0	63.5 km
20	Si Phuthon	306	947	465	KM1676.5	65.0 km
21	Pak Niam	208	800	399	KM1672.5	69.0 km
22	Sa Ngao	267	897	444	KM1669.0	72.5 km
23	Non Sawan	254	931	464	KM1668.0	73.5 km
24	Huai Thapchang	93	389	199	KM1663.0	78.0 km
25	Pak Mung	113	341	157	KM1661.8	80.2 km
26	Hat Khamphi	214	528	348	KM1658.0	83.0 km
27	Khok Wao	108	382	188	KM1653.0	88.0 km
28	Huai Khop	236	912	451	KM1650.0	91.0 km
29	Huai Hiam	188	702	344	KM1648.0	93.0 km
	Total	***3,265***	***10,267***	***5,185***		
	Grand Total	***6,109***	***20,847***	***10,532***		

Source: Surveys by study team
MRRB = Mekong River Right Bank, KM = Distance in km from estuary, HH = Households

Most of riparian houses are detached houses only a few are row houses. For construction materials, approximately 30 % are cement/brick house, 20% wooden house and 65% use combination of wood and brick. The cottage houses are very few, accounting for only 2.8%.The ownership status includes owned with land 91.5%, rented 2.6% and occupied rent free 5.9%. The average monthly household net income of riparian households is estimated at 20,504 Baht at Chiang Khan and 15,411 Baht at Pak Chom.

Table 32: Average Household Net Income in Chuang Khan District

Sources of Income	***Average (Baht/month)***	***Average (Baht/year)***
1) Wages and salaries	6,300	75,600
2) Net profits from business	5,337	64,044
3) Net profits from farming	1,935	23,220
4) From current transfers	1,521	18,252
5) From property income	2,100	25,200
6) Non-money income	2,551	30,612
7) Non - current money income	759	9,108
Total monthly income/HH (Baht)	**20,504**	**246,036**
Total monthly income/HH (US $)	***684***	***8,201***
Average (net) US $/person/day		***6.6***

Sources: Estimated by study team based on 2010 Loei Statistical Office,
Note: Exchange Rate - US $ 1 = Baht (B) 30

Table 33: Average Household Net Income in Pak Chom District

Sources of Income	*Average (B/month)*	*Average (B/year)*
1) Wages and salaries	4,400	52,800
2) Net profits from business	2,327	27,924
3) Net profits from farming	3,938	47,256
4) From current transfers	1,521	18,252
5) From property income	149	1,788
6) Non-money income	2,734	32,808
7) Non - current money income	342	4,104
Total monthly income/HH (Baht)	**15,411**	**184,932**
Total monthly income/HH (US $)	***514***	***6,164***
Average (net) US $/person/day		***4.9***

Sources: 2010 Loei Statistical Office,
Note: Exchange Rate - US $ 1 = Baht (B) 30

Both Chiang Khan and Pak Chom districts use the Mekong water for waterworks pumped by the Provincial Waterworks Authority. The main service area is within the municipality. However, many riparian villages have their own waterworks with at least one pumping station but operated by the sub-district administration. Very little water was observed being pumped for irrigation and cropping/agricultural purposes. In sum, 85.1% had inside pipe water, 7.7% using underground piped water and the remaining have their own water supply system.

For drinking water, about 20% enjoy bottled water, 10% from tabs and 70% from rain-water storage tanks.

A number of river bank agriculture based on such cash crops as rice, banana, eggplant, papaya, cabbage, maize, groundnuts and soybean. The popular riverbank products in the area are banana and maize which supply Loei and nearby northeastern provinces.

Figure 105: River bank Gardening *(left)* and Fish Culturing *(right)* in Chiang Khan

Interviews with senior district administrators revealed that natural Mekong fishery cannot be the main income sources of the people anymore because of the limited fish population in this zone. Since there are limited fish resources, a number of fish culturing baskets were observed, mainly performed in the Chiang Khan Area. The size of fish culturing basket size is 4m x 4m with 2 m in depth. The only type of fish cultured is Tilapia *or Pla Nil (Thai), Panin (Lao).* The survey in the same period found that there are totally 220 fish-culture baskets, of these 180 were in Chiang Khan and 40 were in Pak Chom.

Another use of the Mekong River is navigation. In this zone, navigation consists mainly of taxi boat crossing the Mekong between Chiang Khan (Thailand) and Sanakham (Lao PDR). Some boat rental services available depend on the route and distance: for example, the cost for boat rental from Sanakham town to the upper zone of some 20-30 km cost about 100 US $ per trip. Navigation in the Nam Heung River (Thai-Lao border) is limited mainly due to the support of the Thai Government to construct a bridge across the Nam Heung River. This bridge links two main towns, Tha Li of Thailand and Kenthao of Lao PDR.

3.8.4.1 Tourism

3.8.4.1.1 The Tourism System

In Zone 2, tourist linkagesacross theLao-Thai border are via 4 bridges: the Friendship Bridge on the Nam Heung in Tha Li (Thailand) to Kenthao (Lao); Nakhon Phanom – Thakhek; Mukdahan – Savanakhet; and the Mekong Bridge in Champassak that can link to Chong mek on the border of Thailand in Ubon Ratchathani Province. Tourist links to Vietnam are via Thakhek/Savanakhet and to Cambodia viaChampassak of the Lao PDR.

Source: prepared by the study team

Figure 106: Tourism System in Zone 2

3.8.4.1.2 Tourist Attractions

a) Left Bank (Lao PDR)

In five provinces on the left bank, namely, Vientiane Province, Vientiane Capital, Bolikhamxay, Khammouane, and Savannakhet, there are a number of tourist sites. These are as follows.

Province	Tourist sites	Highlighted Photos
Vientiane Province and Vientiane Capital	Vang Vieng, Nam Ngum lake,Stupa That Luang, Patuxay (Victory Monument), Nam Phu Square, Phou Khao Khouay,Vat Sisaket, Vat Ho Phra Keo, vat Xieng Khuan and other temples and museum	 **Figure 107: Vang Vieng Scenery**
Province	**Tourist sites**	**Highlighted Photos**
Bolikhamxay, Khammouane, and Savannakhet	Ban Nahin, Phu Pha Mane (lime stone forest), Nam Theun NBCA , Stupa Sikhottabong (Thakhek),Old Style French Houses (in Savannakhet Town),That Ing hang Stupa, Vat Heuan Hin	 **Figure 108: Old French Houses**

b) Right Bank (Thailand)

The international tourist spots in Lao PDR include Vientiane linked to Champassak (Zone 3) while international travel can be made to Vietnam (via Thakhek and Savanakhet) and Cambodia (via Champassak).

On the Thai side, the Tourism Authority of Thailand (TAT) has proposed four routes for "Journeys along the River og Life" in Zone 2. They are:

- Route 3 : Pact of the River, Loei Province
- Route 4 : Small Houses by the River, Loei Province - Nong Khai Province
- Route 5 : Gateway to the Neighbour - Nong Khai Province - Nakhon Phanom Province
- Route 6 : Mystical Mix of Culture and Natural Phenomenon - Mukdahan Province - Ubon Ratchathani Province

In Route 3, the key tourist attraction places are Buddha Image at Phu Knok Ngio, Old Town Chiang Khan, Kaeng Khut Khu, Wat Si Khun Mueang, Wat Maha That, Phu Khwai Ngoen (Buddha foot print), Wat Aranyabanphot, Wat Si Chomphu Ong Tue.

Figure 109: Tourism Routes in Thailand within Zone 2

InRoute # 4, the following tourist activities and visits are suggested:

- ***Offering sticky rice as alms to the monks* -** This beautiful ritual is similar to that of Luang Prabang, reflecting the bond between the two countries on either side of the Mekong River.
- ***Thai massage***– There is a popular souvenir shop where visitors can buy gifts and also relieve their tension with a traditional Chiang Khan style of massage.
- ***Sticky rice in bamboo tubes* -** Tourists can find delicious sticky rice in the longest bamboo tube in Thailand and homemade donuts are available as well.
- ***Nine Temples Tour in Chiang Khan*** - Wat Phu Chang Noi, Wat Santi Wanaram, Wat Phon Chai, Wat Tha Khok, Wat Si Phanommat, Wat Si Khun Mueang, Wat Pa Tai, Wat Si Khun Mueang, Wat Pa Tai, Wat Matchimaram (Wat Pa Klang), and Wat Maha That.
- ***Driving along the Mekong River***– The tourists can drive car from Chiang Khan Town to Pak Chom and Sangkhom towns of which can visit many tourist attractions isuch as: Buddha Statue at Phu Khok Ngio; Kaeng Khutkhu the spectacular cataract at the curve of the river; paying respect to the Buddha’s footprint at Phu Khwai Ngoen, starting the day by witnessing a stunning sea of fog at Phu Thok**;** driving among the picturesque scenery from Pak Chom to Si Chiang Mai; strolling along the sandy beach by Kaeng Fa**;** experiencing peace of mind at Wat Hin Mak Peng**;** paying respect to Luangpu Rian at Wat Aranyabanphot andLuangpho Phrachao Ong Tue.

For Route # 5, there are variety of tourism activities. These include:

- Crossing the first Thai-Lao Friendship Bridge to Vientiane, visit to Mekong beach, exploring under-water world
- Visiting monuments, stupas, and Buddhist monasteries which include Phrathat La Nong, Phrathat Bung Phuan, Prap Ho Monument, Wat Chetiya Khiri Wihan, Friday's Stupa, Lord Buddha Footprint, Saint Joseph's Church, Phrathat Renu, Phrathat Phanom
- Home staying at Ban Si Kai, visiting to Queen Sirikit National Library, marvel the spectacular and Khong Long Lake, visit the simple Vietnamese house of Ho Chi Minh.

Route # 6 is a mystical mix of culture and natural phenomena which includes the beautiful Phrathat Nong Bua, Phu Pha Thoep National Park, Phu Mu Forest Park Phu Manorom, Phu Sa Dok Bua National Park, Phu Pha Taem, Phu Pha Hom, Wat Pho Phrachao Yai Ong Saen, Phrachao Yai Ong Tue at Wat Phra To, Wat Up Mung Phrachao Yai Ong Muen, the Ancient Human Museum that exhibits evidence of human habitation in this area from the last 2,000-3,000 years, Thung Si Mueang, a beautiful public park located in front of the Town Hall in the heart of the city. Then follow all this with a visit to Ho Trai Klang Nam.

Figure 110: Nong Bua Pagoda

3.8.4.1.3 Left-Bank Tourism Condition in 2009

The left-bank is within Laos. Vientiane capital has the highest number of visitors followed by Savannakhet with the occupancy rate ranged from 63% to 67%.

Table 34: Tourism in Left Bank of Zone 2 (Lao PDR)

Item	Province	No. of Visitors	No. Rooms	Occupancy Rate
1	Vientiane	290,015	3,341	61.0%
2	Vientiane Capital	807,445	7,972	63.0%
3	Bolikhamxay	140,736	720	54.0%
4	Khammouane	170,579	992	49.0%
5	Savannakhet	791,924	2,302	67.0%
	Whole Country	2,008,363	26,558	54.0%

3.8.4.1.4 Tourism Situation on Right Bank (Thailand)

The Statistics by the Department of Tourism Thailand (DOT) indicated that the rightbank provinces have made significant progress: Nong Khai (80% growth) and

Ubon Ratchathani (65% growth), which generates income ranging from 3,000 to 3,700 million Baht per province per year.

Table 35: Tourism Situation on Right Bank Provinces (Thailand)

Item	Tourism situation	Loei	Nong Khai*	Nakhon Phanom*	Mukda-han	Amnat Charoen	Ubon
1	No. of Visitors	1,044,467	1,874,230	599,246	891,499	226,744	1,832,383
	• *Thai*	10,025,569	1,611,117	577,173	873,527	218,801	1,743,727
	• *Foreigners*	18,898	263,113	22,073	17,972	7,943	88,656
2	Length of stay (days)	2.68	2.61	2.29	2.22	2.51	2.79
5	Revenue (mil. Baht)	1,367	3,060	807	1,184	182	3,711
6	No. of rooms	2,674	3,045	908	1,239	277	3,461
7	Occupancy rate	20.1%	56.8%	45.7%	42.1%	54.3%	44.5%

** included Bung Kan Province (the newly Thailand's established province)*

3.8.4.1.5 Waterway Tourism on the Mekong

The Mekong waterway tourism in this zone normally consists of a boat taxi crossing the Mekong River between:

- Chiang Khan (Thailand) and Sanakham (Lao),
- Nongkhai (Thailand) and Vientiane (Lao),
- Nakhon Phanom (Thailand) and Thakhek (Lao),
- Mukdahan (Thailand) and Savannakhet (Lao).

After the construction of the 3 bridges in this zone (Friendship Bridge #1 – Nongkhai-Vientiane; Friendship Bridge #2 – Mukdahan-Savannakhet; and recently on 11/11/11 Friendship Bridge #3 Nakhon Phanom - Thakhek) waterway tourism on the Mekong River was found to be limited. There is only one river cruise service operated by a Thai Company. This Mekong River Cruise Thai Tour Package provides a day cruise destination to the Friendship Bridge, Nong Khai via Vientiane. Its services include hotel transfers and accommodation near the Mekong River at Nong Khai.

3.8.5 Social Condition in Zone 3 (Southern Laos)

The Mekong in this part flows into the Champassack Province of Lao PDR at KM 904 to Lao-Cambodian Border (KM 723).

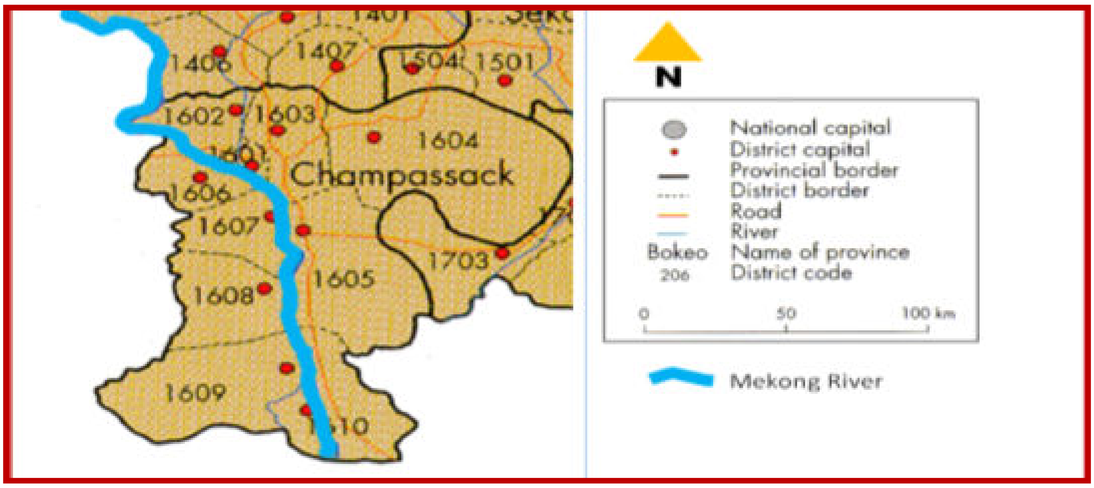


Figure 111: Zone 3 [Ban Woenbuk (KM 904) to Cambodian border (KM 723)]

Khong District has been selected to identify the riparian social characteristics of this zone.

3.8.5.1 Population, Etnicity and Culture

There are 4 districts on the left bank (Pakse, Sanasomboon, Khong, Pathoomphone) and 4 districts on the right bank (Phonthong, Champassak, Sukhuma, Moonlapamok). The riparian people (living in the 5-km corridor from the Mekong) are estimated at 114,322 household with the population of 571,069.

Table 36: Population in the 5-km Corridor of Zone 3

Zone	*Provinces*	*Districts*	*No. of Population*
Zone 3	**Left bank** 1) *Champassak*	***4 Districts*** • *Pakse, Sanasomboon, Khong Pathoomphone*	Total Households: **114,322** Total Population: **571, 069**
	Right Bank • *Champassak*	***4 Districts*** • *Phonthong, Champassak, Sukhuma, Moonlapamok*	

Source: prepared and estimated by the study team

The Khong total population is approximately 3,834 persons, of which 1,921 were female. Male to female ratio was 49.9%: 50.1%. Only two ethnic groups are living in these six villages of which 99.25 % was Lao and 0.75 % was Mon Khmer. People living in this area were mostly Buddhists. More than 60% of people were local to the area (they were born in the project area). The annual rate of population growth through both the internal growth and immigration during the last 2 years was about 2% or 70 people. The average size of the household was 5.8 persons.

Table 37: Population and Ethnicity in the Selected Village of Khong District

No.	Village	No. of population			Ethnic composition	
		Total	Male	Female	Lao (%)	Mon Khmer (%)
1	Thakho	1156	580	576	100	0
2	Bung Ngam	998	481	517	100	0
3	Hang Sadam	527	284	243	100	0
4	Hua Sadam	426	220	206	99.6	0.38
5	Hang Khon	282	135	147	100	0
6	Don Sahong	445	213	232	95.92	4.08
Total		3834	1913	1921	-	-
Percentage of total		*100*	*49.89*	*50.11*	*99.25*	*0.75*

Survey by the study team

People believe quite strongly in Buddhism. Every village has pagoda. Their main festivals which are annually celebrated include boon phavet, boon kongkhao, boon khaophansa, boon ockphansa and kathin. Main traditional song of the area is “Siphandon”.

3.8.5.2 Socio-Economics and Livelihood

- ***Household Economy***

Households in the selected area have been classified according to their living standard into three categories: better off, medium, and poor following the criteria developed by the Poverty Alleviation Program. Based on village information, people in the area were neither rich nor poor. Overall they seemed to be sufficient with about 82.5% of households were classified as sufficient.

Table 38: Household Economy in the Selected Villages

No.	Village	Number of household			
		Total	Better off	Suffi-cient	Below sufficient/poor
1	Thakho	174	0	100	74
2	Bung Ngam	198	0	188	10
3	Hang Sadam	96	0	93	3
4	Hua Sadam	74	0	67	7
5	Hang Khon	49	0	42	7
6	Don Sahong	71	5	46	10
Total		**662**	**5**	**546**	**111**
Percentage of total		*100*	*0.76*	*82.47*	*16.77*

Source: Survey by the study team

A relatively large proportion of vulnerable groups were found in the area. The single male or female headed households comprised about 7% and astonishingly, as high as 21 people were found to be physically and mentally handicapped.Among the six villages, poverty incidence was highest at Thakho with about 45.5%reported to be poor or insufficient. The main causes of poverty in the area were reported to come from a number of factors, but the most pressing ones were the lack of land and the lack of investment funds in production. A lack of labour was reported to be also rather serious. However, natural calamities like floods were reported to be quite problematic to agriculture production.

Table 39: Vulnerable groups

No.	*Village Name*	*Orphans*	*Single head led household*	*Physically handicapped people*	*Mentally handicapped people*
1	Thakho	10	5	2	2
2	Beuang Ngam/Veunkham	14	16	6	2
3	Hang Sadam	1	5	2	2
4	Hua Sadam	3	10	1	0
5	Hang Khon	0	6	0	1
6	Don Sahong	10	6	3	0
Total		***38***	***48***	***14***	***7***

Source: Survey by the study team

- **Electricity, Communications and Infrastructures**

Out of total of 6 selected villages, only one village (Thakho) was connected to the electricity network. Two villages i.e. Thakho and Bung Ngam were accessible through gravel roads connected to Road No. 13 South. Hua Sadam, Hang Sadam, Don Sahong and Hang Khone are all situated on the islands of Mekong River which can only be accessible by boat. An improving infrastructure facility has been reported in the area. Quite good basic infrastructure and facilities exist for goods circulation, primary agricultural processing and production. Both motorized and paddled boats were important means of transportation in the area. Altogether, there were 202 motor-boats and 149 paddled boats which belonged to about half of total households. In addition, 160 motorcycles and 320 bicycles were useful for traveling within and between villages. There were 2 telephone networks; Lao GSM and ETL existin this area and about 4% of the populations had mobile phones.

Table 40: Infrastructure and Facilities in the Selected Villages

Descriptions	*Number*
1) Retail shops	40
2) Restaurant	25
3) Temporary petrol station	14
4) Drug store	3
5) Hand tractors	41
6) Cars (light vehicle)	4
7) Boat (paddle)	202
8) Boat (motorize)	149
9) Truck	1
10) Mobile phones	182
11) Tailor shop	2
12) Mechanical repair and Battery charging shop	3
13) Motorcycle	160
14) Bicycle	320

Survey by the study team

- **Cottage Industry**

The most active cottage industry in the area from which significant income was made by a number ofhouseholds was fish processing, rice milling, furniture and battery charging. All were small scale household based businesses operated by individual households. About 26% of households have engaged in fish processing business

Table 41: Cottage industry in the Selected Village

No.	*Types*	*No. HH involved*	*Percent*
1	Fish processing	180	27
2	Rice milling	24	3.6
3	Furniture	2	0.3
5	Noodle making	5	0.7

Survey by the study team

- **Access to Education**

The educational background of the majority of interviewed villagers was generally low with about 57% of primary school level and 20% of lower secondary level. The number of illiterate people was as high as 8.5%. Those with upper secondary level were about 7% and below 1% completed vocational and technical colleges.

Every village in the project area has a primary school. There were 482 students in all the primary schools with 19 teachers. Kids in the project area, after their primary school, continued their lower secondary education at 3 locations; either at Huasadam the only one lower secondary existed in the project villages or at the other two at Nakasang and Khinak depending on distance to their villages. However, quite a few children made their way up to higher education. Most of them howeverstoppedtheir study after primary school and engaged themselves in fishing and farming activities. There were only 28 students studying at lower secondary and 16 at upper secondary from all the six villages when this survey was made.

There was no higher level of education than lower secondary available in the area. For upper secondary level, villagers sent their children mainly to Nakasang or Khinak. Children finishing their education in the area had to go for higher education at university level mainly in Pakse (Champassak) or in Vientiane municipality. However, quite a proportion of students who completed their secondary school have not had the opportunity to go for higher study due to low financial support capability of the family.

Table 42: Access to Education in the Selected Villages

School	*Teachers*	*Students*	*Remark*
Primary (class 1-5)	19	482	Study at the villages
Lower secondary (class 6-8)	-	28	Study at Hua Sadam, Nakasang and Khinak
Upper secondary (class 9-11)	-	13	Study at Nakasang and Khinak
University study	-	3	Pakse and Vientiane municipality
Total		***526***	

Survey by the study team

- **Access to water**

Although located close to Mekong River, access to clean and safe water sourceswas still a major problem in the area. Over the whole area, there were only 25 deep wells and all were located in mainland villages. Shallow wells were found only in Beung Ngam but mostly dried up during dry season. The majority of the population especially in all island villages were still dependent on non-treated Mekong water as a single source for drinking water and other domestic uses. None of these island villages had deep or shallow well. The situation has been causing a significant problem on people's health.

- **Sanitation and health**

Over the whole project area there was only one primary healthcare centre. There were 15 midwifes, 6 health workers, 8 traditional healers, 4 drug revolving funds and 3 pharmacies. Most villages had one to two traditional healers and two to three midwives (table below) and one health worker. People with serious illnesses were either sent to Khong district hospital located about 19 km (to nearest village) to 45 km (farthest away village) or Khinak or Pakse (provincial hospital) or even Vientiane municipality hospital.

Village health workers were given practical training in primary health care services and provided with drug revolving funds of K150,000 to 500,000 to operate in the village depending on the village size. The programs have been in operation in the area for a few years with funding support from the government and NGOs' project. Only about 21% of the household had access to toilet of which pour flush toilet type was 18%. The remaining 79% did not have any type of toilet. Village health workers have been used to assist the district in sanitation programs e.g. construction of toilet, disease prevention campaign such as vaccination for children, malaria, tuberculosis and diarrhea prevention campaigns, etc. The staff from district health offices visited the villages few times per year to follow up on health care activities especially before the season of disease outbreak.

Table 43: Health Service and Facilities in the Selected Village

No.	*Types*	*Number*	*Remark*
1	Traditional healers	8	3 villages had no drug revolving fund and 1 village with no health worker
2	Midwife	15	
3	Drug revolving fund	4	
4	Health worker	6	
5	Pharmacy	3	
Total		36	

Survey by the study team

Table 44: Main Diseases in the Selected Villages

No.	*Disease*	*Number of casualties*	*Percent*
1	Diarrhea	29	4.13
2	Malaria	136	19.40
3	Dengue hemorrhagic fever	3	0.43
4	Measles	5	0.71
5	Tuberculosis	12	1.71
6	Diphtheria	35	4.99
7	Sexually transmitted diseases	1	0.14
8	HID/AIDS	0	0
9	Accidents	1	0.14
10	Other	-	-
Total		**222**	

Source: prepared by the study team

- **Occupation**

Activities that people considered engaged them most were used for the sake of differentiation. In the table below we will find that people in the area were mostly farmers who were engaged in lowland paddy cultivation, livestock rearing and other agriculture activities. Those who were engaged in fisheries as the main activity were only 6%. Quite a sizable number were involved in retailing, traders and services. The number of daily wage laborers was also quite high, although employment opportunity was very limited.

Table 45: Occupation of Households in Selected Villages

Occupation	*Percent*
Farmer	79.4
Fishermen	6
Casual daily labourer or permanent labourer	3.4
Business man or retailer	7.7
Service	0.9
Others (gov's official, traditional healer, health worker)	2.6
Total	**100.0**

Source: Survey by the study team

- **Food Consumption**

Rice and vegetable were the two main food items reported to be consumed in their every daily meals i.e. 3 times a day. Two important sources of protein intake for people in the area were fish and meat but fish was almost found in every daily meal. Eggs and fruits intake were found to be low. Few households consumed milk.

Table 46: Household Food Consumption in the selected Village

No.	*Food items*	*Number of intake*	
		Per day	*Per week*
1	Rice	3	21
2	Vegetables	3	21
3	Fruit	0.5	3.5
4	Fish	2.7	19
5	Meat	1.25	8.8
6	Eggs	0.8	5.6
7	Milk	-	0.7

Source: Survey by the study team

- **Trade**

There were three main markets nearwhere local villagers in the project area bought necessary goods and rice and also sold their products. Mainland villages mainly went to Veunkham market by motorcycle and bus to sell their products while those on the islands either went to Khinak, Nakasang and also Veunkham depending on the proximity. Access to markets for these villages, was solely by boat. Occasionally they also went to Pakse. Trading of fish products and livestocks were the most active ones in the project area. Traders from Pakse came to buy these products at these markets and then transport to Pakse. Main products sold by local villagers include fresh fish, dried fish, processed fish and livestock. Quite a number of livestock were also slauthered and shared among people in the village itself. This traditional type of trade was quite common in the project villages.

Other main business found in the area was retailing. Goods like fuel, clothes and cooking ingredients were bought from other places chiefly from Pakse and sold in the area and occasionally to Cambodia. Fuel was the most important traded commodity to Cambodia for transport and lighting purposes. Although prohibited, certain quantity of fish was reported to be bought from Cambodia as it was cheaper. This was then sold to traders coming from Pakse. Despite being close to Cambodia border, trade with Cambodia was in general not active.

Table 47: Access to Market in the Selected Villages

No.	*Destination*	*Travel time*	*Mode of travel*
1	Veunkham market	10-30 min.	Motorcycle and boat
2	Khong market	1.30-4.00h 15 -30 min.	Boat Bus
3	Pakse market	2.00h-2.30h	Bus
4	Nakasang market	30 min.	Boat

Source: Survey by the study team

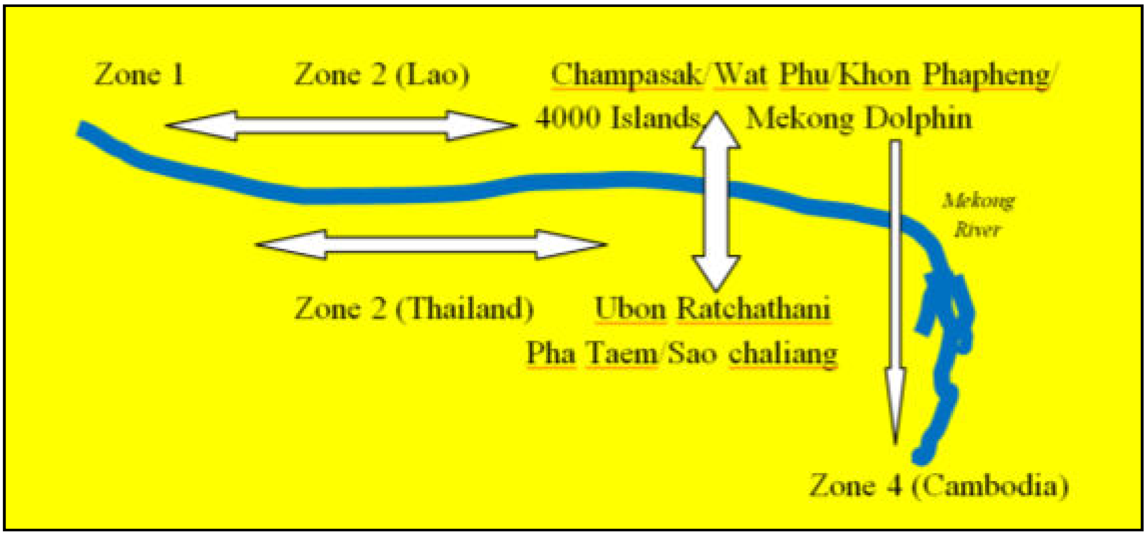
More active and an organized service was found in boat transportation. There were two boat transportation service groups formed at two villages. Both the groups were engaged in two types of services including village to village transportation and transportation service for tourists to Irrawadi dolphin conservation area. The group operated in a way that its members rotated turns among them to provide service either for Irrawadi dolphin watch or for village to village transport. Each member has to pay fee on trip basis (about 10% of the fare for any single trip) to the group. This fee was used to cover administration and operational costs of the group and as developmentfunds for the village.

3.8.5.3 Tourism

Champassak is well known for its tourist attraction sites which include Wat Phu, Khone Phapheng and fresh water dolphin (Irrawadi dolphin) conservation area. There were not many types of services provided by people in the project area. At Khone Phapheng, most services were found to be run by outsiders and only two villagers of Thakho had small restaurants. Some villages occasionally brought NTFPs and traditional medicine to sell.

3.8.5.3.1 Tourism System

The tourism system is closely linked with Zone 1 and 2 via Vientiane and Ubon Ratchathani of Thailand. Since the highway route number 13 is currently available the tourist can now link with Zone 4 (Cambodia) by overland and/or by air.



Source: prepared by the study team

Figure 112: Tourism System in Zone 3

3.8.5.3.2 Key Tourism Attraction

a) Southern Lao

- **Wat Phu**

The ancient Khmer religious complex of Wat Phu is one of the highlights of any trip to Laos. Stretching 1400 m up to the lower slopes of the Phu Pasak range (also known more colloquially as Phu Khuai or Mt Penis), Wat Phu is small compared with the monumental Angkor-era sites near Siem Reap in Cambodia. But the tumbledown pavilions, ornate Shiva-lingam sanctuary, enigmatic crocodile stone and tall trees that shroud much of the site in soothing shade give Wat Phu an almost mystical atmosphere. These, and a site layout that is unique in Khmer architecture, led to Unesco declaring the Wat Phu complex a World Heritage Site.

Figure 113: Wat Phu in Champassak

- **Khon Phapheng**

The waterfall on the Mekong or Khone Falls is the largest in southeast Asia that block navigation from South China Sea to Lancang River in China. The falls are characterised by thousands of islands and countless waterways, giving the area its name Si Phan Don or 4,000 islands. The highest falls reach to 21 metres (69 ft); the succession of rapids stretch 9.7 km (6.0 mi) of the river's length.

Figure 114:Khon PhaphengWaterfalls on the Mekong

b) Lower Northeast of Thailand

For international travel Zone 3 in Southern Lao is closely linked with the prehistoric paint or “Pha Taem” and Sao Chaliang in Ubon Ratchathani of Thailand. Most tourists can easily travel from Ubon to Champassak via Chong Mek Border and cross the Mekong Bridge in Champassak.

Figure 115: Pha Taem *(left)* and Sao Chaliang *(Right)* in Ubon Ratchathani

Other popular tourism event is the Ubon Ratchathani Candle Festival. This is the most elaborate of the traditional parading of candles to temple around the days of *Asanha Bhucha or*commemorates the Buddha’s first sermon. At the start of the Lenten period, it is traditional in preparation for the rainy season for the devout to donate to items for the personal use of monks, and of candles to dispel gloom in their quarters and elsewhere within the wat. The latter is often the core event of many village celebrations, but is at its most elaborate in the Ubon Ratchathani version, which nowadays is a major event both for residents and for tourists: giant candles are paraded through the town, each representing a local temple, district or other institution. The more elaborate versions are accompanied by scenes of Hindu and Buddhist mythologysculpted in wood or plaster and coated with wax.

Figure 116: Candle Festival in Ubon Ratchathani

3.8.6 Social Condition in Zone 4(Cambodia and Tonle Sap Lake)

In Zone 4, the Mekong River in Cambodia flows southward from the Cambodia-Laos border to a point below Kratie, where it turns west for about 50 kilometers and then turns southwest to Phnom Penh. Extensive rapids run above Kratie Town. From Kampong Cham the gradient slopes very gently, and the inundation of areas along the river occurs at flood stages—June to November—through breaks in the natural levees that have built up along its course. The Tonle Sap Lake swells in the wet season as the Mekong floods it. Cambodia's great lake provides a source of livelihood for thousands of fishermen and fishing communities along the lake, including those of numerous floating and stilt villages on and around the lakes.

Figure 117: Map of Zone 4 in Cambodia

In the lower area from Kratie and Kampong Cham, the Mekong runs through Phnom Penh where four major water courses meet at a point called the Chattomukh. The Mekong River flows in from the northeast and the Tonle Sap—a river emanating from the Tonle Sap—flows in from the northwest. They divide into two parallel channels, the Mekong River proper and the Bassac River, and flow independently through the Delta areas of Cambodia and Vietnam to the estuary.

3.8.6.1 Population, Etnicity and Culture

a) Population

Nine provinces of Cambodia are located in this zone, they include: Stung Treng, Kratie, Kampong Cham, Kampong Thom,Siem Reap, Battambang,Pursat, Kampong Chhnang, Phnom Penh, and Kandal. In total, all nine provinces have an area of 81,737 km^2 with 10.2 million inhabitants.

About 1.8 million households or 8.4 million people are living within the 5 km corridor from the Mekong River and Tonle Sap Lake.

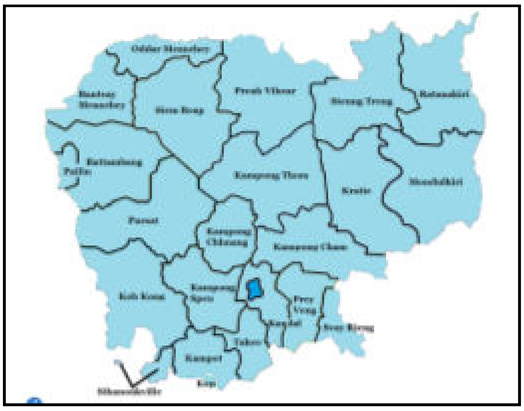


Figure 118: Provincial Boundary of Cambodia

Table 48: Social Information of Zone 4

No.	*Provinces*	*Approx. Area (km²)*	*Approx. Population (persons)*	*Density (persons/km²)*	*Population in 5 km corridor (HH/persons)***
1	Strung Treng	10,299	896,309	87	Total Households: **1,801,300** Total Population: **8,466,107**
2	Kratie	11,094	318,523	29	
3	Kampong Cham	9,799	1,680,694	172	
4	Kampong Thom	13,814	708,398	51	
5	Siem Reap	10,299	896,309	87	
6	Battambang	11,702	1,036,523	89	
7	Pursat	4,883	947,357	194	
8	Kampong Chhnang	5,521	472,616	86	
9	Phnom Penh	758	2,000,064	2,638	
10	Kandal	3,568	1,265,805	355	
Total		**81,737***	**10,222,598***		

*Source:Wikipedia, ** Estimated by the study team.

Brief individual provincial information is as follows:

- **Stung Treng** – It is a northern province of Cambodia with a population of about 900,000. It is an important trade hub owing to the fact that the Lao border is about 50 km away. It's a friendly, quiet country town situated on the confluence of the San River and the Mekong River. It actually sits on the banks of the San River, with the mighty Mekong coming into the picture on the northeastern outskirts of the town. The river port area locates in front of the small city park is fairly busy, handling trade between Cambodia and Lao PDR.
- **Kratie** – This province is one of Cambodia's eastern provinces with population of about 320,000, who make their lives on the riverbanks of the Mekong. Beyond the riverbanks it is a remote place with almost no population and thick-forested areas to calm down. The provincial capital is also called Kratie and lies also on the banks of the mighty Mekong River, which emboss the province from the North to the South. The stretch of the river around Kratie town is home to a group of rare sweet water Irrawaddy dolphins. Therefore the dolphins are the main tourist attraction of the province and the town. The river also has hundreds of green island, and circling water, which are also attracting some tourists. Kratie town is sleepy but picturesque with sandbars and big islands out front and bends in the river.

- **Kampong Cham** – This province is the third largest city in Cambodia. With its Mekong River location and relatively close proximity to Phnom Penh (123km) and Vietnam, Kampong Cham has always been an important trade and transportation hub of the country.Kampong Cham also has the population of about 1.7 million.
- **Kampong Thom** – The Kamapong Thom is Cambodia's second largest province by area. It has a capital city namely Kampong Thom, a picturesque town on the banks of the Stung Saen River. The Kamapong Thom has the population of about 700,000.
- **Siem Reap** – The Siem Reap is the capital city of Siem Reap Province in northwestern Cambodia, and is the gateway to Angkor region. It has the population of approximately 900,000.
- **Battambang** – This province locates in the northwest part of Cambodia with the population of about 1 million. It is the Cambodia's second-largest city. The Battambang is a secondary hub on the overland route between Thailand and Vietnam, and if the National Highway No 6 from Poipet to Siem Reap.
- **Pursat** – The Pursat Province, home of about 950,000 people, is the fourth biggest province (in area) of Cambodia. The province is located in the western part of the country and borders clockwise from the north with Battambang, the Tonle Sap Lake, Kompong Chhnang, Kompong Speu, Koh Kong, and Thailand. Pursat offers a perfect access to both the Tonle Sap (just 35km far) and the Cardamom Mountains (right to the West).
- **Kampong Chhnang** – The small province with the population of 500,000 located at the heart of Cambodia bordered Kampong Thom to the North, Kampong Cham to the East, Kampong Speu to the South and Pursat to the West. This province is not only at the fertile and almost ever-wet heart of Cambodia, but also just a 91km ride from Phnom Penh. As located next to the Tonle Sap Lake, the Kampong Chhnang's population is predominantly in fishery and rice plantation involved.
- **Phnom Penh** – It is the capital and largest city of Cambodia with the population of approximately 2 million. It locates on the banks of the Mekong River, Phnom Penh has been the national capital since the French colonized Cambodia, and has grown to become the nation's center of economic and industrial activities, as well as the center of security, politics, economics, cultural heritage, and diplomacy of Cambodia.

* **Kandal** – Kandal has the population of about 1.3 million. The provincial location is like the white egg that surrounds Phnom Penh.

For the Tonle Sap lake area, the flow of water into the Tonle Sap is seasonal. In September or in October, the flow of the Mekong River, fed by monsoon rains, increases to a point where its outlets through the Delta cannot handle the enormous volume of water. At this point, the water pushes northward up the Tonle Sab and empties into the Tonle Sap, thereby increasing the size of the lake from about 2,590 square kilometers to about 24,605 square kilometers at the height of the flooding. After the Mekong's waters crest—when its downstream channels can handle the volume of water—the flow reverses, and water flows out of the engorged lake.

As the level of the Tonle Sap retreats, it deposits a new layer of sediment. The annual flooding, combined with poor drainage immediately around the lake, transforms the surrounding area into marshlands unusable for agricultural purposes during the dry season. The sediment deposited into the lake during the Mekong's flood stage appears to be greater than the quantity carried away later by the Tonle Sap River. Gradual silting of the lake would seem to be occurring; during low-water level, it is only about 1.5 meters deep, while at the flood stage it is between 10 and 15 meters deep.

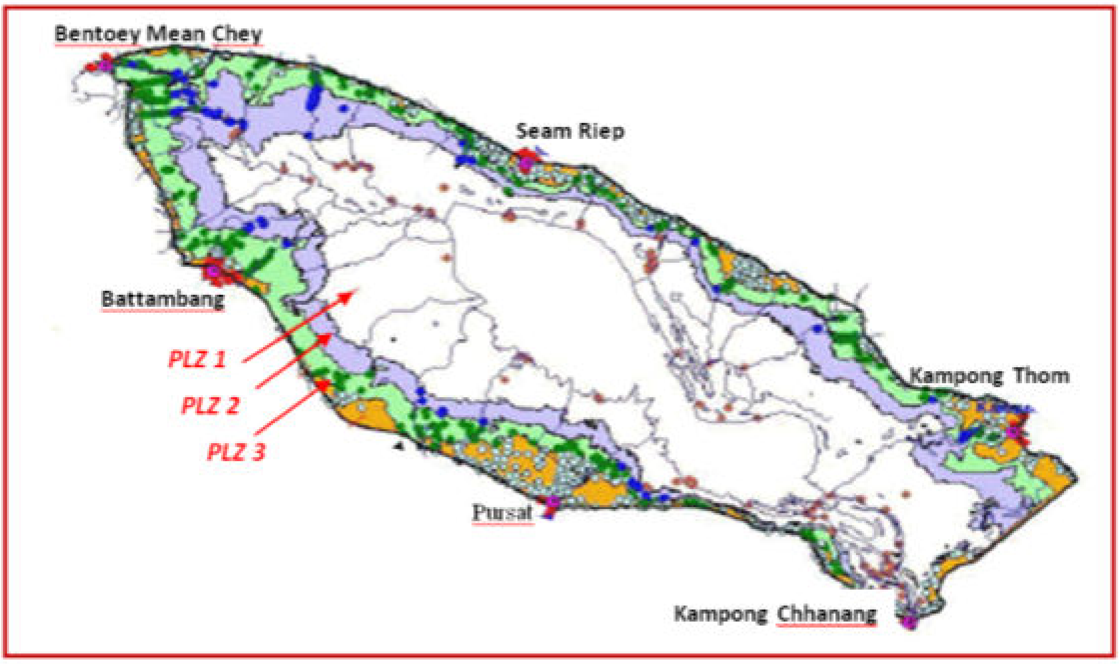


Figure 119: Social Map of Tonle Sap Lake

In and around the Tonle Sap Lake, there are 4 Population Lake Zones (PLZ). PLZ 1 has apopulation of approximately 900,000, while PLZ 2, PLZ 3, PLZ 4 has populations of about 640,000, 350,000 and 600,000 respectively. The area is home to many ethnic "Vietnamese" and numerous "Cham (Muslim)" communities, living in floating villages around the lake.

Based on the latest Demographic and Health Survey by the National Institute of Statistics (NIS), the Cambodian people have 35% of children under age 15, 61% in the age bracket 15-64 while only 5% are in the group aged 65 or older.

Table 49: Age Group of Cambodian People

Age	1998 census[1]	2000 CDHS[2]	2004 CIPS[3]	2005 CDHS[4]	2008 census[5]	2010 CDHS
<15	42.8	42.7	38.6	38.9	33.7	34.5
15-49	46.9	46.3	49.5	47.9	53.4	50.5
50-64	6.8	7.4	8.0	8.6	8.6	10.0
65+	3.5	3.6	3.9	4.6	4.3	5.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Male-headed households account for 72% while female-headed householdsaccount for 27%. On average a household contains 4.7 persons where urban households have 5.0 persons per household on average which is slightly larger than rural households (4.7 persons).

Table 50: Household Characteristic in Zone 4

Characteristic	Urban	Rural	Total
Household headship			
Male	72.2	73.1	72.9
Female	27.8	26.9	27.1
Total	100.0	100.0	100.0
Mean size of households	5.0	4.7	4.7

3.8.6.1.1 Etnicity and Culture

Three main ethnic groups are identified within the 5 km corridor from the Mekong River and Tonle Sap Lake – Khmer, Vietnamese, Khmer and Cham.

- The Khmer are the lowland Khmer that are mostly found in all parts of Cambodia. In fact there are "Khmer Loeu" that are found in the northeastern provinces of Rattanakiri, Stung Treng, Mondulkiri and Kratie. Most Khmer Loeu live in scattered temporary villages that have only a few hundred inhabitants. The Khmer are Theravada Buddhist. The Khmer traditional ceremonies include Visak Boches, Meak Bochea, Khmer New Year, Phchum Ben, and Water Festival.
- The Vietnamese are found in floating villages on Tonle Sap Lake. The recent survey by the study team revealed that they have lived there for generations. Most of them are Khin that migrated from Vietnam since the Indochina War. The Vietnamese do not integrate with Khmer.
- The Cham people of Cambodia live in 70 desolate villages along the banks of the Mekong and Tonle Sap Rivers. There are communities of Cham in the central part of Vietnamalso. A small and disenfranchised minority, the Cham are a hunting and very needy people. The Muslim Cham are normally observed in the Tonle Sap Lake provinces.

3.8.6.2 Socio-Economic Livelihoods

The field surveys conducted in early November indicated that the livelihoods of the people living in 5-kmcorridor from Lao-Cambodian border to Strung Treng, Kratie, Kampong Cham, Phnom Penh and around the Tonle SapLake are closely linked with the Mekong and local climate.

Water usage has no problem in the wet season since there is plenty of water both from the streams and from the rain. More than one-third of household utilize rainwater in the rainy season. About 40% of household utilize non-improved sources of water in the dry season.

Table 51: Source of Household Water Utilization in Cambodia

	Households		
Characteristic	Urban	Rural	Total
Source of drinking water during dry season			
Improved source	87.0	53.1	58.8
Piped water into dwelling/yard/plot	57.2	5.3	14.1
Public tap/standpipe	1.0	0.3	0.4
Tube well or borehole	11.4	35.5	31.4
Protected dug well	1.7	3.6	3.3
Protected spring	0.1	0.4	0.4
Rainwater	5.2	7.3	6.9
Bottled water	10.5	0.6	2.3
Non-improved source	10.4	45.6	39.7
Unprotected dug well	2.7	17.2	14.7
Unprotected spring	0.1	1.0	0.8
Tanker truck/cart with small tank	4.4	4.4	4.4
Surface water	3.2	23.1	19.7
Other	2.5	1.3	1.5
Total	100.0	100.0	100.0

The Tonle Sap Lake supportsproductive freshwater fish. The Tonle Sap area is considered poorer than the national average. Morethan 1 million people livearound the lake and its floodplain. This area canbe divided into three livelihood zones: fishingzone, agricultural zone and urban zone. People in the fishing zone are directly dependent on fish and other aquatic resources andthey live closest to the lake, either in the floatinghouses or houses built on stilts. People in this zoneare in many ways worse off than people living inthe higher areas, as they are on average the poorest,least educated with poor access to servicesand markets.

Figure 120: People at Floating Village in the Tonle Lap Lake

For people living further away from the lake, they rely largely on rice cultivation for their livelihood. However, the importance of the lake and its floods is still significant particularly for cultivation of floating and recession rice as well as for seasonal fishing activities. Urban people have less dependence on natural resources but more involvement in secondary occupations.

3.8.6.3 Health and Nutrition

The World Bank revealed that the health status of the population in Cambodia is considered one of the poorest in Asia. The government spending on health is about US$3 per capita per year; donor spending on health has been around twice this level. Private out-of-pocket spending accountedfor about 75 percent of total health spending. The main problems that the public health sector is facing include:

- shortage of critical skills (e.g. midwives) and mismatch of staff distribution to population need
- poorly motivated staff due to low public sector low salaries, fragmented donor salary supplementation, higher earnings in NGOs and private sector
- weak governance and management systems
- under-utilization of public health services due to poor quality and accessibility
- very limited public financial resources, misallocation and bottlenecks in public and Official Development Assistance expenditure on health, limited protection against high out-of-pocket spending on health services.

The WB also mentioned that there is a lack of progress in improving child and maternal mortality and nutrition outcomes, though progress has been steady in communicable disease control through relatively well funded vertical programs for HIV/AIDS, TB, malaria and immunization. Substantial progress was made in the past decade in reconstruction and development of the public health system following the long period of conflict. Many projects have been launched (including the earlier Disease Control and Health Development, a Project financed by IDA) to tackle key sector weaknesses, including the lack of public health facilities, the low numbers of trained health professionals, the limited availability of essential drugs, the low immunization coverage, and the lack of effectiveness of the infectious disease-control programs.

Some indicators are average life expectancy at birth, which increased from 42.6 to 62.3 in 50 years.

The top ten causes of death in the country includes (1) Influenza and Pneumonia, (2) Tuberculosis, (3) Coronary heart disease, (4) Stroke, (5) Hypertension, (6) Diarrhoeal diseases, (7) Low birth weight, (8) Birth trauma, (9) Diabetes Mellitus and (10) HIV/AIDS.

Figure 121: Food Vendor in Phnom Penh

3.8.6.3.1 Nutrition

Cambodia has also among the highest malnutrition rates in Asia. More than one-third of all Cambodians eat less than the daily minimum food energy requirement off 2100 calories. The report of Maternal and Child Nutrition in Asia stated that 45% of children under five years of age are stunted; 15% are wasted due to malnutrition; and 11% of infants are born with low birth weight. The average diet in Cambodia, according to the Food and Agriculture Organization of the United Nations, consisted of 78% starchy foods. Most children and adults in Cambodia eat two meals per day consisting of rice and vegetables. Fish, the most common protein source, is eaten less than once per day. Meat is reserved for celebrations. The Tonle Sap Lake provides approximately two-thirds of the fish consumed annually in Cambodia. Fish harvested, similar to rice harvested, are fluctuates with rainfall. The report by the Council for Agricultural and Rural Developmentnoted higher water levels on the Tonle Sap and a reduction in illegal fishing.

High levels of malnutrition contribute to disease - 45% of all under 5 year olds are moderately to severely stunted in their growth from malnutrition. Only 36% of Cambodians have access to safe drinking water and only 16% have adequate sanitation facilities. Not surprisingly, Cambodia has the lowest Human Development Score in Southeast Asia. This is a combined score of life expectancy (56 years), education (literacy 67%) and quality of life.Childhood mortality is also high in rural area such as Strung Treng, Kratie and Kampong Chhnang.

Figure 122: Children at Tonle Sap Lake

Table 52: Childhood Mortality in Zone 4

No.	***Provinces***	***Infant mortality rate***	***Child mortality rate***	***Under 5 mortality rate***
1	Strung Treng	95	26	118
2	Kratie	76	10	86
3	Kampong Cham	54	4	58
4	Kampong Thom	57	11	67
5	Siem Reap	50	10	60
6	Battambang	45	10	54
7	Pursat	53	4	57
8	Kampong Chhnang	78	20	97
9	Phnom Penh	13	5	18
10	Kandal	61	8	69

3.8.6.4 Tourism

Key tourism destinations in Cambodia are related to Siem Reap's Angkor region. Siem Reap today, being a popular tourist destination, has a large number of hotels and restaurants. The world-renowned temples of Angkor are situated in the nor-western province of Siem Reap. Within an area of approximately 600 square kilometers, over 100 temples have been discovered. All were built between the 9th and the 13th centuries, and those remaining temples constitute the skeleton of what was once the religious and administrative centre of the Khmer Empire.

The constant building program undertaken by successive Khmer kings can be compared-favourably --with the pyramid construction projects of the Pharaohs in Egypt. Similarly to the Pharaohs, the Khmer kings made use of a vast force of slave labor. Each new "project" was made possible by the 750,000 people estimated to have lived at Angkor during the 12th and 13th centuries. Despite the scores of temples that remain today, there is little evidence of these nameless souls who lived in what must have been one of the biggest cities on earth at the time. This is because the people-everyone from the lowliest peasant to the King's most senior courtiers-lived in wooden structures, all of which have long-since rotted away in the tropical heat. Only gods could live in stone, or in this case, the god-kings of the Khmer nation.

Portuguese travelers are believed to have been the first westerners to gaze in wonder at the temples of Angkor while journeying during the 16th Century. However, most credit for the "discovery" of Angkor has fallen to French botanist Henri Mouhot, whose visit to Angkor in 1860 was posthumously documented in Paris in 1868. During the remainder of the 19th Century and into the 20th Century, several French expeditions visited the temples and work was carried out to clear the jungle, which had enveloped most of the monuments. In 1907, Thailand returned control of Angkor to Cambodia and in the same year the first tourists arrived. In the early days of tourism, visitors to Angkor followed one of two circuits to see the temples, the Little (Petit) Circuit or the Big (Grand) Circuit. These were often undertaken on the back of an elephant. Today things are different, and air-conditioned vehicles make the experience significantly more comfortable.

If time is limited, visitors may choose to follow "the Petit Circuit", which includes visits to the Royal City of Angkor Thom with its numerous temples, Angkor Wat, the royal bathing pool of Sras Srang, and several other monuments. Extended tours continue to the "Grand Circuit", visiting a number of other temples and an Angkorean reservoir. If time allows, tourists may also arrange to visit other prestigious temples such as Banteay Srey or Banteay Samre, situated slightly further from the main temple complex.

Figure 123: **Famous Angkor Wat for Cultural Tourism in Cambodia**

Other nearby tourism sites include:

- **Chong Kneas Village**

  The floating village on the Tonle Sap Lake closest to Siem Reap is Chong Khneas. This is where most tourists go to have a quick tour of a floating village. There are various Khmer and Vietnamese floating houses, floating markets, clinics, schools, etc. Chong Khneas is an interesting place to visit, especially in the rainy season when everything really is floating. However, it is by no means the only, or even the best floating village on the lake. Being close to Siem Reap, and heavily promoted, it is somewhat touristy. The usual stops are at a floating fish and bird exhibition with a souvenir and snack shop, and at the Gecko Environment Centre with information about the ecology and biodiversity of the area. There can also be boatloads of other tourists, and it is not as unspoiled as and other floating villages further away. This is why it is important to visit other villages further away, and to interact with the people living there in order to really appreciate and understand their way of life.

- **Prek Toal Village**

  There is a large floating village at Prek Toal. The village is a nice floating village and is interesting. The Tonle Sap Biosphere Reserve Core Area office is located there, with information on the flora and fauna of the reserve. There is also a water hyacinth basket weaving center there, but there is not much to see or do in the village itself. The village can be reached by taking a boat from either Mea Chrey Village or Chong Khneas.

- **Bird Sanctuary**

  The bird sanctuary at Prek Toal is about 30 minutes from the floating village by boat. The Tonle Sap Biosphere Reserve is an important breeding area for threatened water birds Southeast Asia, and is home to many large bird species including ibis, storks, pelicans, eagles, etc. The Prek Toal biosphere is approx. 31,300 square hectares located in the northwest corner of the Tonle Sap Lake, and is the most popular with birdwatchers. It is the most accessible from Siem Reap of the three biosphere core areas on the Tonle Sap Lake. The best time for bird watching is in the dry season when there are large flocks of migratory birds at the reserve. Boat trips to the sanctuary are by trained, English speaking guides. The guides take you to the location of several bird colonies, and you learn about the birds and their unique habitat. An overnight trip is recommended for those who want sunset and early morning viewing.

- **Kompong Phhluk Village Kompong Phhluk**

  It is not a floating village, but is a cluster of villages with houses built on high stilts. It is on the Tonle Sap floodplain about 16 km southeast of Siem Reap, and has a population of about 3,000. As with all villages on the Tonle Sap, the economy here is based on fishing, and catching small shrimp. In the rainy season when water level is high, both the surrounding forest and the village are flooded. When the water is at its highest, the village does become a kind of floating village. The flooded forest is home to a wide variety of wildlife. Relatively few tourists visit Kompong Pleuk, and one can explore the undisturbed submerged forest by small boat, and learn about the fishing village way of life.

- **Mea Chrey Village**

  Mea Chrey Natural Tourism is located in Peam Ta Uor village, Keo Por Commune, Puok District, Siem Reap; 15 km on the south west of Siem reap. Just only 25 minutes drive, you will arrive at ancient-built port waiting to board the tourists on the boat to discover the attractive nature along the waterway. With one and a half hour exploration round trip, at first you will see a floating village where hundreds of families earn their living depending entirely by fishing in a traditional way by making 2 dollars a day in average. When you go further, there is an old pagoda constructed in 1964 on 2700 m^2 Island engulfed with water and a stopover to take photos of surrounding natural beauty such as floating houses, traditional fishing, people living, and children rowing boat to school. To travel further, you will go through an impressive flooded forests stretching over 24 km^2. The forest is a habitat of hundreds types of fish and waterbirds and from November to May, hundreds of waterbirds will come to this area to look for foods as it is a safe and full of proteins for those birds.

- **Kompong Khleang Village**

  The village of Kampong Khleang is on the northeast side of the lake, and can be reached by boat or road depending on the time of year. It is further away from Siem Reap than Kampong Phluk, and thus receives even fewer visitors. Kampong Khleang is actually two villages; an outer floating village, and an inner stilted village. It is a permanent community on the floodplain, and the economy is based on fishing. But it is much larger than Kampong Phluk with almost 10 times the population. During the dry season, the stilted houses rise up to 10 meters in the air, and in the rainy season, the water rises up to a meter or so below the floors of the buildings.

3.8.7 Social Condition in Zone 5 (Sounthern Vietnam and Mekong Delta)

The lowest river section of the Mekong River is the Mekong Delta that has an area of about 40,000 km2 with the population of approximately 17 million. In this zone, the

Mekong River splits into two main streams – Hau River and Tieng River. The Mekong Delta contains 13 provinces with 700 km of coastline. Social information of the area is shown in Table below.

Table 53: Social Information in Zone 5

No.	*Provinces*	*Area (km²)*	*Population (persons)*	*Density (persons/km²)*	*Population in 5 km corridor (persons)*
1	Can Tho	1,401.6	1,188,435	813.3	Total Households:
2	An Giang	3,536.8	2,142,709	625.0	
3	Bạc Liêu	2,584.1	856,518	317.4	Total
4	Ben Tre	2,360.2	1,255,946	573.4	Population:
5	Ca Mau	5,331.7	1,206,938	231.1	
6	Dong Thap	3,376.4	1,666,467	494.0	**12,487,310**
7	Hau Giang	1,601.1	757,300	497.7	
8	Kien Giang	6,348.3	1,688,248	265.4	
9	Long An	4,493.8	1,436,066	316.7	
10	Soc Trang	3,312.3	1,292,853	385.3	
11	Tien Giang	2,484.2	1,672,271	691.3	
12	Tra Vinh	2,295.1	1,003,012	451.7	
13	Vĩnh Long	1,479.1	1,024,707	714.6	
	Total	***40,604.7***	***17,191,470***	***423.4***	

Source: prepared and estimated by the study team

- **Can Tho**–The center province of the Mekong Delta has 9 districts (Ninh kieu, Cai Rang, Binh Thuy, O Mon, Thot Not, Phong Dien, Co Do, Vinh Thanh, and Thoi Lai. The capital city of Cantho was linked to Ho Chi Minh City through national Highway 1A and the Can Tho Bridge. Can Tho has an area of 1,401.6 km^2 with the population of about 1.2 million.
- **An Giang**– A border province on the Southwest has 9 districtsAn Giang has an area of 3,406 km^2 with the population of about 2.2 million.
- **Bạc Liêu –** The province is located in the south with its coast at the South China Sea. It has an area of 2,520.6 km^2 with the population of 860,000.

Figure 124: Map of the Mekong Delta Provinces in Southern Vietnam

- **Ben Tre**–This province is located in the low flow of the Mekong River bordering with South China Sea to the east. Ben Tre has an area of 2,322 km^2 with the population of 1.4 million.
- **Ca Mau**–It is called the land of peace located at the southernmost of Vietnam. The province is surrounded by the sea. It has an area of 5,329 km^2 with the population of 1.2 million.
- **Dong Thap**–This province is rich of fertile land well-known as one granary of Vietnam. It has an area of 3,376.4 km^2 with the population of 1.7 million.
- **Hau Giang**–The new province established in 1994. It locates in the heart of western sub-region of Hau River. It has an area of 1,608 km^2 with the population of about 800,000.
- **Kien Giang**–The province that has mountain and sea and the boder with Cambodia. It has large area of 6,347 km^2 with the population of about 1.7 million.
- **Long An**–Long An is the gateway to the Mekong Delta. The province is actually the transition land extending between the southeast and Southwest.It has an area of 4,493.8 km^2 with the population of about 1.5 million.

- **Soc Trang**-Soc Trang is the coastal province which is home of big communities of Khmer and Chinese people. It is also the rice bowl of the south. Soc Trang has an area of 3,331.8 km^2 with the population of about 1.3 million.
- **Tien Giang** -The province that locates near to Hochi Minh City. The main popular city called My Tho. It has an area of 2,482 km^2 with the population of about 1.7 million.
- **Tra Vinh**–This province locates on the lower section of the Mekong River. Tra Vinh is known as the land of green trees and ancient pagodas. It has an area of 2,292 km^2 with the population of about 1.0 million.
- **Vĩnh Long**-Vĩnh Long is compared as a microcosm of the Mekong Delta because of the diversity and prosperity of the land between two big rivers, Tien Giang and Hau Giang. It has an area of 1,475 km^2 with the population of about 1.0 million.

3.8.7.1 Population, Etnicity and Culture

The ethnicity of people in the Mekong Delta people are mainly Viet, with small minority groups of people living primarily in the Trà Vinh, Sóc Trăng, and Muslim Chăm in Tan Chau, by An Giang provinces. There are also sizeable Hoa (ethnic Chinese) populations in the Kiên Giang and Trà Vinh provinces. The Delta provinces have approximately 17 million people while the minority groups (Khmer, Hoa and Cham) was estimated around 6.5% of the total population in the Delta.

The Khmer are the largest group and the most economically and socially disadvantaged. Poor Khmer are similar to other poor in the region, tending to have little or no land and few opportunities for stable employment. The jobs available to them are mostly manual labor with low income. They are particularly vulnerable to economic shocks due to their limited assets. Poor Khmer also tend to be marginalized from mainstream village organizations, having little contact with commune officials and few opportunities to participate in community decision-making processes.

3.8.7.2 Socio-Economic Livelihoods

The Mekong Delta (including 13 provinces) has been a leading driver of national development and international trade. About 27% of the country's manufacturing firms and 29% of manufacturing workers are located in Ho Chi Minh City. The Provincial Competitiveness Index indicates that 10 of the 12 Delta provinces, along with Ho Chi Minh and Can Tho cities, are ranked in the top 22 positions, and national production statistics. Table below identifies the Delta as the main business center, rice and fisheries producer, and revenue earner in Vietnam.

Table 54: Economy of the Mekong Delta Province

Industry, agriculture, and fishery statistics	***Mekong Delta[a]***	***Percent in country***
Gross industry output (Billion VND)b	460,993	31
Net business turnover (Billion VND)c	1,194,230	35
Planted area of paddy rice ('000 Ha)	3,889	52
Production of paddy rice ('000 tons)	20,788	53

Number of farms	58,896	49
Number of fish farms	25,770	74
Aquaculture water surface (‘000 Ha)	762	72
Aquaculture shrimp production (tons)	315,691	81
Aquaculture fish production (tons)	1,428,972	77
Gross output of fisheries (Billion VND)	34,407	69
Production of fisheries (tons)	2,744,145	60

Source: B. Fabres, [a]I ncludes Ho Chi Minh City, Can Tho city, and 12 provinces,
[b] Current prices

The region is famous as a large rice growing area. It produces about half of the total of Vietnam's rice output. Vietnam is the second largest exporter of rice globally after Thailand.[10] In fact, the Delta produces more rice than Korea and Japan combined. Additionally, the region is home to large aqua-cultural industry of “Basa” fish, “Tra” catfish and shrimp, much of which is exported.

The construction of the CanTho Bridge, a cable-stayed bridge over the largest distributary of the Mekong River, was completed on April 12, 2010, three years after a collapse that killed 54 and injured nearly 100 workers. The bridge replaces the ferry system that currently runs along National Road 1A, and links Vĩnh Long Province and Cần Thơ city. The cost of construction is estimated to be 4.842 trillion Vietnamese đồng (approximately 342.6 million U.S. dollars), making it the most expensive bridge in Vietnam.

Despite the fact that the Mekong Delta comprises only around 10% of the total area of Vietnam, it plays a central role in country’s development. The Delta is also determined as a key area for the national food security strategy. Rice cultivation and aquaculture are dominant livelihood activities, although in recent years agricultural production has diversified significantly and also the importance of non-agricultural sector has increased.

The Delta contributes currently about half of the national food volume of the entire country, 55% of the national fishery and fruit production, and around 60% of the national export value. Despite the high agricultural production and economic growth, the Delta still remains as one of the poorest areas in Vietnam.

The challenges with poverty reduction have been linked, among other things, to the Delta’s low educational level, and resulting lack of human capital. When compared to the other parts of Vietnam, the education level in the Delta is remarkably low with 33% of the population having not finished their primary school. Thus, despite clear economic successes of long-term commitment in infrastructure development in the Delta, there are also drawbacks and challenges. While the problems related to water quantity have largely been solved, water quality problems have increased. With the construction of defensive water resources infrastructure, the Delta has become more physically interconnected and complex, and is now increasingly subject to human regulation.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

3.8.7.3 Environmental Condition

Hydrological management in the Mekong Delta to support agricultural development in the Delta region include: sea dykes, embankment, sluice gates, and pumping station for irrigation. These man-made infrastructures are used to control floods in the upstream part of the Delta areas. The results of effort have supported the increase in rice production to serve the whole country and become the world'ssecond largest rice export.

However, the agricultural development mainly involved the use of agricultural chemicals such as fertilizers and pesticides that created severely widespread environmental degradation and pollution in the area.

Some environmentproblemsintheMekongDeltaregionarecreatedbybothnatureand man. They include:

- Lowagriculturalproductivityduetohighlevelsof alum
- Pollutionofdrinkingwaterresourcesisseveredueto poorsanitationandincreaseduseofpesticides
- Naturalaquacultureresourceshavebeenexhausteddueto uncontrolled exploitation
- TheMelaleucaforestanditsassociated bio-ecologicalsystemhasbeenreducedanddepravitieswiththedevelopmentofagricultural land
- Localpeopleareincreasinglyawarethatenvironmentalpollutioncausesdangersforpeople'slifeand health. However, local people, especially the poor, experience difficultywhenprotectionoftheenvironmentcomesindirectconflictwiththeirlivelihood,cultureorcustoms.

Figure 125: Rice Field with Livestock *(left)* and Use of Chemicals *(right)* in Tra Vinh

The recent research by Buschmann, *et. al*. indicated that the lower Mekong Deltagenerally features saline groundwater. However, where groundwater salinity is <1 g L^{-1}Total Dissolved Solids (TDS), the rural populationstarted exploiting shallow groundwater as drinking water to replace microbially contaminated surface water. In the groundwater used asdrinking water, arsenic concentrations ranged from 0.1–1340 µg L^{-1}, with 37% of the studied wells exceeding the WHO guidelines of10 µg L^{-1}arsenic. In addition, 50% exceeded the manganese WHO guideline of 0.4 mg L^{-1}, with concentrations being particularly high inVietnam (range 1.0–34 mg L^{-1}). Other elements of (minor) concern are Ba, Cd, Ni, Se, Pb and U. Our measurements imply thatgroundwater contamination is of geogenic origin and caused by natural anoxic conditions in the aquifers. Chronic arsenic poisoning is themost serious health risk for the ~2 million people drinking this groundwater without treatment, followed by malfunction in children'sdevelopment through excessive manganese uptake. Government agencies, water specialists and scientists must get aware of the serioussituation. Mitigation measures are urgently needed to protect people from such health problems.

3.8.7.4 Health and Nutrition Condition

The World Health Organization indicates general health status of Vietnam as below:

- Life expectancy at birth male/female (years): 70/74
- Probability of dying under five (per 1 000 live births): 24
- Probability of dying between 15 and 60 years m/f (per 1 000 population): 173/107
- Total expenditure on health per capita (Intl $): 213
- Total expenditure on health as % of GDP: 7.2

In some region of Vietnam, 20-40% of children under 5 have been found to be sub-clinically vitamin A deficient.Meanwhile according to a survey conducted, the prevalence of anemia has fallen considerably, but remains high in pregnant women (29-35%) and children (32-38%).

In contrast, overweight and obesity issues have become an increasing community health problem since 1995 before which there was no report of this problem. In 2005, the National survey on overweight and obesity showed that the prevalence of overweight/obesity among the 45-54 age group was around 43% in urban and 17% in rural areas respectively.

Some conclusions and action needed to solve the newly emerging nutrition problems in a new context requires continuous and strong efforts in health and nutrition promotion. This includes the need to find effective solutions for childhood malnutrition, with sustainable reductions in stunting, underweight, vitamin A deficiency, iron deficiency anemia, and iodine deficiency disorders, along with measures to identify and control newly emerging nutrition problems.

Research by N. C. Khan and H. H. Khoi found that protein energy malnutrition in children remains a large challenge for community health and development in Vietnam. Until a few years ago, the percentage of malnutrition in Vietnam reduced impressively. However, the malnutrition rate is still high and varies greatly geographically, particularly with regard to stunting.Low birth weight and early malnutrition still prevail, especially in poor and underdeveloped regions. As a result of effective micro-nutrient deficiency prevention programs, there have been definite improvements with regard to vitamin A deficiency as well as iodine deficiency disorders and nutritional anemia. However, subclinical vitamin A deficiency (assessed by serum vitamin A) still exists and varies by region, even with the implementation of on-going universal and periodical vitamin A supplementation programs throughout the country.

Figure 126: Healthy Children in Vinh Long

3.8.7.5 Tourism

3.8.7.5.1 Tourist Attraction in Mekog Delta Province

The Mekong Deltahas its specific way of life of the people. It'soften referred to as Vietnam's rice basket. It's the biggest rice-growing region in the country with rich alluvial soils producing three harvests a year. Despite being a predominantly rural region, the Mekong Delta is one of the most densely populated areas in Vietnamand most of the land is under cultivation. Other Delta products include coconut, sugar cane, fruit and fish.

The main towns of the Delta are My Tho, Vinh Long, Can Tho and Chau Doc. Driving south from Ho Chi Minh City, My Tho is the first major Mekong Delta town you come to. Its proximity to Ho Chi Minh City has made My Tho the most popular destination for day-trippers to learn about Delta life.

Figure 127: Tourists at My Tho Preparation for Waterway Tourism

The other popular destination for day-trippers from Ho Chi Minh City is Vinh Long, another 65km deeper into the Delta. The islands in the Mekong River rather than the town itself are the highlight of a trip to Vinh Long. Most of the islands are given over to fruit orchards and the narrow canals are often straddled by flimsy-looking wooden bridges made from the trunks of coconut palms or bamboo and known as monkey bridges. An early morning visit to nearby Cai Be Floating Market offers great photographic opportunities as all manner of produce is traded from boats. To make shopping easier the boats suspend a sample of what they sell from the top of a long pole. On the way back to Vinh Long it is possible to stop off to visit small riverside workshops including blacksmiths and rice huskers. Just over 30km and a ferry ride away from Vinh Long isCan Tho**,** the bustling commercial centre of the Mekong Delta. Can Tho is one of the more attractive Delta towns but as in the rest of the Mekong Delta the best sights are on the water.

The Delta's biggest floating market, Cai Rang Floating Market, is 6km from Can Tho and well worth an early morning visit.

For a memorable boat trip, the Victoria Can Tho Hotel operates sunrise and sunset cruises on the Lady Hau, a renovated traditional rice barge.

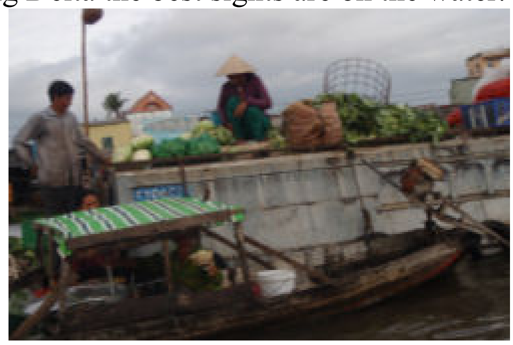


Figure 128: Cai Rang Floating Market

Chau Doc, nestling at the foot of **Sam Mountain** on the Cambodian border, has a real frontier town feel to it. This busy little riverine town has large Cham, Khmer and ethnic Chinese communities and the distinctive architectural styles of each community can be seen in their places of worship around the town. A boat trip on the river is the best way to see the unusual floating fish farms, houses with wooden pens suspended underneath where live fish are kept. Chau Doc's Sam Mountain is home to dozens of temples and shrines and is a popular pilgrimage site for ethnic

Chinese as well as Vietnamese.

3.8.7.5.2 Number of Visitors

According to the General Statistics Office - GSO, the number of international visitors to Vietnam in December estimated 449,570 arrivals, increasing by 19.0% over the same period last year. Total international arrivals reached 5,049,855 representing a 34.8% growth.

For Mekong Delta area, the Mekong Delta Tourism Association revealed that it has attracted more than 10 million visitors since the beginning of the year, up 720,000 compared to last year's period and earning a record high of VND 1,700 billion.

In comparison, Can Tho City had highest number of tourists followed by An Giang, Kien Giang, and Ca Mau. The rise in number of tourists is attributed to Mekong provinces and cities' coordinating for training the human resources, establishing tourism promotion centers, launching a website providing tourist information and diversifying and improving the quality of tourism products. In addition, the region has invested hundreds of billions of VND to upgrade infrastructure for the industry and encouraged diverse economic sectors to invest in tourism.

Table 55: Number and Type of International Tourist to Vietnam

Descriptions	Dec. 2010 (est)	12 months of 2010	Dec. 2010 vs. Nov. 2010 (%)	Dec. 2010 vs. Dec. 2009 (%)	12 months 2010 vs. 12 months 2009 (%)
Total	**449,570**	**5,049,855**	**105.0**	**119.0**	**134.8**
By means of transportation					
By air	365,070	4,061,712	104.8	119.1	134.2
By sea	4,500	50,500	112.5	104.7	76.6
By road	80,000	937,643	105.3	119.5	143.0
By purposes of trips					
Tourism	258,689	3,110,415	105.1	109.3	138.8
Business	91,129	1,023,615	102.7	125.5	137.9
Visiting relatives	53,841	574,082	108.2	112.7	110.9
Others	45,911	341,743	105.0	221.5	138.6
By countries and territories					
China	72,279	905,360	117.9	152.5	174.5
South Korea	45,529	495,902	99.4	134.9	137.7
Japan	43,517	442,089	100.9	135.9	124.0
USA	35,585	430,993	95.3	98.2	106.9
Taiwan	27,455	334,007	100.5	110.9	123.7
Australia	26,803	278,155	118.2	106.1	128.1
Cambodia	20,839	254,553	127.7	1,517.8	215.2
Thailand	21,459	222,839	105.9	117.2	139.7

Malaysia	23,818	211,337	117.2	116.6	127.6
France	17,058	199,351	78.5	113.1	115.3
Others	115,228	1,275,269	102.8	93.5	126.9

The tourism sectors in Can Tho City and An Giang, Kien Giang, and Ca Mau provinces are also cooperating to develop tourism in the Mekong Delta key economic zones for the 2011-2015 period with a vision to 2020.As the country's leader in promoting orchard tourism, Can Tho has made great efforts to diversify its tourism products. The infrastructure of 20 ecological tourism areas has been upgraded and 154 new hotels have been built by different economic sectors to meet the demands of the growing numbers of visitors.

4 HYDROLOGY AND SEDIMENT CHANGED FROM THE PROJECT DEVELOPMENT

4.1 Development of Scenarios and Modeling Approach

4.1.1 Background

In terms of classification by upstream and downstream of the river, the PaklayHPP is located in the upstream section of the Lower Mekong Basin.

The development of Paklay HPP may have significant positive or negative impacts on transboundary environmental and social parameters along the Mekong River, especially at areas downstream from the project. PaklayHPP Development Scenarios were created to provide an appreciation of how different water related developments within the basin impact upon the economic, environmental and social objectives of MRC member countries, which enablesan examination of the trade-offs between different types of development.

4.1.2 The PaklayHPP Development Scenarios (2017 and 2030)

The PaklayHPP Development Scenarios fall into four main categories:

1. *Baseline Situation*
   This scenario was developed to compare the existing conditions with future developments conditions. The hydrological situation of the years 1995-2010 and existing development projects up to year 2011 were used for this scenario. The study areas were divided into 5 zones as shown in Figure 4.1-1

2. *Paklay Hydropower Project Situation*
   This scenario was developed to assess the transboundary impacts of the PaklayHPP development and other developments that could occur up to the time that the PaklayHPP starts to operate.

3. *Definite Future Situation year 2017*
   This scenario was developed to assess the transboundary impacts of developments that are going to occur by 2017 (i.e. those built since 2011, under

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

construction, or already firmly committed), including the new dams on the Lancang River (in China) and 33 significant tributary reservoir developments in the LMB.

4. *Foreseeable Future Situation*
   This scenario was developed to assess the impacts of LMB countries water resources development plans up to 2030, including irrigation expansion (1.6M hectares), water supply demands, the 11 proposed mainstream dams and additional 30 tributary dams. The scenarios investigate the transboundary impacts of these proposed developments, with and without various combinations of mainstream dams ("20-year plan scenarios").

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

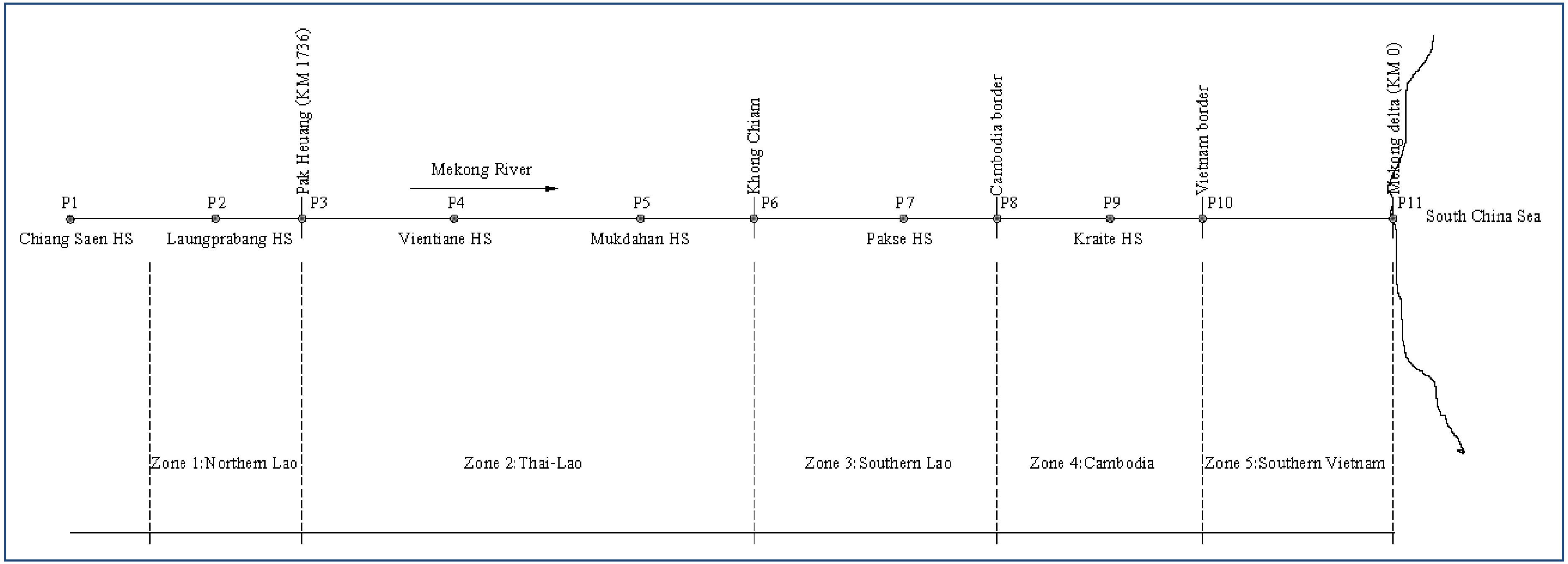


Figure 129: Study Zones for Development Scenarios

4.1.3 The Hydrologic Models

Hydrology is the main governing backbone of all kinds of water movement and hence of water-related pollutants. Understanding the hydrology of a watershed and modeling different hydrological processes within a watershed are therefore very important for assessing the environmental and economical well-being of awatershed(Manoj Jha, 2009). Simulation models of watershed hydrology and water quality are extensively used for water resources planning and management. For this study, the SWAT (Soil and Water Assessment Tool) developed by the U.S. Department of Agriculture (USDA) was used to assess the hydrology and water quality of Mekong basin based on the 4 scenarios.

SWAT is a physically based model and offers continuous-time simulation, a high level of spatial detail, an unlimited number of watershed subdivisions, efficient computation, and the capability of simulating changes in land management. It operates on a daily time step and is designed to predict the impact of management on water, sediment, and agricultural chemical yields. SWAT models water flow, sediment transport, crop/vegetation growth, and nutrient cycling. The model allows users to model watersheds with less monitoring data and to assess predictive scenarios using alternative input data such as climate, land-use practices, and land cover on water movement, nutrient cycling, water quality, and other outputs. Major model components include weather, hydrology, soil temperature, plant growth, nutrients, pesticides, and land management. Several model components have been previously validated for a variety of watersheds.

In SWAT, a watershed is divided into multiple sub-watersheds, which are then further subdivided into Hydrologic Response Units (HRUs) that consist of homogeneous land use, management, and soil characteristics. The HRUs represent percentages of the sub-watershed area and are not identified spatially within a SWAT simulation. The water balance of each HRU in the watershed is represented by four storage volumes: snow, soil profile (0-2 meters), shallow aquifer (typically 2-20 meters), and deep aquifer (more than 20 meters). The soil profile can be subdivided into multiple layers. Soil water processes include infiltration, evaporation, plant uptake, lateral flow, and percolation to lower layers. Flow, sediment, nutrient, and pesticide loadings from each HRU in a sub-watershed are summed, and the resulting loads are routed through channels, ponds, and/or reservoirs to the watershed outlet.

For this study the Lower Mekong Basin was divided into 43 sub-watersheds as shown in Figure 131. The input data for the developed SWAT model was shown in Table 59 and 60. The developed SWAT model was calibrated at 5 stations (Luang Prabang, Vientiane, Nakhon Panom, Mukdahan, and Pakse) as shown in Figure 132to 136 before being used for watershed assessment.

Table 56: Input data for SWAT model

Input Data	Data sources
DEM 90m (SRTM)	CGIAR-CSI
Land use Map	USGS
Soil Type Map	FAO/UNESCO
GIS	MRC
Meteorological data	http://www7.ncdc.noaa.gov/CDO/cdo
Reservoir data	Paklay Feasibility stusy
Hydrologic data	MRC

Table 57: Meteorological Stations used in SWAT model

Sta. Type	Sta. Name	Country	Lat.	Long.	Elev.
Rain Gage	PCP_Mengla_CI	China	21.500	101.583	633.0
	PCP_Chiang Rai_TH	Thailand	19.967	99.883	393.0
	PCP_Nong Khai_TH	Thailand	17.867	102.717	175.0
	PCP_Loei_TH	Thailand	17.450	101.733	254.0
	PCP_Sakon Nakhon_TH	Thailand	17.150	104.133	172.0
	PCP_Udon Thani_TH	Thailand	17.383	102.800	182.0
	PCP_Mukdahan_TH	Thailand	16.533	104.717	139.0
	PCP_A. Si Chomphu_TH	Thailand	16.800	102.190	200.0
	PCP_A. Kranuan_TH	Thailand	16.707	103.083	200.0
	PCP_Khon Kaen_TH	Thailand	16.433	102.833	166.0
	PCP_Surin_TH	Thailand	14.883	103.500	147.0
	PCP_Vinh_VS	Vietnam	18.667	105.683	6.0
	PCP_Dong Hoi_VS	Vietnam	17.483	106.600	8.0
	PCP_Phan Thiet_VS	Vietnam	10.933	108.100	5.0
	PCP_Tan Son Hoa_VS	Vietnam	10.817	106.667	5.0
Temperature Gage	Temp_Mengla_CI	China	21.500	101.583	633.0

Sta. Type	Sta. Name	Country	Lat.	Long.	Elev.
	Temp_Chiang Rai_TH	Thailand	19.967	99.883	393.0
	Temp_Nong Khai_TH	Thailand	17.867	102.717	175.0
	Temp_Loei_TH	Thailand	17.450	101.733	254.0
	Temp_Sakon Nakhon_TH	Thailand	17.150	104.133	172.0
	Temp_Udon Thani_TH	Thailand	17.383	102.800	182.0
	Temp_Mukdahan_TH	Thailand	16.533	104.717	139.0
	Temp_Khon Kaen_TH	Thailand	16.433	102.833	166.0
	Temp_Surin_TH	Thailand	14.883	103.500	147.0
	Temp_Vinh_VS	Vietnam	18.667	105.683	6.0
	Temp_Dong Hoi_VS	Vietnam	17.483	106.600	8.0
	Temp_Phan Thiet_VS	Vietnam	10.933	108.100	5.0
	Temp_Tan Son Hoa_VS	Vietnam	10.817	106.667	5.0
Wind Gage	Wind_Mengla_CI	China	21.500	101.583	633.0
	Wind_Chiang Rai_TH	Thailand	19.967	99.883	393.0
	Wind_Nong Khai_TH	Thailand	17.867	102.717	175.0
	Wind_Loei_TH	Thailand	17.450	101.733	254.0
	Wind_Sakon Nakhon_TH	Thailand	17.150	104.133	172.0
	Wind_Udon Thani_TH	Thailand	17.383	102.800	182.0
	Wind_Mukdahan_TH	Thailand	16.533	104.717	139.0
	Wind_Khon Kaen_TH	Thailand	16.433	102.833	166.0
	Wind_Surin_TH	Thailand	14.883	103.500	147.0
	Wind_Vinh_VS	Vietnam	18.667	105.683	6.0
	Wind_Dong Hoi_VS	Vietnam	17.483	106.600	8.0
	Wind_Phan Thiet_VS	Vietnam	10.933	108.100	5.0
	Wind_Tan Son Hoa_VS	Vietnam	10.817	106.667	5.0

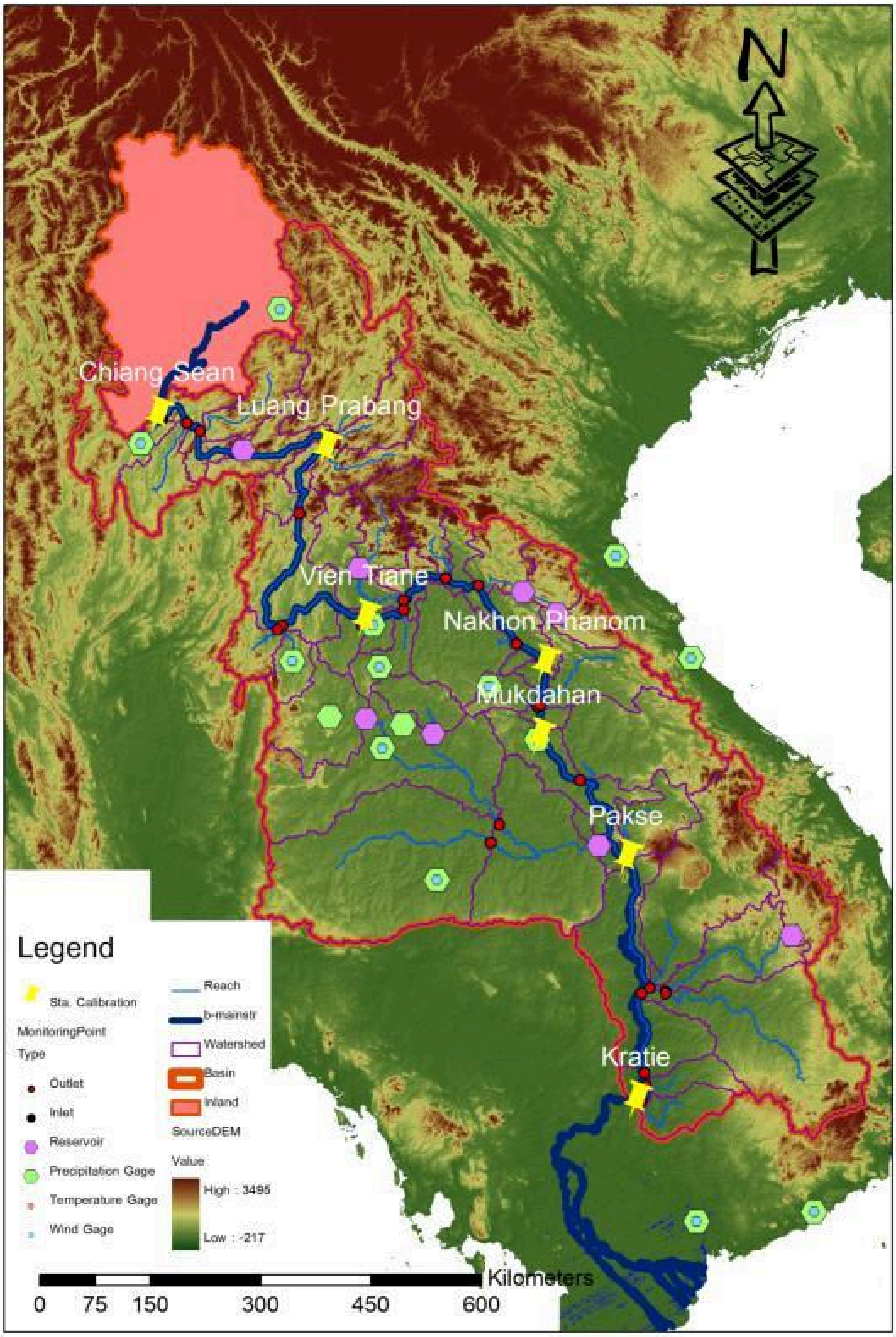


Figure 130: Sub-watersheds of Lower Mekong Basin Input in SWAT model

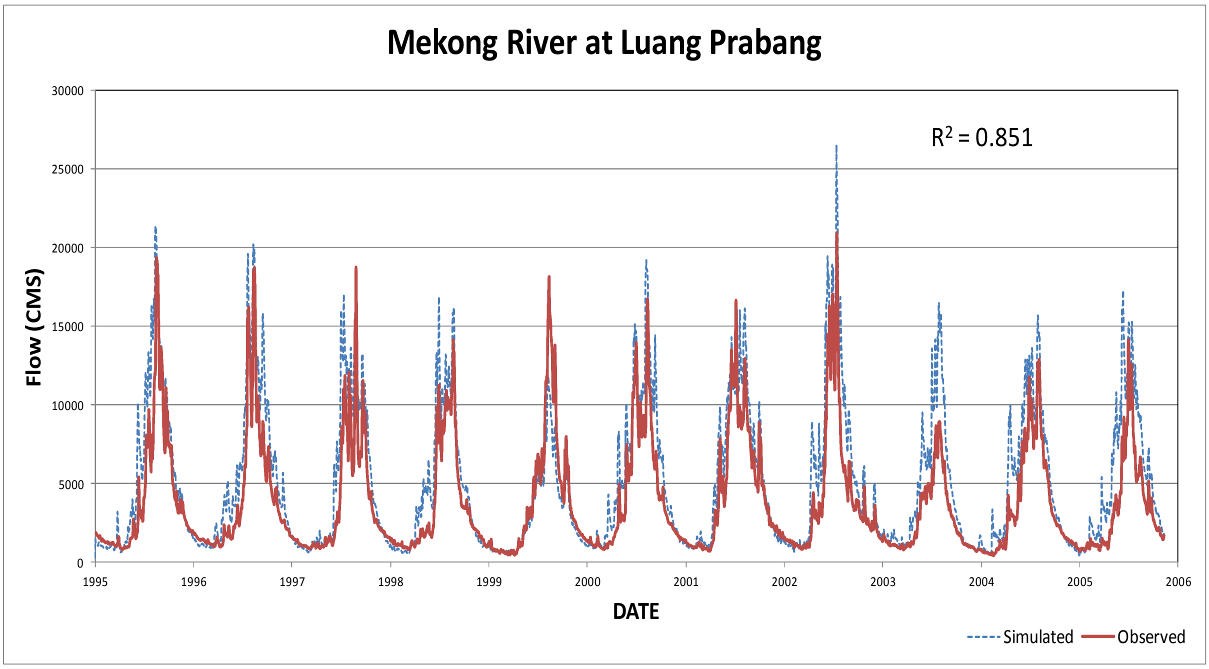


Figure 131: Model calibration at Luang Prabang station

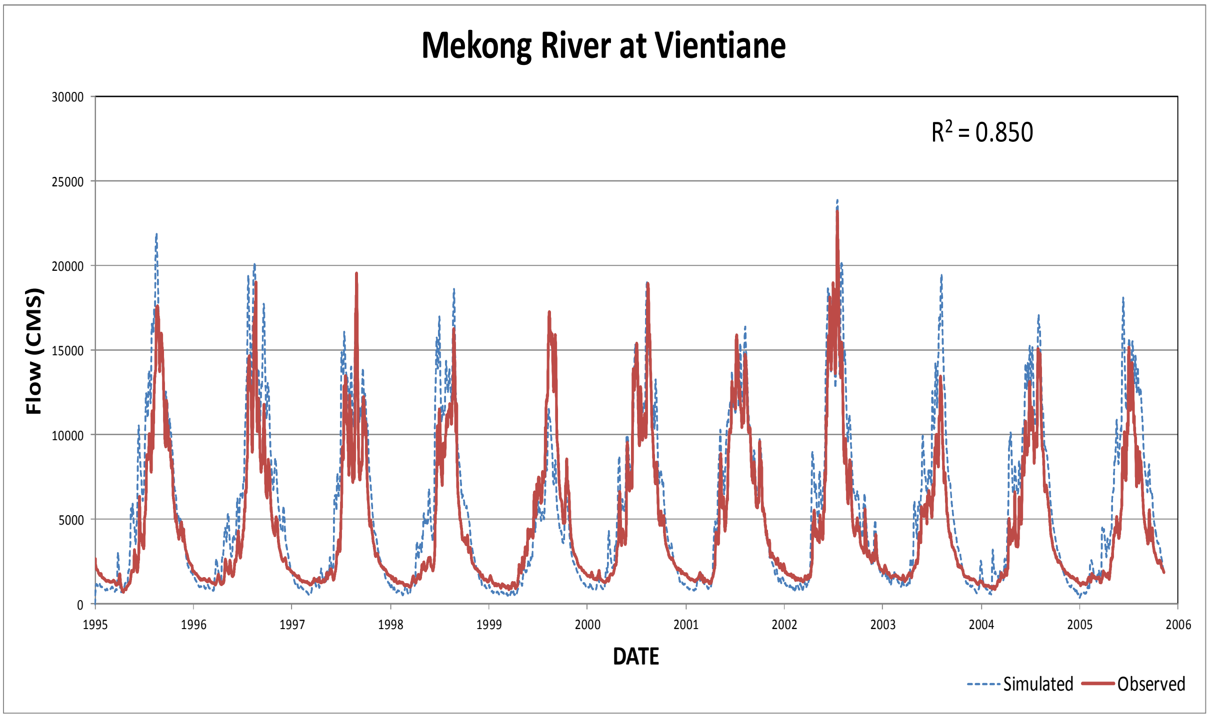


Figure 132: Model Calibration at Vientiane Station

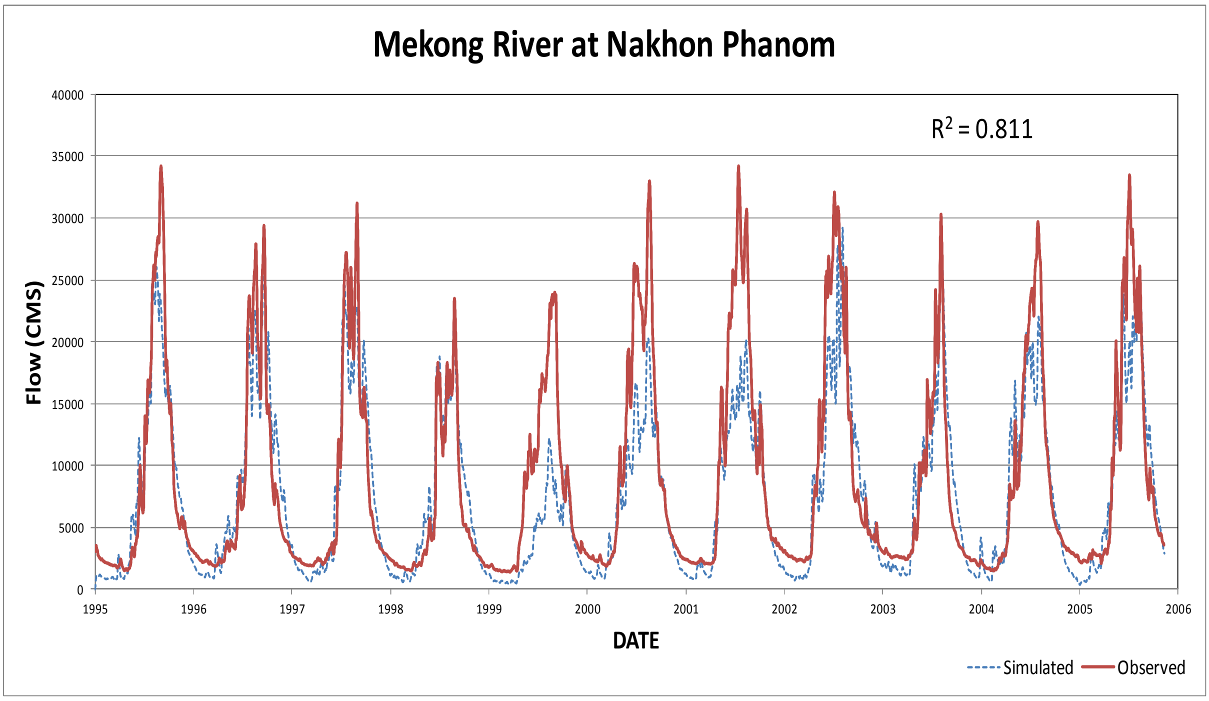


Figure 133: Model Calibration at Nakhon Phanom Station

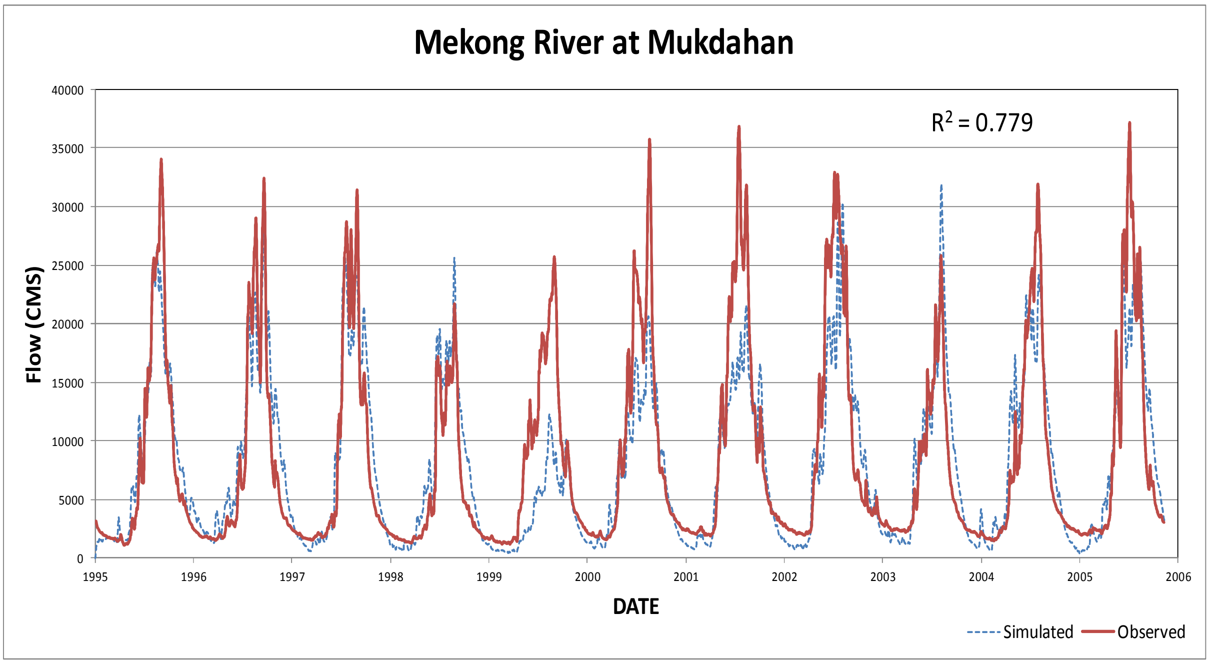


Figure 134: Model Calibration at Mukdahan Station

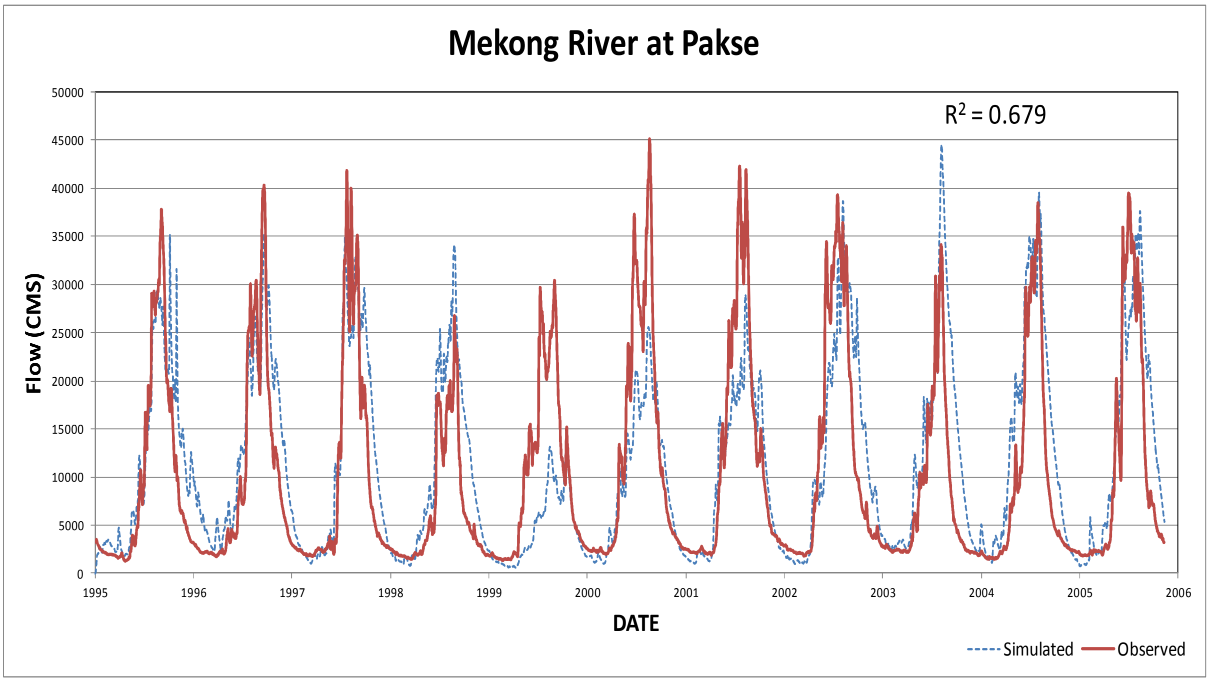


Figure 135: Model Calibration at Pakse Station

4.2 Hydrological and Sedimentation Changes

4.2.1 Detail Analysis of Flow

4.2.1.1 Changes in wet and dry season mainstream flows

The simulated flow with PaklayHPP using the SWAT model was compared with the baseline flow at 6 stations as shown in Figure 4.2-1 to 4.2-6. It shows clearly that the Paklay HPP will have a substantial impact on the natural flow regime of the mainstream river. This new dam will store and release water in the wet season reducing flood peaks and, significantly, will cause increased flows during the dry season. These changes will result in an increase in dry season flows at Kratie of 20% on average. In contrast, wet season discharges will reduce by about 4% on average.

The difference between the baseline and the scenarios is most marked at the northerly end (e.g. Vientiane) where the influence of the upper mainstream dam scenario is greatest and, as shown, these effects (flow change) diminish further downstream as the effect attenuates.

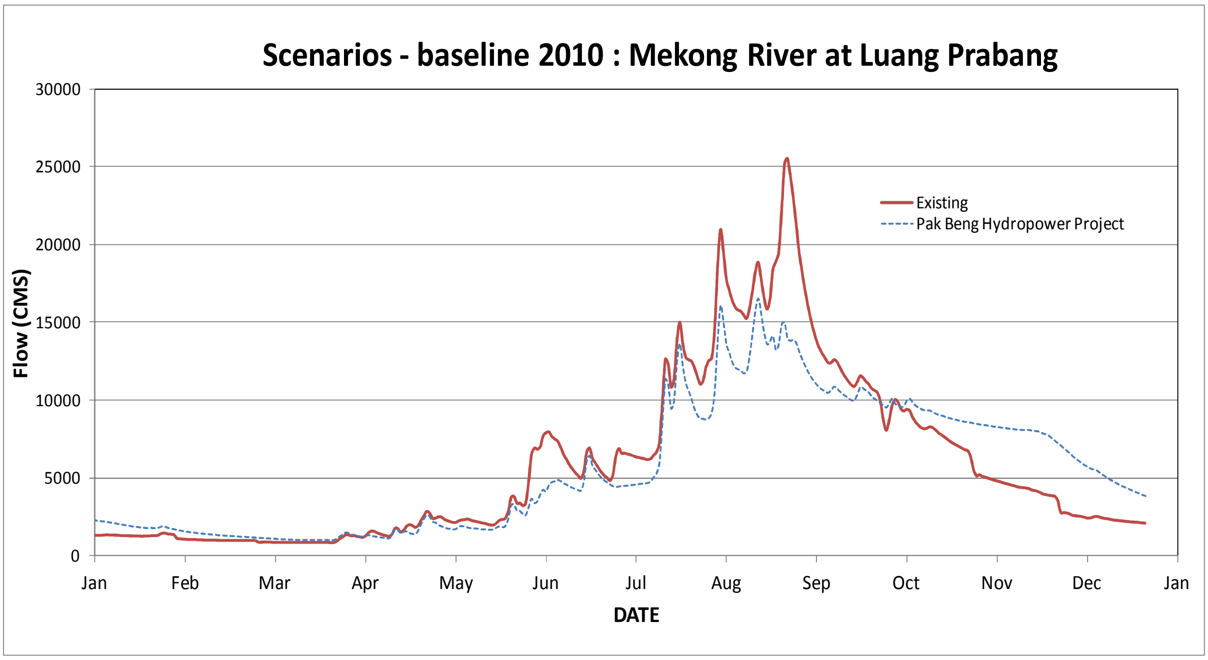


Figure 136: Comparison of Daily Discharge of Year 2010 at Luang Prabang Station with and without Paklay HPP

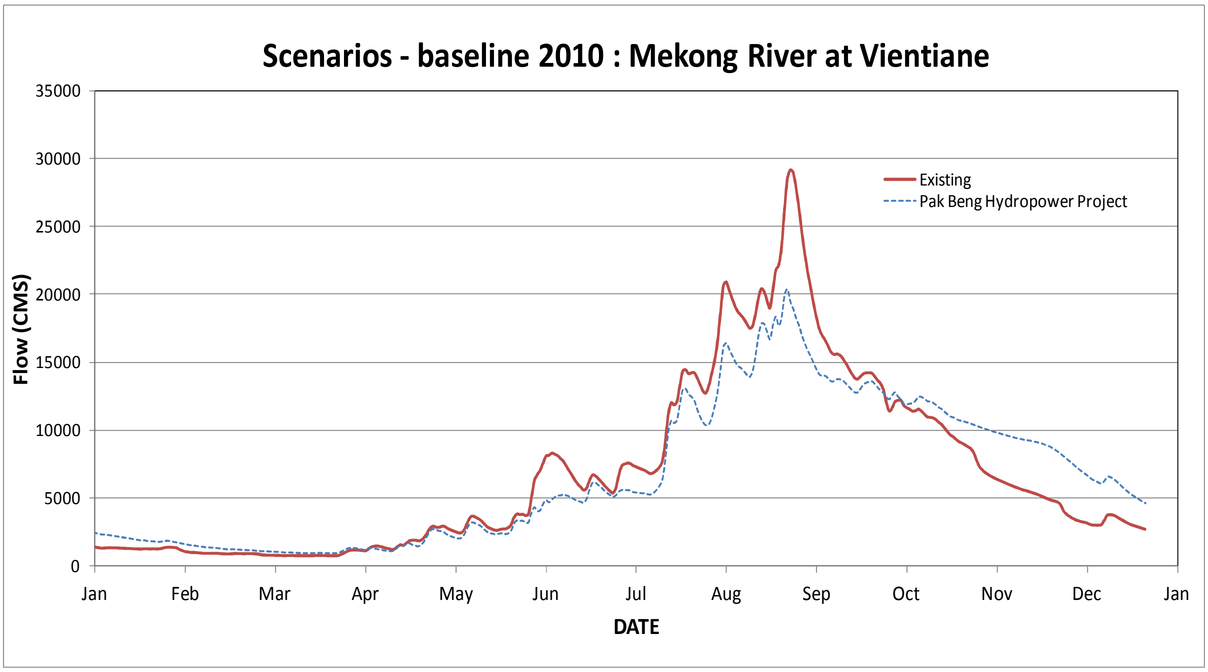


Figure 137: Comparison of Daily Discharge of Year 2010 at Vientiane Stationwith and without Paklay HPP

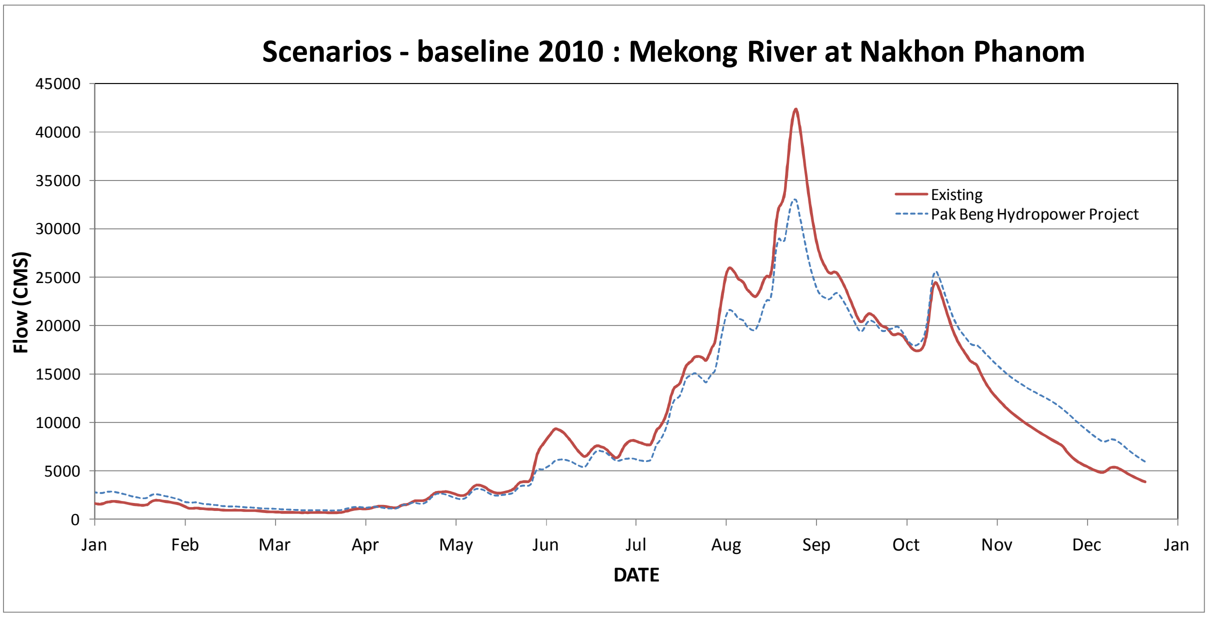


Figure 138: Comparison of Daily Discharge of Year 2010 at Nakhon PhanomStation with and without Paklay HPP

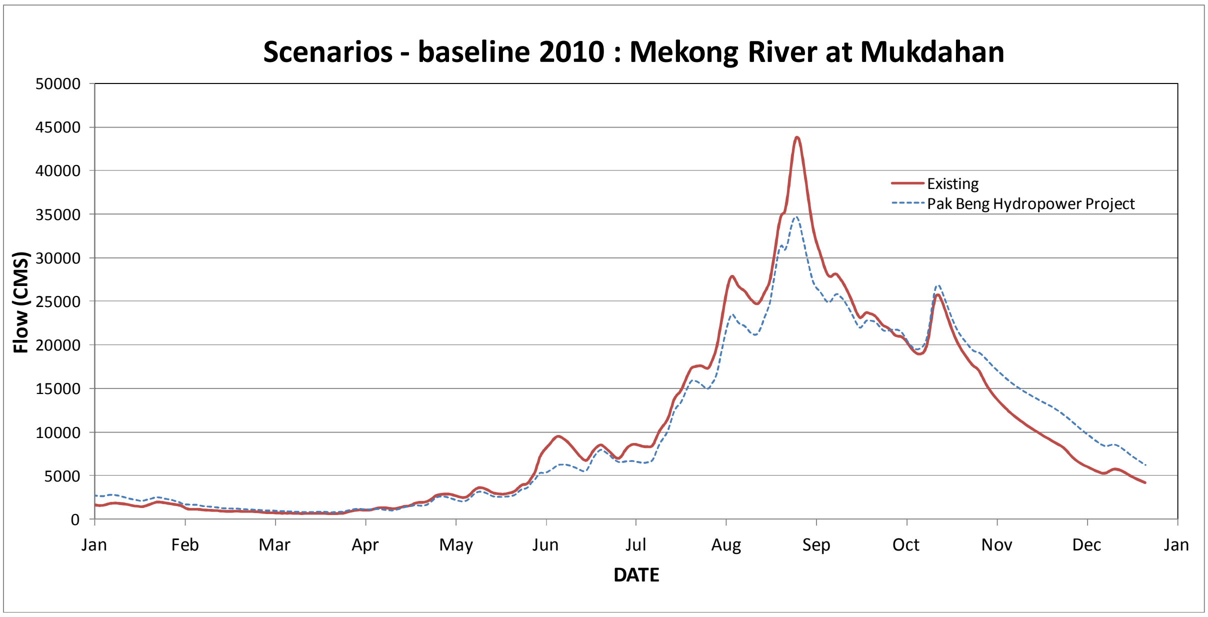


Figure 139: Comparison of Daily Discharge of Year 2010 at MukdahanStation with and without Paklay HPP

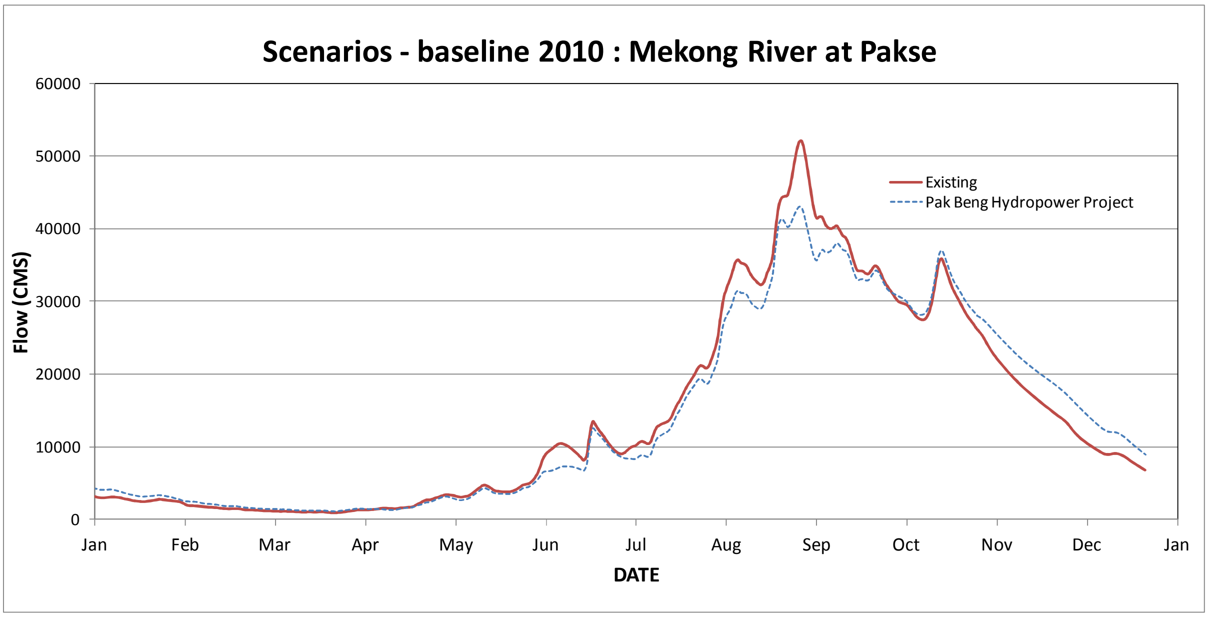


Figure 140: Comparison of Daily Discharge of Year 2010 at PakseStation with and without Paklay HPP

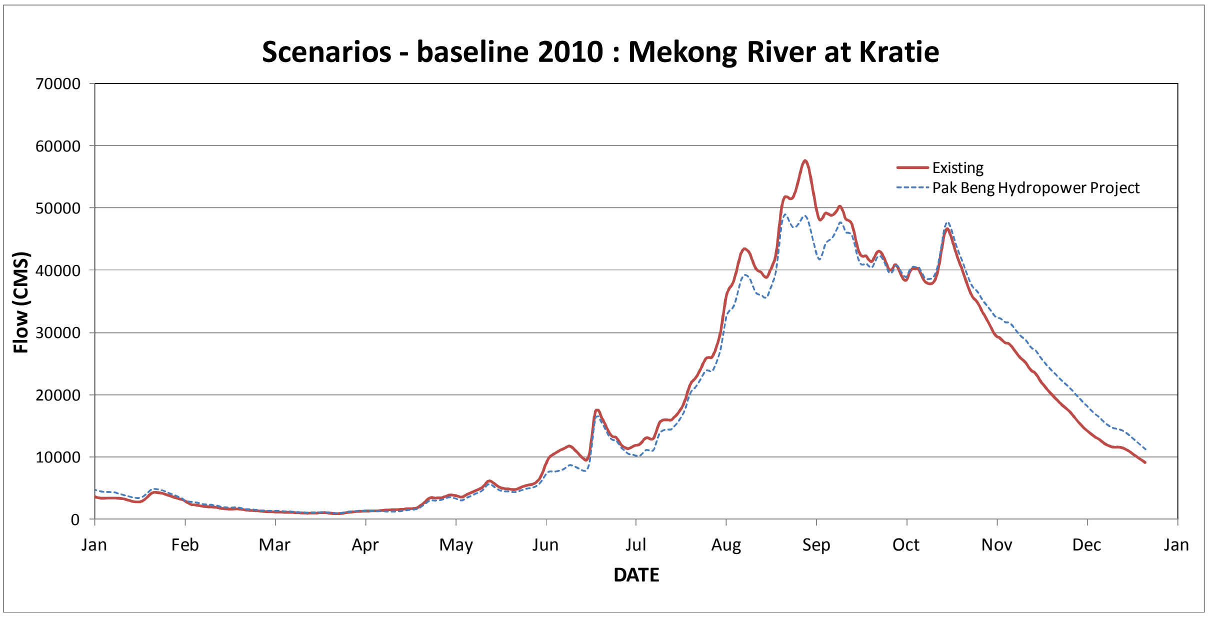


Figure 141: Comparison of Daily Discharge of Year 2010 at KratieStation with and without Paklay HPP

4.2.1.2 Foreseeable Future Scenarios - further changes up to 2030

According to the MRC's scenarios, the developments included in the Foreseeable Future Scenarios include the rapid expansion of irrigation by 50% over and above current levels (as included in the Definite Future Scenario) and the construction of a further 30 tributary hydropower dams with an additional active storage of 20.7 BCM (representing a 50% increase over the Definite Future Scenario), raising total active storage in the basin to 15% of the MAR.

In addition the Foreseeable Future Scenarios include all or some of the 11 identified mainstream dams in the LMB. These are run-of river dams and potentially add up to only a further 5.2 BCM of active storage in total. Thus, in broad terms, the mainstream dams in the LMB would have only marginal effect on the overall mainstream flow volumes, which is reflected in the similarity of all Foreseeable Future hydrographs.

However, the operation of the mainstream dams can cause significant downstream fluctuations during any one day if they are operated as peaking projects. In this case, water level fluctuations locally may amount to typically 2-4 m or more in extreme cases. The mainstream dams are generally sized and sited at intervals where the backwater effects of one reaches close to the next. Thus, although they may have a small effect at basin-scale on flow volumes, water levels will be significantly affected both up and downstream of their sites.

The planned 50% increase in irrigation abstractions over current levels would be more than offset by the planned increase in active storage on the LMB tributaries. Compared to the new flow regimes established under the Definite Future Scenario, the different Foreseeable Future Scenarios would cause an average further net increase of overall dry season flow volumes of typically 9-12% with about a further 4% reduction in wet season flow. In March, during the dry season, average daily flows would be expected to become typically between 30% and 100% above baseline conditions, representing a further increase over the Definite Future Scenario of between 7% and 19%, depending on location along the mainstream and the scenario under consideration.

Peak daily discharges during the flood season would be somewhat less affected, being typically between 4% and 15% less than the baseline and between 2% and 4% below Definite Future conditions.

Whilst the picture that emerges is that with the developments as set out in the scenarios, in all cases the average monthly flows in the dry season will be exceeded relative to the Baseline.

However, more detailed assessments have been made at the transitions between the wet and dry season. In early December, water levels predicted for Tan Chau, whilst averaging higher than the baseline, are below the baseline by typically 5cm only in up to 20% of the years simulated. At end of the dry season during May similar circumstances arise right at the end of the month. These small deficits could possibly be removed with minor adjustments to upstream reservoir operating rules.

In dry years (without climate change) the percentage changes in flooded areas tends to be less with changes in Lao PDR and Thailand being smaller (typically below -3% for all scenarios compared to the Baseline) compared to Cambodia (9-12.5%) and Vietnam (3.5%) compared to the Baseline for all scenarios. By contrast in a wet year, flooding in Lao PDR and Thailand, compared to the Baseline, increases somewhat whereas in Cambodia and Vietnam the total flooded area decreases slightly.

4.2.1.3 *Flooded Areas*

The attenuation of flood season flows due to increasing amounts of storage envisaged within the basin under the different storages would have a consequential effect on year-to-year average flooding. The total area inundated by the mainstream flooding in an average hydrological year reduces from 4.76 Mha to 4.45 Mha (-7%) going from the Baseline to the LMB 20-Year Plan Scenario. In percentage terms, changes are biggest in Thailand (-21.8%) and Lao PDR (-18.6%), are moderate in Cambodia (-6.5%) and small in Vietnam (-0.9%). In a dry year changes in Lao PDR and Thailand are smaller, only about 3%, in Cambodia bigger (-9%).

Under the Long Term Development and Very High Development scenarios the flooded areas decrease by a further 8%.

As may be seen, in absolute terms the reductions in flooded areas (without climate change) are greatest in Cambodia (up to 142,000 ha reduction under the 20-year plan and potentially more in the longer term). However, when climate change is taken into account, the total flooded area in Cambodia is estimated to increase by 13% (286,000ha) under the 20-year plan scenario. A similar trend is forecast across the overall basin with total flooded areas increasing by 6% in both the 20-year and long term scenarios with climate change.

4.2.1.4 *Flow reversal in the Tonle Sap River*

Flow reversal in the Tonle Sap River will also be affected. In the baseline the average start date for flow reversal is about 24 May with the natural year-to-year variation by +/- 19 days (5 May- 12 June). In comparison with the baseline, flow reversal occurs typically on average 3 days earlier and with slightly increased variability. Also the flow reversal volume into the Tonle Sap Lake reduces on average by 7-8%. Whilst, by comparison, the natural year-to-year variation in flow volume amounts to up to about 300%, it will be appreciated that the forecast changes indicate a downward trend in flow reversal volume.

4.2.1.5 *Salinity intrusion*

As a consequence of the increased dry season flows, salinity intrusion will also reduce with the area potentially affected each year being 15% less than currently observed (272,000 ha).

4.2.2 Details Analysis of Sedimentation

This section aims to present the calculation of natural sediment runoff at the Paklay Dam site and its impacts. It was carried out by reviewing the project reports and relevant published documents. The SWAT model was also applied to estimate the suspended sediment concentration at various stations downstream of the dam site.

4.2.2.1 Estimation of Sediment Load at Paklay Dam Site

According to the Feasibility Study Report of Paklay HPP (SINOHYDRO et al., 2011), the suspended sediment load data at Chiang Khan hydrological gauging station, located at 101 km downstream of the dam site, was taken into accountfor sediment assessment at the dam site. There were 46 years (during 1960 – 2005) of observed suspended load available. It was found that the average amount of suspended sediment at Paklaydamsite was 66.7 Mt/yr and the mean annual sediment concentration was 0.51 kg/m^3. The mean annual suspended sediment was about 63.7 Mt accounting for 95.5% of the total annual load, during the flood season (June – November), the rest was 3.0 Mt (or 4.5%) during the non-flood season (December – May). They also mentioned that due to the effects of cascade hydropower projects upstream, the mean annual suspended sediment concentration flowing into the reservoir was only 60% of the natural sediment concentration, which was about 40.04 Mt/yr.

Furthermore, SINOHYDRO (et al.,2011) also calculated the bed load sediment by assuming that the bed load was approximately 3% of the suspended one, which obtained the total bed load at Paklaydamsite to be 2.0 Mt/yr. Similarly to the suspended load, after considering the sediment retaining in the upstream cascades, the bed load runoff at the dam site was therefore decreased to be about 1.20 Mt/yr accounting for 60% of the natural yield.

It could be therefore concluded that SINOHYDRO et al., (2011) calculated the amount of suspended load and bed load at the Paklay Dam site to be about 40.04 Mt/yr and 1.20 Mt/yr respectively, which accounting for 60% of the natural yield.

Besides, both suspended load and bed load grain size grading were also presented in the report as shown in Table 61. It was found that the mean and the average grain size of the suspended load were 0.015 mm and 0.068 mm respectively.

Table 58: Grain size distribution of suspended load and bed load sediment at Paklay Dam Site

<table>
<tr><td colspan="10">Suspended Load Sediment</td></tr>
<tr><td colspan="3">Grain size (mm)</td><td>0.005</td><td>0.01</td><td>0.05</td><td>0.10</td><td>0.25</td><td>0.50</td><td>1.00</td></tr>
<tr><td colspan="3">Percentage (%)*</td><td>27.2</td><td>42.2</td><td>70.0</td><td>80.6</td><td>94.1</td><td>99.2</td><td>100.0</td></tr>
<tr><td colspan="10">Bed Load Sediment</td></tr>
<tr><td>Grain size (mm)</td><td>2</td><td>5</td><td>10</td><td>20</td><td>40</td><td>60</td><td>80</td><td>100</td><td>200</td></tr>
<tr><td>Percentage (%)*</td><td>1.2</td><td>9.6</td><td>12.5</td><td>13.4</td><td>16.6</td><td>9.7</td><td>9.5</td><td>11.2</td><td>16.4</td></tr>
</table>

* Percentage refers to the weight of sediment less than the grain size.

However, Thorne stated that 10% of the total sediment load consists of coarse sediment or bed load, with the rest constituting the fine sediment load. That estimation was based on their judgment and experience from other large rivers. Moreover, the International Centre for Environment Managementestimated the bed load proportion of tributary sediment load for 11 sites in the Sesan, Sekong and Srepok (3S) river basins. It was found that the average bed load comprised 11 -12% of the total load, as illustrated in Table 62.

According to the above mentioned references, the total bed load at Paklaydamsite should be re-estimated to be 10% of the suspended load, which yields about 4.0 Mt/yr. It could be therefore summarized that the annual average quantity of suspended sediment load and the annual average bed load at the damsite are 40.04 Mt and 4.0 Mt respectively.

Table 59: Sediment load and storage capacity of 11 tributaries in the Sesan, Se Kong and Srepok (3S) river basins

Reservoir	River	Reservoir Capacity (MCM)	Total Sediment Load (MCM/yr)	Bed Load		Trapping Efficiency (%)	Sediment Retained (MCM/yr)
				(MCM/yr)	(%)		
Nam Theun 1	Nam Theun	6,000	0.679	0.062	9.13	0.95	0.645
Sekong 4	Sekong	7,750	0.279	0.035	12.54	0.98	0.273
Sekong 5	Sekong	4,750	0.374	0.049	13.10	0.98	0.367
Xe Kaman 3	Sekong	1.6	0.184	0.024	13.04	0.04	0.007
Nam Kong 1	Sekong	600	0.097	0.009	9.28	0.96	0.093
Huay Lamphan Gnai	Sekong	85	0.046	0.006	13.04	0.96	0.044
Low Srepok 2	Srepok	12,200	1.099	0.143	13.01	0.66	0.725
Low Sesan 2	Sesan	1,581	1.120	0.144	12.86	0.98	1.098
Sesan 3	Sesan	140	0.283	0.030	10.60	0.56	0.158
Sesan 4	Sesan	2,250	0.789	0.087	11.03	0.93	0.734
Upper Kontum 2	Sesan headwater	357	0.291	0.038	13.06	0.96	0.279
Total		**35,715**					**4424**
Average					**11.88**		

4.2.2.2 Possible Impacts of the Dam

The impacts and risks associated with Mekong River mainstream dams are particularly relevant with respect to:

1) Effects on sediment and river morphology, with associated risks to the economic life of the mainstream impoundment of water and safe operation; and effects on long-term river bed stability, river bank erosion, and channel changes in the downstream reaches.
2) Potential water-quality changes, especially with regard to water pollution and effects on aquatic ecosystem functions and services, as well as wetland systems, both in the mainstream channel above the dams and localized effects downstream.
3) Potential for longer-term sediment and nutrient flowchanges in the downstream Mekong system (including the Tonle Sap and the Mekong Delta) in relation to the cumulative effects of dams in a cascade.

The potential impacts of the mainstream hydropower dams on sedimenttransport and morphology were also recognized by Lao PDR's Department of Electricity. In their report, they pointed out that:

1) Sedimentation of coarse sediments at the mouth of the reservoir can worsen local inundations and disturb navigation.
2) Sedimentation in the reservoir in front of the sediment sluices can prevent correct functioning of gates.
3) Sedimentation in the whole reservoir decreases its dead capacity and reduces its life time, affecting long-term hydropower profitability.
4) Sedimentation can lead to high dredging maintenance costs.

Hydropower dam proponents and builders argue that apart from providing renewable energy, dams enable mitigating extreme hydrological conditions by controlling the flow of water seasonally. The dams also create benefit to downstream areas by storing water in the rainy season to reduce flooding and releasing it to alleviate water shortages during the dry season (Lu and Siew, 2006). The common possible effects of dams include the following:

- the change of flow regimes upstream and downstream
- trapping of sediment in reservoirs
- disruption of sediment transport downstream
- reduction of biodiversity due to the flooding of habitat
- isolation of animal populations and blocking of migration
- changes in downstream riparian vegetation and salt wedge dynamics in estuarial areas.

Table 60: Possible positive and negative impacts of the hydropower projects in China on LMB

Action	Positive impacts	Negative impacts
Controlling the flow	Increase capacity for flood control	Changes in the river's natural flow pattern, and possible increase of flow fluctuation
	More assured dry-season flows	Increase average downstream dry-season flows; permanent flooding of important ecosystems
	Increase navigation options	Decrease wet season flows
	Reduce saline intrusion in Delta (higher dry-season flow)	Shift of the flood regime, flood arrival delays, shorter flooding period
	Creation of extra irrigation opportunities	
Trapping of Sediments	Ease navigation in LMB, less problems with sedimentation	Decrease flux of sediments and nutrients
Blocking the river	-	Increase geomorphological changes, such as bank erosion and bed degradation
		Block migration routes of fishes
		Divide/fragment river ecosystems, disturb local biodiversity

The dams probably would have some positive impacts downstream (Plinston and He, 1999; Hori, 2000; MRC, 2003). However, strong concerns have been expressed about the negative impacts of the dams on the lower basin and the river (Blake, 2001; MRC, 2003). The possible impacts of the hydropower projects in China on the LMB could be summarized as shown in Table 4.2.2-3.

Walling (2008) stated that the fine sediment load of a river represents an important measure of its hydrology and of the erosion and sediment delivery processes operating within its catchment. Furthermore, the magnitude of the load and the associated suspended sediment concentrations could have important implications for both the natural functioning of the system. For example, through their influence on channel morphology and on the aquatic ecosystems and habitats supported by the river, as well as for human exploitation of the river system. The fine sediment load of a river is sensitive to both climate change and to a wide range of human activities within its drainage basin. Such activities could influence sediment mobilization and transfer, including land clearance, agricultural development, mineral extraction, urbanization and infrastructure development, dam and reservoir construction, and soil conservation and sediment control programs.

Increased sediment loads could bring many problems linked to accelerated loss of reservoir storage capacity through sedimentation and siltation of river channels and water distribution systems, and an associated loss of conveyance capacity and increased turbidity of river water. Although decreasing sediment loads would frequently bring obvious benefits in terms of reduced sedimentation and siltation, it is important to recognize that there can also be negative impacts associated with reduced nutrient inputs to lakes, floodplains, the Delta, and coastal ecosystems and reduced sediment supply to Deltas and coastal areas, resulting in Delta recession and coastal erosion.

As a large river basin, the Mekong River Basin, impacted by accelerated development in recent years, including population growth, land clearance, infrastructure development, and water resource and hydropower development. The sediment load of the Mekong River might be expected to have changed over the past few decades. The ongoing construction of a suite of major dams on the headwaters of the river in China is likely to bring further changes in the future. In this context, the Mekong River could be seen as being at a crossroads because of the potential for past changes to be followed by further major changes, depending on the scale and speed of future development. It is important for available information on past, present, and likely future changes in the sediment load of the Mekong River to be evaluated, both to establish the sensitivity of the river system to the drivers of change and to assess their implications for future management strategies.

Moreover, Lu and Siew (2006) found that the main concern with dam construction in the Mekong River was the influence on suspended sediment flux. A change in sediment behavior might be potentially detrimental to the health of the entire river ecosystem. Comparison of mean sediment fluxes in pre-dam (1962-1992) and post-dam (1993-2000) periods for each station shows the apparent effects of flow impoundment on sediment fluxes, and downstream persistence of these effects. The sediment loads in four out of six stations have declined since the Manwan Dam began its operations in 1992. However, the change in mean sediment load was only statistically significant at Chiang Saen. Mean annual sediment load at Chiang Saen has decreased by more than 50% from 74.1 Mt/yr (pre-dam) to 34.5 Mt/yr (post-dam). Stations in the middle section produced variable results. The sediment flux at Nong Khai showed very little variation from a pre-dam mean load of 74.4 Mt/yr to 76.1 Mt/yr in the post-dam period, whereas the sediment flux in Mukdahan has increased from a mean sediment load of 97.5 Mt/yr to 131.1 Mt/yr (34% increase). The stations located further downstream, Khong Chiam and Pakse, also experienced decreased mean sediment loads after 1992.

Lu and Siew (2006) also mentioned that the completion of the cascade dams on the Lancang would increase regulation of the flood cycle, thereby reducing the frequency and magnitude of floods, and the amount of sediment delivered downstream. Areas dependent on floods to supply nutrient-rich sediments to the soil, riparian vegetation or aquatic ecosystem could be severely deprived, and productivity of these areas might deteriorate as a consequence. Zalinge et al. (2003) have cautioned that excessive regional developments utilizing water from the Mekong River, such as cascade dams and damming of tributaries, may lead to lower downstream flood levels and excessive trapping of sediment, which will have a negative impact on the TonleSap system, as the latter appears to depend on high flood levels with a correspondingly high sediment load.

Kummu et al. (2006) reported similar decreases in post-dam sediment transport at Chiang Saen (68.5 Mt/yr to 35.1 Mt/yr), Luang Prabang (65.6 Mt/yr to 46.9 Mt/yr) and Pakse (120.6 Mt/yr to 99.2 Mt/yr). The variation in estimation of sediment fluxes is attributable to differences in estimation methodologies and the number of sediment sample records. Furthermore, Kummu and Varis (2007) stated that Manwan, the first dam in the Lancang Cascade, was closed in 1993. Following its completion, it impacted on the sediment flux downstream along the Lower Mekong. In Chiang Saen, 660 km downstream from the dam, the measured annual sediment flux based on total suspended sediment data decreased by more than half from 70 Mt to 31 Mt. In other stations the sediment flux has changed as well after the closure of the Manwan Dam but not statistically significant.

In some stations sediment fluxes have even increased in the post-dam period. It should be noted that a number of tributaries of the Mekong have dams and reservoirs on them. Thus, the decline of the sediment fluxes in stations downstream from Chiang Saen may also be partly explained by the impact of these reservoirs. Other problems are the limited data at some stations and the variation in the quality of data between stations.

The major hydrological impacts of these reservoirs on the Lower Mekong are:

- increasing average downstream dry-season flow
- decreasing wet-season flow (Adamson, 2001)
- increasing water level fluctuations (Lu and Siew, 2006).

These hydrological changes may impact negatively on the ecosystem but at the same time may reduce saline intrusion in Delta, ease navigation, and increase irrigation opportunities during the dry season. Flux of sediment from the upper basin is decreasing due to sediment trapping by dams. This will likely increase bed and bank erosion downstream and have negative impacts on ecosystem productivity. The changes are greater closer to the dams but reduce in scale moving downstream.

4.2.2.3 Impacts of Paklay Dam

The Mekong River transports large amounts of sediment, much of which originates in the upper part of the basin. This process helps to redistribute nutrients within the basin and is very important for areas of high productivity, such as the Tonle Sap Great Lake. In this sense, transboundary transportation of nutrients along the river has, so far, been regarded as a benefit rather than a cause of pollution. Walling (2008) studied on the evidence for recent changes in the sediment load of the Mekong River. It was found that, as of 2002, the construction of major dams on the headwaters in China appears to have had little impact on the sediment load, although as further larger dams are commissioned, the sediment load of Mekong River could be expected to decrease.

The MRC (2009) published the “Preliminary design guidance for proposed mainstream dams in the LMB”. It provides background on strategies for sustaining reservoir capacity, mitigating downstream sediment starvation, and managing sediment in cascades of dams. According to the MRC (2009) and Thorne et al., (2011), the potential local and transboundary impacts could be summarized as follows:

1. Sediment deposition in backwater reach upstream of the reservoir, which could result in morphological changes including shoal formation and bed aggradations, leading to increase backwater effect and flood probability.

2. In-reservoir sedimentationcould lead to:
    - Reduced depths and water quality in deep pools.
    - Reduced reservoir volume, leading to decreased storage capacity.
    - Possible increase in the probability of landslides.
    - Dam overtopping during extreme flood conditions.

3. Localized sedimentation close to the damcould:
    - Adversely affect the power house intakes and operation of the low-level sluices.
    - Accelerate turbine abrasion damage, particularly if the quartz content of the sediment is high.

4. Reduction in sediment discharged downstreamcould:
    - Adversely affect the fluvial geomorphology of the river due to “sediment hungry” water released downstream of the dam.
    - trigger adverse morphological responses including: loss of existing sediment features in non-alluvial reaches; channel instability (bed

degradation, bank retreat, and plan form changes) in alluvial reaches; reduced sediment supply to floodplains and wetlands including the Tonle Sap; and land loss in the Mekong Delta and along the adjacent coastline.
- reduce the extent and sediment concentration of the plume offshore of the Delta.

JV presented in Chapter 4 Project Planning,: Calculation Principle and Method, on page 4-22 of the Feasibility Study Report that:

"b) The bed load sediment in upstream of Xayaburi Dam site is all intercepted, and only a little of bed load sediment between both dam sites (i.e.) flow into the reservoir."

NB: Both damsites in the above sentence refer the Xayaburi Dam and Paklaydam sites, and the reservoir means the Paklay reservoir.

Furthermore, in Section 4.8.5: Analysis of Calculation Resultsalso analyzed the regulation reservoir capacity of Paklay Project in different operating years. It was stated that:

"d) After 50-year reservoir operation, the regulation reservoir capacity decreased $10.55x10^6$ m^3 *and the loss rate was 13.6%. During the design operating years of the project, the sediment silting has small effects on the regulation reservoir capacity."*

However, Paklaydam is a Run-of-River hydropower project with relatively a small reservoir. The water is supplied directly to the turbine water intake through a desanding structure. The efficiency of sediment management in such a project depends on the performance of the desanding structure. It is necessary to equip the diversion of sediment with adequate gate size and number which will allow establishment of pre-dam stage discharge conditions at the dam site. This will allow efficient flushing of the sediments accumulated at the upstream end of the upper pool under normal operating conditions. Such flushing is necessary otherwise permanent aggradations of the river bed upstream of the diversion dam will occur.

According to Executive summary section of the Feasibility Study Report of PaklayHPP, JV present the information on the dimensions and features of Paklay Dam and its spillways as follows:

- The dam height is 57.00 m with the crest elevation of 146.00 m (main dam), which means that the bottom elevation of the dam is 189.00 m.
- There are 2 outlet structures;
  - 4 bays of left spillway with the size of 19.00 m x 17.00 m (WxH)
  - bays of right spillway with the same size.
- Both spillways have the same crest elevation (223.00 m) and the same bottom elevation of 206.00 m (223.00 – 17.00 = 206.00 m).
- The spillways don't have any sand sluice structure.

It is obvious that the dam operators have to organize the sediment flushing through the spillways which have too high elevation, i.e., the spillways' bottom are 17.00 m (206.00 – 189.00 = 17.00 m) above the dam's bottom, to flush the sediment downstream of the dam especially the bed load sediment.

Therefore, it could be concluded that flushing sediment from the reservoir would not be feasible at Paklaydam with the current dam design. It is because there is no sluice gate and the spillways are too high to accomplish draw down flushing. Hence, it would be necessary for JV to apply a proper mathematical model to simulate how much sediment will accumulate in the reservoir and when an equilibrium condition will be achieved. The result from the simulation could enable them to make a decision whether to modify the sand flushing devices design.

4.2.2.4 Transboundary Impacts

As mentioned in section above, JVon Section the Calculation Principle and Method on page 4-22 of the Feasibility Study Report that the bed load sediment upstream of Xayaburi Dam site would be all intercepted. Only a little amount of bed load sediment between Xayaburi Dam and Paklay Dam would flow into the Paklay reservoir.

However, the operators of Xayaburi Dam were also recommended to organize the flushing downstream not only of the suspended load but also the bed load. Therefore, some amount of the flushed sediment from Xayaburi Dam would further flow into the Paklay Reservoir. This kind of operation implies that Paklaydam should organize the same manner of sediment routing and flushing as well. If the flushed sediment is not well organized, it would likely create impacts not only atthe project level but also the at transboundary level.

It could therefore be concluded that Paklaydam would likely be responsible for transboundary sediment, morphology and nutrient impacts, leading to environmental impacts. The impacts could include not only the channel but also the floodplains, wetlands and seasonal lakes, the Delta, the nearby coastalarea, and the offshore sediment plume.

4.2.2.5 Conclusions

Based on analysis on the available sediment information, there is no measured sediment information at the dam site of Paklay HPP. The characteristic values of sediment at the dam site are calculated according to the measured sediment data from 2009 to 2015 at the Chiang Khan Hydrological Station about 112 km downstream of the dam site, and the suspended sediment series from 1960 to 2015 (56 years in total) is taken as the calculated sediment series at the dam site.

According to the statistical calculation, the suspended sediment characteristic value of Paklay upper dam site is shown in Table below

Table 1.2-6 Suspended Sediment Characteristic Value of Paklay Upper Dam Site

Station Name	Mean Annual Sediment Discharge	Maximum Annual Sediment Discharge	Mean Annual Sediment Concentration
	10^6 tons	10^6 tons	g/m^3
Upper dam site	16.50	30.35	129

At present, suspended sediment at the river reach of the dam site is being measured. The collected suspended sediment information is not complete yet, which can hardly achieve the verification of the suspended sediment results. After the field measurment is completed, we'll further analyze and compile the information, and officially submit the suspended sediment results of the river reach of the dam site. Based on it, we'll further verify the suspended sediment at the dam site.

5 TRANS-BOUNDARY AND CUMULATIVE IMPACT ASSESSMENT

5.1 Fish Migration and Fisheries

5.1.1 Transboundary impact

*Obstruction of fish migration:*Construction of a big dam, like the one for the Paklay HPP at either alternative 1 or 2, would divide the river ecosystem causing separation of living organisms upstream and downstream. It would impact on the movement of living organisms that migrate for reproduction and spawning as part of their normal life cycle. Based on the study of Baran E (2006), there are a total of 768 fish speciesin the Mekong River consisting of 165 migratory fish species, 24 non-migratory and 579 fish species that have not been scientifically identified as either migratory or non-migratory.

Migrating fish species include ones that are Critically Endangered (CR), Endangered (EN), Vulnerable (VU) orNear Threatened (NT):

- CR species: Mekong Giant Catfish (*Pangasianodon gigas*), Giant pangasius (*Pangasius sanitwongsei*).
- EN species: Mekong stingray (*Dasyatis laosensis*).
- VU species: Laotian shad (*Tenualosa thibaudeaui*),*Bangana behri.*
- NT Species: *Mekongina erythrospila*, Indochina featherback (*Chitala blanchi*), Long pectoral-fin minnow (*Macrochirichthys macrochirus).*

Evidently, the Mekong giant catfish (*Pangasianodon gigas*)migrate from their habitat in the middle Mekong Basin to spawn at the Upper Mekong Basin at Ban Had Krai, Chiang Khong District, Chiang Rai Province, Thailand during the end of April to May. Construction of the Paklay dam in the upper Mekong Basin would obstruct the Mekong giant catfish unless an appropriate fish pathway can be designed.

Limitation of fish habitat: Construction of dam would cause a limitation of fish habitat unless an appropriate fish pathway can bedesigned. Fishes would tend to congregate in upstream and downstream areas, which would allow the fishermen to catch more fish. However, this higher fish catch would decrease the quantity of species, particularly in the Upper Migration Mekong Basin, which runs from the location ofPaklay dam at Ban Moung, Tai Paklay District upto Laung Prabang and down to Chiangkan District, Loei Province, Thailand) the boundary of upper and middle migration of the Mekong Basin.

*Impact to fish population:*The construction of the dam would impact on the fish population due to the change of water level downstreamunless an appropriate fish pathway can be designed.. The lower level of water would accordingly lower normal flood levels, and floodplains along the river bank. Various aquatic organisms could not adjust themselves to the alteration of water level and river flow. This would decrease biodiversity, particularly downstream. It might also decrease the water quantity in rapids and deep pools to a level that is not adequate for fish and other aquatic organisms to live safelyduring the dry season (December-beginning of April), particularly downstream of the proposed Paklay dam site down to Chiangkai District, Loei Province, Thailand, and perhaps go further to Vientiane Province if the discharg water downstream is lower than the Operational Rule Curve.

Dam construction might cause a severe depletion of fish species as listed by IUCN Red of Threatened species.

A transboudary impact would occur at 2 areas; Middle Migration Mekong Basin and Upper Migration Mekong Basin, particularly on the fish that migrate between the connecting point of middle and upper basins such as the Mekong giant catfish and the Mekong stingray. However, negative impacts on the small scaled fishes in the Cynprinidae would be less as these fish could migrate to the tributaries (no need to pass through dam) for reproduction and spawning.

Fish migration to the tributaries would increase the risk of fish being caught because the tributaries are not wide and deep like the Mekong River. A high fish catch would decrease the quantity of fish in the basin and the sustainability of such fish catchesunless an appropriate fish pathway can be designed.. In the tributaries, there are a varietyof fishing equipments eliminating any chance of survival (Figure below). A critical fish catch would have an graveeffecton fish and aquatic organisms

Figure 142: Fish catch equipments laying across the stream

5.1.2 Cumulative Impact

The impact on the Mekong giant catfish (*Pangasianodon gigas*) should be evident. As mentioned above the construction of thePaklay dam would cause the separation of the upstream and downstream sides of the dam. This would cause the obstruction of migration of the Mekong giant catfish during reproduction and spawning. Itwould reduce the numbers of the fish and possibly cause the fish to become extinct.If the fish passis designed well for the Mekong giant catfish to pass, this effect could be minimized. (See Page 5-188 to 5-199, details of Fish Pass Structure could be found in the section of Project Layout and Main Structure in FS approved in March 2017 as attached in this Report).

Considering the cumulative impact on the Mekong River, the existing ecosystem would possibly change. Construction of the dam would cause a long termimpact on the quantity and size of fishas stated previously. The impact level can not be distinctly assessed since the data of fish migration is not sufficiently available. Due to the migration pathway the Mekong giant catfish is likely to be seriously and negaitively impacted. If the fishpassis designed well for the Mekong giant catfish to pass, this effect could be minimized.

In addition, an increasing number of transshipping would impact on the normal living of fish and other aquatic aqua- organisms due to noise level generated from engined boating/shipping. In case of disposing solid wastes and wastewater from boats would cause water pollution further impacting on fish living and status.

5.2 Navigation

5.2.2 Transboundary impact

Impact of dam construction on navigation between Luang Prabang and Vientiane is now assessed. The transhipping time would be longer, particularly when ships pass through ship locks. It is estimated that the time going through a ship lock takes 30-40 minutes, which would increase overall time by 8-10%.

On the other hand, the construction of dam would increase water levels upstream in the dry season, which would facilitate enhance the capability of transshipping. This would have a positive impact on the growth of navigation. However, there is need of caution about the possibility of transshippingaccidents due to rapids and outcrops at the hot spots along the Mekong River.

In the case of cargo transshipping, such as chemicals and gasoline, there is risk of accidental leakage or spills of such materials. The International Convention for the Prevention of Pollution from Ships (MARPOL) only covers sea and seashore areas.However, transshipping downstream of Paklay dam construction will be like the existing condition without dam construction, the impact along this section would be less to none. Positive impact on this task might be high, particularly on the tourism business.

5.2.3 Cumulative Impact

Cumulative impacts are similar to transboundary impacts as stated above. Four environmental aspects are considered as follows.

- Impacts in terms of longer time due to dam construction.
- Increased risk of ship accidents.
- Increased risk of chemical leakage.
- Impact on living organisms and their habitat.

For the transshipping from Vientiane downsouth to Pakse might not be impacted, as transshipping activities are less popular for time consuming long distance travel. Land transportation by bus is more popular because it is more convenient and quicker than navigation. In addition, the impact to tourism business by boating/shipping that uses travel time not exceeding 3 hours might occur. Business locations far from the proposed Paklay dam site, would not be impacted from the construction of the Paklay dam.

5.3 Water Quality

5.3.1 Transboundary impact

5.3.1.1 Constrution Period

*Impacts on water quality due to erosion/sedimentation:*Impacts on water quality are the result of erosion and sedimentation and can take place during construction. Construction of the project will take about 7years including land preparation and construction of the main dam, coffer dam, construction camps, office and living facilities, warehouses, E & M equipment assembly yard, auto and machinery repair workshop, machinery depot, concrete batching plant, quarry sites, disposal areas, etc. These construction activities involve clearing of the forest biomass of the proposed dam construction site, which would induce erosion and release sedimentation in to the river. Transboundary impacts on water quality could occur from suspended solids dispersion. Best practices in dam construction are needed to minimize deforestation and erosion/sedimentation which would accordingly minimize negative impacts on water quality.

Impacts on water quality due to Solid Waste:
In addition, solid wastes generated during construction include construction material residue (wood, soil, stone, brick, cement, etc), biomass residue, etc. These solid wastes also cause water pollution if they are disposed ofin the river.

*Impact on water quality due to wastewater discharge:*Impacts on water quality can potentially be caused by wastewater discharge from the worker's camp. Dam construction employs a high number of workers who will need to be accommodated on site. The worker's camp should be hygienicand include an adequate number of sanitary latrines and an onsite wastewater treatment system. Household solid wastes (e.g. garbage, rubbish, etc) are also pollution sources that will impact on water quality if disposed in the river. Location of the camp site should be far from the river at some distance. Otherwise, wastewaters and household solid wastes might be discharged and disposed in the river, thus causing water pollution.

5.3.1.2 Operation Period

During the operation period the impacts on water quality can be assessed as follows:

*Impact on Water Quality due to Erosion/Sedimentation:*Impact on water quality due to erosion and sedimentation cantake place in the reservoir at the location where the degraded forest exists. Accumulation of sediment could take place in the reservoir causing suspended solids dispersion in the downstream river to be lower than the existing natural condition; this may induce erosion and a scouring effect. Periodical sediment release from the reservoir is necessary to minimize such problems.

*Impact on Water Quality Due To Degradation of Biomass Residue:*Impact on water quality due to degradation of biomass residuecould also take place in the reservoir and further impact downstream river areas. Near the beginning of the dam operation (in about 5 years) when the water upstream is at its normal operating level, the degradation of trees, plants and other vegetable residue under anaerobic condition could cause water pollution with an odor problem. This problem is evident in some newly constructed reservoirs (when inundated land has not been adequately cleared before flooding). It results in a water quality problem in the project area for domestic water users and can impact on people's health who reside downstream of the dam. When the polluted water is discharged downstream, the assimilation capacity of the river may recover the water. In this regard, the transboundary impact of water pollution is assessed in terms of recovery distance. If the recovery distance is adequately far from the proposed downstream dam site, the dam would have little or no impact on the downstream area as the water being discharged is likely to be at normal water quality levels. However, it is necessary to maintain good water quality in the reservoir by a proper removal of biomass.

*Impact on Water Quality due to Wastewater Discharge:*Impact on water quality can attribute to wastewater discharge from the human activities carried out around the reservoir and along the river bank. Construction of the PaklayHPP will possibly stimulate the expansion of communities, industries, agriculture, aquaculture, and tourism along the Mekong River particularly in the upstream area. If the management of wastewater and solid waste is inadequate, new sources of pollution would negatively impacton water quality. In addition, these water quality changes would have an impact on aquatic organisms, such as possible reduced biological diversity, fish numbers andwater for domestic use.Project Area Wastewater Dischargecould affect areas downstream so they have potential transboundary impacts. If land use is regulated by pollution protection and control measures, such impacts would be minimized.

*Impact on Water Quality due to Agriculture and Aquaculture:*In addition, agriculture and aquaculture activities are potential supplementary results from dam construction. Agriculture and aquaculture can directly impact on water quality. Intensive agricultural activities use chemical substances such as fertilizers and pesticides, which create nutrients and toxic substances that contaminate the river. Based on the existing water quality mentioned earlierin Chapter 3 of this document, dispersion of nutrients and sediment, such as nitrogen and phosphorus tend to increase every year in the Mekong Delta, particularly in the Chau Doc area of Vietnam. Also found were pollutants such DDT and PCB.

Aquaculture could cause high organic and nutrient contamination in the river as a result of using fish food that contains high carbohydrates and proteins. The nutrient and chemical pollutants could be dispersed to other river reaches so they have potential transboundary impacts. High nutrient contents can cause eutrophication or algal bloom which is one type of pollution. Good practice in agriculture and aquaculture is necessary to prevent eutrophication as well as safeguards on the ecosystem from toxic substances.

Other potential transboundary impacts concern nutrients attached with sediment. Such nutrient-sediment can get trapped in the reservoir and be prevented from being transported downstream,particularly to the Mekong Delta and Tonle Sap Lake area, where there are an abundance of fish species. The lack of nutrient-sedimentcould possibly impact on fisheries. This impact could be considered as a potential transboundary one. A periodical release of sediment during dam/reservoir operation would help alleviate such nutrient obstruction problems.

*Impact on Water Quality due to Navigation and Oil spills:*Impacts on water quality from navigation stem from wastewater, grease and oil being discharged directly into the river from ships/boats. Oil spills might result from accidental leakages. Increased navigation for cargo transshipping would directlyimpact on water quality if waste treatment and anti-oil spill measures are not properly provided. Impacts caused by navigation activities are likely to be transboundary ones. Ship locks to facilitate cargo transshipping as well as navigation routes have to be designed according to the MRCs recommended guidelines.

5.3.2 CummulativeImpact

5.3.2.1 Constrution Period

*Impacts on water quality due to erosion/sedimentation:*During construction, impacts would be the same as transboundary impacts assessed above. The major cumulative impact in this period is due to erosion and sedimentation from construction activities in the clearance area. Erosion on land moving downward to the reservoir disperses soil particles, which finally settles as sediment in the reservoir. Sediment will accumulate in the reservoir prior to the state of dam operation. Such accumulation would possibly shortenthe reservoir/dam operation agecompared to the designed project age.

*Impact on Water Quality due to Wastewater Discharge:*Pollution in the reservoir can also be due to organic and nutrient wastewater discharge from existing communities and agriculture and aquaculture. Presently, as observed from the field survey, such pollutants are not high – compared to the high amount of water stored in the reservoir, the existing mentioned activities have low loading. Dilution as well as biodegradation of low organic and nutrient loading would minimize the pollution effect.

5.3.2.2 Operation Period

Cumulative impacts due to dam construction canbe considered in terms of upstream discharge of substances including sediment, nutrients, organic matters and toxic substances. These pollutants would accumulate in the reservoir, particularly at the front of the dam. The organic matters in sediment would undergo an anaerobic reaction, causing carbon dioxide, methane, hydrogen sulfide, etc. Greenhouse gases (carbon dioxide and methane)can be generated from the reservoir. Also, the accumulation of nutrients can lead to eutrophication in some areas wherever the condition is suitable for such phenomena (shallow water level, sufficient sunlight, high nutrients).

When considering that PaklayHPP is one proposed dam in a series of proposed dams along the Mekong River, there is likely to be a continual cumulative impact. As previously stated, sediment accumulated in the upstream reservoir would minimize suspended solids dispersion in the downstream river and reservoir. The greater accumulation of sediment upstream would cause less suspended solids dispersion downstream, which would then stimulate more river bank erosion and riverbed scouring. Besides erosion and the scouring effect, nutrients accumulated in the reservoir could possibly cause a decrease of nutrients downstream that would have an impact on aquatic life because of low nutrient feeding.As mentioned above, periodical sediment release is a practical measure of reservoir operation which would help alleviate the negative cumulative and transboundary impacts.

5.4 Dam Safety

There is no obvious evidence of earthquake activity in the last 553 years, although there are several faults running NNE; also, there is no historical record about a strong earthquake greater than 6 magnitudes. Thus, from the regional geological tectonics and crustal activity point of view, Paklay HPP site is a relatively stable region.

If necessary, areas of rock and soils that may be loosened by the filling of the reservoir should be identified and artificially released to minimize landslides during impoundment.

5.5 Climate Change

- Paklay HPP will not create significant impact on climate change; in contrast, the changes in climate would be directly and indirectly affected by those changes.
- Major adjustments to local livelihoods and key development sectors would be required.
- Paklay hydropower projects would require auditing and possibly retrofitting
- Catchments experiencing high rainfall and runoff would have increased hydropower capacity.

5.6 Social Impacts

5.6.2 General Assumptions

5.6.2.1 Method

The impact significance is determined by its type, severity, and duration as detailed below:

- **Type:** Relates to the adverse or beneficial nature of impacts
- **Severity:** The extent of an impact is assessed by considering the proportion of the area within which the impact is likely to occur and whether positive benefits or negative impacts will impact many people or relatively few (i.e. only a small number of individuals or households). On the basis of these impacts are categorized as ***Low*** - meaning the influence area extends to individuals/ household, ***Medium* -** meaningtheinfluence area extends to a small number of households and ***High* -** meaning that the influence area extends to large part of or full village.
- **Duration:** Is assessed by whether positive benefits or negative impacts will be ***Short-term*** (less than two years), ***Medium-term*** (3-6 years) or ***Longer-term*** (more than 6 years);

5.6.2.2 Anticipated Key Bio-physical Changes

The creation of the above mainstream hydropower dams in the Lower Mekong Basin may change the river and its ecosystems. The following bio-physical changes are anticipated:

1) Long-term water level changes on the Mekong that may increase in the range of 1m to 3m during the dry season
2) Long-term downstream sediments decrease that may decrease in a range of 10% to 20% depending on number of dams to be operated on the Mekong mainstream and its tributaries
3) Long-term changes in the Mekong River morphology and ecosystems that mayhave more water (both in depth and width)
4) Upstream quantity of fish may decrease from the obstruction of migratory fishes and from loss of rapids and wetlands that are aquatic habitats
5) Short-term poorer water quality on the Mekong River due to construction activities during construction periods.

5.6.2.3 Degree of Livelihood Dependence in Each Zone

One indicator is to identify most/second most important occupation of people who are residing in the Mekong corridor. The MRC revealed that 73% of people earn a living on farming while only 8% on fishing. This reflected that farming is the key income generation activity and considered as the most important livelihood of the riparian people. However, fishing is still important for some people especially those residing in Don Sahong and Don Sadam of Southern Lao PDR, Tonle Sap Lake of Cambodia and some areas in the Mekong Delta.

Table 61: Livelihoods Considered from Occupation

Item	***Occupation of riparian households***	***First most important occupation***	***Second most important occupation***
1	Farming	72.9%	7.7%
2	Fishing	8.0%	26.9%
3	Collecting other aquatic animals	0.1%	2.8%
4	Collecting useful plants	0.1%	2.3%
5	Aquaculture	0.0%	1.0%
6	Other fish and water related occupations	1.1 %	2.2%
7	Farm labor	2.9%	3.9%
8	Other irregular work	2.7%	14.3%
9	Permanent employment	4.5%	8.8%
10	Business	4.6%	8.8%
11	Others	2.9%	13.3%

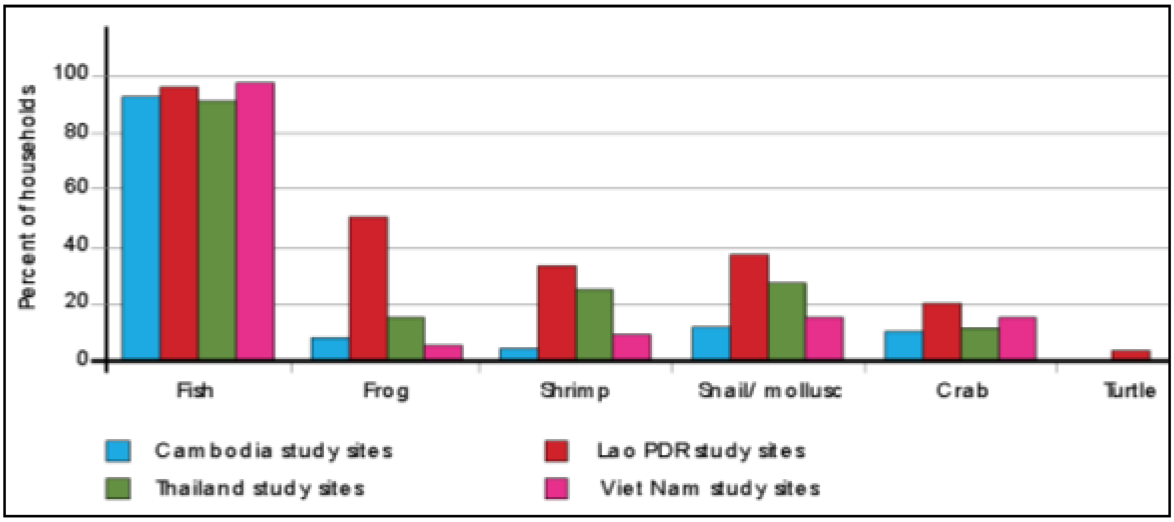
A second indicator is related to the consumption of aquatic generated food (such as fish, frogs, shrimp, snail/mollusks, crabs, and turtles). The MRC also found that more than 80% of riparian people eat fish as source of protein.

It should be noted that the recent surveys in all zones by the study team (including scientific sampling of aquatic biology by fishery experts) indicated that there are limited number of fish on the Mekong River in Zones 1 and 2. Most aquatic foods are based on aquaculture products such as Tilapia and Red Snapper fishes, frogs, eels, etc. Zone 3 still has some fish for export but very expensive.

Figure 143: Aquatic products in Kampong Chhnang, Cambodia

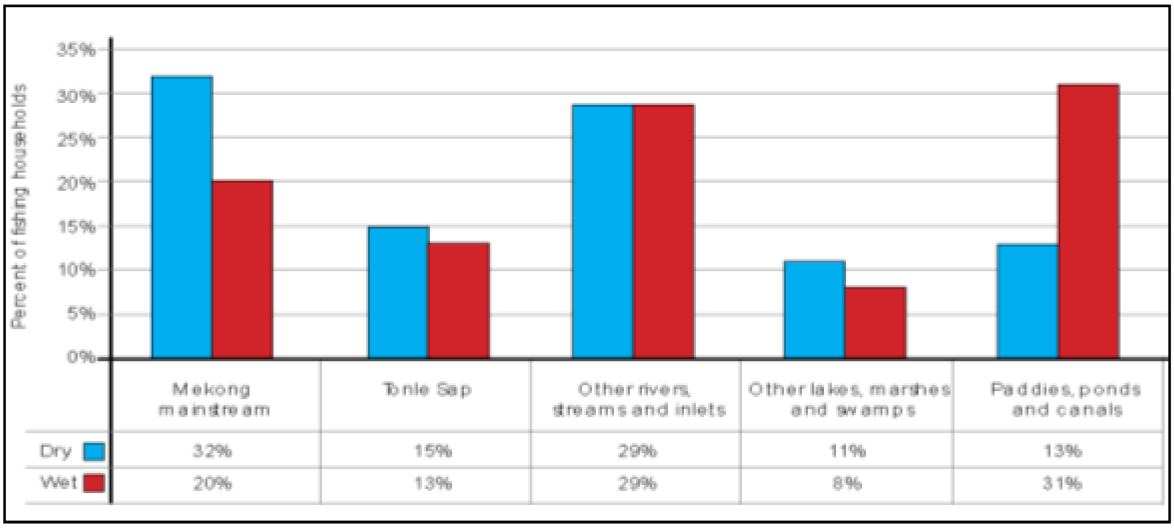
Figure 144: Tilapia Fish Culturing on the Mekong in Zone 2 (Thai-Lao)

Figure 145: Red Snapper Fish Culturing on the Mekong in Zone 5, My Tho, Vietnam



Source: MRC (2010)

Figure 146: Consumption of Aquatic Food by Riparian People



Source: MRC (2010)

Figure 147: Fishing Livelihoods of Riparian People

The dependence of riparian people on Mekong River and its natural ecosystem (resource base) can be summarized as follows:

Table 62: Degree of Dependence on the Mekong River and Its Ecosystems

Item	***Zones***	***Degree of Dependence****	
		Left Bank	***Right Bank***
1	Zone 1: Northern Laos – Pak Tha (KM 2281) to Pak Heuang (KM 1736)	3.7	3.8
2	Zone 2: Thai-Laos – Pak Heuang (KM 1736) to Ban Woenbuk (KM 904)	3.1	2.7
3	Zone 3: Southern Laos – Ban Woenbuk (KM 904) to Cambodian border (KM 723)	3.3	3.2
4	Zone 4: Cambodia – Cambodia border (KM 723) to Vietnam Border (KM218)	4.1	4.0
5	Zone 5: Southern Vietnam – Vietnam border (KM 218) to Mekong Delta (KM 0)	4.1	4.2

**Estimated by the study team (Scale: 1=Very low, 2=Low, 3=Medium, 4=High, 5=Very high)*

5.6.3 Cummulative Social Impacts

5.6.3.1 List of Cummulative Social Impacts

From recent hydropower development in the LMB, it showed that there are a number of social impacts (both positive and negative) that can be listed as follows:

- **Positive Impact**s are related to the improvement of basic social infrastructure and facilities such as roads, bridges, water and electricity supply system, education and health facilities, markets, and other economic benefitslike employment.
- **Negative Impacts** are mainly concerned with compensation of lost assets and relocation and resettlement of directly affected people.

5.6.3.2 Assessment of Cummulative Socila Impacts

Consideration of cumulative social impacts has been made primarily in Zones 1 and 3 that are located in the Lao PDR territory. Since there will be 7 Mekong mainstream hydropower development projects in Lao PDR, the key cumulative impacts may concern the following:

1) The loss of production land for plantation of rice and other food crops in the country. Cumulatively, there will be approximately 18,000 ha of production land that will be submerged due to the creation of the proposed hydropower dams of which food production (mainly rice and other food crops) with a minimum of 45,000 tons per year will be lost. This will affect the food supply and its price in the project areas and in the country as a whole.
2) The creation of Mekong mainstream projects will displace about 5,700 families with a population of about 30,000 people. Despite resettlement packagesfor the displaced people with provison of better infrastructure, the improvement of peoples livelihoods will be a problem since there is very limited good production land for resettlement.

The above social impacts need to be carefully considered not only at a project level but also national.

Table 5.6-3 and Matrix 1 show cumulative social impacts from the creation of seven hydropower dams on the Mekong mainstream in Lao PDR.

Table 63: Key Cumulative Social Impacts from the Development of Seven Mekong Mainstream Hydropower Dams within Lao PDR

Mekong Mainstream Hydropower Projects within Lao PDR	*Estimated loss of production land(ha)*	*Estimated no. of people to be relocated*		*Current project status*
		HH/Families	*Persons*	
1) Pak Beng	4,105	203	1,040	On-going ESIA/TBESIA
2) Luangprabang	2,700	2,300	11,800	Finished FS/ESIA
3) Xayaburi	400	494	2,600	Delayed Construction
4) Paklay -	3,000	1,100	4,800	On-going ESIA/TBESIA
5) Sanakham	4,400	618	2,935	Finished FS/ESIA
6) Tha Kho	170	-	-	Finished FS/ESIA
7) Don Sahong	265	11	63	Finished FS/ESIA
Cumulative Total	***18,040***	***5,726***	***30,328***	

Matrix 1: Degree of Cumulative Social Impacts from the Development of Seven Mekong Mainstream Hydropower Dams within Lao PDR

Anticipated Cumulative Social Impact/Risks	Type		Severity			Duration			Significance		
	Adverse(-)	Beneficial (+)	Low	Medium	High	Short Term	Medium Term	Longer Term	Minor	Medium	Major
Improvement in basic social infrastructures and facilities											
Loss of Production land for rice and other food crops											
Relocation and resettlement of directly affected population											

All hydropower project development is usually associated with the improvement in basic infrastructures and facilities (such as roads, bridges, water and electricity supply system, education and health facilities, markets) in the project area. Other economic benefits such as country revenue and local employment are also identified as beneficial impacts. These are in the long-run and the severity is predicted high since limited improvement in Lao PDR is observed in the last decades.

For loss of production land and relocation and resettlement, given long-term adverse impacts, the degree of severity is predicted high.

5.6.3.3 Mitigation Measures for Cumulative Social Impacts

The aim of mitigation of social impact includes selection of optimum project alternative (i.e. upstream water level, amount of water release) to avoid and minimize social impacts. If the final alternative has been selected the goal of mitigation is focused on how to make affected people better off.

There will be a number of social plans and programs. The project compensation and resettlement developmentpolicy should at least include:

- Establishing effective communications with affected individuals, households and stakeholders groups throughout the resettlement process;
- Procuring adequate land at new relocation site to accommodate all houses, and amenities and other improvements that existed at the previous location;
- Providing equivalent or improved housing and infrastructure;
- Compensating affected individuals, households for all losses associated with land takes in a timely fair and equitable manner;

- Providing interim compensation to resettlers whose income generating capacity has been adversely affected, until their livelihood base can be adequately reestablished;
- Assisting with the physical move and provide support to resettled individuals and households during the transition period;
- Ensuring that every resettled household or individuals can effectively restore its household food and livelihood income; and
- Monitoring all aspects of the resettlement program after the relocation relative to pre-relocation period to ensure compliance with the GOL Policy.

The development in the relocation sites will be implemented by respective committees/implementing units with the participation of key stakeholders and the APs, the provisions include:

- Home plot and farming areas of appropriate and acceptable size
- Acceptable housing and structures
- Acceptable community infrastructures including replacement of temples
- Feasible livelihood and income restoration
- Additional training and social development activities in a separate action plan

Resettlement implementation timeframe should spans longer period such as 10 years and with livelihood development over 8 years.

To ensure the rights of the Affected People (AP) in receiving compensation package, the following entitlement issues need to be addressed in the resettlement action plan of the proposed Mekong mainstream hydropower development projects in the Lao PDR.

1) Permanent loss of agricultural land:

   - Replacement land of at least the same size and equal productive value at a location acceptable to the AP;
   - Replacement land will be cleared, fenced and prepared by the resettles (food for work program) or mechanically cleared if the AP cannot provide sufficient labour;
   - In cases where replacement land is not available in sufficient area, the AP may accept cash payment for difference between land registered and land provided in the resettlement site.

2) Permanent loss of irrigated land:
   - Replacement necessary irrigation system in resettlement site orCompensation by cash to the labour fee of current irrigation system development;

3) Permanent loss of residential land:
   - Replacement land for housing.

4) Permanent loss of commercial land:

- Replacement land of at least equal value, location will be potable to the AP in order to continue viable commercial activities; or
- Cash payment for the value of land if commercial activities cannot be continued or AP does not wish to do so.

5) Loss of houses:
   - Provision for new material and construction of new house with better standard
   -
   - Barn, livestock pens and other outbuildings will be replaced
   - Private fences will be replaced by shared fences
   - Flushing latrines will be installed on new house plots
   - Household electrical wiring and basic fixtures for three lamps and one plug will be provided.

6) Loss of commercial structures:
   - Replacement structure in a location acceptable to the AP
   - Cash option if commercial activities cannot be continued or PAP does not want to continue.

7) Loss of physical cultural resources:
   - Provision of rituals and acceptable arrangements for transporting moveable items and re-establishment at new site
   - Replacement of holy house and structures of at least the same value and acceptable to the APs
   - Provision for appropriate rituals for cemeteries, holy sites and other immoveable cultural landmarks prior to moving.

8) Loss of agricultural production system:
   - Allocation and development of land in an off-village location on a community basis (with host village if any)
   - A range of feasible production and income generating options in order to get better off
   - Supply of basic tools and equipment for agriculture work
   - Fertiliser and agro-chemicals, as required.

9) Loss of fruit trees and timber / industrial trees:
   - Cash compensation of production or estimated return on investment
   - Replacement seedling at new village location as part of the livelihood restoration package.

10) Loss of common property resources:
   - Access to forests, grazing land, fisheries in the new area, livelihood restoration packages, replacement natural common property with more productive private assets
   - Enhancement and development of common property resources of new villages.

11) Loss community infrastructure:
   - All-weather road to each resettlement site

- Replacement of all community infrastructure of at least the same value and function or improvement of host village situation
- Village Office and meeting/community hall at each resettlement village location
- New water supply system or improvement of host village year-round water supply
- Market place
- Electricity connections to community facilities.

12) Loss of educational facilities:
    - Replacement school or upgrading of existing host village facilitiesincluding library
    - Provision of equipment, materials and furniture as required
    - Training of existing and new teaching staff.

13) Loss of health facilities:
    - Replacement health centre or upgrading of existing host village health facilities
    - Provision of equipment, medical supplies, water and sanitation arrangements
    - Improvement of health prevention, diagnosis treatment of common diseases
    - Training of existing and new village health volunteers

14) Loss of cemetery:
    - New cemetery at the resettlement site as requested

15) Moving Assistance:
    - One time disturbance allowance for moving.

16) Training and Support:
    - Training and support for livelihood after moving and establishment of household plots or until getting better off in a sustainable manner
    - Skill training for all households based on consultations and agreed to by the community and individual households
    - Social development training for all households, e.g. household budget training, saving and credit groups
    - Support and advice from Project Resettlement Unit, RMU and District line agencies
    - Priority for labour opportunities on project sites.

17) Food support:
    - Assistance of milled rice
    - Additional support of supplementary protein to meet basic nutritional shortfalls during first year of resettlement.

18) Venerable Households:
    - Households with insufficient labour force will receive special assistance for their individual needs during the movement to new place

- Vulnerable households will receive assistance for the establishment of suitable production systems in relation to their needs and capacity.

19) Self-relocation:
    - Those who do not wish to partake in the Project resettlement program will receive a one-time payment for the loss of structures, land, trees and produce with the agreement of the Committees.

20) Conflict resolution:
    - All households to have access to Grievance Committee for complaints.

5.6.4 Transboundary Social Impacts

5.6.4.1 List of Anticipated Transboundary Social Impacts

Transboundary social-impact zones from Paklay HPP and other proposed Mekong mainstream hydropower dams (within Lao PDR territory) include Right-bank Thailand (Zone 2), Cambodia (Zone 4) and Vietnam (Zone 5). The bio-physical changes may include water level increase approximately 1m-3m in the dry season; 10%-20% sediment reduction; more upstream water volume; decreased quantity of fish upstream (if no fishery development program); and deterioration of downstream water quality during dam construction. These may create some transboundary social risks that may include:

- Domestic and irrigation water uses risks
- Downstream cropping risks
- Downstream health and nutrition risks
- Downstream tourism risks
- Socio-political conflicts.

The degree of above risks will depend upon locations of the riparian communities and nature of the ecosystem in each area andf zone.

5.6.4.2 Assessment of Transboundary Social Impacts

As discussed earlier, because social, cultural and political conditions differ in disparate locations, the transboundary social impact assessment will beperformed for individual zones: Thai-Lao (Zone 2); Cambodia (Zone 4); and Vietnam (Zone 5) as shown in Matrix 2, 3 and 4, respectively.

a) Zone 2 (Thai-Lao)

The transboudary social impact assessment for Zone 2 (Thai-Lao) is shown in Matrix 2. The dependence on the Mekong River and its ecosystem in this zone is identified as medium.

Matrix 2: Degree of Transboundary Social Impacts in Zone 2(Thai-Laos)

Anticipated Cumulative Social Risks	Type		Severity			Duration			Significance		
	Adverse(-)	Beneficial (+)	Low	Medium	High	Short Term	Medium Term	Longer Term	Minor	Medium	Major
Domestic and irrigation water use											
Cropping											
Health and nutrition											
Tourism											
Socio-political conflict											
Climate change											

Since there will be higher water levels in the Mekong River in the dry season, domestic and irrigation water uses will benefit from lower costs of pumping and having more quantity of water during the dry season. The severity is predicted medium and will be in the long run. The impact on cropping may be positive given easier access to the river but some drawdown cropping areas on both banks of the Mekong will be lost from higher water levels in the dry season.

The improvement of infrastructure and facilities and communication by the projects will benefit health and tourism but the higher water level in the dry season may impact on some rapids sites for tourism (such as Kaeng Khut Khu) while the proposed dam will obstruct the migration of fish that are main sources of protein for the riparian people. The severity of impacts is predicted medium and will be in the long-term period.

There will be some conflicts between groups of people who agree and disagree with the projects which are predicted as of medium severity and will occurin short period. Other beneficial issuesare climate change where electricity produced will be exported to neighboring countries especially Thailand that can replace the use of fossil fuel in electricity generation that helps global warming. This will be in the long run with medium severity.

b) Zone 4 (Cambodia) and Zone 5 (Mekong Delta)

As discussed earlier, the dependence of riparian people on the Mekong River in Zones 4 and 5 is high, especially in and around the Tonle Sap Lake of Cambodia and in the Vietnamese Delta provinces including An Giang, Dong Thap, Can Tho, My Tho, Hau Giang, Soc Trang, Vinh Long, Tra Vinh, Ben Tre and Tien Giang. The transboundary impact will depend on water level and sediment trapped during operation stage. In fact, there will be other non-project factors that also create some impacts to the Delta area such as:

- Industrial development in the area
- Waste water from Ho Chi Minh City
- Environmental sanitation practice within the Delta
- Use of agriculture chemicals
- Use of illegal fishing gears
- Government intervention in above and in improving welfare of the people.

The prediction of impacts can be done well after hydrological and sedimentation simulation and modeling by using HecResSim has been accomplished. This process for modeling is now ongoing. However, to provide some results of assessment in this report, attemptsz have been made to predict transboundary impacts to Zone 4 and 5 as presented in Matrices 3 and 4, respectively. It should be noted that these transboundary impacts are in the preliminary stage only.

Matrix 3: Preliminary Transboundary Social Impacts in Zone 4 (Cambodia)

Anticipated Cumulative Social Risks	Type		Severity			Duration			Significance		
	Adverse(-)	Beneficial (+)	Low	Medium	High	Short Term	Medium Term	Longer Term	Minor	Medium	Major
Domestic and irrigation water use											
Cropping											
Health and nutrition											
Tourism											
Socio-political conflict											
Climate change											

Matrix 4: Preliminary Transboundary Social Impacts in Zone 5 (Vietnam)

Anticipated Cumulative Social Risks	Type		Severity			Duration			Significance		
	Adverse(-)	Beneficial (+)	Low	Medium	High	Short Term	Medium Term	Longer Term	Minor	Medium	High
Domestic and irrigation water use											
Cropping											
Health and nutrition											
Tourism											
Socio-political conflict											
Climate change											

6 MITIGATION AND MANAGEMENT INTERVENTIONS

6.1 Project Level Mitigation

At the project level, the PaklayHPPplanners have made some significant concessions in an attempt to avoid and mitigate any environmental or social impacts. These include:

- Project proponent will follow MRC and MoNRE guidelines and requirements with respect to the potential establishment of an environmental Panel of Experts.
- Minimization of noise and vibration from blasting. A warning siren will be sounded and daily blasting will be done as much as possible all at once rather than spreading out many individual blasts over the day.
- The blasting for the downstream excavations will be done after the coffer dams are constructed so it will be on dry land and will avoid impacts to fish that would occur with underwater blasting.
- The construction camp site will choose in a suitable site in order to avoid possible conflicts with the local populations.
- The construction company will be selected based on their experience, expertise, and financial strength to make sure that the project is built according to plan and that there is little or no danger of the project being abandoned due to contractor's problems.
- Unlike NT2 which emphasized "livelihood restoration", PaklayHPP will strive for "livelihood betterment". This may include the appointment of "wealth-creation" advisors who would work with the local people to help them maximize the project's local economic benefits (such as increased land values and the potential to switch to higher-valued agriculture).
- The "No Project" scenario means that livelihoods in the area will continue to deteriorate.

6.1.1 Hydrology

As the results indicate in section 4.2.1, the large storage dams on the Lancang, the existing LMB tributary dams, and Paklay dam, operated primarily for power generation in response to fluctuating demand, will alter mainstream river flows substantially along its length by reducing wet season flows and increasing dry ones. However, the inevitable and irreversible flow changes will have substantial impacts compared with the Baseline Situation. These include a reduction of wetlands, reduced flow reversal into Tonle Sap and reductions in sediment flows causing long-term irreversible riverbed incision and bank erosion, with consequent impacts on the Delta-shaping processes. Reduced sedimentation will occur within a decade, with consequences for reduction of valuable wetland and agricultural productivity as well as for the discharge of sediments and associated nutrients to coastal waters which may affect marine fishery production. Therefore, to mitigate the hydrologic impact, the following guidance should be considered:

1) *During construction*

Accelerated soil erosion and subsequent downstream sedimentation and decreasing surface water quality could be potentially increased during construction of the proposed project. The construction activities should not obstruct the normal flow of the Mekong River. Mitigation measures have to be implemented to minimize impact due to construction such as replanting of vegetation after soil excavation and construction of sedimentation pond at the construction site.

2) *After construction*

- Using demarcation of flood zones before and after construction of a dam project, frequently flooded areas should be used as nature reserves or for grazing, no permanent buildings should be built.
- For areas which after construction of the dam, are subjected to infrequent, but severe flooding, it is worthwhile to install a flood warning system and to evacuate people, livestock and valuable items from the area if a major flood is expected.
- Cropping calendars can be adapted to the expected time of year and frequency of flooding events.
- Data should be incorporated into dynamic fishery models whose outputs can be used by dam operators in water management control models.
- The environmental flow strategy should be set-up for the river downstream of the dam. However, such a strategy could not be fixed. In fact, it would need to be updated and adapted as knowledge gained from long-term monitoring accumulates, during operation of the dam.
- Mitigation on damage is a complex issue and all options including changing the operation of reservoir projects must be compared with each other to identify the most efficient solutions.

6.1.2 Sidementation

This section aims to present the sedimentation impact mitigations and development of Paklay Dam in the project level by reviewing of relevant published documents and also the project reports.

6.1.2.1 *Sidementation Management Measures*

MRC (2009) described the sediment management measures that may be employed to avoid or mitigate the potential impacts. These can be analyzed by different areas and include:

1) Upstream of the reservoir

- Sediment traps - structures constructed in the river upstream of the reservoir to capture part of the sediment load.

2) In-reservoir

- ***Sediment routing*** - operating the dam to transport as much of the sediment load as possible through the reservoir for discharge downstream by maintaining high sediment transport capacity during the period of the year when the sediment concentration and discharge are highest. This means avoiding trapping sediment by releasing sediment-laden water and impounding sediment free water.

- ***Sediment bypass channel*** - used to convey sediment around the reservoir and discharge it downstream.

- ***Sediment flushing*** - re-suspending previously deposited sediment in the reservoir and discharging it downstream of the dam. This is only feasible if river-like flow conditions can be re-created in the reservoir by drawing down the water surface elevation using low-level outlets that have the ability to pass free surface flows at very low elevations at the dam.

3) Localized sediment deposition

- ***Pressure flushing*** - flushing deposited sediment through low-level conduits to keep intake structures clear and minimize the amount of sediment that passes through turbines. This technique is usually implemented by maintaining a high water surface elevation at the dam (i.e., no need for reservoir draw down), while concurrently opening the low-level outlets.

4) Downstream of the dam

- Sediment augmentation - introducing sediment into the river downstream of the dam to replace the sediment trapped in the upstream reservoir and by so doing reduce the extent and intensity of adverse impacts caused by "sediment hungry" water.

- The clear water released from the dam is often referred to as "hungry water", because the excess energy is typically expended on erosion of the channel bed and banks for some years following dam construction, resulting in incision (down cutting of the bed) and coarsening of the bed material until equilibrium is reached and the material cannot be moved by the flows. Reservoirs also may reduce flood peaks downstream, potentially reducing the effects of hungry water, inducing channel shrinking, or allowing fine sediments to accumulate in the bed (Kondolf G.M., 1997).

The details of pressure flushing, sediment routing and flushing technique are as follows:

1) Pressure Flushing

The accumulated sediment in front of the power intakes could be flushed by using low-level conduits to sluice sediment through the dam. This should be possible through pressure flushing, which would be performed by maintaining a high water surface elevation, while releasing water through the low-level outlets, as shown in Figure 149. However, Thorne et al. (2011) pointed out that experience from many other dams demonstrated that pressure flushing would only remove localized sediment deposits immediately upstream of the power house.

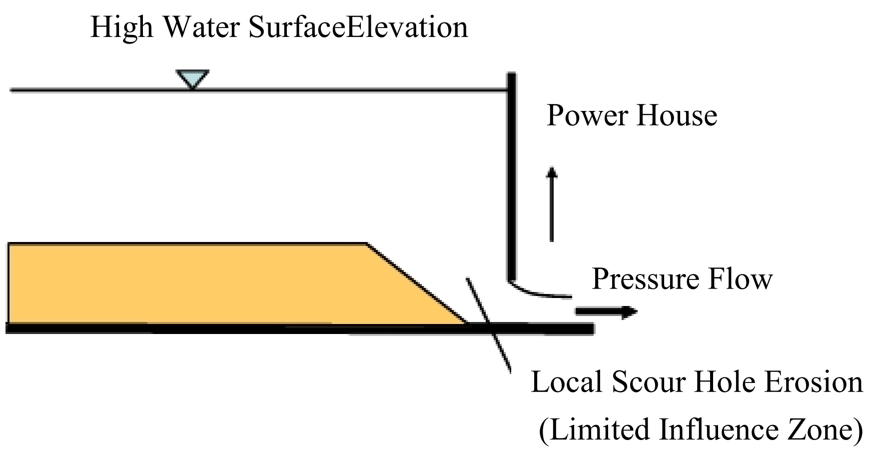
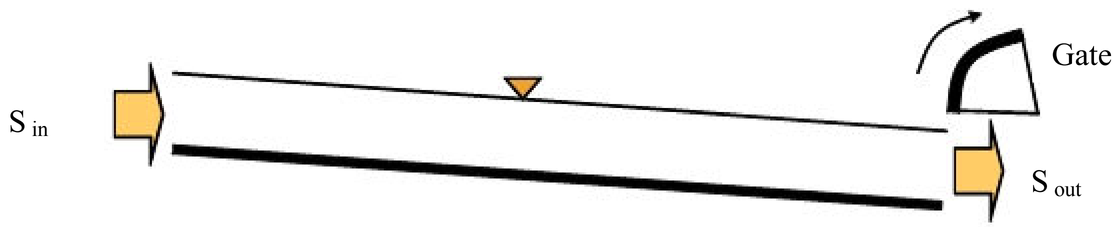


Figure 148: **Pressure flushing to remove localized sediment deposits (Thorne et al., 2011)**

2) **Sediment Routing**

The sediment routing is feasible if the spillway gates are opened completely (as shown in Figure below) during high-flow events with high sediment concentrations, it might be possible to generate sufficient transport capacity throughout the reservoir to pass a substantial proportion of the incoming sediment (especially the finer fraction) without its ever settling in the reservoir.



Maintain Sediment Transport Capacity throughout reach, such that: $S_{in} = S_{out}$

Figure 149: **Schematic illustrating the concept of sediment routing (Thorne et al., 2011)**

If the timing of annual sediment routing operations could be matched to key periods for fish migration, the required design modifications could possibly help minimise the impacts of the dam on fish as well as sediments. Also, if this measure were implemented during a period of high discharge, it might be possible to continue hydropower generation during sediment routing operations. It would provide the sediment concentration of the flowing water is not too high and sufficient discharge were available for concurrently passing water through the turbines.

3) Sediment Flushing

Sediment flushing requires operators to draw the water level at the dam down and increase the water surface slope (referred to as hydraulic gradient) through the reservoir. It creates river-like flow conditions that re-suspend previously deposited sediment from the bed and banks and carry it downstream of the dam through the low-level outlets, as shown in Figure below. This method would be necessary to install large, low-level outlets capable of conveying flushing flows through the dam without impediment, so recreating flow conditions in the reservoir that mimic natural, pre-dam conditions.

Sediment concentrations would be unnaturally high during flushing and so it would be essential to comply with the advice provided by fisheries and environmental experts to avoid adverse impacts on fish and wildlife. It would not be possible to generate hydropower during flushing operations.

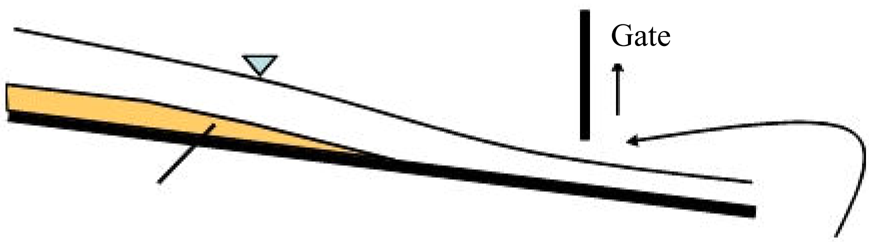


Figure 150: **Schematic illustrating the concept of sediment flushing (Thorne et al., 2011)**

As the project will be a run-of-river scheme, JV(2011) believed that the bed load sediment upstream of Xayaburi dam site would be all intercepted, the only little amount of bed load sediment between Xayaburi Dam and Paklay Dam would flow into the Paklay reservoir. Besides, they concluded that during the design operating years of the project, the sediment trapping caused small effect on the regulation reservoir capacity. However, there were strong recommendations for Xayaburi dam operators to organize the routing and flushing not only the suspended load but also the bed load into downstream. There would be some amount of the flushed sediment from Xayaburi Dam further flow into the Paklay Reservoir, which means that Paklay Dam should organize the same manner of routing and flushing as well. However, there is no sluice gate and the spillways are too high to accomplish draw down flushing. Hence, it would be necessary to install large, low-level outlets capable of conveying flushing flows through the dam without impediment, so recreating flow conditions in the reservoir that mimic natural, pre-dam conditions.

If the dam design are properly modified to optimize routing and flushing operations, and these are conducted on a regular basis, its trap efficiency could be significantly reduced. This means not only all the sediment impacts alluded to earlier would be minimized, but also the capability of the dam to generate hydropower in a sustainable manner could be maintained, ideally, in perpetuity.

6.1.2.2 Recommendatations

1) Modifications to Operations

It is recommended that JVshould reconsider the proposed operating procedures with respect to optimising sediment routing and flushing, based on exploiting the enhanced sediment management capabilities provided by the recommended design modifications. JVshould then demonstrate the effectiveness of the revised design and operating regime in:

- Avoiding sedimentation to the highest degree possible and mimicking the natural time distribution of sediment transport downstream by sediment routing.
- Flushing downstream as much as possible of the sediment that is deposited in the reservoir, while selecting flushing times and durations to avoid undesirable environmental impacts associated with artificially high concentrations of sediments and nutrients.

JVshould perform these demonstrations through mathematical modelling to:

- Determine how much sediment will accumulate in the reservoir and when an equilibrium condition will be achieved using the enhanced sediment management measures.
- Prepare sediment yield estimates to feed into computations of cumulative effects should the dam be operated as one of a cascade of mainstream dams.
- Provide the basis for ensuring that the dam can achieve multipurpose objectives to sustainable hydropower generation and, ideally, in perpetuity while minimising adverse impacts on sediments, morphology and nutrients.
- Underpin the on-going assessments necessary to support adaptive adjustments of sediment management measures based on a holistic view that encompasses multiple aspects of the entire LMB. This is of utmost importance to maintaining the productivity and environmental integrity of the basin.

The extent to which biodiversity is affected by nutrient imbalance in the reservoir will depend on the degree of siltation and accumulation of organic debris that accompanies the change from fluvial to more lake-like conditions.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

It is, therefore, recommended that detailed investigations are carried out to identify whether siltation, the accumulation of organic debris, and the potential for dry season thermal stratification in deep pools are likely to require mitigation and, if so, specification of the most appropriate mitigation measures.

It is highly recommended that an environmental flow strategy is set-up for the river downstream of the dam that takes into account the dynamics of sediment-associated nutrients and, especially, how sediment flushing operations can avoid potentially serious, adverse impacts on downstream environments and ecosystems. However, it is important to note that such a strategy could not be fixed: in fact it would need to be updated and adapted as knowledge gained from long-term monitoring accumulates, during operation of the dam.

2) *Modifications to the Monitoring Program*

a. *Monitoring Specified by MRC*

The MRC is very clear concerning the requirement to set-up a comprehensive sediment monitoring program covering all relevant temporal and location issues. The MRC document makes it clear that monitoring should:

- Be initiated before the construction starts (to establish a baseline to be used to establish reference conditions).
- Continue through construction (to allow detection and solution of any problems).
- Be maintained throughout the operating period (in order to support adaptive management of sediments and nutrients).
- include monitoring stations located:
  - Upstream of the dam in the reservoir and backwater reaches.
  - At the dam site itself.
  - In the river downstream of the dam site.
- Record both the quantity and composition of sediments (grain size distribution, associated nutrients, organic constituents, and bio-indicators).

b. *Monitoring Recommendations*

The standards and methods used should be the same or compatible with the existing sediment monitoring in the LMB and sediment monitoring should be coordinated and synchronized with monitoring programs for Hydrology, Water Quality, Biota, and Fisheries - as recommended by MRC.

During the construction period, monitoring of sediment and nutrient-related impacts upstream and downstream of the dam site should be carried out. Sampling frequency should vary between monthly and weekly, depending on the type of construction activities on-going at the time. During periods of intense construction activity, sampling frequency may need to be even higher.

It is recommended that sediment and nutrient monitoring continues throughout the operating period with the aim of supplying data relevant to the following issues:

- Sediment accumulation (quantity and composition) in the reservoir with an emphasis on sediment features at the upstream and lateral margins and siltation in deep locations, including the deep pools. Frequency: at least biannually, prior to and following the monsoon. This frequency may be adjusted as experience is gained on the actual rate of sedimentation.

- Sediment (quantity and composition), sediment features, and morphological changes along the river reach between the dam site and Vientiane. Emphasis to be placed on river banks and flood-level lines, mid-channel islands, and sediment deposits at tributary junctions. Frequency: at least annually, following the monsoon; later adapted as experience dictates.

During sediment flushing, sampling should be carried out with a frequency that is suitable to establish the maximum sediment concentration in water being used to flush deposited sediment from the reservoir. The purpose of monitoring is to alert dam operators should flushing cause sediment concentrations to reach a level potentially harmful to fish and other aquatic fauna.

3) Soil Erosion and Sediment Control During The Construction

The soil erosion should be controlled during the construction of dam and relevant components of the project. It aims to minimize soil loss and that of the sediment to discharge into streams. The recommendations relevant to soil erosion control are as follows;

- Natural vegetation should be retained, protected or supplemented to the extent practical. The stripping of vegetation should be done in a manner that minimizes soil erosion.

- Excavation equipment should not be placed in the base of an infiltration area during construction. Excavation or other construction vehicles should not be placed in the root zone areas of trees to be retained during construction. Furthermore, construction equipment and materials should be stored at a distance greater than 10 meters from drainage channels, streams, lakes or wetlands.

- No ground disturbed as a result of site construction and development should be left as exposed bare soil. All areas exposed by construction, with the exception of finished building, structure, and pavement footprints, should be compacted (aerated) and covered with a minimum thickness of six inches of non-compacted topsoil, and should be subsequently planted with a combination of living vegetation such as grass, groundcovers, trees, and shrubs, and other landscaping materials such as mulch, loose rock, gravel or stone.

- All applicable erosion and sediment control practices should be in place prior to any grading operation and/or installation of proposed structures or utilities. Soil erosion and sediment control practices on the plan should be constructed in accordance with the standards for soil erosion and sediment control. Moreover, applicable erosion and sediment control practices should be left in place until construction is completed and/or the area is stabilized.

- The contractor should be perform all work, furnish all materials and install all measures required to reasonably control soil erosion resulting from construction operations and prevent excessive flow of sediment from the construction site.

- Any disturbed areas that is to be left exposed for more than thirty days and not subjected to construction traffic should immediately receive a temporary seeding and fertilization. All critical erosion areas subject to erosion should receive a temporary seeding in combination with straw or another suitable material. Mulching is required on all deeded areas to insure against erosion before grass is established to promote earlier vegetation cover.

- The site should at all times be graded and maintained such that all storm water runoff is disturbed to soil and sediment control facilities. All sedimentation structures should be inspected and maintained on a regular basis and after every storm event. A crushed stone, tire cleaning pad would be installed wherever a construction access exists.

- All driveways must be stabilized with two inches crushed stone or sub-base prior to individual lot construction. Besides, all paved areas must be kept clean at all times. All storm drainage outlets should be stabilized, as required, before the discharge points become operation.

- All dewatering operations must discharge directly into a sediment filter area. The sediment filter should be composed of a suitable sediment filter fabric. The basin must be dewatered to normal pool within ten days of the design storm. Offsite sediment disturbance may require additional control measures to be determined by the erosion control inspector.

- Immediately after the completion of stripping and stockpiling of topsoil, the stockpile must be stabilized according to the standard for temporary vegetative cover. Stabilize topsoil stockpile with straw mulch for protection if the season does not permit the application and establishment of temporary seeding. All soil stockpiles are not to be located within fifteen meters of a floodplain, slope, roadway or drainage facility and the base must be protected with a sediment barrier.

6.1.2.3 Conclusions

The sediment routing and flushing could be used in tandem to reduce local and transboundary effects. JV believed that the bed load sediment upstream of Xayaburi dam site would be all intercepted, the only little amount of bed load sediment between Xayaburi Dam and Paklay Dam would flow into the Paklay reservoir. Furthermore, they also concluded that during the design operating years of the project, the sediment trapping caused small effect on the regulation reservoir capacity.

However, some amount of the flushed sediment from Xayaburi Dam would further flow into the Paklay Reservoir, which means that Paklay Dam should organize the same manner of flushing as well.

Therefore, in order to avoid or mitigate the impacts of sedimentation at the project level and transboundary, JV should apply a proper mathematical model to simulate how much sediment will accumulate in the reservoir and when an equilibrium condition will be achieved. The result from the model simulation could be useful for them to reconsider the modification of the sand flushing devices design. Such proper devices and an appropriate sediment management strategy will allow establishment of pre-dam stage discharge conditions at the dam site. It aims to modify the design and operational strategy to enhance the capability for routing and annual flushing, coupled with monitoring and adaptive sediment management to minimise fine sediment and nutrient retention within the reservoir. Furthermore, JV should consider and follow the proposed recommendations not only the modification of the dam design but also the operation and monitoring programs, as well as the soil erosion and sediment control during the construction phase.

6.1.3 Fish Migration and Fisheries

Construction of the Paklay dam would cause an impact to fish migration in the middle and upper Mekong Basin. In order to minimize impacts to fish migration, a fishway is proposed. Proper design and operation of the fishway is very necessary for fish migration, particularly to the Mekong giant fish species, which travel upstream for reproduction and spawning.

Similarly, to minimize the impact on fisheries (decreasing quantity and species of fishes), the establishment of fish hatcheries for the cultivation of fish and other aquatic organisms is required; these aquatic animals would be released into the Mekong River when ready. Increased fish pen aquaculture is needed for the upstream area of the dam in order to make use of the backwater caused by the dam construction.

However, to accomplish such mitigation measures fishery experts from the responsible government agencies need to be consulted as well as agencies such as the MRC. Emphasis should be put on critically endangered or economically important species.

6.1.4 Navigation

The impact on navigation during the construction of the Paklay dam cannot be avoided and the impact is permanent. It is a must to construct a ship lock following specifications/recommendations for ship lock design on Mekong mainstream damsauthored bythe Mekong River Commission such as the "Preliminary Design Guidancefor Proposed Mainstream Damsin the Lower Mekong Basin." This can be found here: http://www.mrcmekong.org/assets/Publications/Consultations/SEA-Hydropower/Preliminary-DG-of-LMB-Mainstream-dams-FinalVersion-Sept09.pdf.

6.1.5 Water Quality

The impacts on water quality at the project level are assessed in the ESIA. Potential causes of the impacts on water quality are the subject of mitigation measures, which are divided into 2 phases, namely, the construction and operation periods.

*Construction period:*Wastewater and solid wastes generated from the worker camps will deteriorate water quality in the receiving water unless treated properly. Domestic wastewater creates high organic matter, nutrients as well as bacterial contamination. Mitigation measures are proposed as follows:

– Installing onsite treatment systems for wastewater generated from worker camps.
– Installing an adequate numbers of sanitary latrines with septic tanks for toilet waste.
– Collection of household solid wastes (e.g. garbage, rubbish, etc.) from construction camps and disposal of it at sanitary landfills located nearby the construction area.
– Storing construction materials and residue in an appropriate manner for convenient and safe use, reuse of construction residue as much as possible, and properly dispose of non-used construction residue (which has become waste).
– Avoid open burning of solid wastes and if it cannot be avoided, burning should be done in pits.
– Constructing the temporary settling pond to trap sediment eroded during construction. Sediment would not cause high turbidity in the receiving water.

*Operation period:*Due to the impacts on water quality from the beginning of the reservoir storage and wastewater discharge from human activities during the dam operation mitigation measures are proposed as follows.

– Correct removal of biomass (trees, plants and other vegetables) as described in the Climate Change study of this TBESIA.
– Periodic releasing of sediment from the reservoir to minimize accumulation of sediment. In the mean time maintain suspended solids in the downstream river to prevent bank erosion and scouring effects of the river bank and bottom.
– Installation of wastewater treatment system and solid waste disposal systems in the community area (these measures should be under the responsibility of the local authorities).

- Providing knowledge of safe agricultural and aquaculture practice to farmers/fishermen to help safeguard water quality, the ecosystem of the river as well as the well being of farmers and fishermen themselves.
- Installation of an on-site wastewater collection and treatment (if available) for cargo transshipping. Provide garbage collection bins on boats/ships to be emptied and disposed of on land.
- Precautionary measures against oil spills/leakages due to navigation activities and accidents.

6.1.6 Dam Safety

There is no obvious evidence of earthquake activity in the last 553 years, although there are several faults running NNE; also, there is no historical record about a strong earthquake greater than 6 magnitudes. Thus, from the regional geological tectonics and crustal activity point of view, Paklay HPP site is a relatively stable region.

If necessary, areas of rock and soils that may be loosened by the filling of the reservoir should be identified and artificially released to minimize landslides during impoundment.

6.2 Basin-Level Mitigations and Development

6.2.1 Hydrology

6.2.1.1 Reservoir Management (FAO & MRC, 1999)

The various storage reservoirs established or planned in the country for hydropower development will provide valid options to reduce the high discharges caused by excessive rainfall of short duration. Storage for floods will reduce the capacity for power generation and income. An optimization of hydropower generation and flood absorption through reservoir management modeling is therefore required based on economic criteria.

6.2.1.2 Regional Flood Monitoring and Flood Forecasting

The size of the Mekong Basin makes international cooperation imperative and any flood monitoring, forecasting, simulation and decision support system of Mekong Basin needs to be made in close cooperation with the four member countries of the Mekong River Commission and in consultation also with the two countries sharing the upstream Mekong Basin.

6.2.1.3 Flood Control Works and Investments

More lasting solutions to floods will be achieved in the construction of flood control works such as flood gates and protection dikes. Considerable investments are required however to provide more durable protection of agricultural lands and infrastructure.

6.2.1.4 Local Awareness and Preparedness in Flood control

At district and village level, communities should be encouraged to co-operate in the implementation of self-help flood control projects making use of the considerable local knowledge and traditional technologies to find cost effective and sustainable flood control works.

Furthermore, to compensate for recurrent losses due to floods, farmers need to be encouraged to diversify agricultural production and to extend their production basis to irrigated crops during the dry season.

6.2.1.5 National Flood Management Strategy and Capacity

To deal effectively with recurrent floods and flood emergencies, an appropriate mechanism and capacity needs to be established which will put in place at national and district level adequate measures to cope with flood emergencies and to plan for long-term solutions to reduce and mitigate recurrent flood damages.

6.2.2 Fish Migration and Fisheries

Mitigation on fish migration and fisheries at the project level of all projects constructed along the Mekong River would be employed to accomplish and protect fisheries at the basin level. Detail had been explained in the Chapter 3 of this report.

6.2.3 Sedimentation

The basin-level mitigations of sediment impact of Paklay dam could be carried out by of the modification of dam design and sediment management strategy as described in section 6.1.2. This means that if the recommendations have been implemented, the impacts of sedimentation in the project level would be minimized to be at the acceptable degree. Whenever there is no significant impact at the project level, there should also not be an effect downstream of the Mekong River. The recommendations could be summarized as follows:

1) JV et al. should follow the sediment management measures to avoid or mitigate the potential impacts of sediment as described by MRC.

2) The dam design should be modified in order to make it suitable for sustainable hydropower generation, and ideally with appropriate maintenance, in perpetuity. This means that the dam must have the capability to allow future generations of dam operators to manage sediments adaptively.According to future conditions and changing priorities for river and resource management in the LMB, changes in sediment routing and flushing operations may need to be made as appropriate

3) The recommended design would involve modifications to the spillway and provision of low level outlets with dimensions sufficient to allow operators to re-create the river-like flow conditions required to execute flushing operations.

4) JV et al. should reconsider the proposed operating procedures with respect to optimising sediment routing and flushing, based on exploiting the enhanced sediment management capabilities provided by the recommended design modifications.

5) The dam operating procedures should be revised for avoiding sedimentation to the highest degree possible and mimic the natural time distribution of sediment

transport downstream by sediment routing. Furthermore, procedures should aim to flush downstream as much as possible of the sediment that is deposited in the reservoir, parallel with selecting flushing times and durations to avoid undesirable environmental impacts associated with artificially high concentrations of sediment and nutrients.

a) JV et al. should perform simulations through mathematical modelling to determine how much sediment will accumulate in the reservoir and when an equilibrium condition will be achieved using the enhanced sediment management measures. The modelling would enable the preparation of sediment yield estimates to feed into computations of cumulative effects should the dam be operated as one of a cascade of mainstream dams. Furthermore, the model will provide the basis for ensuring that the dam can achieve multipurpose objectives in sustainable hydropower generation in perpetuity, while minimising adverse impacts on sediments, morphology and nutrients.

b) The simulations also aim to underpin the on-going assessments necessary to support adaptive adjustments of sediment management measures based on a holistic view that encompasses multiple aspects of the entire LMB. This is of utmost importance to maintaining the productivity and environmental integrity of the basin.

c) The model should be simulated in order to assess the sediment and morphological impacts for 4 scenarios:
   - Scenario 1: Existing condition (no Paklay Hydropower Project).
   - Scenario 2: Having Paklay Hydropower Project condition (Dam operation).
   - Scenario 3: Having Paklay Hydropower Project condition + development plan (2017).
   - Scenario 4: Having Paklay Hydropower Project condition + development plan (2017 and 2030).

d) The capability to manage sediment adaptively is essential because modelling uncertainty concerning future sediment loads and operating conditions is high. The best way to deal with these irreducible uncertainties is to design a dam with the maximum capability for implementing sediment management measures, allowing its operators to optimize sediment management operations regardless of how the characteristics of the sediment and nutrient transport system evolve in the future. Moreover, this will make it possible for operators to respond positively to changing priorities for the management of natural resources of the river. This is not only common sense; it also ensures that the design complies with the principles set out by MRC for adaptive management.

6) It is highly recommended that an environmental flow strategy is set-up for the river downstream of the dam that takes into account the dynamics of sediment-associated nutrients and, especially, how sediment flushing operations can avoid potentially serious and adverse impacts on downstream environments and

ecosystems. However, it is important to note that such a strategy could not be fixed. In fact, it would need to be updated and adapted as knowledge gained from long-term monitoring accumulates, during operation of the dam.

7) The comprehensive sediment monitoring programs should be set-up covering all relevant temporal and location issues as the requirement of MRC.

8) The soil erosion should be controlled during the construction of dam and relevant components of the project;the aim being to minimize soil loss and that of the sediment to discharge into streams.

6.2.4 Navigation

Mitigation measures at the basin level are recommended as follows:

1) Install distinct signals and signs at dangerous parts of the river such as rapids, outcroppings, etc.

2) Establish agreements or treaties between GMS countries for the following Aspects:

- Permission on freight transshipping.
- Safety policies on transshipping.
- Prevention of pollution to the Mekong River. For example, prohibiting the discharge of wastes and grease/oil to the river.
- Correct navigation practices to minimize impact on aquatic life in the Mekong.

6.2.5 Water Quality

Mitigation at the basin level could help alleviate negative impacts on water quality on a substantial scale. However, mitigation at the basin level requires cooperation as the following proposes.

- Reforestation of existing deforested and degraded areas along the river bank and related tributaries, particularly of the exposed and excavated areas of the Project area
- Modeling on biomass removal in order to remove biomass as designated amount at specific area in order to minimize impact on water pollution and GHG due to anaerobic digestion of the accumulated sediment with organic matters.
- Modeling on assimilative capacity of the downstream river in order to identify the recovery zone of the reservoir water discharge incorporated with the organic load from human activities along the river bank.
- Appropriate design of ship lock and transshipping routes to facilitate navigation that would accordingly minimize negative impacts on water quality from crowded navigation and parking.
- Educating farmers/fishermen of good practice in agriculture and aquaculture that would help reduce negative impacts on water quality and other related impacts on fisheries, ecosystem, water use and health.

6.2.6 Dam Safety

There is no obvious evidence of earthquake activity in the last 553 years, although there are several faults running NNE; also, there is no historical record about a strong earthquake greater than 6 magnitudes. Thus, from the regional geological tectonics and crustal activity point of view, Paklay HPP site is a relatively stable region.

If necessary, areas of rock and soils that may be loosened by the filling of the reservoir should be identified and artificially released to minimize landslides during impoundment.

7 PUBLIC INVOLVEMENT

Public involvement (PI) is a crucial step in constructing mainstream hydropower dams in Lao PDR. Public information and disclosure have been performed for Paklay HPP in the early stage of the ESIA process. This is to comply with the Lao PDR's recent decree on the ESIA (Instruction No 8030). Additionally, because the Paklay HPP is a mainstream hydropower dam, the involvement of other riparian countries is required, namely, Thailand, Cambodia and Vietnam.

7.1 Objective and Scope

The PI aims to introduce the proposed project to stakeholders, inform them as it develops, and identify their views and concerns. The main aim is to incorporate stakeholder concerns and local knowledge in the design and implementation of the project, and avoid/reduce potential conflicts as much as possible. This approach fosters stakeholders' engagement and contribution to the project, enhances its acceptability and encourages realistic expectations as to what the project will deliver to them. The objectives of PI program are to:

- Identify problems, concerns and needs;
- Inform stakeholders about the project;
- Obtain feedback;
- Learn from local knowledge and understanding;
- Evaluate alternatives;
- Promote ownership and enhance social acceptability;
- Avoid or resolve conflicts;
- Demonstrate commitment of the project proponent in addressing issues raised during consultations.

The scope of consultation is focused on four main components, namely:

- Information Collection - involving collecting information on the environmental and social baseline conditions of the study area to determine key sensitive receptors.
- Information Dissemination - involving disclosure of information about the intended activity, project objectives and their outcomes in order to enable meaningful consultation.
- Consultation - involving an interactive, two-way flow of information, views and ideas between stakeholders and the project proponent, China Datang Overseas Investment Company.
- Participation - defined as a voluntary process in which stakeholders and project proponents come together to share, negotiate and control the decision-making process in the project design and management. This builds on the consultation component.

The consultation process involves the following but will not be limited to:

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

1) Formal meetings with government authorities, institutions, individuals, specialists and any NGOs identified;

2) Meetings with opinion leaders, community representatives (village committees or councils);

3) Household survey questionnaires, aimed at the local population within the project area. The survey questionnaires are a fundamental component of both the RAP and the SIA as they provide the basis for identifying impacts and developing management and mitigation measures that are specific to the local conditions.

7.2 Identification of PI Levels and Stakeholders

Four levels of PI are identified, they include:

- Village level
- District and provincial level
- National level
- Regional level

7.2.1 Village Level

The priority groups of people located in the project area are at the village level in particular, project affected people and village leaders including gender and vulnerable groups. All need to be involved. Specifically:

- Village heads in each of the project affected villages
- Key village informants, including village teachers, village elders, spiritual leaders and health-care workers.
- Directly and indirectly affected families in the project area.
- Gender and vulnerable groups (including ethnic minority group).
- Key village interest groups including landowners, land users, identified vulnerable groups, guardians of cultural and spiritual sites etc.

The participation of NGOs at village level is also required such as the Lao Women's Union, Lao National Front, Lao Front for National Construction and the Lao Youth Association.

7.2.2 District and Provincial Levels

Any study and project planning cannot be done without the participation of provincial and district administration and related key authorities of which the main ones are:

- Provincial/District Cabinet Offices
- Provincial/District Energy and Mines Offices
- Provincial Natural Resources and Environment Office
- District Environment and Land Offices
- Provincial/District Agriculture and Forestry Offices
- Provincial/District Planning and Investment Offices

- Provincial/District Health Offices
- Provincial/District Labor and Social Welfare Offices
- Provincial/District Information and Culture Offices
- Local NGOs who are actively working in the areas.

7.2.3 National/Central Levels

The central government bodies concerned with hydropower development can be listed as follows:

- Laos's National Mekong River Commission
- Ministry of Natural Resources and Environment
- Ministry of Energy and Mines
- Ministry of Agriculture and Forestry
- Ministry of Planning and Investment
- Ministry of Finances
- Ministry of Health
- Ministry of Labor and Social Welfare
- Ministry of Information and Culture
- National Land Management Administration
- Any other relevant agencies including NGOs.

7.2.4 Regional Levels

The regional involvement level is based on the regional agreement on Cooperation for the Sustainable Development of the Mekong River Basin (1995)of which the member countries are involved. At this level, key stakeholders include:

1) Mekong River Commission Secretariat (MRCS) and Lao National Mekong Committee (LNMC)
2) Cambodia
3) Thailand
4) Vietnam

The MRCS is the center of regional participation. Any road map/agenda for inter-countryconsultations requires suggestion and guidance of the MRCS.

Other agencies such as international/local NGOs are also part of the program for listening to their voices and comments.

7.3 Results of Public Involvement

7.3.1 Village Level Participation

Members of the communities in the vicinity of the project area participate through village meetings, interviews with representatives of the local villages and as part of the household surveys. The survey is used to develop a baseline socio-economic profile of the local communities. Information is sought on the level of awareness of the project, concerns and expectations of the project. Individual household interviewees and social dialogues are used to document the profile of communities, the range and extent of impacts both at the household and community level. Specifically the village level consultations will be held for the following purposes:

- Gather information on the profile of the community and the possible social impacts of the project on community structure, local resources and livelihood patterns. Some specific "focus group" were conducted in some villages
- Assess the scale of resettlement, loss of assets and livelihood (individual and community) and explore options for the most suitable livelihood restoration and asset replacement measures, including resettlement site options.
- Identify key environmental concerns of the communities, especially related to the diversion of water, impacts on land use, and construction activities.

Figure 151: Consultation at Village Level in the Project Area

7.3.2 District and Provincial Level Participation

A series of formal meetings and discussions with district and provincial authorities have been performed. The purpose of the interviews at national, provincial and district levels were to inform the stakeholders of the proposed project, to discuss the associated environmental, socialand resettlement issues as well as to gather any relevant secondary data. The consultations with district and provincial stakeholders also discussed the most practical and feasible mitigation measures in the opinion of these stakeholders. The majority of these interviews were undertaken by NCG and the local consultant team. Consultation at these levels was an important step in the protocol of working in the local area. It was a courtesy to inform the relevant government bodies and leaders of the intention to conduct surveys and interviews in the project districts.

The consultations/meetings employed the form of semi-structured interviews in which a short presentation about Datang and the purpose of the TBESIA, EIA, SIA and RAP tasks. This was followed by discussions about the role and responsibilities of the government office in general; it's specific role in relation to the Paklay HPP; any requirements in relation to construction and operation of the project; opinions about the positive and negative impacts of the project and suggestions for Datang and NCG.

Many of such meetings were envisaged with the central and provincial line departments, agencies, MONRE etc. During these meetings, the key issues and concerns raised by the stakeholders were recorded for inclusion in the reports.


Figure 152: Participation of District Authorities

7.3.3 National Level Participation

The official national consultation will be conducted after the final draft (TBESIA, EIA, SIA, EMMP, SMMP, RAP) and after the district/provincial consultation on these draft reports. During the course of the study many Central GOL authorities including the National Lao Mekong Committee have been contacted and cooperated.

7.3.4 Regional Level Participation

a) MRCS

Both MRCS in Phnom Penh (Cambodia) and Vientiane (Lao PDR) were officially visited with many meetings on the transboundary issues such as hydrology and sedimentation,fisheries, navigation, and other environmental and social aspects.

The MRCS is now preparing guidelines for TBESIA. Concerns about transboundary issues have been considered since the First Summit of the Mekong River Commission (MRC) took place in Hua Hin, Thailand, on 5 April 2010. Regional Prime Ministers, political leaders, MRCs Dialogue Partners, The People's Republic of China,The Union of Myanmar, and range of experts in the field of transboundary water resources management attended. This conference summarized challenges for trans-boundary river basin organizations in a changing world as follows:

- Benefit sharing means "the process where riparians cooperate in optimizing and equitably dividing goods, products and services connected directly or indirectly to the water course or arising from the use of its water."
- Increased involvement of civil society stakeholders in planning activities and decision making processes is increasingly recognized as an essential part of

sustainable development, and which may yet require additional emphasis to be effective.

- As relevant examples the Yangtze and Zambezi basins have developed mechanisms for the synchronization of dam operations and flood releases to optimize water use from existing and future systems. These experiences offer valuable lessons for the Mekong.
- Collaboration involves technical and policy issues that address long-term, short-term and real-time planning and operations.
- As an example from this region, the MRC's integrated water resources management based development strategy provides a framework for managing the "development space" in the basin. The “development space” is not just a volume of water that can be used, but a space for development and management of water and related resources, shaped by sustainable boundaries, e.g. acceptable transboundary impacts and basin-wide procedures.
- Basin organizations need to find sustainable financing mechanisms to support the core functions for management of the basin. *(MRCS, 2011)*

Figure 153: Meetings with MRCS on Transboundary Impact Assessment

The study team sent an official letter ***(see Appendix xx)***to the MRCS to cooperate well on the transboudary impact assessment. A number of meetings were conducted during the period October to November 2011.

The results of meetings can be summarized as follows:

- The study team was warmly welcomed by the MRCS. A*ll parties m*et at the MRCS in accord with the 1995 Mekong Agreement in which the TBESIA framework aims to facilitate MRC cooperation to support the protection of the environment, natural resources, aquatic life and conditions, and the ecological balance of the Lower Mekong River Basin and prevention and cessation of harmful effects resulting from development projects/activities.
- All parties agreed to support the study team on data and information and other suggestions for the transboundary study.
- Suggestions on hydrological and sedimentation scenarios/modeling (based on HecRecSim software) and a fishery survey were made by the MRCS senior staff and advisors.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

- Since the project is within the Lao territory, any official contacts should be passed through the Lao National Mekong Committee.

List of contacted persons at the MRCS are as follows:

1) Mr. Xaipadeth Choulamany (Env. Program), MRCS Phnom Penh, Cambodia
2) Mr. Peng Bun Ngor, Fishery, MRCS Phnom Penh, Cambodia
3) Mr. Bounphet Phommachanh, Navigation, MRCS Phnom Penh, Cambodia
4) Mr Anthony Green, Senior Modeling Advisor, Information and Knowledge Management Program, Technical Support Division, MRCS Phnom Penh, Cambodia
5) Dr. Inthavy Akkharat, Hydrologist, MRCS Phnom Penh, Cambodia
6) Ms. Ornanong Vonnarart, Hydrologist, MRCS Phnom Penh, Cambodia
7) Dr. Vithet Srinetr, Environment Program Coordinator, Environment Division, MRCS Vientiane, Lao PDR
8) Nguyen Van Duyen, Environmental management Specialist, MRCS Vientiane, Lao PDR

b) Thailand

The riparian provinces including Loei, Nong Khai, Nakhon Phanom, Mukdahan, and Ubon Ratchathani were visited in particular the riparian districts located wihin 5 km corridor. Official meetings were conducted in Chiang Khan, Pak Chom and Muang Mukdahan. The following governmental agencies were contacted:

- Riparian District Administration Offices;
- Riparian Sub-district Administration Offices;
- Provincial Statistical Offices;
- Tourism Authority of Thailand;
- Academic and non-governmental institutions.

The study team had a good chance to present and exchange knowledge and ideas on the "Role of Hydropower Dams in Water Resources Development" at Rajabhat University, Thailand on 2 December 2011. Attendants from various agencies discussed the role of hydropower in flood protection and other related issues.

Concerns about baseline information, monitoring, and post evaluation of hydropower dams related to methods and techniques were also included in the meeting.

Figure 154: Meeting at Rajabhat Thailand

c) Cambodia

Three governmental agencies were visited and the meeting included:

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

- Ministry of Environment (MOE), Environmental Impact Assessment Department, Royal Government of Cambodia;
- Ministry of Industry, Mines and Energy (MIME), Royal Government of Cambodia;
- Ministry of Planning, Royal Government of Cambodia;
- MRCS at Phnom Penh Office (already discussed in Section 3.4 a).

The study team informed the agencies visited about objectives and provided informationabout the mainstream projects and the Paklay HPP, the type of data required, and exchanged information and ideas concerning the feasibility stage of mainstream hydropower development. The gathering of social data and information was done at the same time as the visits.

Figure 155: Meetings with MOE *(left)* and MIME *(right)* in Cambodia

The MIME has plans for 14 hydropower dams to be operated in 2020. Many projects are proceeding as public-private partnership where NGOs need participation in the decision making process.

d) Vietnam

The plans for visiting Governmental Agencies in Hanoi and University of Can Tho have been postponed because of the need of official communication between countries. However, the meetings with local and international NGOs have been done (see next Section).

7.3.5 Dialogues with International NGOs

A number of dialogues with NGOs, locally and internationally, have been conducted and positions and voices listened to. The following meetings with some results were conducted.

a) NGO Forum on Cambodia

The "NGO Forum on Cambodia (NFOC)" is a network of national and international organizations working for social justice and sustainable development in Cambodia. In October 2009, the NFOC, Probe International, has published a document entitled "Powering the 21st Century, Cambodia with Decentralized Generation – A primer for Rethinking Cambodia's Electricity Future". This document addressed 6 main issues, namely:

- Cambodia's Electricity Sector;
- Rethinking Cambodia's Power development Strategy;
- A Better Strategy for Powering 21st Century Cambodia;
- Central generation vs. Decentralized Generation;
- Promotional Policies, Financial Incentives, Common Barriers;
- Powering 21st Century Cambodia with Decentralized Generation.

The document concluded that in allowing multiple decentralized power producer to sell into local distribution network (or directly to consumers), Cambodia can surpass theelectrify-cation objective through avoiding costly and high-risk investment in environmentally damaging hydro dams and coal-fired power plants. These can be done through introducing explicit and enforceable rules encouraging decentralized generation including: building a superior electricity system; adding capacity in smaller, more affordable increments; and using locally available resources and the best generating technologies.

Figure 156: Meeting with NGO Forum on Cambodia, Phom Penh, Cambodia

Other conclusion is related to political issue that the Cambodia's political leaders have to choose between the last century's model of power generation and the public interest.

On 23 March 2011, the NFOC has sent a letter to the Chairman of Cambodia National Mekong Committee to inform about the negative impacts of the proposed Xayaburi Mainstream Dam such as fishery, ecosystem and bio-diversity, transboundary, agriculture, and livelihood of which the project require to do more research and EIA study since the previous EIA was addressed only 10 km downstream of the project where considered not enough.

List of contacted NFOC persons are as follows:

- Ms Chea Phallika, Hydropower & Community Rights Project Coordinator, The NGO Forum on Cambodia
- Ms Im Phallay, Environmental Program Manager, The NGO Forum on Cambodia

List of non-government persons related to environment and tourism:

- Dr Ngy Laymithuna, Cambodian Environment Limited, Phnom Penh
- Mr John Pilgrim, Resettlement Specialist, Korea Consultants International
- Mr Ea Sophy, Resettlement Specialist, Korea Consultants International
- Mr Kriengkrai Krueysai, Hotel and Tourism Professional, Phom Penh

b) Vietnam Save the Mekong Coalition

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

The meeting with active NGOs in Vietnam was conducted to listen to their views on transboundary issues of mainstream hydropower dam development. At the Centre for Biodiversity and Development (CBD) in Ho Chi Minh City, there is a river coalition network with International Rivers which has recently expressed their views on Xayaburi Dam (in Lao PDR) and Son La and Yali dams (in Vietnam).

This NGO is part of "Save the Mekong Coalition" that have written a letter to Australia's Minister of Foreign Affairs expressing their concern with the Xayaburi Dam and the grievous failure of its PNPCA process. As the process has been funded by the Australian Government, the signatories called on Australia and other donors to use its leverage to call for an improved process and a delay in decision-making.

Figure 157: Meeting with NGO in Vietnam

Many mainstreams and some main Mekong tributary hyrodams may have environmental and social impacts (such as fishery, sedimentation, etc) that are considered as transboundary issues required to be studied.

List of key contacted persons of Vietnam NGOs are:

– Ms Pham Thi Hong Van, Environmental Activist, International Rivers Coalition/Journalist, Mekong Delta Provinces
– Mr Lam Dinh Uy, Environmental Scientist, Center for Biodiversity and Development, Ho Chi Minh City

– Dr Dao Trong Tu, Executive Director, Centre for Sustainable Water Resources Development and Climate Change Adaption, Hanoi, Vietnam
– Ms Nguy Thi Khanh, Coordinator of Vietnam Rivers Network, Centre for Sustainable Water Resources Development, Hanoi, Vietnam

Other nongovernmental persons contacted during the field surveys in Vietnam included:

– Mr Nguen Trong Khang, Tour Operator, My Tho Tourist
– Mr Le Van Nhu, Tour Guide, My Tho
– Ms Bao Yen Tran Thi, Tour Guide, Can Tho

c) Development NGOs in Lao PDR

The involvement of international and local NGOs in Lao PDR are found different than those in Cambodia and Vietnam where most of NGOs are supporting the country development in many aspects such as livelihoods, health, education, and tourism. Below are some results of meeting with NGOs in the Lao PDR. Since key project area is located in Oudomxay and Xayaboury provinces. The following local and international NGOs have met and discussed on their roles.

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

1. ***Community Health Development***

Name of NGO: Croix-Rouge Francaise (CRF)
Name of Project: *LRC/FRC Community Health Program (Phase II)*

Program objective: *Improving the sanitary conditions of vulnerable rural communities in Xayaboury and Vientiane Provinces*

Expected results:

- Water supplies and sanitation systems are available for all
- Appropriate related hygiene behaviors are adopted by the family members
- First aid and primary health cares are effectively provided by the Village Health Volunteers
- Health status among children are specifically improved as the District Health Department successfully implement the "Child Survival Strategy" (WHO/UNICEF)

Place of implementation: *Khob, Hongsa and Xienghone districts of Xayabouri Province and Maet, Kasy, Vang Vieng and Hom disctricts in Vientiane Province.*

Beneficiaries: *60 villages for an estimated population of 32,000*

Program duration: *40 months, from April 2008 to August 2011*

Total budget: *2,626,702 Euro*

Financial support: *French Red Cross 46% ; EU 28%; French MoFA 26%*

Primary implementer: *Lao Red Cross*

Lead technical assistance: *French Red Cross*

Associated partners: *Ministry of Public Health – Institut Francophone de la Medecine Tropicale (Vientiane)*

Contacted person: *Mr Arounphone French Red Cross, Xayaboury*

2. ***Tourism Development***

Name of Agency:
German Development Service (Deutscher Entwicklungsdienst - DED)
Activities:
The German Development Service (Deutscher Entwicklungsdienst – DED)Laos is supporting Lao PDR by providing advisers with professional experience. In Oudomxay four advisers, one junior adviser as well as four volunteers are engaged in the rural development, vocational training as well as in the tourism sector. The Provincial Tourism Department is cooperating with the DED since 2004. At the moment, an adviser, a junior adviser as well as a volunteer are supporting the PTD on improving sustainable tourism.The DED now is called GIZ.

Contacted persons:
Mr Siegfried Moser, GIZ - German Development Service, Advisor Tourism Development Oudomxay

Transboundary and Cumulative Impact Assessment (TBESIA/CIA).

7.3.6 The Prior Consultation Process

The Pak Lay hydropower project is proposed on the Mekong mainstream in Pak Lay district, Xayaburi province, in north-western Lao PDR. The proposed project sits downstream of the currently under-construction Xayaburi hydropower station and is 241 kilometers upstream of Vientiane, the capital city of Lao PDR.

The run-of-river dam will operate continuously year-round and produce 770 megawatts of electricity, designed with 14 turbines or generators, each producing 55 MW. Designed to discharge the flow of 6,101 m^3/s, the power plant is intended mainly for power generation for domestic supply.

The project's total investment cost is estimated at USD 2,134 million with the construction expected to start in 2022 and the commercial operation to begin when the construction finishes in 2029. Power China Resources Ltd is named as the developer, according to the official notification documents from Lao PDR.

On 13 June 2018, the Lao government, through its Lao National Mekong Committee, notified the Mekong River Commission Secretariat of its intention to undertake the formal process of Prior Consultation on the Pak Lay hydropower project. The notification includes the detailed description of the planned project for the MRC Secretariat to review and take further action to inform the other member countries about the project's scope and other requirements under the prior consultation process.

The MRC's Joint Committee Working Group (JCWG) on the Procedures for Notification, Prior Consultation and Agreement (PNPCA) convened its first meeting on 8 August 2018 to hear and discuss several key issues that require advanced proper attention and common understanding and agreement to ensure successful implementation of a six-month Prior Consultation process of the proposed project with an aim of increasing the joint benefits and cooperation among the member countries and MRC Secretariat.

The MRC has scheduled two regional stakeholder forums – one in September this year and another early next year – and a field visit to the project site to exchange and share information, investigate the site, and discuss and document legitimate concerns.

The Commission is now implementing the Prior Consultation process, officially starting on 8 August 2018. The consultation is conducted by the MRC Joint Committee (JC), a higher governance body comprising one senior government official at no less than head of department level from each member country, with technical and administrative support by the MRC Secretariat and the joint working group.

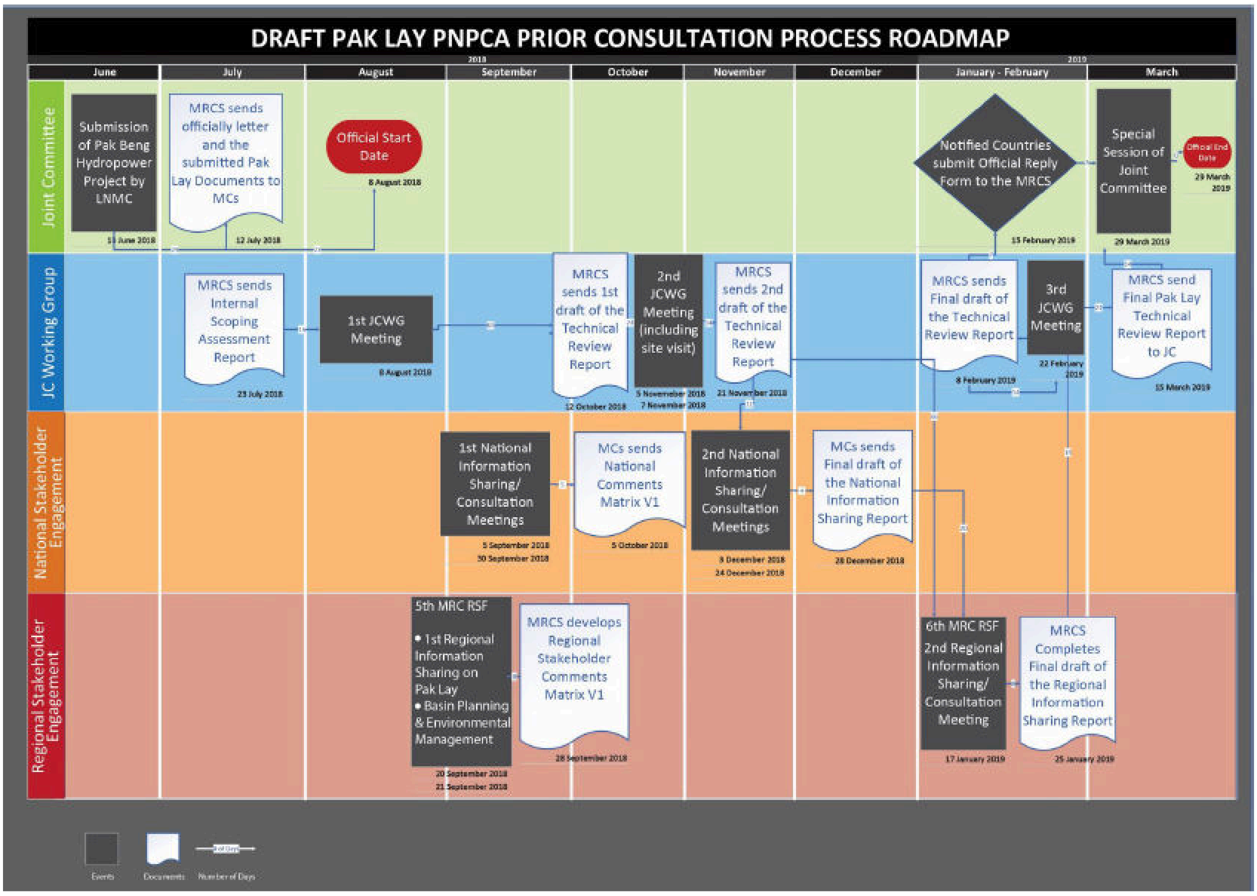
The Prior Consultation is part of the MRC's procedural rules on cooperation on water use of the Mekong mainstream governed by the PNPCA. Under the Procedures, any infrastructural project using the mainstream water during the dry season within the same basin, as well as during the wet season between two basins, must undergo the Prior Consultation process. Applicable projects include large-scale irrigation and hydropower development which may cause significant impacts on the environment, water flow and quality of the Mekong mainstream.

In the Prior Consultation process, with technical and administrative support from the MRC Secretariat, the notified member countries will review technical aspects of the proposed project, assess any potential transboundary impacts on the environment and livelihoods along the riparian communities, and suggest measures to address those concerns. The member countries aim to come to an agreement on how the consulted case should proceed. It is not meant to approve or disapprove the proposed project.

This process normally lasts six months, but it could be extended further, if required, by the Joint Committee. The Prior Consultation is one of the three procedures required for the development of different types of water-use projects in the lower Mekong basin as specified in the PNPCA established under the 1995 Mekong Agreement.

Region Forum 20 Sep2018 in Vientiane

The result of PNPCA (Statement of Pak Lay HPP - 4April 2019) is attached to This Report part of Public Consultation.



Pak Lay PNPCA Prior Consultation Process Road Map

Site Visit with LNMC 2-3 July 2018






Site Visit MRC- Nov 2018

Sit Visit MRC - Nov 2018

Site Visit IAV - Nov (Pak Lay)

Site Visit IAV - Nov (Pak Lay)

8 CONCLUSIONS AND RECOMMENDATIONS

The results of the studies carried out for this assessment indicate that the PaklayHPP will not have significant transboundary and cumulative impacts on the Mekong River flows, fish migration, or fisheries. Besides the well designed fish pathway, this assumes that the recommended fisheries monitoring is implemented.

Transboundary and cummalative impacts on navigation will be insignificant due to the navigation route from Vientiane to Vietnam is separated by Khone Falls. On the other hand, the construction of dam would increase water levels upstream in the dry season, which would enhance the capability of transshipping.Ship lock design for PaklayHPP will be followed the specifications/recommendations from the MRC "Preliminary Design Guidancefor Proposed Mainstream Damsin the Lower Mekong Basin."

In terms of the flows in the Mekong, the studies have determined that the changes that can be expected will occur as a result of the upstream projects that are planned, including several main stream dams and the large dams planned and under construction in China. The PaklayHPP's contribution to this change will be insignificant due to the fact that it is a run-of-river project with minimal storage unlike many of the larger upstream projects. Because the PaklayHPP's impact is negligible, it will not affect downstream flows in Cambodia and at the Mekong Delta, therefore not causing ecological or economic impacts to Tonle Sap, or saline intrusion in the Delta.

At present there is no guideline for transboundary impact assessment for the Mekong River Basin. All the proposed mainstream projects can conduct the TBESIA but may not the acceptable standard agreed by member countries. Therefore, the transboundary impact assessment guidelines agreed by MRC member country is urgently required.

The detail of TBESIA and Cummulative Inpact Assessment had been sammaried below:

8.1 Transboundary Environmental and Social Impact Assessment

Transboundary issues due to dam/reservoir construction along the Mekong River which are considered as the potential priority ones are sedimentation, water quality deterioration, water quantity alteration, fishery and navigation.

1. *Sedimentation aspect:* Land clearance for dam/reservoir construction would cause soil erosion, then eroded soil particles disperse and settle in the reservoir via sedimentation process. Accumulation of the sediment in the reservoir would lessen the suspended solid in the river downstream of the reservoir. River bank erosion and river bed scouring effect would be occurred in order to maintain equilibrium of suspended solids in the river. Sedimentation is thus assessed as transboundary impact because it occurs in the reservoir but its impact is occurred at the river downstream. Direct impact is assessed as river bank erosion and river bed scouring. While indirect impact is on water quality and domestic water supply due to suspended solids dispersion which is generated by erosion and scouring. In addition, the river bed scouring would cause destruction of aquatic habitat of which the consequence impact would be on fish reproduction in the Mekong River.

2. *Water quality:* Impact on water quality is also taken place in the reservoir due to a

removal of biomass. Biodegradation of the remained biomass and organic matter component in the sediment under an aerobic condition would cause water pollution as indicated by low dissolve oxygen content as well as generate greenhouse gas (methane and carbon dioxide), hydrogen sulphide gas, nutrient, etc. Releasing the polluted water to the river downstream significantly impact on water uses. Low dissolve oxygen affect aquatic life in the river. However, recovery of the river water quality will be occurred by the river self purification. The main point how far is the pollution or the recovery taken place in the river. Modelling of river assimilation capacity is required for assessing the transboundary impact (degradation and recovery zone). Regarding the impact of nutrient, it is considered for two points. Nutrient existed in the reservoir might cause eutrophication at some locations where the condition is fit, ie. shallow water with sufficient sunlight penetration. Another point is low nutrient released to the downstream because it is trapped into the sediment settled in the reservoir. Low nutrient cause impact to fish production at the water sources downstream particularly at the Tonle Sap in Cambodia and the Mekong Delta at Vietnam because nutrient is relatively linked with the fish food source.

3. *Water quantity alteration:* This aspect is major feature of dam/reservoir project. Alteration of water quantity (flow) play significant role on other aspects including sedimentation, water quality, fishery, etc. Water flow from the upstream tributaries has become stand still in the reservoir that would accelerate sedimentation in the reservoir. If the higher eroded particles taken place due to the more improper land clearance, the more sedimentation would be occurred. Again, water quality problem in terms of biodegradation of the non-removed biomass and eutrophication for the stand still water would be easily induced. For the river downstream, the transboundary impact on bank erosion and river bed scouring depend on how much sediment released with water from the reservoir. For water quality, it depends on water quality in the reservoir released to the downstream river. Higher flow would increase aeration, increasing dissolved oxygen and better self purification of the river downstream. However, water flow in the river downstream will be optimally operated in accordance with the seasonally design. Water flow rate releasing is designed for multi purposes including electricity generation (as the main purpose), irrigation, domestic water supply and ecosystem maintaining (this will help alleviate water pollution problem if have). Water level alteration, from the running inflow to the standstill water in reservoir area, would also impact to fish habitat and migration.

4. *Fish migration obstruction:* This is a critical transboundary issue to be considered for dam construction. The Mekong River is the most recognized river for fish reproduction source. Based on the State of the Basin Report(2010) of the Mekong River Commission: MRC, the species of fish caught in the Mekong River Basin are Critically endangered species (2 species); Giant catfish (Pangasianodon gigas), Freshwater sawfish orLargetooth sawfish (*Pristis microdon*) and Endangered species (4species); Mekong stingray (*Dasyatis laosensis*), Isok barb or Julien's golden carp (*Probarbus jullieni*), Laotian shad (*Tenualosa thibaudeaui*), Marbled stingray (*Himantura oxyrhynchus*). Dam construction if it is not appropriately design for fish pathway, it would obstruct fish migration cycle between upstream and downstream for spawning, reproduction and back to their habitat along the Mekong River and tributaries. Loss of fish species and reproduction in the Mekong River Basin, particularly Tonle Sap and Mekong Delta would be evidently encountered. Fish pathway is consequently designed to reduce the obstruction problem.

5. *Navigation route blockage:* This is also considered as a potential transboundary issue for dam construction. As known that navigation between GMS countries, particularly from China to Laos and Thailand is for cargo transhipping and communication as well as for tourism at some locations in the country (example; Paklay- Luang Prabang-Vientiane in Laos) and between countries (such as Chiang Saen, Thailand-Bo Keo,Laos).Dam construction might obstruct navigation. Dam with ship lock is appropriately designed to minimize the navigation problem.

6. For **transboundary social impacts,** the preliminary assessment indicated thatthe creation of Mekong mainstream hydropower dams in Lao PDR will surely provide both adverse and beneficial impacts to Zone 2 (Thai-Lao), Zone 4 (Cambodia and Tonle Sap Lake), and Zone 5 (Mekong Delta in Vietnam). The degree of impact will depend on the dependence of riparian people (within 5 km corridor) on the Mekong River and its ecosystem where indicated medium in Zone 2 while high in Zone 4 and Zone 5. The key impact for the Delta area will concern with cropping (rice and other food crops) while fishery are of key concern in Tonle Sap Lake.

7. All impacts mentioned can be mitigated by monitoring, management and technical measures. Investor committed to carry out environmental management plans in accordance with legislation of Lao PDR and other riparian countries and international treaties.

Recommendations

1. Minimizations of erosion on land and in water body are recommended as follows.
   - Minimizing soil erosion and sedimentation during construction phase can be made through a good practice of construction with the emphasis of land clearance. Sedimentation pond should be constructed at the area down slope of the construction area to trap eroded particles prior to discharge to the river. Plantation of grass and tress covering the clearance area has to be carried out as much as possible.

   - Minimizing river bank erosion and river bed scouring during operation can be performed by periodical release of sediment from the reservoir.

2. Prevention of water pollution in the water body are recommended as follows:
   - Biomass removal in the reservoir area before storing water can be performed by an appropriate design for location and amount. It can be estimated through mathematical modelling.

   - If the water released from the reservoir is good quality that will not impact to the river downstream. Self purification of the river is naturally occurred. Recovery time and distance are dependent on the organic loading discharge and flow condition. Additional water supply for domestic use should be provided to the communities in case of water pollution occurred at some locations.

3. Appropriate design for fish migration pathway should be made through the

comprehensive study of fish migration behaviour and Fish Monitoring Program should be implemented to protect and possibly enhance the fisheries in the area of the Mekong River.

4. Appropriate design for navigation ship lock should be made to be a less impact on cargo transhipping. Tourism route should be suitably modified to accommodate tourism purpose.

8.2 Cummulative Impact Assessment

Cumulative impact on erosion and sedimentation during construction of dam and reservoir is similar to transboundary impact as concluded above. Erosion on land is dependent on how land clearance is performed. The higher clearance of land (without appropriate land protection), the higher erosion on land and the higher sedimentation in the reservoir are induced. But erosion and sedimentation during operation is different. Accumulation of sediment in the dam/reservoir construction in the series would cause less and less suspended solids along the river downstream. The more river bank erosion and river bed scouring will be come out. Cumulative impact at source (reservoir) causes transboundary impact along the river downstream.

Water quality problem in the reservoir is likewise the transboundary impact as mentioned above. It depends on how biomass removal in the reservoir area. Biodegradation of biomass and organic matter attached in the sediment through anaerobic condition cause water pollution, particularly odour problem of hydrogen sulphide in the reservoir water, as well as greenhouse gas that is of interest in terms of climate change. This is cumulative impact that becomes transboundary impact along the river downstream. The degradation and recovery zone of the transboudary impact along the river downstream is dependent on water quality in the reservoir and river flow released from the reservoir.

Water quantity alteration is dependent on dam operation. As mentioned above, it is the key role to cause the degree of transboundary impact along the downstream river. Construction dam in series along the Mekong River have to be operated in correspond to accomplish the multipurpose objectives of dam construction with protection of the ecosystem quality as well.

Fish migration along the river is obstructed by dam construction. The consequence of any dam construction particularly in a series is a critical transboundary impact. Appropriate design for the dam series has to be performed in accordance with the fish migration cycle.

Navigation along the Mekong River is also blocked by dam construction. Consequence of the dam construction in series will cause more impact on navigation. Similarly to the fish pathway, ship lock has to be appropriate designed to facilitate navigation.

In the *cumulative social impacts*, not only economic benefits to be created to the countries, however, the creation of the above Mekong Mainstream projects would lead to acquisition of land and relocation/resettlement of those who residing on both river banks of the Mekong in the upstream tailed water area. Bio-physical changes of land use from river-bank farming area into water will decrease the country production land for rice and food crops that may consequence to the country food supply as well.

Resettlement is associated with hydropower development. Even though the run-off-river dams have less resettlement impacts compared to the conventional storage dam. However, population displacement by the proposed Mekong mainstream hydrodams in Lao PDR is is depend on the full supply level (FSL) of specific sites and also in ragrds of the GOL master plan that to merge the small villages to bigger village.inevitably. For Paklay Project the potential affected people depend on two dam site alterantve decision (Lower Dam Site and Upper Dam Site).

Recommendations

Cumulative impact is likely impact at source (reservoir and dam) and will generate transboundary impacts along the river downstream. The higher cumulative impact at source will cause the higher transboundary impact downstream impact. Subsequently, the mitigation measures should be undertaken at source that will minimize impact at river downstream. Mitigation measures for cumulative environmental impact will be the same as mitigation measures for transboundary impact as stated above.

It is recommended that the project should work closely with concern stakeholders in many levels in local and in the rgion in the future and try to avoid severely land lost and resettlement impacts as much as possible.

10 REFERENCES

Adamson, P.T., 2001. "Hydrological perspectives on the Lower Mekong Basin — the potential impacts of hydropower developments in Yunnan on the downstream flow regime." International Water Power and Dam Construction, pp. 16-21, March.

AusAID (2004), *Mekong Delta Poverty Analysis*

Batalla, R. J., Gomez, C. M., and Kondolf, G. M. 2004. "Reservoir induced hydrological changes in the Ebro River basin (NE Spain)." Journal of Hydrology, 290, 117–136.

Blake, D., 2001. "Proposed Mekong dam scheme in China threatens millions in downstream countries." World Rivers Review 16 (3), 4-5.

Baran E. 2006. Fish migration triggers in the Lower Mekong Basin and other tropical freshwater systems. MRC Technical Paper No. 14, Mekong River Commission, Vientiane. 56 pp.

Briggs, L. P. 1951. The Ancient Khmer Empire. White Lotus Co.,Ltd. Bangkok, Thailand. ISBN 974-8434-93-1.

Carlos L. Muñoz Brenes, Jonathan B. Mazumdar (2009) Mekong River Basin - A Study of Water Management and Development. Tufts University, November 2009.

Cambodia's Ministry of Tourism (2011), *Tourism Statistics Report 1st Semester 2011.*

Chiang Khan District (2010), *District Development Plan 2010-2013.*

Committee for the Coordination of Investigations of the Lower Mekong Basin. 1972. "Report on Indicative Basin Plan." United Nations: Bangkok, Thailand.

Chanh, S., C. K. Chhuon & J. Valbo-Jorgensen. 2001. Lateral migrations between Tonle Sap River and its flood plain. p. 102-111. In: Matics, K.I. Editor. Proceedings from the Third Technical Symposium on Mekong Fisheries, 8-9 December 2000. Mekong Conference Series No. 1. Mekong River Commission, Phnom Penh.

Department of Tourism (2011),*Tourism Statistics of Thailand 2011*

FAO and MRC (1999) Flood Management and Mitigation in the Mekong River Basin. MRC, Bangkok, March 1999.

General Statistics Office (GSO) (2011), *Tourism Statistics in Vietnam.*

Gupta, A., Hock, L., Xiaojing, H., Ping, C., 2002. "Evaluation of part of the Mekong River using satellite imagery." Geomorphology 44 (3-4), 221-239.

Gupta, A., Liew, S.C., 2007. "The Mekong from satellite imagery: a quick look at a large river." Geomorphology 85, 259-274. doi:10.1016/j.geomorph.2006.03.036.

Hori, H., 2000. "The Mekong: Environment and Development." United Nations University Press, Tokyo. 398 pp.

http://en.wikipedia.org/wiki/Mekong#cite_ref-MRC.2C_2005_6-25

http://www.tuvy.com/Countries/vietnamese/land/mekong_river.htm

International Centre for Environment Management, (2010). "Hydrology & sediment baseline assessment working paper." Volume II, prepared for the Mekong River Commission.

IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org> [retrived on 4 November, 2011].

Johanna Buschmann,Michael Berg, Caroline Stengel, Lenny Winkel, Mickey L. Sampson, Pham Thi Kim Trang, Pham Hung Viet (2008), *Contamination of drinking water resources in the Mekong Delta floodplains:Arsenic and other trace metals pose serious health risks to population*

Kummu, M. and Varis, O., 2007. "Sediment-related impacts due to upstream reservoir trapping, the Lower Mekong River." Geomorphology, volume 85 (3-4):275-293.

Kunming Hydropower Investigation, Design and Research Institute (KHIDI), 2011a. "Feasibility Study Report", Paklay Hydro Power Project.

Kunming Hydropower Investigation, Design and Research Institute (KHIDI), 2011b. "Environmental and Social Impact Assessment", Paklay Hydro Power Project.

Kummu, M., Sarkkula, J., and Varis, O. 2006. "Sediment-related impacts due to upstream reservoir trapping in the lower Mekong River." Geomorphology, in press.

Kummu, M. and Varis, O., 2007. "Sediment-related impacts due to upstream reservoir trapping, the Lower Mekong River." Geomorphology, volume 85 (3-4):275-293.

Kondolf, G. M. 1997. "Hungry water: Effects of Dams and Gravel Mining on River Channels." Environmental Management, Springer-Vertag New York Inc. 21(4):533-551.

Lao National Tourism Authority (2009),*Tourism Statistics of Lao PDR 2009.*

Lao National Tourism Authority (2010),*Destination Laos.*

Lonely Planet (2007), *Vietnam, Cambodia, Laos & Greater Mekong*

Lu, X. X. and Higgitt, D. L., 1999. "Sediment yields variability in the Upper Yangtze.", Earth Surface Processes & Landforms, 24, 1077-1093.

Lu, X.X., Siew, R.Y., 2006. "Water discharge and sediment flux changes over the past decades in the Lower Mekong River: possible impacts of the Chinese dams." Hydrology and Earth System Sciences 10, 181-195.

Manoj Jha (2009) Hydrologic Simulations of the Maquoketa River Watershed Using SWAT. Center for Agricultural and Rural Development, Iowa State University, USA, June 2009.

Makkonen, K., 2005. "Integrated water resources management in China." In: Biswas, A.K., Varis, O., Tortajada, C. (Eds.), Integrated Water Resources Management in South and South-East Asia. Oxford University Press, New Delhi, pp. 267-296.

Mekong River Commission. 2010. State of the Basin Report 2010. ISBN 978-993-2080-57-1.

Mekong River Commission (2010) Hydrology & Sediment Baseline Assessment Working Paper. MRC SEA for Hydropower on the Mekong Mainstream, March 2010.

Mekong River Commission. http://www.mrcmekong.org/topics/river-transport/ [retrived on 31 October, 2011].

Mekong River Commission2010 .State of the Basin Report 2010 .ISBN .8-58-2080-993-978 Chiang Khong-Wiang Kaen Villager Research Team, 2006. Villager Research, Local Wisdom Knowledge of the Mekong River Fish Species.ISBN 974-85126-8-1.

Mekong River Commission (2010) Assessment of Basin-wide Development Scenarios. Basin Development Plan Programme, Phase 2. Mekong River Commission, Vientiane, November 2010.

Mekong River Commission (2005) Overview of the Hydrology of the Mekong Basin. Mekong River Commission, Vientiane, November 2005. 73pp.

MRC (2010),*Social Impact Monitoring andVulnerability AssessmentReport on a Regional Pilot Study for theMekong Corridor*

Ministry of Health (2011),*Health Statistics in Lao PDR.*

Milliman, J.D., Meade, R.H.,1983. "World-wide delivery of river sediment to the oceans." Journal of Geology 91, 1-21.

Milliman, J. D. and Syvitski J. P. M., 1992. "Geomorphic/tectonic control of sediment discharge to the ocean: the importance of small mountainous rivers." Journal of Geology 100:525–544.

MRC, 2000. "Mekong River Commission Secretariat Database and Information System."

MRC, 2003. "State of the Basin Report: 2003." Mekong River Commission (MRC), Phnom Penh, p. 316. 1728:3248.

MRC, 2004. "Databases of Mekong River Commission." Mekong River Commission (MRC), Vientiane, Lao PDR.

MRC. 2009. "Preliminary design guidance for proposed mainstream dams in the Lower Mekong Basin." Final version, August.

MRC, 2003. "State of the Basin Report: 2003." Mekong River Commission (MRC), Phnom Penh, p. 316. 1728:3248.

MRC. 2009. "Preliminary design guidance for proposed mainstream dams in the Lower Mekong Basin." Final version, August.

MRC. 2010. Stat of the Basin Report 2010. Mekong River Commission, Vientiane, Lao PDR.

MRC. 2007. Diagnostic study of water quality in the Lower Mekong Basin. MRC Technical Paper No. 15. Mekong River Commission, Vientiane, Lao PDR.

MRC. 2008. An assessment of water quality in the Lower Mekong Basin. MRC Technical Paper No. 19. Mekong River Commission, Vientiane. Lao PDR.

N. C. Khan and H. H. Khoi (2008), *Double burden of malnutrition: the Vietnamese Perspective.*

National Institute of Statistics, Kingdom of Cambodia (2010), *Demographic and Health Survey*

NCG (2020), *Environmental Impact Assessment of Paklay Hydropower Project*

NCG (2020), *Social Impact Assessment of Paklay Hydropower Project*

NCG (2020), *Resettlement Action Plan of Paklay Hydropower Project*

Pak Chom District (2010), *District Development Plan.2010-2013.*

Pearce, F., 2004. "China drains life from Mekong River." New Scientist 182 (2441),14.

Phillips, J. D., 2001. "Sedimentation in bottomland hardwoods downstream of an east Texas dam." Environmental Geology, 40, 860–868.

Phillips, J. D. 2004. "Dam-to-Delta sediment inputs and storage in the lower trinity river." Texas, Geomorphology, 62, 17-34,

Phillips, J. D., 2003. "Toledo Bend Reservoir and geomorphic response in the lower Sabine River." River Research and Applications, 19,137–159.

Plinston, D., He, D., 1999. "Water Resources and Hydropower." ADB TA-3139 Policies and Strategies for Sustainable Development of the Lancang River Basin. Asian Development Bank, Manila. 35 pp.

Poulsen A.F., Ouch Poeu, Sintavong Viravong, Ubolratana Suntornratana and Nguyen Thanh Tung. 2002. Fish migrations of the Lower Mekong River Basin: implications for development, planning and environmental management. MRC Technical Paper No. 8, Mekong River Commission, Phnom Penh. 62 pp. ISSN: 1683-1489.

Roberts, T. 2001. "Downstream Ecological Implications of China's Lancang Hydropower and Mekong Navigational Project International Rivers Network (IRN) Report."

Royal Thai Survey Department (1996), *Hydrographic Atlas, Mekong River in Lao PDR and Thailand*

Shisong L. 1997. "Economic Cooperation and Development in the Lancang-Mekong River Sub region." Developing the Mekong Sub region, Edited by Bob Stensholt. Monash University: Clayton, Australia.

Sverdrup-Jensen, S. 2002. Fisheries in the Lower Mekong Basin: Status and Perspectives. MRC Technical Paper No. 6, Mekong River Commission, Phnom Penh. 103 pp. ISSN: 1683-1489

Ta, K. T. O., Nguyen V. L., Tateishio M., Kobayash I., Tanabe S., and Saito Y., 2002. "Holocene Delta evolution and sediment discharge of the Mekong River, southern Vietnam." Quat. Sci. Rev. 21:1807–1819. CrossRef.

TEAM Consulting Engineering and Management Co., Ltd. 2010. "Executive Summary EIA, SIA, EMP, and RAP." Xayaburi Hydropower Power Project, Lao PDR, August.

The NGO Forum on Cambodia, Probe International (2009), *Powering 21th Century Cambodia with Decentralized Generation: A Primer for Rethinking Cambodia's Electricity Future.*

Thorne, C., Annandale, G., Jensen, K., Jensen, E., Green, A. and Koponen, J. 2011. "Review of Sediment Transport, Morphology, and Nutrient Balance." Report to the Mekong River Commission Secretariat prepared as part of the Xayaburi MRCS Prior Consultation Project Review Report, Nottingham University, UK, February 2011, 82p.

Tourism Authority of Thailand (2011), *The Mekong River: Journeys along the River of Life.*

VCCI Can Tho (2011), *Mekong Delta Tourism Guide Book.*

Walling, D. E. and Fang, D., 2003. “Recent trends in the suspended sediment loads of the world’s rivers.” Global and Planetary Change, 39, 111–126.

Welcomme, R. .2001Inland Fisheries Ecology and Management. Fishing News Books, Blackwell Science, Oxford. 358pp.

Williams, G.P., Wolman, M.G., 1984. “Downstream effects of dams on alluvial rivers.” Geological Survey Professional Paper 1286. USGS, Washington DC. 61 pp.

Walling, D.E., 2005. Evaluation and analysis of sediment data from the Lower Mekong River, Report prepared for the Mekong River Commission, 61 pp.

Walling, D. E. 2006. “Human impact on land-ocean sediment transfer by the world's rivers.” Geomorphology 79:192–216. CrossRef.

Walling D. E. 2008. “The Changing Sediment Load of the Mekong River.” AMBIO: A Journal of the Human Environment 37(3):150-157. Royal Swedish Academy of Sciences. http://www.bioone.org

World Fish Center. http://www.fishbase.org[สืบค้นเมื่อวันที่31 ตุลาคม2554]

Zalinge, N., Deap, L., Ngor, P., Sarkkula, J., and Koponen, J. 2003. “Mekong flood levels and Tonle Sap fish catches.” Second International Symposium on the Management of Large Rivers for Fisheries, Phnom Penh, 11-14 February.

APPENDICES

Appendix A: The Project Team

No	Designation	Name
1	Project Director	Dr. Somdet Munsaveng
2	Project Manager	Mr. Videth Visounnarath
3	Project Coordinator 1	Mr. John Wilcox
4	Project Coordinator 2	Mr. John Moore
5	International Advisor	Dr. Greg Weary
6	Environmental Expert	Dr. Sengdeuane Wayakone
7	Social Expert	Dr. Montri Suwanmontri
8	Social Expert	Dr. Sengdara Kattingasack
9	Environmental Expert	Dr. Wanpen Wirojanagud
10	Hydrologist	Dr. Vichian Plermkamon
11	Sedimentation	Dr. Winai Sri-amporn
12	Water Quality	Dr. Anousorn
13	Fishery	Dr. Prathak Tabthipwon
14	Fishery & Fish Passage	Dr. Thares Srisatit
15	Fishery Assistant	Ms. Sujanee
16	Navigation	Dr. Thares Srisatit
17	Climate Change	Dr. Sitanon Jesdapipat
18	Tourism	Mr. Suchart Sailamay
19	GIS	Mr.Phuksouliya Phommathed
20	GIS	Ms. Sengdao Thavonesouk
21	Gender	Mrs. Soukphaphone Phanit
22	Gender	Ms. Pangkham Inhaksa
23	Gender	Ms. Souphlak Inthavong

Appendix B: Environmental Impacts and Mitigation of the Paklay HPP

A summary of the potential environmental and social impacts and possible mitigation during the project construction, operation and decommission periods are shown in the table that follows. Details are provided in the PaklayHPP Environmental Impact Assessment and the Environmental Management and Monitoring Plan, bound separately.

The scope of the TBESIA/CIA includes physical, biological, and human impacts from the PaklayHPP when considered in the context of the hydropower development process in Lao PDR. While dams have provided significant impetus to growth it is well known that dam developments present a number of economic, environmental and social concerns. In the case of mainstream dams on the Mekong such as the Paklay HPP these issues need to be addressed, and in particular the following aspects require careful analysis and are addressed in the TBESIA/CIA:

- Mekong River Flows, and downstream impacts from their modification
- Fish Migration and Fisheries in the Lower Mekong
- Water quality and sedimentation
- Resettlement of displaced people
- Social and livelihoods impacts, and
- Health and Nutrition

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
Construction Phase					
Physiochemical					
Noise and vibration due to construction and transportation	Construction areas; movement of vehicles, blasting, excavation, construction activities	During the construction	Potential minor negative impact, can be mitigated	Adopting International standards on occupational Health and safety as well as noise minimization program (in Contractor's EMMP). Acceptable noise levels to be specified.	**No Significant Impact**
Air Pollution; dust due to the construction and transportation	Construction areas and surrounding villages	During the construction	Potential minor negative impact, can be mitigated	Develop site management program prior the construction Appropriate road engineering; good compacting and runoff design, reduce speed limits, developing watering schedule for all roads (in Contractor's EMMP)	**No Significant Impact**
Water Pollution; soil erosion and siltation	Construction areas, And embankment areas subjected to drawdown.	During the construction and operation	Potential minor negative impact, can be mitigated	Develop best management practice on soil erosion and sedimentation at all constructed areas as well as pollution control technique -Maximize the use of excavated rocks, develop runoff system , installing sediment traps, rehabilitate construction areas by planting shrubs and trees Develop appropriate monitoring program (in Contractor's EMMP)	**No Significant Impact**
Handling and Storage of Fuel and Explosive materials	Mainland and island sites	Temporary/ During the construction	Potential minor negative impact, can be mitigated	Develop specific policy, safety, emergency response and SOP which comply to international standards, install oils and grease aggregators and separators and appropriate storage facilities (in Contractor's EMMP)	**No Significant Impact**
Disposal of earth, rock spoils	Construction areas and dump sites	Temporary/ During the construction	Potential minor negative impact, can be mitigated	Identify earth rock disposal sites and develop best practice management program (in Contractor's EMMP)	**No Significant Impact**
Solid wastes	Construction sites and workers camps	Temporary/ During the construction	Potential minor negative impact, can be mitigated	Constructing approved-offsite disposal facilities and develop management program. (in Contractor's EMMP)	**No Significant Impact**
Biological					
Terrestrial Vegetation:	Power house, switch	Temporary and Entire	Potential minor	Mapping and inventory of impacted areas	**No Significant**

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
Loss of forest, plantation trees and wild life	yards, camps, embankments, transmission lines, building access roads and resettlement	project life	negative impact can be mitigated	including village areas, project works areas, spoil disposal, quarry and temporary land use Consulting with local villagers and forestry provincial government to minimize impact Setting reforestation and wildlife life conservation program	**Impact**
Reduced fish migration	Down stream area	During the construction	Potential negative impactcan be mitigated	Implement Fish monitoring program	**No Significant Impact**
Human (Health and Safety)					
Unexploded Ordnance	Constructed areas	During the construction	Very low incidence of UXO	Develop appropriate technical measure for safe infrastructure development and resettlement	**No Significant Impact**
Parasitic, water borne and communicable, sexual transmitted disease due to influx workers, project employees	PaklayHPP area	During the construction	Potential minor negative impact can be mitigated	Establishing health care system to prevent, control and provide medical treatment Screening and medical surveys of all employees before engagement Provide education on health and hygienic Working closely with local and provincial health Department	**No Significant Impact**
Safety hazards for villagers, workers and project employees at work places	Workers, project employees, surrounding villagers	During the construction	Potential minor negative impact can be mitigated	Develop or adopt the international best practices on occupational Health and safety at the work place (in Contractor's EMMP and Health and Safety Plan) Establish local and village security committee	**No Significant Impact**
Social and Economics					
Employment opportunities	Project areas, and surrounding villages	During the construction	Positive major positive impacts	Required by RAP	**Positive Impact**
Housing and Resettlement need	Project areas	Entire project life	Potential minor negative impact can be mitigated	Implement resettlement program and provide compensation per RAP Establish grievance and other committees as per the RAP	**No Significant Impact, with RAP and SMMP**
Loss of infrastructure	Project areas, and surrounding villages		Potential positive impact. Infrastructure will be improved by Project.	Inventory all existing infrastructure, developing management program prior the construction. Carry out PaklayHPP infrastructure improvements	**Positive Impact**
Loss of fishery	Down stream and upper	Entire project life	Potential negative	Implement Fish monitoring program and	**No Significant**

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
	stream areas	without mitigation	impact that can be mitigated	SMMP Dependency on fishery will be replaced with alternative livelihood systems	**Impact, with Fish monitoring program & SMMP**
Loss of lands	paddy field Rai others	Entire project life	Potential minor negative impact can be mitigated	Establish committees to identify measures and options for compensation	**No Significant Impact, with SMMP**
ROW for Access roads	Affected and surrounding villages	Entire project life	Potential major positive impacts; having new access roads	Require a separate IEE	**Positive Impact**
Power supply	Affected and surrounding villages	Entire project life	Potential positive impacts on local and surrounding villages	Required by RAP and SMMP	**Positive Impact**
Aesthetic and cultural					
Landscape and visual impacts	constructed areas	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Impacts to Religious places and Structures	Constructed areas	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Operations Phase					
Surface Water					
Flow variation	MekongRiver	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Water Quality	MekongRiver	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Water Balance	MekongRiver	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Flooding	PaklayHPP area	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Existing Use	PaklayHPP area	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Biological/Ecological					
Impacts to fish migration and aquatic habitats	MekongRiver at the GFL	Entire project life without mitigation	Potential major negative impact that can be mitigated	Implement Fish Monitoring program	**No Significant Impact, with FishMonitoring program**

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
Human					
Aesthetic and cultural	PaklayHPP area	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Landscape and visual impacts	Hou Sahong	Entire project life	No Impact anticipated	None required	**No Significant Impact**
Dam failure	MekongRiver downstream	May never occur	Major impact, but unlikely to occur	No major impoundment. Dam failure plan for maximum flood based on designed overflow portion western embankment into the Mekong.	**No Significant Impact**
Decommissioning Phase					
Physiochemical					
Land					
Flood plain/swamp	Downstream	After decommissioning	Potential minor positive impact	None required	**No Significant Impact**
Seismic	Downstream	During and after decommissioning	Potential minor negative impact	Minimize the potential effects of seismic events in the design of the decommissioning	**No Significant Impact**
Surface Water					
Flow Variation	MekongRiver	After decommissioning	No change anticipated	None required	**No Significant Impact**
Noise					
Increasing traffic level	Project areas and nearby villagers	During decommissioning	Potential minor Negative impact	Adopting International standards on occupational Health and safety as well as noise minimization program	**No Significant Impact**
Blasting and removing dam and concrete infrastructure	PaklayHPP area	During decommissioning	Potential minor Negative impact	Blasting may affect aquatic animals. Other methods to be used.	**No Significant Impact**
Air quality					**No Significant Impact**
Increasing dust and air emission level due to the truck movements, removing dam and concrete infrastructure	Project areas and nearby villagers	During decommissioning	Potential minor Negative impact	Develop site management program for dust suppression prior to decommissioning.	**No Significant Impact**
Increasing transport network	Project areas and nearby villagers	During decommissioning	Potential minor Negative impact	Appropriate road engineering; good compacting and runoff design, reduce speed limits, developing watering schedule for all unpaved roads	**No Significant Impact**
Biological/Ecological					
Fish migration	Mekong River	During	Potential minor	Restore fish ability to move freely through the	**Positive Impact**

Potential Impact	Impact Areas	Impact Duration and Period	Impact Significance	Required Mitigation Measures	Potential Residual Impacts
		decommissioning	positive impact	channel. Short-term negative impacts possible during dam removal until natural conditions are restored	
Terrestrial vegetation and wildlife	Project areas	After the project decommissioning	Potential Minor Positive Impact	Restore original plant communities. Short-term negative impacts possible during dam removal until natural conditions are restored	**Positive Impact**
Endangered species	MekongRiver	After the project decommissioning	No Impact Anticipated	None required	**No Significant Impact**
Aquatic habitat	PaklayHPP area	After the project decommissioning	Potential Minor Positive Impact	Restore aquatic habitat.	**Positive Impact, with FishMonitoring Prgram**
Human					
Fisheries	PaklayHPP area	After the project decommissioning	Potential Minor Positive Impact	Restore fishery activities	**Positive Impact, with FishMonitoring Prgram**
Employment	Project areas and nearby villages	During decommissioning	Potential Minor Positive Impact	Creating work and job opportunity	**Positive Impact**
Employment		After the project decommissioning	Potential Minor Negative Impact	Apply the SMMP during construction and operation	**No Significant Impact, with long-term results of the SMMP**
Landscape	PaklayHPP area	After the project decommissioning	Potential Minor Positive Impact	Restore/rehabilitate visual landscape	**Positive Impact**
Tourism	Project areas and nearby villages	During and after the project decommissioning	No Impact Anticipated	None required	**No Significant Impact**

Appendix C: Questionnaires Use in the Project Areas for Collecting Data and Information

ໂຄງການ

(Project)________________________________

GPS. No: _______________

ເລກທີແບບສອບຖາມ ________

ບ້ານ ___________

ເມືອງ ___________

ແຂວງ ___________

ລະຫັດຟອມ: W 04

ແບບຟອມສອບຖາມ / ເກັບກຳຂໍ້ມູນສຳລັບແມ່ຍິງຂັ້ນຄົວເຮືອນ

A. ກ່ຽວກັບການສຳພາດ (Interviewer Section)

A1. ຊື່ຜູ້ສຳພາດ (Interviewer) ເພດ: ຍ ☐ / ຊ ☐			
A2. ຊື່ຜູ້ຖືກສຳພາດ (Interviewee)			
A3. ວັນ,ເດືອນ,ປີ ສຳພາດ (Date)		ເວລາເລີ່ມ (Start):	ສຳເລັດ (Finish):
A4. ພາສາທີ່ໃຊ້ສຳພາດ (Language)			
A5. ນາຍພາສາ (Translator)			
A6. ເລກທີຮູບຜູ້ໃຫ້ສຳພາດ (Pic No.)			
A7. ອາຍຸ (Age)			
A9. ສາສະໜາ(Religion)			
A10. ຊົນເຜົ່າ (Ethnic)			
A11. ສະຖານະພາບ	☐ ໂສດ ☐ ແຕ່ງງານ ☐ ແມ່ຮ້າງ ☐ ແມ່ໝ້າຍ		
A12. ລະດັບການສຶກສາ	☐ ປະຖົມ ☐ ມັດທະຍົມຕົ້ນ ☐ ມັດທະຍົມປາຍ		
A13. ເປັນຫົວໜ້າຄອບຄົວ	☐ ແມ່ນ ☐ ບໍ່ແມ່ນ		
A14. ອາຍຸໃນເວລາແຕ່ງງານ	________ ປີ		
ຈຳນວນຄັ້ງແຕ່ງງານ	☐ 1 ຄັ້ງ ຖ້າຫລາຍກວ່າ 1 ຄັ້ງໃຫ້ລະບຸຈຳນວນ.............ຄັ້ງ ສາຍເຫດ :...		
ເປັນເມຍຜູ້ທຳອິດບໍ່	☐ ແມ່ນ ☐ ບໍ່ແມ່ນ ຖ້າບໍ່ແມ່ນຍ້ອນຫຍັງ ?		
B. ກ່ຽວກັບສະມາຊິກໃນຄອບຄົວ	ຍິງ________ຄົນ ຊາຍ________ຄົນ		
B1 ຈຳນວນລູກ	ຍິງ________ຄົນ ຊາຍ________ຄົນ		
B2 ຈຳນວນລູກທີ່ໄດ້ເຂົ້າໂຮງຮຽນ	ຍິງ________ຄົນ ຊາຍ________ຄົນ		
B3. ຈຳນວນລູກທີ່ໄດ້ອອກໂຮງຮຽນ	ຍິງ________ຄົນ ຊາຍ________ຄົນ ສາເຫດ : ________________________________ ________________________________		
B4 ຈຳນວນລູກທີ່ຮອດອາຍຸໄດ້ເຂົ້າໂຮງຮຽນ ແລ້ວບໍ່ໄດ້ເຂົ້າ	ຍິງ________ຄົນ ຊາຍ________ຄົນ ສາເຫດ : ________________________________ ________________________________		
B5 ຊື່ຜົວ			

1

B6. ອາຍຸຂອງຜົວ	________ປີ
B7. ອາຍຸຂອງຜົວໃນເວລາແຕ່ງງານ	________ປີ
B8 ຜົວແຕ່ງງານຈັກຄັ້ງ	☐ 1 ຄັ້ງ ຖ້າຫລາຍກວ່າ 1 ຄັ້ງໃຫ້ລະບຸຈຳນວນ..............ຄັ້ງ ສາຍເຫດ :...
B9. ຊົນເຜົ່າຂອງຜົວ	
B10. ສາສະໜາຂອງຜົວ	
B11. ອາຊີບຂອງຜົວ	☐ ຄ້າຂາຍ ☐ ຊາວໄຮ່ນາ ☐ ທະຫານ ☐ ຕຳຫລວດ ☐ ເຮັດວຽກຢູ່ຮ້ານອາຫານ/ບ້ານພັກ/ໂຮງແຮມ ☐ ອື່ນໆ ______________

C. ບົດບາດຕໍ່ກິດຈະກຳອື່ນໆ

C1. ຄະນະບ້ານ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C2. ຄະນະໜ່ວຍໄກ່ເກັ່ຍ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C3. ຄະນະສະຫະພັນແມ່ຍິງ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C4. ສະມາຊິກສະຫະພັນແມ່ຍິງ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C5. ຄະນະຊາວໜຸ່ມ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C6. ຄະນະແນວໂຮມ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C7. ຄະນະພັກບ້ານ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C8. ກອງທຶນພັດທະນາບ້ານ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C9. ໂຄງການພັດທະນາຕ່າງໆ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C10. ກຸ່ມທ້ອນເງິນ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C11. ການຝຶກອົບຮົມວິຊາຊີບຕ່າງໆ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C12. ຮີດຄອງປະເພນີ, ຄວາມເຊື່ອຖື ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

C13. ການຕັດສິນໃຈກ່ຽວກັບການສ້າງພື້ນຖານໂຄງລ່າງບ້ານ ☐ ແມ່ນ ☐ ບໍ່ແມ່ນ

ອື່ນໆ_______________________________________

D. ດ້ານສຸຂະອະນາໄມ

D1. ແຫລ່ງນ້ຳດື່ມ-ນ້ຳໃຊ້ພາຍໃນບ້ານ

☐ ແມ່ນ້ຳ ☐ ນ້ຳຂອງ ☐ ບຶງ, ໜອງ ☐ ນ້ຳລິນ ☐ ນ້ຳບາດານ ☐ ນ້ຳສ້າງ

D2. ການປັບປຸງຄຸນນະພາບຂອງນ້ຳກ່ອນໃຊ້ດື່ມ

☐ ຕົ້ມ ☐ ຕອງ ☐ ໃຊ້ສານເຄມີ (ກູໍລີນ) ຂ້າເຊື້ອພະຍາດ ☐ ດື່ມນນ້ຳດິບ

D3. ວິທີກຳຈັດຂີ້ເຫຍື້ອ

☐ ຖິ້ມຕາມແຄມບ້ານ ☐ ຖິ້ມລົງແມ່ນນ້ຳ ☐ ຈູດ ຫລື ເຜົາ ☐ ຂຸດຂຸມຝັງ

D4. ມີວິດຖ່າຍບໍ່?

ບໍ່ມີ ☐, ມີ ☐

ຖ້າມີ, ແມ່ນວິດປະເພດໃດ? ☐ ຊັກໂຄກ ☐ ວິດຊຶມ ☐ ວິດແຫ້ງ ☐ ອື່ນໆ__________

E. ດ້ານສຸຂະພາບ

E1. ທ່ານເຄີຍເປັນພະຍາດຫຍັງ? ☐ ເຄີຍ ☐ ບໍ່ເຄີຍ ລະບຸ ________________

E2. ເວລາທ່ານເຈັບເປັນ ທ່ານມັກໄປໃຊ້ບໍລິການ / ປິ່ນປົວຢູ່ໃສ ?

☐ ໄປຫາ ອສສບ ຫຼື ແພດບ້ານ

2

- ☐ ປົວຢາພື້ນເມືອງຢູ່ກັບບ້ານ
- ☐ ຊື້ຢາຈາກຮ້ານຂາຍຢາ
- ☐ ໄປຫາສຸກສາລາ
- ☐ ໄປໂຮງໝໍເມືອງ
- ☐ ໄປໂຮງໝໍແຂວງ
- ☐ ອື່ນໆ ໃຫ້ບອກແຈ້ງ..

E3ແມ່ນໃຜເປັນຜູ້ຕັດສິນໃຈ

☐ ຜົວ ☐ ເມຍ ☐ ຮ່ວມກັນ ☐ ຜູ້ອື່ນ..

E4. ທ່ານເກີດລູກຢູ່ໃສ?

☐ ໂຮງໝໍ ☐ ສຸກສາລາ ☐ ເຮືອນຂອງຕົນເອງ ☐ ຢູ່ປ່າ ☐ ອື່ນໆ ....

ຍ້ອນຫຍັງ? ....

....

F. ທາງດ້ານເສດຖະກິດ

F1. ອາຊີບຫລັກເມຍ.. ອາຊີບຫລັກຜົວ..

F2. ລາຍຮັບສະເລ່ຍຕໍ່ປີຂອງຄອບຄົວຂອງທ່ານ ....ກີບ

ໄດ້ມາຈາກໃສແດ່...

ລາຍໄດ້ຫລັກແມ່ນ:..ໄດ້ເຮັດຈັກມື້/ເດືອນ..................,ຈັກມື້/ປີ....................................

ລາຍໄດ້ສຳຮອງແມ່ນ:..ໄດ້ເຮັດຈັກມື້/ເດືອນ..................,ຈັກມື້/ປີ....................................

F3. ສັດລ້ຽງສ່ວນຫລາຍແມ່ນ (ຕອບໄດ້ຫລາຍກວ່າ 1 ຂໍ້):

☐ ເປັດ,ໄກ່ ☐ ແບ້ ☐ ໝູ ☐ ມ້າ ☐ ງົວ ☐ ຄວາຍ ☐ ຊ້າງ

ອື່ນໆ:____________________

F4. ລາຍໄດ້ທັງໝົດໄດ້ນຳໄປໃຊ້ເຮັດຫຍັງແດ່: (ຫລາຍສຸດ, ປານກາງ,ໜ້ອຍສຸດ)

....

....

....

G. ແຫລ່ງພະລັງງານທີ່ໃຊ້ຫຸງຕົ້ມ

☐ ຟືນ ☐ ຖ່ານ ☐ ໄຟຟ້າ ☐ ອື່ນໆ ____________________

H. ພະລັງງານແສງສະຫວ່າງທີ່ໃຊ້ໃນຄອບຄົວ

☐ ຕະກຽງ ☐ ໝໍ້ໄຟ ☐ ໄຟຟ້າ ອື່ນໆ________________

I. ຄອບຄົວຂອງທ່ານມີເຂົ້າກຸ້ມກິນຈັກເດືອນ?

☐12 ເດືອນ ☐ 9 ເດືອນ ☐ 6 ເດືອນ ☐ 3 ເດືອນ ☐ 0 ເດືອນ

ສ່ວນຫລາຍໄດ້ແກ້ໄຂແນວໃດ ? ....

....

J. ທ່ານມັກເຂົ້າຮ່ວມການປະຊຸມ, ໂຮມຊຸມນຸມຕ່າງໆ ທີ່ທາງການຈັດຂຶ້ນບໍ່?

☐ ເຂົ້າຮ່ວມ ☐ ບໍ່ເຂົ້າຮ່ວມ ຍ້ອນຫຍັງ ....

....

....

3

K. ແມ່ນໃຜໃນຄອບຄົວຂອງທ່ານທີ່ເປັນເຈົ້າການ ໃນການ:

• ໄປຫາແຫລ່ງພະລັງງານທີ່ໃຊ້ໃນການຫຸງຕົ້ມ (ຟືນ)	☐ ຍິງ	☐ ຊາຍ
• ໄປຫາແຫລ່ງນ້ຳກິນ-ນ້ຳໃຊ້ໃນຄອບຄົວ	☐ ຍິງ	☐ ຊາຍ
• ກຳຈັດຂີ້ເຫຍື້ອ	☐ ຍິງ	☐ ຊາຍ
• ລ້ຽງ/ດູແລສັດປີກ (ເປັດ, ໄກ່, ໄກ່ງວງ)	☐ ຍິງ	☐ ຊາຍ
• ລ້ຽງ/ດູແລແບ້, ໝູ	☐ ຍິງ	☐ ຊາຍ
• ລ້ຽງ/ດູແລສັດໃຫຍ່ (ຊ້າງ, ມ້າ, ງົວ, ຄວາຍ)	☐ ຍິງ	☐ ຊາຍ
• ໄປຫາເຄື່ອງປ່າຂອງດົງມາເປັນອາຫານສຳລັບຄອບຄົວ	☐ ຍິງ	☐ ຊາຍ
• ໄປຫາເຄື່ອງປ່າຂອງດົງມາເປັນຢາສຳລັບຄອບຄົວ	☐ ຍິງ	☐ ຊາຍ
• ໄປຫາເຄື່ອງປ່າຂອງດົງມາຂາຍ	☐ ຍິງ	☐ ຊາຍ
• ຜະລິດເຄື່ອງຫັດຖະກຳຈັກສານ	☐ ຍິງ	☐ ຊາຍ
• ຜະລິດເຄື່ອງຫັດຖະກຳຕ່ຳ, ຖັກ, ແສ່ວ	☐ ຍິງ	☐ ຊາຍ
• ຄ້າຂາຍ	☐ ຍິງ	☐ ຊາຍ
• ເຮັດໄຮ່	☐ ຍິງ	☐ ຊາຍ
• ເຮັດນາ	☐ ຍິງ	☐ ຊາຍ
• ເຮັດສວນ	☐ ຍິງ	☐ ຊາຍ
• ຊື້ເຄື່ອງໃຊ້ໃນຄອບຄົວ	☐ ຍິງ	☐ ຊາຍ
• ສົ່ງເສີມລູກເຂົ້າໂຮງຮຽນ	☐ ຍິງ	☐ ຊາຍ
• ຕັດສິນໃຈໃຫ້ລູກເຂົາໂຮງຮຽນ	☐ ຍິງ	☐ ຊາຍ
• ຕັດສິນໃຈໃຫ້ລູກອອກໂຮງຮຽນ	☐ ຍິງ	☐ ຊາຍ
• ຕັດສິນໃຈໃຫ້ລູກແຕ່ງງານ	☐ ຍິງ	☐ ຊາຍ
• ເຂົາຮ່ວມປະຊຸມ	☐ ຍິງ	☐ ຊາຍ

- ກະລຸນາເລົ່າໃຫ້ຟັງແດ່ໜ້າວຽກຂອງຜູ້ຍິງເຮັດຫຍັງແດ່ແຕ່ລະມື້? ນັບແຕ່ຕື່ນນອນ

....
....
....
....
....
....
....
....

- ກະລຸນາເລົ່າໃຫ້ຟັງແດ່ໜ້າວຽກຂອງຜູ້ຊາຍເຮັດຫຍັງແດ່ແຕ່ລະມື້? ນັບແຕ່ຕື່ນນອນ

....
....
....
....
....
....

4

L. ຜ່ານມາທ່ານເຄີຍເຂົ້າຮ່ວມໃນກິດຈະກຳໃດແດ່ຂອງບ້ານ ?

☐ ໜ່ວຍໄກ່ເກ່ຍ ☐ ການຕັດສິນໃຈກ່ຽວກັບການສ້າງພື້ນຖານໂຄງລ່າງຂອງບ້ານ
☐ ຮີດຄອງປະເພນີ, ຄວາມເຊື່ອຖື ☐ ໂຄງການພັດທະນາຕ່າງໆ
☐ ກອງທຶນພັດທະນາບ້ານ ☐ ກຸ່ມທ້ອນເງິນ
☐ ອື່ນໆ______________________________

____

M. ທ່ານມີສ່ວນຮ່ວມໃນພິທີກຳ ແລະ ປະເພນີທີ່ສຳຄັນແນວໃດແດ່?

____
____
____

N. ຊົນເຜົ່າຂອງທ່ານມີປະເພນີໃນການມອບຊັບສິນ ຫລື ທີ່ດິນໃຫ້ລູກສາວ / ລູກຊາຍ ຄືກັນ ຫລື ແຕກຕ່າງກັນແນວໃດ ?

____
____
____

O. ການອອກຊື່ໃນເອກະສານກ່ຽວກັບທີ່ດິນປະເພດຕ່າງໆ (ເອກະສານຢັ້ງຢືນການເສຍພາສີທີ່ດິນ, ເອກະສານຢັ້ງຢືນການນຳໃຊ້ທີ່ດິນ, ໃບແຜນທີ່ດິນ ແລະ ອື່ນໆ) ຂອງຄອບຄົວທ່ານແມ່ນອອກຊື່ໃຜ ?

☐ ອອກຊື່ຜົວ ຫລື ພໍ່ ຫລື ລູກຊາຍ ☐ ອອກຊື່ເມຍ ຫລື ແມ່ ຫລື ລູກສາວ
☐ ອອກຊື່ທັງຜົວ ແລະ ເມຍ (ສິນສົມສ້າງ) ☐ ອອກເປັນກຳມະສິດຮ່ວມ

P. ສະພາບທົ່ວໄປ

ແມ່ຍິງຊາວບ້ານທົ່ວໄປປະກອບອາຊີບຫຍັງແດ່?	
ຊອກຢູ່ຫາກິນເດ ພາກັນໄປຊອກໃສ? ຫາກິນປະເພດໃດ?	
ຜູ້ຍິງແຕ່ງງານອາຍຸຈັກປີ	
ຜູ້ຊາຍແຕ່ງງານອາຍຸຈັກປີ	
ຍິງໜຸ່ມສ່ວນຫລາຍເຮັດອາຊີບຫຍັງ? ແລະເຂົາເຈົ້າມີການເຄື່ອນໄຫວແນວໃດ?	

Q. ຜ່ານມາທ່ານເຄີຍໄດ້ຮັບຮູ້ກ່ຽວກັບໂຄງການນີ້ ຫລື ບໍ່? (ໝາຍ ✓)

☐ ບໍ່ເຄີຍ ☐ ເຄີຍ

5

ຖ້າເຄີຍ ຮູ້ຈາກໃຜ?

- ☐ ອຳນາດການປົກຄອງບ້ານ
- ☐ ພະນັກງານໂຄງການທີ່ລົງມາສຶກສາເບື້ອງຕົ້ນ
- ☐ ຊາວບ້ານຜູ້ອື່ນໆ / ຈາກບ້ານອື່ນ
- ☐ ....

R. ໃນຖານະທີ່ເປັນແມ່ຍິງ ທ່ານຄິດວ່າຕົນເອງຈະໄດ້ປະກອບສ່ວນໃນໂຄງການນີ້ຄືແນວໃດ?

____

____

____

S. ທ່ານຄິດວ່າແມ່ຍິງຄວນມີສ່ວນຮ່ວມໃນໂຄງການນີ້ ຫລື ບໍ່?

☐ ຄວນ ☐ ບໍ່ຄວນ

ຍ້ອນຫຍັງ? ____

____

ປະກອບສ່ວນແນວໃດ? ____

T. ທ່ານຄິດວ່າແມ່ຍິງຄວນໄດ້ຮັບຜົນປະໂຫຍດຈາກໂຄງການນີ້ແນວໃດ?

____

____

____

U. **ຄຳຄິດຄຳເຫັນຂອງທ່ານຕໍ່ກັບຜົນກະທົບຂອງການພັດທະນາໂຄງການນີ້**

ໃຫ້ຈັດລະດັບຄວາມຮ້າຍແຮງຂອງແຕ່ລະຜົນກະທົບ ແລ້ວໝາຍ ☑ ໃສ່ຫ້ອງຄະແນນລຸ່ມນີ້.

ຄະແນນ: 1= ບໍ່ມີຜົນກະທົບ, 2= ຜົນກະທົບຕ່ຳ, 3= ຜົນກະທົບຮ້າຍແຮງ, 4= ຜົນກະທົບຮ້າຍແຮງທີ່ສຸດ

	1	2	3	4
ທຳລາຍປ່າໄມ້, ສິ່ງຜົນກະທົບ ໃຫ້ແກ່ສິ່ງທີ່ມີຊີວິດໃນທຳມະຊາດ	☐	☐	☐	☐
ແຕະຕ້ອງຮີດຄອງປະເພນີ, ຄວາມເຊື່ອຖືຂອງປະຊາຊົນໃນບ້ານ	☐	☐	☐	☐
ສູນເສຍເນື້ອທີ່ສຳລັບການປຸກສ້າງ ແລະ ທຳການຜະລິດຕ່າງໆ	☐	☐	☐	☐
ສູນເສຍຊັບສິນບັດສ່ວນລວມ ແລະ ສ່ວນບຸກຄົນ	☐	☐	☐	☐
ທຳລາຍໄມ້ປູກ ແລະ ພືດ/ຜົນລະປູກຂອງປະຊາຊົນ	☐	☐	☐	☐
ຫຼຸດຜ່ອນລາຍຮັບຈາກການນຳໃຊ້ດິນ ຫຼື ສະຖານທີ່ດັ່ງກ່າວ	☐	☐	☐	☐
ຜົນກະທົບຕໍ່ຄຸນນະພາບຂອງນ້ຳສິ່ງຜົນແກ່ສິ່ງທີ່ມີຊີວິດ	☐	☐	☐	☐
ຜົນກະທົບຕໍ່ການຊອກຢູ່ຫາກິນ/ເກັບເຄື່ອງປ່າຂອງດົງຂອງປະຊາຊົນ	☐	☐	☐	☐
ຜົນກະທົບຕໍ່ການເຂົ້າເຖິງໂຮງໝໍ/ສຸກສາລາ	☐	☐	☐	☐
ຜົນກະທົບຕໍ່ການປະກອບອາຊີບເດີມຂອງປະຊາຊົນ	☐	☐	☐	☐
ຜົນກະທົບຕໍ່ການເຂົ້າໂຮງຮຽນຂອງລູກຫລານ	☐	☐	☐	☐

- ຜົນກະທົບດ້ານອື່ນໆ ____

____

V. –ໃນຖານະທີເປັນແມ່ຍິງ ທ່ານຄິດວ່າໂຄງການນີ້ຈະສົ່ງຜົນກະທົບຕໍ່ທ່ານແນວໃດ?

____

____

____

W. ຄຳຄິດຄຳເຫັນຂອງທ່ານຕໍ່ການສະໜັບສະໜູນໂຄງການນີ້

ໃຫ້ຈັດລະດັບການເຫັນດີສະໜັບສະໜູນ ແລ້ວໝາຍ ☑ ໃສ່ຫ້ອງຄະແນນລຸ່ມນີ້:

1= ບໍ່ສະໜັບສະໜູນ, ☐ *2= ຂ້ອນຂ້າງສະໜັບສະໜູນ,* ☐

3= ສະໜັບສະໜູນ, ☐ *4= ສະໜັບສະໜູນທີ່ສຸດ* ☐

X. ການຍົກຍ້າຍຈັດສັນບ້ານ

ຖ້າຫາກມີການຍົກຍ້າຍບ້ານຂອງທ່ານໄປຢູ່ບ່ອນໃໝ່ທ່ານຢາກຈະຍົກຍ້າຍໄປບ່ອນໃດ?

ຍ້ອນຫຍັງ:______________________________________

____

____

W. ຖ້າຊັບສິນຂອງຂອງທ່ານຖືກຜົນກະທົບຈາກໂຄງການ, ທ່ານມີຄຳຄິດເຫັນແນວໃດ ຕໍ່ການທົດແທນຄ່າເສຍຫາຍ?

- ຂ້າພະເຈົ້າ ເຫັນດີ ມອບໃຫ້ລັດ ເພື່ອປະກອບສ່ວນ: ____________________ ☐
- ຕ້ອງການໃຫ້ທົດແທນສິນຕາມຕົວຈິງ ເປັນເງິນຕາ ໂດຍອີງໃສ່ລາຄາຂອງລັດທີ່ກຳນົດ: ☐
- ຕອ້ງການໃຫ້ທົດແທນສິນຕາມຕົວຈິງ ເປັນເງິນຕາ ໂດຍອີງໃສ່ລາຄາຂອງທອ້ງຕະຫຼາດ: ☐
- ຕອ້ງການໃຫ້ທົດແທນສິນຕາມຕົວຈິງ ເປັນວັດຖຸ ຕາມມູນຄ່າເທົ່າທຽມກັນ:

  (ໃຫ້ກຳນົດຊື່ ຫຼື ປະເພດວັດຖຸທີ່ທ່ານຕອ້ງການໃສ່ລຸ່ມນີ້):

  - ______________________________
  - ______________________________

X. ຂໍ້ສະເໜີຂອງທ່ານ ຕໍ່ກັບໂຄງການ.

____

____

____

ທີ່ບ້ານ(at Village)____________________, ວັນທີ(date)____________

ຢັ້ງຢືນຈາກນາຍບ້ານ (ເຊັນ ແລະ ປະທັບຕາ) Sign and Stamp from Chief village	ລາຍເຊັນຜູ້ຖືກສຳພາດ Signature of interviewer	ລາຍເຊັນຜູ້ສຳພາດ Signature interviewer
____________	____________	____________
ຊື່ແຈ້ງ(Name):	ຊື່ແຈ້ງ(Name):	ຊື່ແຈ້ງ(Name):

Appendix D: Paklay-Hydrology-Final FS-20170320

Appendix E: Paklay-Project Layout and Main Structures-Final FS-20170320

Appendix F: Summary of Technical Review Report

POWERCHINA RESOURCES LTD.
No. 428, Unit 39 Ban Phonthan,
Saysettha District Vientiane Capital
Lao PDR
Telephone: (00856) - 21- 419075
Fax: (00856) - 21- 419075

National Consulting Group (NCG)
No. 012, Kaysone Road, Ban Phonexay, Xaysettha District
Vientiane, Lao PDR
Email: sdncclaos157@yahoo.com
Telephone: 856-21 261882