Strategic Environmental Assessment
Pre-Study of That Luang Marsh
For Sustainable Development
in Vientiane Capital, Lao PDR

Fredrik Olsson

Master of Science Thesis
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Minor Field Study

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Summary

Introduction
Lao People Democratic Republic (Lao PDR / Laos) has a population of 5.8 million people and is today one of the least developed countries in Asia. That Luang Marsh (TLM) is the largest remaining urban wetland (2000 hectare) in Vientiane Capital, which historically has supplied wildlife and local people with several eco-services. Some important functions are wastewater treatment, flood control (water storage), and several agricultural and aquacultural services. Due to the flat landscape and the low permeability in soil, the area becomes naturally flooded during the wet season when the water level in the Mekong River is high. All storm water in Vientiane is drained through TLM. There have been several projects in Vientiane aimed to solve the drainage and sanitary situation. However, the problems have still not been completely solved today.

Aim and objectives
This Master of Science thesis aims at providing a prestudy for a Strategic Environmental Assessment (SEA), which may be used for creating a full-scale SEA in the future. The main objectives that will be analyzed are:

- Wastewater treatment in Vientiane.
- The environmental impact caused by human activity and how it can be reduced in TLM / Vientiane / Mekong River.
- Sustainable development in Vientiane.
- The need of SEA in TLM.
- Flood control in Vientiane.
- Agriculture and aquaculture in Vientiane.
- The WATER Project and New Town Development Project.
- Socioeconomic overview of Laos / Vientiane.

Methodology
This thesis is a collaboration between the Swedish university KTH and the Thai university AIT. The student (author of this report) was linked to Dr. Shipin, co-advisor at AIT through Dr. Frostell, supervisor at KTH, and Dr. Berg. A field study was made from October 2008 - December 2008 in Vientiane Capital, Laos. The student has collected information from NGOs, institutions, departments, laboratories, libraries, local people, and Internet in the form of hardcopy literature, electronic documents, e-mail contacts, and interviews. During two days the student had the favour to join a team sent out by WWF for collecting water samples around the marsh. The team consisted of representatives from WWF and the three districts that surround That Luang Marsh.

Strategic Environmental Assessment
The main purpose of a SEA is to support sustainable decision-making processes in an area. Except from environmental aspects, the SEA also considers socioeconomical aspects. SEAs may differ in terminology and practice between countries and organisations but do usually include stages like preliminary scan, conduction of SEA, preparation of the report, implementation of SEA in PPP (policy, plans, or programmes), and review of the implementation. This report gives a short briefing about how SEAs are produced by CIDA (Canadian International Development Agency) and according to the European Directive. The European Directive is the standard SEA for several European countries. The report does also present the project oriented EIA (Environmental Impact Assessment)
Wetland valuation
Wetlands may be valuated in different ways. This report explains one method where the valuation is separated into: DUV (Direct Use Value), IUV (Indirect Use Value), OV (Option Value), and NUV (Non Use Value). These are added to TEV (Total Economical Value).

WATER Project
The WATER project is a response to the environmental and socioeconomical problems that have occurred in Vientiane. Several past projects have been less successful, which have resulted in adverse impact on the society and the ecosystem. The WATER project tries to highlight the wetland values and convince authorities to use CWs (Constructed Wetlands) instead of conventional wastewater treatment plants for treating wastewater. This project will first do five pilot studies in Vientiane. Three will be used for treating domestic wastewater and two for industrial. The project is a part of the Wetland Alliance Programme. Main partners during the project are the government of Lao PDR, WWF Laos, WWF Germany, Wild Fowl & Wetland Trust (WWT). Other involved partners are CORIN, AIT, WFC, CIDA, and Sida. It seems that the authorities will allocate 22 hectares for constructing a CW that will purify Vientiane’s most polluted urban water canal Hong Ke. The WATER Project recommends that even Hong Xeng is included which totally requires 61 hectare CW area.

New Town Development Project
The New Town Development is a collaboration between the Lao and Chinese government. The plan is to develop the city so it attracts more foreign and domestic investors. 1000 hectares low valued land will be developed for business and 200 hectare will be used for creating an artificial lake aimed for compensating lost wetland area. As a part of the negotiations, the Chinese has already constructed a stadium that was used during the SEA Games 2009. 670 hectare will be developed in TLM, 100 hectare in Dongphosy Forest, and 430 hectare close to the new stadium. The Chinese investors will lease the developed land for 50 years. This may be used for business. When the project period is over, the Lao government have the right to reclaim all developed land without compensation. The Chinese Suzhou City stands as model for the development project in Vientiane. The estimated cost of the project is USD 800-1000 million.

Discussion and conclusions
Choosing SEA, CEA (Cumulative Effect Assessment), or another strategic assessment method should not be the main issue. As long as the method contributes to a strategic sustainable development and is internationally accepted it may be used for PPPs. The main issue of SEA is not to create a report, but convincing authorities about the importance of sustainable decision-making processes. Factors that may inhibit a sustainable development in Laos are low education, corruption, and greedy investors that devastate the environment for own profit. The laws are in several cases enough but due to the lack of a judicial organization and economical funding the legislative system becomes inefficient.

It is difficult to valuate wetlands. The greatest challenge is to valuate OV's and NUV's. OV's are difficult because they are just options. NUV's are based on a subjective estimation because these consider cultural and aesthetical values. A problem with the New Town Development Project is that some vulnerable groups that live in TLM will be forced to live in a resettlement area. These people may have difficulties to adapt to the new environment. It is important that the authorities work extra hard with helping project affected people. Wetland degradation is probably a result of i) intense water pollution (wastewater from households and industries), ii) physical destruction (housing, filling, and artificial drainage), iii) overuse of wetland
resources, iv) invasions or invitations of new species (golden apple snail). In theory, wetlands may be replaced with modern technology for protecting the city against flooding. One way is to build a cement layer in Houay Mak Hiao River for increasing the drainage capacity. However, because the country has very small economical margins and the hydrological situation is not completely investigated, this could be treated as a risk project. Another problem is that the wastewater capacity will reduce and the biodiversity in the river will be lost. The loss of wastewater treatment needs to be compensated with modern technology.

Something needs to be done for increasing the sanitarian situation in Vientiane. This report has compared the benefits of using conventional wastewater treatment plants and CWs. Probably the most reasonable solution is to use a CW for treating the wastewater in Hong Ke while the new centre in TLM uses a conventional wastewater treatment plant. This is an optimal solution because a conventional wastewater treatment plant for treating the water in Hong Ke would require a completely new sewage system, which could become very expensive. Maintaining a conventional wastewater treatment plant is also expensive and requires special trained staff. An easier alternative would be to use CWs for the old part of Vientiane. Because the new centre will be built in a modern style with new infrastructure this part of Vientiane could treat wastewater conventionally. Building a conventional wastewater treatment plant would also save some high-valuated land.

The author will not decide if Vientiane should develop into a top modern city or remain as a small sized capital as it is today. However, today the situation is unsustainable and something needs to be done. Better organization and planning is necessary for not repeating mistakes that were made during past projects. All decisions have to be based on a non-corruptive process and sustainable thinking. Integrating an environmental and socioeconomical strategy into the future of Vientiane should be of interest for all Laotians. Vientiane is the economical centre of Laos and an increased discharge of polluted water into the Mekong would increase the stress of the important river. A collapse of the biodiversity in the Mekong would strike hard on Laos’ fishing industry and economy. Decisions made today will surely more or less affect people at local, regional, national, and international level in the future.

<table>
<thead>
<tr>
<th>Conventional Wastewater Treatment</th>
<th>Constructed Wetland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced</td>
<td>Long lifetime</td>
</tr>
<tr>
<td>Standardized</td>
<td>Effective in warm climates</td>
</tr>
<tr>
<td>Quick turnover time</td>
<td>No chemical input</td>
</tr>
<tr>
<td>Require small space</td>
<td>Easy to maintain</td>
</tr>
<tr>
<td>Could be more sanitarian</td>
<td>Low sludge production</td>
</tr>
<tr>
<td>Processes better evaluated</td>
<td>Aesthetical</td>
</tr>
<tr>
<td></td>
<td>Less need to change infrastructure</td>
</tr>
<tr>
<td></td>
<td>Low running cost (flat topography)</td>
</tr>
</tbody>
</table>
Sammanfattning

Inledning

Syften och mål
Detta examensarbete är en förstudie till en Strategic Environmental Assessment (SEA). Förstudien skulle kunna utnyttjas till uppbyggandet av en komplett SEA. Huvudområden som undersöks i denna rapport är:

- Vattenreningen i Vientiane.
- Den mänskliga miljöpåverkan och hur denna kan lindras i TLM / Vientiane / Mekongfloden.
- Hållbar utveckling i Vientiane.
- Behovet av SEA i TLM.
- Översvämningsskydd i Vientiane.
- Jordbruk och akvakultur i Vientiane.
- Projekten WATER Project och New Town Development Project.
- En socioekonomisk översikt för Laos / Vientiane.

Metod
Projektet är ett samarbete mellan det svenska universitet KTH och det thailändska universitet AIT. Författaren till denna rapport, Fredrik Olsson är mastersstudent på KTH och har genomfört och utvecklat projektet tillsammans med handledaren Dr. Frostell, KTH och bihandledaren Dr. Shipin, AIT. Även Dr. Berg har haft en viktig roll i utvecklandet och det praktiska genomförandet av projektet. Oktober 2008 – december 2008 genomfördes fältstudier i Vientiane, Laos. Fakta till rapporten inhämtades främst från NGOs (Non-Governmental Organizations), institutioner, laborаторier, bibliotek, lokalbefolkning och internet. Detta skedde i form av tryckta paper/avhandlingar, elektroniska dokument, e-mail kontakter samt intervjuer. Under två dagar genomfördes fältstudier i TLM i samarbete med WWF. Syftet var att mäta vattenkvaliteten i våtmarken på ett antal förutbestämda platser. Gruppen bestod av en representant från WWF samt representanter från de tre distrikt som delar TLM.

Strategic Environmental Assessment (Strategisk Miljöbedömning)
Syftet med en SEA är att skapa hållbarhet i myndigheters beslutsprocesser. SEA integrerar både miljö och socioekonomiska aspekter i samma studie där målet är att sträva mot en hållbar utveckling. Olika SEA kan skilja sig i utformningen beroende på vilken handledning som används.Dock är dessa skillnader små och inträffar oftast i form av annorlunda terminologi och utförande. Normalt ingår moment som preliminär undersökning, genomförande av SEA, förberedelse av rapport, implementering av SEA i PPP (Policy, Plan och Program) samt utvärdering av implementeringen. Den här rapporten redovisar ytligt hur
en SEA genomförs enligt CIDA-modellen (Canadian International Development Agency) och enligt Europeiska Direktivet. Den senare handledningen används som standard i flertalet europeiska länder. Denna rapport kommer även att redovisa grunderna i EIA (Environmental Impact Assessment).

Värdering av våtmarker
Det finns ett antal olika sätt att värdera våtmarker. Ett sätt som redovisas i rapporten är att separera värderingsområdena till DUV (Direct Use Value), IUV (Indirect Use Value), OV (Option Value), och NUV (Non Use Value). Dessa summeras sedan till TEV (Total Economic Value). DUV beskriver de direkt synliga värdena av att bevara en våtmark, IUV de värden som är indirekta, OV de värden som kan vara möjliga i framtiden, NUV de värden som inte kan bedömas ur ett ekonomiskt och TEV våtmarkens sammanlagda värde.

WATER Project

New Town Development Project

Diskussion och slutsats
Det spelar ingen större roll vilken metod som används för att nå en hållbar utveckling om den har någon form av internationell acceptans, är strategisk och tar hänsyn till att integrera både miljö och socioekonomiska frågor i samma studie. SEA och CEA (Cumulative Effect Assessment) är endast några alternativ. Målet med en SEA är först och främst inte avsedd för att skapa en rapport utan snarare hållbarhet i beslutsprocesser på PPP-nivå. Faktorer som motverkar hållbar utveckling i Laos är bland annat korruption, dålig utbildning och giriga investerare som maximera sina ekonomiska vinster på miljön och samhällets bekostnad.


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Glossary and abbreviations

**Aerobic** Conditions where oxygen is present.

**Anaerobic** Conditions where oxygen is not present.

**Baseline data** Information that considers the issues and situation for the case study in the SEA-report.

**Biodiversity** High amount of different species.

**Biological Oxygen Demand (BOD)** The amount of oxygen that is consumed by microorganisms for breaking down organic matter in water during a certain time.

**Chemical Oxygen Demand (COD)** The amount of oxygen required for a total chemical break down of organic substance in water.

**Constructed Wetland** Human-made wetland with purpose to treat wastewater.

**Conventional Wastewater Treatment Plant** Traditional wastewater treatment facility, which is very common in most developed countries. The plant is often divided into different stages like mechanical, biological, and chemical treatment.

**Cumulative Effects Assessment (CEA)** May be used as a complement to EIA. Considers in a larger scale cumulative effects.

**Denitrification** Conversion of nitrate into molecular nitrogen. The reaction requires usually the presence of bacteria.

**Direct Use Values (DUV)** Values that easily could be estimated by analyzing the direct benefits.

**Drainage Canal** Channel for evacuating storm water.

**Environmental Assessment (EA)** Different kinds of environmental assessments like SEA, CEA, and EIA.

**Environmental Impact Assessment (EIA)** Assessment method aimed to minimize the environmental impact from projects. EIA is mandatory in most countries for projects that may affect the environment.

**GDP** A measure for analyzing a country’s economic performance.

**Indicator** A signal that could be connected to an objective.

**Indirect Use Values (IUV)** Values that are more difficult to predict than DUV. They may indirectly affect a society’s economy.

**MDG** Eight international millennium development goals that are included in the UN Millennium Declaration, 2000. These are meant to be fulfilled in 2015.

**Multifunctionality** Different wetland functions that may benefit people and an ecosystem.

**Mitigation** Avoid or minimize the environmental impact. In SEA cases this could be related to improving or compensating measures.

**New Town Development Project** Larger urbanization project in Vientiane. The project will probably radically change the socioeconomical and environmental situation in the capital.

**Nitrification** Conversion of ammonia into nitrate. The reaction requires usually presence of bacteria.

**Non Use Values (NUV)** Values that are difficult to translate into monetary units like ethical, cultural, or aesthetical.

**Option Values (OV)** Possible future wetland values.

**Permeability** The measure of the ability to transport a fluid through a porous material.

**Policy** Broad statement, usually in the top of an organisation. Guidance for an action.

**Plan** A set of co-coordinated and timed objectives. These are used for implementing the policy.

**Programme** A set of projects in a particular area.

**Sa dung** Fishing device that consists of bamboo sticks and a fishing net.

**Septic Tank** A device that may pre-treat sewage water. There are different kinds of septic tanks. They are usually primitive in design in developing countries.
Strategic Environmental Assessment (SEA) Assessment method on policy, plan, and programme level that strategically promotes a sustainable socioeconomical and environmental development.

Sustainable Development Symbiosis between human needs and ecological preservation.

That Luang Marsh (TLM) The largest remaining urban wetland in Vientiane.
Total Economic Value (TEV) The value when DUV, IUV, OV, and NUV are summarized.
WATER Project Introduction of constructed wetlands in Vientiane, preservation of TLM, and promotion of a sustainable development.

A
ADB Asian Development Bank
AIT Asian Institute of Technology
Al Aluminium
As Arsenic

B
BOD Biological Oxygen Demand
CaCO₃ Calcium Carbonate
Cd Cadmium
CEA Cumulative Effect Assessment
CH₄ Methane
CIDA Canadian International Development Agency
COD Chemical Oxygen Demand
CODₜₜ Chemical Oxygen Demand (oxidation with bichromate)
CODₘₙ Chemical Oxygen Demand (oxidation with permanganate)
CORIN Costal Resources Institute
Cu Copper
CW Constructed Wetlands

D
DANIDA Danish International Development Assistance
DCTPC Department of Communication, Transport, Post and Construction
DO Dissolved Oxygen
DOAF Department of Agriculture and Forestry
DUV Direct Use Values

E
EA Environmental Assessment
EAP Environmental Action Plan
EIA Environmental Impact Assessment
EC Electrical Conductivity
EMDP Ethnic Minority Development Plan

F
Fe Iron
FWS (FWSCW) Free Water Surface

G
GDP Gross Domestic Product

H
Ha Hectare
HDI Human Development Index
HDPE High Density Polyethylene
Hg Mercury
hSSF Horizontal Sub Surface Flow

I
ISA Initial Social Assessment
ITSUP Institute for Technical Studies and Urban Planning
IUCN International Union Conservation of Nature
IUV Indirect Use Values
IZ Impact Zone

J
JICA Japanese International Cooperation Agency

K
K Potassium
Kip Lao Currency
Km Kilometre
KTH Kungliga Tekniska Högskolan (the Royal Institute of Technology)

L
Lao PDR Lao People’s Democratic Republic
LNMC Lao National Mekong Committee
LAS Linear Alkyl benzene Sulphonate
LDC Least Developed Countries
LNMC Lao National Mekong Committee
LPRP Lao People’s Revolutionary Party

M
MAF Ministry of Agriculture and Forestry
MCTPC Ministry of Communication, Transportation, Post and Construction
MDG Millennium Development Goals
MIH Ministry of Industry and Handicraft
MRC Mekong River Committee
MTT Ministry of Trade and Tourism

N
N Nitrogen
N₂ Nitrogen gas
NGO Non Governmental Organisation
NH₂⁻ Nitrite ion
NH₃ Ammonia
NH₄⁺ Ammonium ion
NO₃⁻ Nitrate ion
NPK Nitrogen Phosphorous Potassium
NSDP National Socioeconomic Development Plan
NTFP Non-Timber Forest Product
NUV Non-Use Values
NWRP National Water Resource Plan

O
O₂ Oxygen gas
OV Option Values

P
P Phosphorous
Pb Lead
PEC Predicted Environmental Concentration
PFP Primary Facultative Pond
PNEC Predicted No-Environmental Concentration
PO₄³⁻ Phosphate ion
PP Plan and programmes
PPP Policy, plan and programmes

R
RP Resettlement Plan

S
SEA Strategic Environmental Assessment
SFP Secondary Facultative Pond
SIA Social Impact Assessment
Sida Swedish international development cooperation agency
SS Suspended solids
SPC Sulphophenyl carboxylates
SSF (SFSCW) Sub Surface Flow
STEA Science, Technology and Environmental Agency
STEO Science, Technology and Environment Office
STPP Sodium tripolyphosphate

T
TEV Total Economic Value
TLM That Luang Marsh
T-N Total Nitrogen
TOC Total Organic Carbon
T-P Total Phosphorous
TSS Total Suspended Solids

U
UNDAF United Nations Development and Assistance Framework
UNDP United Nations Development Programme
UNEP United Nations Environmental Programme
USD American Dollar
UXO Unexploded Ordnances

V
VCP Vientiane City Planning
VIUDP Vientiane Integrated Urban Development Programme
VLMA Vientiane Land Management Authority
vSSF Vertical Sub Surface Flow
VUDAA Vientiane Urban Development and Administration Authority
VUDMC Vientiane Urban Development and Management Committee
VUISP Vientiane Urban Infrastructure and Service Project
1 Introduction

Since the early days of the industrial revolution, the human impact on environment has increased. Until recently, socioeconomical development has been more prioritized than environmental conservation. This has resulted in adverse impacts on world’s populations and ecosystems. The awareness about environmental impact caused by human activities, has rapidly increased, probably because the effects have become more visible. The awareness has resulted in the creation of several new environmental laws and development of more environmental friendly technologies. Different kinds of standards and assessment methods like ISO 9000 and 14000, EIA, SEA, and LCA have been developed for making productions and activities more sustainable. Many of the new technologies mimic biological processes that occur in the ecosystem. In some cases these may be more cost-efficient than conventional technologies. Constructed wetlands (CWs) are growing in popularity and have been introduced in several countries. For developing countries, CWs may be an efficient and cheap way of treating polluted wastewater. However, the general trend is that CWs mostly are introduced in Western countries due to its simplicity and aesthetical advantages, while developing countries trust more in the conventional alternatives. Maybe this could be explained by that many developing countries have a limited knowledge about the true values of “eco-technologies”. Many developing countries have suffered from failure projects, which in worst case have resulted in large socioeconomical and environmental damages. Laos, a country known for its unique biodiversity may soon loose its position as one of the most beautiful countries in the world. As the rich environment is an important source for future development, a sustainable development thinking needs to be in focus. Several large domestic and foreign investors are today spoiling a rare heritage because Laotian laws are inefficient. However, this trend will probably change in the future because some authorities are today developing to become more efficient. Some non-governmental organizations (NGOs) with environmental interest like WWF, MRC, and the multi-NGO organisation IUCN are monitoring the development and tries to affect the decision-making processes in the country. Such NGOs play a key-role when convincing different authorities and stakeholders about proper sustainable development.

Strategic Environmental Assessment (SEA) is a powerful tool that integrates environmental aspects with socioeconomical. The broadness of SEA has both advantages and disadvantages. While SEA is useful for promoting sustainability in decision-making at policy-, plan-, and programme-level, it might be unhandy if it is used at project-level. For these cases the Environmental Impact Assessment (EIA) might be a better choice. Cumulative Effect Assessments (CEA) is commonly used in Southeastern Asia and reminds of SEA. However, the focus in this report will be on SEA.

The use of SEA is very uncommon in Laos. This could probably be linked to the poor environmental knowledge among authorities and the lack of an effective organisation. This prestudy of That Luang Marsh, an urban wetland east of Vientiane Capital, is probably one of the first reports that introduce the SEA terminology to authorities in Laos. Hopefully the information in this report could contribute to the production of a future full-scale SEA.
2 Aim and objectives

The overall aim of this work is to create a prestudy SEA for the That Luang Marsh in Vientiane, Laos. The main objectives are to:

- Discuss if there is any need of a full SEA in That Luang Marsh.
- Analyze how the wastewater issue could be solved for reducing the impact on That Luang Marsh / Vientiane Capital / Mekong River.
- Discuss the plans about building constructed wetlands and conventional wastewater treatment plants. Advantages and disadvantages about the different options will be analyzed in this report.
- Describe some important projects in TLM, especially the WATER Project and the New Town Development Project.
- Discuss how flooding in Vientiane could be controlled.
- Describe the general environmental impact caused by human activity in Vientiane.
- Analyze how sustainable environmental and socioeconomical development could be promoted for the region.
- Analyze how a sustainable agriculture and aquaculture in Vientiane could be developed.
- Give some background information about the socioeconomical situation in Vientiane / Laos.

The report will discuss the complex interactions between environmental and socioeconomical issues. The thesis will discuss the importance of wetlands in the Vientiane region. The New Town Development Project and the WATER Project could have a large impact on the region and therefore this will be an important part of the report. The report will also discuss some old and some possible future drainage and wastewater treatment plans. The information is collected for creating an understanding about the current economical, social and ecological situation in Vientiane. Based on the collected information, some recommendations will be given on how sustainability could be introduced in That Luang Marsh and Vientiane as whole. As this is a prestudy, decision-making processes should not be based on this report. A full-scale SEA would bring a deeper understanding of how sustainability in Vientiane could be promoted.

3 Methodology (phases in work)

The project was initially created by Fredrik Olsson, student and author of this report, Dr. Frostell, supervisor at KTH, Dr. Shipin, co-advisor at AIT, and Dr. Berg. Scholarships were awarded by Sida, Sveriges Ingenjörer, and Ångpanneföreningen (ÅF). The project was created because there is a large interest of promoting a sustainable development in That Luang Marsh, Vientiane.

When the student arrived to AIT, there were uncertainties if the report should adapt the SEA or CEA guidelines. Usually KTH follows the SEA guidelines according to the European Directive 2001/42/EC, while AIT seems to be more familiar with CEA. Finally, the student decided to follow the SEA. However, the difference between SEA and CEA is probably insignificant. Due to the lack of time and resources, and the great complexity of the issues discussed, the report should be regarded as a prestudy to an SEA. During the field study, plenty of data were collected. The prestudy may be used as a base for a full-scale SEA. The report therefore has tried to adapt the SEA guidelines.
Dr. Shipin introduced the student to several persons in Vientiane. They were able to broaden the student’s contact network. Almost all contacts were established from AIT or in the field. It was very difficult to predict how the information should be collected when the project was planned in Sweden. One reason was that the information in Swedish libraries and on the Internet was limited. Several times the student was in direct contact with the authors of the collected reports. The student have gathered information from NGOs, institutions, departments, laboratories, libraries, local people, and Internet in the form of hardcopy literature, electronic documents, e-mail contacts, and interviews. Due to the lack of recent studies made on That Luang Marsh, a significant part of the information retrieved was old. Probably this could be linked to the fact that Laos is still under development and in general there is a lack of environmental competence. Many documents were only available in Lao. Some key-persons that were interviewed required a translator. Water quality data were mainly received from WWF or the Water Quality Laboratory in Vientiane. During two days the student had the favour to join a team sent out by WWF for collecting water samples in the marsh. The team consisted of staff from WWF and the three That Luang Marsh districts. This project has often been based on trial and error procedure, which required much time and patience. In the end of the field study, the student had enough information to travel home and start writing on the report. Since the projects in That Luang Marsh are ongoing, some information was received by e-mail when the student had returned to Sweden. Overall the field study was very exciting and challenging. Creating the right contacts takes time, especially in developing countries.

4 Literature review of EIA and SEA

During the study, the author came in contact with several assessment methods, directives, and protocols. This chapter gives an overview of the assessment methods Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA). While SEA may have several similarities with

![Figure 4.1: A possible process scheme for an EIA (UNEP, 2007).](image-url)
Cumulative Effects Assessment (CEA) this method will not be described in this report. CEA seems to be more used in Asia compared to Europe.

### 4.1 Environmental Impact Assessment

Many countries have implemented the EIA concept into their environmental laws. While the EIA process may differ, the general goal is to minimize the environmental impact for planned projects. The EIA deals with specific project proposals.

According to UNEP (2007), the first stage in the process is called screening. This analyzes whether or not an EIA is required. If the result from the screening is that EIA is required, the next stage will be scoping. During this stage, all existing information and suitable methods are used for identifying what possible impacts could be caused by the project. Both significant and insignificant impacts are described at the scoping stage. The impact analysis stage digs deeper into the identified problem areas that were revealed during the scoping stage. The mitigation and impact management stage focuses on how the impact from the proposed project could be reduced. The outcome from the whole EIA process is described in an EIA report. Before the report is used in formal decision-making processes, the report has to be reviewed for ensuring good quality. After an EIA is approved, it will be followed-up and implemented. A plan is created that describes how the negative environmental effect is minimized. The outcome from the project needs to be monitored for avoiding adverse environmental impacts. Stakeholders that are directly affected by the project, have to be informed during the whole EIA process. Figure 4.1 describes the stages in a possible EIA process.

### 4.2 Strategic Environmental Assessment

The SEA is actually created from the project oriented EIA. However, SEA is more suitable for plans, programs, and in special cases policies (PPP), rather than projects. When the environmental effects are evaluated, an SEA could be used for creating a comprehensive and systematic process at an early stage of decision-making. The SEA is by its nature strategic and implements sustainability at a high level stage of decision-making. The tool is also analytic and focuses on identifying significant positive and negative environmental effects that may occur as a result of different activities. The assessment integrates socioeconomical and environmental issues so sustainability is created during the whole decision-making process. Similar to other environmental assessments, SEAs give the answer to several questions during the development of PPPs. SEA is usually not mandatory in developing countries.

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**Figure 4.2:** SEA could be treated as more strategic and less detailed than EIA (Countryside Council for Wales, 2004).
According to CIDA (2004), SEA and EIA share several similarities. However, a difference is that EIA is only project oriented and not strategic. As the socioeconomic analysis is limited for EIA, these are easy to neglect when a project is planned. SEA, is most effective when it is implemented before any projects have started. This is because an SEA creates a good overview of the current situation and suggests how actions could be taken for creating an overall sustainability. SEAs do also consider the synergistic and cumulative effects in a better way than EIA. Figure 4.2 and 4.3 describe the relationship between SEA and EIA. SEAs are important when high-risk programmes are initiated in e.g. housing, agriculture, transportation, or energy areas. An SEA could also be of interest if there is a suspicion that an action could have an adverse impact on the environment.

SEAs are usually less detailed and more broad-brush than EIA. The reason is that SEA is guiding the decision-makers at a more general level. However, it is important to remember that some of the detailed information may be lost during an SEA due to the assessment’s broader scope. This could in some cases become misleading during the decision-making. The information becomes more detailed at the lower levels in the decision-making hierarchy (Figure 4.2). A definition of the PPPs could be: “a policy may... be considered as the inspiration and guidance for action, a plan as a set of co-coordinated and timed objectives for the implementation of the policy and programme as a set of projects in a particular area” (Countryside Council for Wales, 2004).

Synergistic effects are effects where two or more effects together become greater than the sum of the effects (CIDA, 2005). Cumulative effects are effects that in combination become more significant than the individual ones. Some of these effects could also become significant if the environmental properties are changed. Since ecosystems usually are dynamic these effects may be difficult to predict.

OECD/DAC declared in 1997 “the objective is not the production of an SEA report, but rather informing decision makers on potential environmental impacts and providing rapid and objective responses when required”. The directive continues later with “it is about comparing valid options at a strategic level”. This shows that the main purpose of creating an SEA is to provide the decision making process with information that could act as a support to create sustainable PPPs. According to CIDA (2004), SEAs could be used to reach the seventh MDG. The MDG was created for ensuring a sustainable development in countries’ PPPs. During the creation of SEAs, valuable sources of information are collected through public
participation and consultation because many stakeholders may broaden their view of the problem.

4.2.1 SEA according to the Canadian International Development Agency

Before an expensive and time consuming SEA is created, there should be a prestudy that investigates the needs of an SEA (CIDA, 2004). When the SEA finally is implemented it has to be evaluated. If stakeholders have been consulted during the process this has to be included during the evaluation. A successful integration of SEA into PPP needs to be done at an early stage of a decision making process. The creation of an SEA is complicated and therefore planning is important. The nomenclature and methods of the SEA process may differ depending on countries and organizations but the outcome should be similar. CIDA starts the SEA progress with a preliminary scan (A). Other SEA guidelines may call this stage prestudy or screening. During the preliminary scan, information is gathered and analyzed. The information is used for deciding if an SEA is needed. If there seems to be significant

![Figure 4.4: The SEA process according to CIDA (CIDA, 2004).](image-url)
environmental effects, the next stage is to conduct the SEA (B). Consultation with specialists, NGOs and other stakeholders will at this stage be necessary. Several questions need to be addressed. These may differ between different SEA processes. Some questions that could be given are presented in figure 4.4. When the conduction stage is finalized, an SEA report is prepared (C). The quality of the report increases when it is reviewed. The SEA is later spread to the stakeholders that have an interest of the study. The SEA is finally integrated into the PPP (D).

4.2.2 SEA according to the European Directive 2001/42/EC

Figure 4.5: Flow chart of the SEA stages in the European Directive 2001/42/EC (Based on Office of the Deputy Prime Minister, UK, 2003).
The Directive may be used for plans and programmes that formally have started their preparation process after 21 July 2004 (Office of the Deputy Prime Minister (UK), 2003). First the context is set up and a baseline is established. It is important to find all background information like possible environmental and socioeconomical effects. There has to be an investigation if similar assessments have been made for the same area. The SEA needs some objectives and indicators so it is possible to afterwards measure environmental and socioeconomical changes in the selected area. Next step in the SEA process is to set up the scope. Later the effects of the plan are predicted and evaluated. At the same time measures should be set up that explain how adverse effects could be minimized. An Environmental Report will be prepared at the next stage that presents the results from the SEA. The SEA will be evaluated after the implementation. Figure 4.5 presents a flow chart of the SEA process according to the European Directive.

4.2.3 Differences and similarities between SEA and EIA

EIA was introduced in the environmental work before SEA. Experience from the use of EIA, showed that a more comprehensive and proactive instrument would be valuable to use before the EIA. To fill this need, SEA was developed. EIA should only be used at the project level, while SEA is mostly useful at plan and programme level. An SEA is often created before an EIA because the SEA is more strategic and wider than the project oriented EIA. Unlike EIA, SEA also considers more detailed socioeconomic impacts on the specific target area, cumulative and synergistic effects, and struggles for sustainable decision-making processes. Table 4.1 presents some differences between EIA and SEA.

According to Therivel et al. (2006), a typical correlation between SEA and EIA occurred when a second ring road was planned around London, England. The SEA controlled the different projects (local road links) that were created. Each of them had their own environmental impact and therefore every project required an own EIA. One EIA for the whole ring road was never a good option because the EIA guideline cannot give the satisfying strategic overview as an SEA. However, many EIAs may become powerful if an SEA controls these. Impacts from the traffic are in many cases local but the SEA may also control the regional impact when drivers travel longer distances between the local projects.

| Some Comparisons between EIA and SEA (Therivel et al., 2006). |
|---------------------------------|---------------------------------|
| **EIA of Projects**             | **SEA of Policies, Plans and Programmes** |
| Takes place near the end of decision-making cycle; aims to minimise impacts | Takes place at earlier stages of decision-making cycle; aims to prevent impacts |
| Reactive approach to development proposal | Pro-active approach to development proposals |
| Considers limited number of feasible alternatives | Considers broad range of potential alternatives |
| Limited review of cumulative effects | Cumulative effects assessment is key to SEA |
| Emphasis on mitigating and minimizing impacts | Emphasis on meeting environmental objectives, maintaining natural systems |
| Narrow perspective, high level of detail | Broad perspective, lower level of detail to provide a vision and overall framework |
| Well-defined process, clear beginning and end | Multi-stage process, overlapping components, policy level is continuing, iterative |
| Focuses on standard agenda, treats systems of environmental deterioration | Focuses on sustainability agenda, gets at sources of environmental deterioration |
5 Case Study: That Luang Marsh

5.1 Introduction

This Master of Science thesis will analyze how the urban wetland That Luang Marsh could be used for promoting a sustainable development in the Vientiane Capital region. Laos is one of the poorest and least developed countries in Asia. The growth of the capital is surely affecting the development of Laos. While the Laotians are treated as poor, the situation is not as alarming as for several African countries. Laos is still rich in natural resources and the population has probably good possibilities to reach a high living standard in the future. However, a problem is that many parts of the country still suffer from UXO-bombs that were dropped from American bomb-planes during the Vietnam War. Every year a number of people are injured or killed due to bomb explosions. The nation is still sparsely populated and offers a unique biodiversity. That Luang Marshland, located east of the capital is the largest urban wetland in this region. The marsh offers today several eco-functions like wastewater treatment and flood control but also makes agricultural and aquacultural activities possible.

Several past drainage projects in the city area have caused a large negative impact on the urban wetlands. There is a risk that some of the wetlands may completely lose their unique multifunctionality. The complexity of wetland multifunctionality has before been underestimated, probably because the knowledge about it has been limited. Some projects and illegal exploitation that continuously reduces the wetland area is also ongoing. Different kinds of destructive projects have seriously changed the hydrologic patterns in Vientiane’s past wetland-network. Some of the effects may seem to be insignificant. However, it is important not to forget the cumulative or synergistic impacts. Figure 5.1(a-b) shows two pictures how the environmental conditions dramatically have changed in Hong Ke Canal between 1990 and 2003.

WWF is trying to promote a sustainable improvement of the natural wastewater treatment in Vientiane. They have suggested that constructed wetlands could be built for treating domestic and industrial wastewater discharged from the city. It has been difficult to convince the decision-makers. Processes in this area are normally slow. However, recently there have been openings for discussions between WWF and local authorities and some pilot sites have already been and will be constructed. The results of these test sites will decide if full-scale constructed wetlands could be built. The heaviest polluted sewage and drainage canal Hong Ke receives a large part of Vientiane’s wastewater discharge. The primary objective will be to treat the water in this canal.

Figure 5.1: Changes in the landscape have occurred as a result of different drainage projects. The photos reveal the environmental difference in Hong Ke between the years (a) 1990 and (b) 2003 (Lacoursiere J et al, 2003).
The Laotian government has agreed with the Chinese government that a large part of That Luang Marsh should become developed urban area. The developed area will become the new high-technological centre of Vientiane. The expectation is that this may boost the slow Lao economy and benefit Chinese investors.

5.1.1 Prestudy of SEA (structure and strategies)

Since a full scale SEA requires more time and resources than were available for this project, the Thesis work was carried out as a prestudy. In the beginning of the project, the student had a limited contact network. Continuous creation of new contacts was an important part of the field study. There were some public environmental data found about That Luang Marsh. However, because several data were old (> 20 years), this had to be considered. Some of the information was found in public libraries and on the Internet. A lot of data that have been used for this report is based on conversations and written information, given directly by the authors. Many meetings were set up with important persons. The student never found any old SEAs that have been made in Vientiane. However, because the environmental law in Laos has adapted EIA, this kind of assessment was more common.

5.2 Screening

Screening is the first stage in an SEA process. The screening analyzes if an SEA is needed for the target area.

5.2.1 Why SEA for That Luang Marsh

SEA is a powerful tool that could be used for creating a more environmentally and socioeconomically sustainable decision-making process in a target area. Several projects are today active in the That Luang Marsh and many old projects have resulted in complications and irreversible impacts on the environment. Probably this trend will not end and therefore a more strategic assessment method could be useful for not worsening the situation. The use of EIA is mandatory in Laos but the assessment could never be used in a strategic way for the whole region. EIA is also weak when cumulative and synergistic effects are analyzed. For the case of That Luang Marsh, the environmental problems are strongly linked to the social and economical situation in the area. Since the marsh is sensitive and important for locals, the destruction of wetlands hits especially on the vulnerable groups. An SEA for That Luang Marsh would in a strategic way explain what projects the decision-makers should approve for promoting an integrated socioeconomically and environmentally sustainable development. It is important to analyse both areas because if too much focus is put on one aspect, the decisions could never become sustainable. A full-scale SEA could minimize the environmental impact and at the same time ensure a positive socioeconomical development. The Ramsar Convention of Wetlands is an intergovernmental treaty that focuses on creating sustainable management plans for wetlands. The convention recommends that SEAs should be created in wetlands that are affected by projects. This far, Laos is not a Ramsar country.

5.3 Scoping (identification of key issues, indicators, stakeholders)

The report focuses on collecting environmental and socioeconomical information about the current situation in That Luang Marsh and analyzes if an SEA should be implemented for the wetland area. Since the marsh has a great importance for Vientiane it is necessary to include the capital within the main system boundaries of this report according to figure 5.2.

A full-scale SEA normally uses several indicators for measuring changes in the environment and socioeconomy. The indicators in this report will not be measured numerically but could
probably be deeper analyzed in a full-scale SEA. Most indicators prove the important relationship between the socioeconomy and environment. Local effects may also become regional or national. Some examples of interesting indicators that could be used are:

- **Inferior water quality**
  - Increased number of waterborne diseases (malaria, dengue-fever, cholera).
  - Increased sick-leaving resulting in less efficient business and reduction of tax revenues.
  - Increased burden on health-care system.
  - Affected biodiversity (increased populations within a fewer amount of species, flexible species outrival native species).
  - Changed hydrological environment (oxygen depletion, changed ammonia: nitrate ratio, acidification, eutrophication, etc.)
  - Wetland degradation.
  - Smelling environment.
  - Reduced tourism.

- **Uncontrolled flooding**
  - Increased costs for repairing infrastructure.
  - Inadequate sanitation in the city due to spreading of wastewater.
  - Reduced business and tax revenues due to inadequate infrastructure.
  - Less business investments in Vientiane resulting in less tax revenues and job opportunities.
  - Deaths and injuries.
  - Reduced tourism.

- **Wetland degradation**
  - Reduced biodiversity.
  - Reduced wastewater treatment capacity.
  - Fewer recreation areas.
  - Reduced tourism.

Several stakeholders may have an interest to affect the future of Vientiane and That Luang Marsh. Some of the key-stakeholders are:

- Authorities (local, regional, and national)
- Local people (fishermen, farmers, Vientiane citizens)
- Landowners
- Laotian and foreign companies
- NGOs
- Universities, institutions
- Other experts
Figure 5.2: The main system boundaries of the project are covered in the map. The Mekong River makes up the southern boundary while the edges of the map are the boundaries to the north, east, and the west. The red ditches on the map gives a hint of what land in Vientiane is developed. That Luang Marsh and Houay Mak Hiao are located east of Vientiane (WWF).
5.4 The baseline study

5.4.1 Socioeconomical overview of Laos

Lao PDR has a population of 5.8 million people and is surrounded by the countries Thailand, Cambodia, Vietnam, China, and Burma (SIDA, 2007). According to UNDP (2007), Laos was among the least developed countries in Asia in 2008. This year Laos was ranked to HDI 133 of 179 countries in the world (UNDP, 2007). Table 5.1 presents the HDI-rank for some countries. 20 % of Laos’ population is estimated to live in poverty (SIDA, 2007). The average education level in Laos is still low. An effect of the poverty is a high child mortality level. Only 51 % of the population has access to clean water (SIDA, 2007). According to Danida (2000), 70 % of the population lives in rural areas. The agricultural activity contributes to more than half of the GDP and more than 80 % of the total labour force is involved in this sector. 20 % of the GDP comes from industrial activity and 20 % from other services. In the end of the 1990s, the national currency was dramatically affected by the financial crisis. The crisis was followed by a rapid inflation, partly worsened by a weak fiscal and monetary policy. Between 1985-1997 the national debt rose from USD 619 million to USD 2,320 million. However, some of the loans are today written off (Danida, 2000).

Table 5.1: Human Development Index (HDI) and other important parameters for some countries (Based on UNDP, 2007).

<table>
<thead>
<tr>
<th>Country</th>
<th>HDI Rank</th>
<th>HDI Value</th>
<th>Life expectancy at birth (years) 2006</th>
<th>Adult literacy rate (% ages 15 and above) 2006</th>
<th>Combined primary, secondary and tertiary gross enrolment ratio</th>
<th>GDP per capita (purchasing power parity, PPP USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>1</td>
<td>0.968</td>
<td>81.6</td>
<td>NA</td>
<td>96.0</td>
<td>35,814</td>
</tr>
<tr>
<td>Sweden</td>
<td>7</td>
<td>0.958</td>
<td>80.7</td>
<td>NA</td>
<td>94.3</td>
<td>34,056</td>
</tr>
<tr>
<td>USA</td>
<td>15</td>
<td>0.950</td>
<td>78.0</td>
<td>NA</td>
<td>92.4</td>
<td>43,968</td>
</tr>
<tr>
<td>Thailand</td>
<td>81</td>
<td>0.718</td>
<td>74.0</td>
<td>90.3</td>
<td>62.3</td>
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</tr>
<tr>
<td>China</td>
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<td>72.7</td>
<td>93.0</td>
<td>68.7</td>
<td>4,682</td>
</tr>
<tr>
<td>Vietnam</td>
<td>114</td>
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<td>70.0</td>
<td>93.9</td>
<td>78.0</td>
<td>7,613</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>133</td>
<td>0.608</td>
<td>63.7</td>
<td>72.5</td>
<td>59.6</td>
<td>1,980</td>
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<td>Cambodia</td>
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<td>58.6</td>
<td>75.6</td>
<td>58.7</td>
<td>1,619</td>
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<td>Liberia</td>
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<td>0.364</td>
<td>45.1</td>
<td>54.4</td>
<td>57.6</td>
<td>335</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>179</td>
<td>0.329</td>
<td>42.1</td>
<td>37.1</td>
<td>44.6</td>
<td>630</td>
</tr>
</tbody>
</table>
5.4.1.1 Politics and public participation

Since the revolution in 1975, Lao PDR is a one-party state where Lao People’s Revolutionary Party (LPRP) controls the nation without letting in any new official parties (Sida, 2008). The purpose of LPRP is to lead the nation towards socialism (Sida, 2008). The new leaders of LPRP have shown willingness to open up the country by several reforms. However, according to Wescott (2003), this process is slow and the opposition against the LPRP is weak. National media is controlled by the government for avoiding political inconvenience. The information that is published “is on the whole dull and formal”. However, the flows of news from foreign countries are impossible to control. These are brought to Laos by cable TV, satellite TV, Internet, and radio (Sida, 2008). Since most Laotians understand what is said on Thai television, this is an important source of spreading uncensored information (Wescott, 2003). Due to the governmental control, public participation is limited in Laos (Wescott, 2003). “The NGOs have contributed in the development of the small scale rural development and community-irrigation projects. No local NGOs are allowed by the Lao government as there is no law that recognizes them. However, there is a fairly strong representation by the international NGOs in the country” (Public Participation in Lao PDR Context, 2002).

5.4.1.2 Corruption

In 2007, Laos received the world corruption rank 140 of 145 and democracy rank 142 of 150 (World Audit, 2007). According to Wescott (2003), corruption is a common problem that decreases the efficiency of the country’s development projects. Martin Stuart-Fox explains that: “the politically powerful avoid paying tax, accept ’commissions’ for facilitating projects or awarding contracts, and pocket pay-offs for reducing charges, duties or taxes for family and friends”. The corruption has infected the system at all levels, which create difficulties when trying to combat it. People with high rank capture cars that were meant for donor-funded projects. Low-paid officials find ways to increase their salary by taking extra “admissions” for approving projects. Officials with influence often promote relatives or friends. The corruptive behaviour “reduces government revenues, misallocates expenditures, reduces foreign investment, and erodes public trust”. In the worst case, corruption may end up in a lower willingness to fight corruption, because the behaviour becomes accepted. A problem with fighting corruption is that many people that should work against corruptive behaviour actually use the system by themselves. For the reason that these people are afraid of becoming discovered, their anti-corruptive work is passive. Since the cold war, the willingness of donating economical funding to high-corruptive countries has reduced. Officially, some actions have been made to fight corruption in Laos. In 1993 an anti-corruption commission was established with the objectives to fight illegal logging and officially condemn the waste of public capital. The anti-corruptive work included:

- The establishment of a constitutional-based rule of law.
- A gradual expansion of political participation.
- An improvement of public financial management.

(Wescott, 2003)

The purpose of the programs was to prevent corruptive behaviour in society (Wescott, 2003). Stronger regulations and monitoring would make it easier to arrest officials during criminal acting. There has also been a greater interest to openly talk about corruption problems on central and provincial level. The government has planned to implement a National Inspection Authority that will work against corruption in Laos (Sida, 2008).
5.4.2 Socioeconomical situation in Vientiane and the That Luang Marsh villages

According to Gerrard (2004), Vientiane Capital consists of 112 villages and covers an area of 30 km$^2$. In 2000, Vientiane had 161,000 citizens. The annual growth in the city core is 1%, while the outskirts have a growth of 3%. The Vientiane citizens have a higher average income than the average Laotian. The income of poor households in 2003 was less than 100,000 Kip (USD 9.6), medium income households had 100,000-1,000,000 Kip (USD 9.6-96), and rich households more than 1,000,000 Kip (USD 96) (Gerrard, 2004). These income levels from 2003 have probably changed due to the strong inflation. The socioeconomical situation is reflected by the sanitary problems. Due to an insufficient drainage/wastewater system, several soak ways and septic tanks become overloaded during the wet season (May-September). TLM is divided into three districts and 17 villages. Rice production is the most important activity for the locals during the dry season, while the wet season offers plenty of aquaculture services like fishing. In the beginning of the 1990s, the marsh area was settled by 14,000 people (2,000 households). The rapid population increase has affected the marsh. In 2000, the estimated population in TLM was 37,914 people (7,139 households) (Gerrard, 2004). About 45% of the population was involved in the agriculture sector or NTFP (Non-Timber Forest Products) activity. 66% of the population was younger than 20 years (Gerrard, 2004). Figure 5.4 presents the age distribution in the 17 villages around TLM. About 80% of the households in Vientiane have access to potable water. The water supply company has two intakes of freshwater from the Mekong. The first is upstream and the second downstream of Vientiane. Poor communities often share water from supply connections (Thongkhammeng, 2007). Income and job situation for the 17 villages are presented in figure 5.5-5.6.

![Village Population and Demographics](image)

Figure 5.4: Age distribution in the 17 villages that surround TLM (Gerrard P, 2004).
5.4.3 Governance of wetlands

5.4.3.1 Governance of wetlands in Lao PDR

Work has been done in Lao PDR to improve the legal and institutional framework for proper wetland use, management and governance. However, there is no national policy that directly deals with wetland management. The policy concerning wetland management could be found in several general policies that cover the management of natural resources. Wetland management is integrated in policies that handle management of agriculture, water resources, and living aquatic animals and plants (Thongkhammeng, 2007). The importance of development, conservation and poverty reduction are highlighted in the natural resource related policies. The hierarchy of wetland management responsibility in Laos and the country’s environmental strategy is presented in table 5.2-5.3. Figure 5.7 shows a flow scheme of the organizational structure. Abbreviations in the tables are explained in the glossary and abbreviation part of this report.
Table 5.2: Description of the organizational responsibility of wetlands in Laos (Thongkhammeng V, 2007).

<table>
<thead>
<tr>
<th>Lao PDR National Committee</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Environment</td>
<td>- National Environmental Strategy 2020 (NES) outlines policy for environmental</td>
</tr>
<tr>
<td></td>
<td>management and protection.</td>
</tr>
<tr>
<td>Department of Livestock and Fisheries</td>
<td>- Wildlife Conservation</td>
</tr>
<tr>
<td></td>
<td>- Aquaculture, Capture fisheries management and protection.</td>
</tr>
<tr>
<td>Advisory Group</td>
<td></td>
</tr>
<tr>
<td>MAF</td>
<td>- Law and Legislations for Land, Water and Forestry</td>
</tr>
<tr>
<td></td>
<td>Protection</td>
</tr>
<tr>
<td></td>
<td>- Strategy, Plan and Policy</td>
</tr>
<tr>
<td>MCTPC</td>
<td>- Master Plan (Land use Zoning)</td>
</tr>
<tr>
<td>STEA</td>
<td>- Environment Protection Law</td>
</tr>
<tr>
<td>LNMC</td>
<td>- Annual activity plans, reports from review</td>
</tr>
<tr>
<td></td>
<td>meetings, reports on efforts to facilitate implementation and regular</td>
</tr>
<tr>
<td></td>
<td>progress reports</td>
</tr>
<tr>
<td>Provinces</td>
<td>- Local involvement in decision and management</td>
</tr>
<tr>
<td></td>
<td>leading to local improvements (expressed through reports from local</td>
</tr>
<tr>
<td></td>
<td>meetings, state of the art reports, local interviews, etc.)</td>
</tr>
<tr>
<td>Cooperation International Organization</td>
<td></td>
</tr>
<tr>
<td>MRC (Environment Unit)</td>
<td>- Lao National Mekong Committee, serve as coordinator for contacts within Lao</td>
</tr>
<tr>
<td></td>
<td>PDR.</td>
</tr>
<tr>
<td>IUCN (UNEP – EAP)</td>
<td>- Institutional aspects of wetland management</td>
</tr>
<tr>
<td></td>
<td>analyses and formula for coordination and cooperation developed</td>
</tr>
<tr>
<td></td>
<td>- Wetland Conservation</td>
</tr>
<tr>
<td>AIT Aqua (Outreach)</td>
<td>- AIT Aqua Outreach will be able to provide some of the wetland data needed</td>
</tr>
<tr>
<td></td>
<td>to analyze the values of the wetlands.</td>
</tr>
</tbody>
</table>

Table 5.3: The environmental strategy of Laos (Thongkhammeng V, 2007).

<table>
<thead>
<tr>
<th>No</th>
<th>Activity</th>
<th>Time-Frame</th>
<th>Responsible Agencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Development of action plan on sustainable natural resource management</td>
<td>2004-2007</td>
<td>All sectors</td>
</tr>
<tr>
<td>2</td>
<td>Environmental management plan for urban, infrastructure, industrial and</td>
<td>2004-2008</td>
<td>MCTPC, MIH, MAF,MC,</td>
</tr>
<tr>
<td></td>
<td>handcraft, special economic and free trade zone, and tourist development</td>
<td></td>
<td>MIC, NTA</td>
</tr>
<tr>
<td></td>
<td>plan on cultural, natural and historical sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Development of action plan for institutional strengthening and capacity</td>
<td>2004-2008</td>
<td>STEA, DPCAS</td>
</tr>
<tr>
<td></td>
<td>building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Development of plan to promote private sector to participate in</td>
<td>2004-2008</td>
<td>All sector</td>
</tr>
<tr>
<td></td>
<td>environmental protection and sustainable use of natural resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Development of plan on investment promotion and establishment of</td>
<td>2004-2008</td>
<td>CPC and MFA</td>
</tr>
<tr>
<td></td>
<td>financial mechanism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Development of plan to implement international environmental conventions</td>
<td>2004-2008</td>
<td>STEA and MFA</td>
</tr>
<tr>
<td></td>
<td>and agreements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.4.3.2 Governance of That Luang Marshland

The governor (mayor) of Vientiane Capital has the main responsibility for all implemented projects in TLM (Thongkhammeng, 2007). The marshland is divided into the districts Saysetha, Sisathanak, and Hatsayfong. They are separated into 17 villages. In 2002 the estimated amount of households was 7,310 (Thongkhammeng, 2007). Vientiane has a master plan with a zoning system that is aimed to create a controlled development of the city. However, the plan has had a limited effect on the urban development. The governance of TLM is presented in figure 5.8.

The governor is responsible for the formal decisions but may discuss the issues with his three vice governors. When the governor has made a decision the responsible committee members (often people representing different departments) become responsible for the implementation. Some decisions could be of national interest. They have to be approved by the prime minister. The action plan that is produced by the New Town Development Project needs to be approved by the governor. However, it is only the prime minister that may approve the general polices and the plans that are connected to the project.

5.4.4 Wetland functions in the Mekong region

A large part of the low-lying and flat areas in the lower Mekong basin are wetlands. Their multifunctionality offers several services and plays a key-role for natural and artificial systems. Some of the functions are flood protection (water storage), wastewater treatment (mostly nutrient processing), and ground water recharge. Several products like food, water, medicines, construction material, and fuel woods could be extracted from wetlands. The productive ecosystems may be essential for local communities. However, if parts of the wetlands are destroyed, the local benefits will reduce. Wetland degradation in the Mekong region is
mostly linked to rapid socioeconomical development and limited environmental knowledge. Wetlands in this region have seriously been disturbed or destroyed which have resulted in less eco-functional productivity. The wetland efficiency is dependent of complex hydrological patterns (Lacoursiere, 1997). The biodiversity in the Mekong River Basin is strongly dependent on the annual flooding. Every year the soil in wetlands receives millions of tons of nutrient rich suspended and dissolved solids by flooding, which results in an amazing bloom of life. During the wet season lower life species like plankton, macro-vegetation and insect larvae grow quickly in population (Lacoursiere, 1997). They are an important source of food for fish, birds and other higher life. Since the animal life grows quickly during the wet season, it has an importance for the local socioeconomy. A growing population also demands increased food production. The wetland area has partly been reduced due to agricultural expansion and housing. Construction of irrigation canals and drainage systems is another reason to losses of wetland area. Upstream hydropower reservoirs that are used for electricity production may trap nutrients and decrease their downstream inflow to wetlands. The total area of Laos is 236,800 km$^2$ (Lacoursiere, 1997). Approximately 4 % of the area (945,000 hectare) is covered by wetlands. The wetland area consists of:

- 480 km$^2$ rice fields
- 254 km$^2$ rivers (mostly Mekong Region)
- 96 km$^2$ swamps or other wetlands
- 57 km$^2$ small reservoirs or ponds
- 10 km$^2$ fish ponds

(Thongkhammeng, 2007)

Compared to the rest of Asia, the Southeastern Asian countries have a very weak wetland protection (Wetlands in Asia). The strongest wetland protection is found in Bhutan, India, Pakistan, Nepal, and Sri Lanka, while the weakest is found in Cambodia, Laos, Myanmar, and Vietnam.

### 5.4.4.1 Fishery

According to WWF/ComFish, the Greater Mekong is estimated to be a livelihood for approximately 1,300 different fish species. The rich biodiversity has a strong socioeconomical impact on the locals living in this region. The annual catches of wild fish in the whole Mekong are valuated to USD 2 billion. This corresponds to 2 % of the global combined freshwater and marine catches of fish. The Lao GDP is by 6-8 % dependent of the fishing industry. An average Laotian consumes 40 kg fish per year. In southern Laos, 20 % of the household income is made on fisheries, and 80 % of the population in these areas are dependent of the fishing industry. This industry is reliant on a sustainable fishery. A collapse of the fishing industry would hit hardest on the Laos’ most vulnerable groups. According to a UNEP-report the increased pollution in the Greater Mekong, the degradation of wetlands, and the depletion of natural resources have been caused by an uncontrolled economical development and by population growth (Greenwood, 2008).

### 5.5 That Luang Marsh

That Luang Marsh is a freshwater marsh located at N $17^\circ$ 56', E $102^\circ$ 39' (Claridge, 1996). The marsh is found in the province Vientiane Municipality (Prefecture) east of Vientiane Capital. The topography is very flat where the height above the sea level is 160-170 meter (Claridge, 1996). The wetlands at the Vientiane Plain are the remaining of a past natural drainage system built up by the Mekong River and the Nam Ngum River (Claridge, 1996). According to Gerrard (2004), Vientiane is actually surrounded by 12 wetlands where TLM is the largest remaining urban wetland built up by the 500 km$^2$ Houay Mak Hiao basin. TLM
covers approximately 20 km², but due to heavy exploitation, the area might have become smaller today. The marshland is a mix of freshwater marsh, shrubland, peat shrubland and seasonally flooded grassland (Danida, 2000). The water level in the region is elevated up to five months a year. TLM is the largest urban wetland in Vientiane and collects water from the smaller wetlands that surround the capital. As the water ends up in TLM, this wetland works as a water buffer for the capital and the surrounding area. The wetlands in Vientiane are able to treat some of the polluted wastewater. Salakham wetland in the southern part of TLM is less affected by human activity compared to the rest of the marsh (IUCN). Half of the wetland area in TLM is used for rice cultivation. Some areas are used for cultivation of beans and cucumbers (Danida, 2000). Some important aquacultural activity are fishing and harvesting of aquatic plants. This is especially common during the wet season when the area becomes flooded. Estimations tell that approximately 15,000 people are involved in fish-related activities (Danida, 2000). The water from TLM is transported to Houay Mak Hiao north of the marsh. During the dry season the southern outflow Houay Deua River is opened. Figure 5.9 describes the geographical location of TLM and its connections to the drainage canals and Houay Mak Hiao River.

5.5.1 History of TLM

For centuries, local people lived in symbiosis with the surrounding wetlands at the place that today is called Vientiane. The capital has been developed in an area that until recently was densely vegetated and constructed on the Mekong River floodplain, which consists of silt and clay soil. According to Danida (2000), the centre of Vientiane is today lying at the remains of the great Nong Chan wetland. Drawings from the beginning of the twentieth century prove that the city was built so the flooding water was directly drained back to the Mekong River. Flooding is occurring during the wet season when the Mekong River is high and due to the low drainage capacity caused by a flat landscape and a low permeability of the soil. However, the flooding is not only a problem, but also a possibility to maintain a rich biodiversity. As nutrient rich water floods lowlands along rivers, a flourishing life at different levels in the food chain develops. Flooding has always been essential for local people because this provides several eco-services in the wetland. Rice, fishes, invertebrates, aquatic plants and numerous other products are every day extracted from the wetlands (Danida, 2000). A large
amount of biomass has been extracted from this region. In 1990 the annual local benefits from aquatic plant and fish production was USD 31,000 (Lacoursiere et al., 2003). While the harvest quantities of agricultural and aquacultural products have decreased, they still are the only source of income for many households in this region (Danida, 2000).

However, as the landscape was transformed by human hand, the living conditions for wildlife and locals were dramatically changed. As the population grew, the discharge of wastewater increased. There is no centralized wastewater treatment in Vientiane. The city relies on an ill maintained combined drainage/wastewater system (Danida, 2000). According to Jean O. Lacoursiere, the bad maintenance of the canals has resulted in a collapse of their functions several occasions (e.g. collapsed structures and clogging). The drainage system that today drains water from ditches and pipes through the main canals into the wetland area is slow due to the flat topography (Danida, 2000). If the water level in the Mekong is too high, the water in the drainage canals remain stagnant. More than 50 % of the villages in Vientiane suffer from flooding more than ten times per year (Thongkhammeng, 2007). The most intense rainfall that has occurred in the modern history of Vientiane was 50 mm per hour (Thongkhammeng, 2007). In 1992, JICA funded a master plan that would try to deal with the drainage situation in Vientiane (Thongkhammeng, 2007). Today the most important parts of the city are protected with constructed sand banks and sand bags to avoid flooding.

Households and commercials have usually water-flush toilets. In 1995, 93 % of the households used often ill maintained municipal holding tanks and/or soak pits, which do not follow the recommendations of design (Danida, 2000). This could almost be compared to direct discharge of effluent into the drainage canals. Open drains along the roads act as recipients for most of the discharged domestic wastewater. When the water level in the Mekong River is high, the ground and surface water becomes polluted due to the lack of well-functioning septic tanks (Thongkhammeng, 2007). The flooding causes sanitary problems in several parts of the city. Many of the septic tanks have an improper design and suffer from a lack of maintenance (Danida, 2000). During the wet season the septic tanks often become flooded. Wastewater and sludge are brought up to the surface and mix with stormwater and finally everything ends up in the drainage canals (Danida, 2000). The two largest drainage canals end up in That Luang Marsh. The uncontrolled discharge of wastewater has caused a degradation of the wetlands in Vientiane. The high levels of organic waste have seriously disrupted the physical, chemical, and ecological functions of the wetlands (Danida, 2000).

The marsh is increasingly used for housing and agricultural activities. This results in that TLM is shrinking. According to Thongkhammeng (2007), the city planning has usually been based on physical approaches rather than environmental. A secondary drainage system has been built out to the marsh, which reduces the flooding risk in the city. However, there are no continuous primary drainages and the existing roadside drainage is falling apart due to lacking maintenance.

5.5.2 Change of an integrated urban wetland system

According to Lacoursiere et al. (2003), the first drainage system consisted of a complicated network of earth canals. In 1986 a program for water quality monitoring was initiated that showed that most of the organic material and nutrients discharged were assimilated into the urban aquatic ecosystem. By this time, no wastewater treatment existed for the half of million inhabitants living in the area. However, during that time, the Nong Chanh wetland located in the centre of Vientiane had a very good water quality. The nitrogen, phosphorous, and COD concentration in the water were 2.5 mgL\(^{-1}\), 0.2 mgL\(^{-1}\), and 5.1 mgL\(^{-1}\) (Lacoursiere et al.,
Today, the wetland area has shrunk dramatically, which has decreased its multifunctionality considerably (Thongkhammeng, 2007). The largest remaining wetlands in Vientiane are TLM, Nong Tha, Nong Duang, Nong Chanh, and Nong Boen (Thongkhammeng, 2007).

According to Thongkhammeng (2007), the Government of Laos has borrowed large sums of money for developing a more effective drainage system that could protect the citizens from serious health problems. A secondary stormwater and sewage canal was built for emptying most of Vientiane’s drainage and wastewater into That Luang Marsh. In 2000, the earth-canals were covered with cement for increasing the drainage velocity. However, the cement canals were less effective on treating the wastewater and the result was that the wastewater problem was just transferred to the peri-urban areas (Thongkhammeng, 2007). According to Lacoursiere et al. (2003), a shunt was constructed through the middle of the wetland for increasing the water outflow from the urban area. The wastewater treatment capacity decreased and tests showed that the day when the new drainage system was completed, the ammonia:nitrate ratio increased 400-fold (Lacoursiere et al., 2003). This is often used as an indicator for measuring the loss of filtration capacity in a wetland. The higher water pollution reduced the presence of oxygen, which favoured the invasion of golden apple snail in 1992 (Lacoursiere et al., 2003). The pest increased the negative impact on wetlands and rice fields. The change in ammonia:nitrate ratio is presented in figure 5.10.

**Scientific study**

In 1999 Swedish and Laotian scientists started a collaboration for investigating the ecological and sanitarian problems (Lacoursiere et al., 2003). The project was created for understanding the reason to the environmental problem and for minimizing the environmental impact in the low-affected Salakhaum wetland. The 12 km² large area in the southern part of That Luang Marsh still provides important wetland goods for locals. The project was aimed to provide expertise for the VUDAA and the LMNC authorities with risk assessments and management tools (Lacoursiere et al., 2003). The investigations were based on adaptive environmental assessment and management approaches, and modelling for predicting the water properties. The project was coordinated by Kristianstad University, Sweden, Asian Institute of Technology (AIT), Thailand and Sheffield University, United Kingdom. The project created an understanding about the limits of the new aquatic network (Lacoursiere et al., 2003). The project has also promoted an interest among authorities concerning environmental issues and highlighted the importance of proper management and design of the system. A conclusion was that plants in non-rectified (preserved) areas are more efficient on wastewater treatment than in rectified areas (Lacoursiere et al., 2003). Conventional treatment options are always the most efficient choice. The water quality could become improved if better management of vegetation and

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*Figure 5.10: The diagram shows an increase of the ammonia:nitrate ratio shortly after the development of the new aquatic network (Lacoursiere J et al. 2003).*
sediment is practiced, oxygenation of the water body is done, and too low water levels are avoided (could be solved with water injection) (Lacoursiere et al., 2003).

### 5.5.3 Valuating wetlands

The interest of mimicking natural wastewater treatment processes has been growing in popularity in developed countries. “Flood buffering, groundwater recharge, sediment transportation control, water quality enhancement, habitat support for biodiversity and urban aesthetics are all considered integral parts of a well balanced design for urban waters” (Lacoursiere et al., 2003). It is of high concern that the functions of the urban watersheds are well preserved and locals do not suffer from decreased life and health quality when they try to reach a sustainable development. Mistakes could be expensive to repair. While developed countries invest large amounts of capital into reconstruction of wetlands, developing countries seem to be more interested in conventional technologies (Lacoursiere et al., 2003). Several developing countries agree that conserving wetlands in urbanized areas is a waste of land and reduces the benefits. The authorities in these areas have difficulties to understand that the present natural aquatic systems like ponds, wetlands and earth canals supplies the town with several services like flood control and wastewater treatment. The lacking insight could be explained by the shortage of national scientists that are experts on wetland related issues. The presence of experts is important for advising key-stakeholders and authorities in their decision-making processes (Lacoursiere et al., 2003).

Several developing countries have founded cities in aquatic systems that seasonally become

<table>
<thead>
<tr>
<th>Table 5.4: Annual direct use values from agriculture and aquaculture in That Luang Marsh (Based on Gerrard P. 2004).</th>
<th>Total Area (ha)</th>
<th>Yield (kg/ha)</th>
<th>Total Produced (kg)</th>
<th>Average Price (kip/kg)</th>
<th>Total Value (kip)</th>
<th>Total Value (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agriculture</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Season Rice</td>
<td>504</td>
<td>4 500</td>
<td>1 815 120</td>
<td>1 200</td>
<td>2 178 144 000</td>
<td>209 436</td>
</tr>
<tr>
<td>Wet Season Rice</td>
<td>270</td>
<td>3 600</td>
<td>1 215 450</td>
<td>1 200</td>
<td>1 458 540 000</td>
<td>140 244</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>774</strong></td>
<td><strong>3 030 570</strong></td>
<td><strong>3 636 684 000</strong></td>
<td><strong>349 680</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vegetables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumber</td>
<td>37</td>
<td>460 491</td>
<td>1 150</td>
<td>529 564 650</td>
<td>50 920</td>
<td></td>
</tr>
<tr>
<td>Long Bean</td>
<td>1.8</td>
<td>4 153</td>
<td>1 300</td>
<td>5 398 900</td>
<td>519</td>
<td></td>
</tr>
<tr>
<td>Cabbage</td>
<td>4.2</td>
<td>9 450</td>
<td>1 300</td>
<td>12 285 000</td>
<td>1 181</td>
<td></td>
</tr>
<tr>
<td>Tomatoes</td>
<td>0.6</td>
<td>528</td>
<td>6 600</td>
<td>3 484 800</td>
<td>335</td>
<td></td>
</tr>
<tr>
<td>Mixed Vegetables</td>
<td>3.7</td>
<td>11 336</td>
<td>1 892</td>
<td>21 447 712</td>
<td>2 062</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47</strong></td>
<td><strong>485 957</strong></td>
<td></td>
<td><strong>572 181 062</strong></td>
<td><strong>55 017</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Aquaculture</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial Aquaculture (carp and tilapia)</td>
<td>5.3</td>
<td>5 625</td>
<td>29 926</td>
<td>12 000</td>
<td>359 112 000</td>
<td>34 530</td>
</tr>
<tr>
<td>Family Run Aquaculture</td>
<td>14</td>
<td>4 896</td>
<td>67 417</td>
<td>10 400</td>
<td>701 136 800</td>
<td>67 417</td>
</tr>
<tr>
<td>Natural Ponds</td>
<td>24.7</td>
<td>3 745</td>
<td>92 389</td>
<td>12 636</td>
<td>1 167 427 404</td>
<td>112 252</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>38</strong></td>
<td><strong>189 732</strong></td>
<td></td>
<td><strong>2 227 676 204</strong></td>
<td><strong>214 199</strong></td>
<td></td>
</tr>
</tbody>
</table>

(I USD = 10400 kip)
flooded. From the beginning, this was the reason why people settled down because the environment offered several eco-services. However, as the area becomes more urbanized, flooding turns out to be inconvenient. A way of increasing the drainage is to expand and concretize earth or artificial canals. In developing countries, these kinds of systems are often also used for collecting and transporting wastewater. However, the drainage issue is usually more prioritized for avoiding acute flooding of the cities. The furiousness results in poor sanitation and ecological damages. Wetland degradation could often be linked to poor knowledge and an underestimation of the real wetland values. Few studies have been made on how socioeconomy is affected by wetland services and there is lack of developed economical assessment tools that convert eco-services into financial terms. Economical data could be useful for deciding how wetland systems should be managed for reaching sustainability. That Luang Marsh, comprised in the mid-1990s 1,500 km² seasonal and permanent water bodies, marshes, swamps, and floodplains (Gerrard, 2004). The wetland treats industrial and domestic wastewater simultaneously as the marsh serves as water supply and flood protection. To this, TLM offers a wide range of agricultural, aquacultural products. In July 2003, a collaboration study concerning That Luang Marsh was made between WWF, IUCN, LNMC, and STEO of Vientiane Municipality called “Integrating Wetland Ecosystem Values into Urban Planning” (Gerrard, 2004). The purpose was to show the importance of integrating wetland values into the decision-making of the urban planning for promoting a sustainable management.

Economical valuation of wetland services

It could be difficult to put monetary units on all wetland services. However, some values could be expressed, which may motivate why wetlands should be preserved. One way of valuating wetland services is to divide them into the categories: Direct Use Values (DUV), Indirect Use Values (IUV), Option Values (OV), and Non Use Values (NUV). The following data and information in the rest of sub-chapter 5.5.3 is based on a report written by Gerrard (2004).

Direct Use Values

DUVs are the resources and services that may be directly connected to the benefits made from wetlands. In TLM, DUVs may be paddy rice and vegetable production, fishery, and collection of non-fish aquatic goods like frogs, snails, and plants. 71 % of the people that live around the marsh receive their primary income from harvesting or selling agricultural products. Rural and semi-rural villagers tend to be producers, while urban villagers sell the products on the market. About 7 % of the population in the area is unemployed and collects wetland food like fish or morning glory. These people often collect the wetland products for own consumption. Probably the misery among the poor would have been greater if the wetlands were unproductive. About 23 % of the population in TLM relies on rice production as primary income. However, only 9 % own fields. Many landowners rent rice fields to other farmers, which spreads the benefits from the rice production among a large group of people like farmers, landowners, and sellers. Due to changed hydrological patterns, reduced water storage capacity, and urbanization, the total rice cultivation area in TLM has decreased. Products from fisheries supply poor and unemployed people in TLM with protein and extra income. The fisheries in That Luang Marsh gave in 2004 an annual household income of USD 466 (480 kg fish). The aquacultural activities are divided into: Commercial aquaculture, household ponds, and household natural ponds. Some ponds are used for breeding and could be used by anyone if they pay an admission.
In 2002, TLM had approximately 14 hectare family run ponds and 25 hectare natural ponds. 65% of the ponds were owned and controlled by rich households while 35% were rent by others. Capture fisheries were more important for households with lower income because everyone may collect these fishes. 82% of the animal products were fish and the rest were frogs, shrimps, invertebrates, and water beetles. Capture fisheries are more common in rural and semi-rural villages. 3,102 households control 90% of the fishing activity. Non-fishery wetland products were aquatic and terrestrial vegetation and terrestrial animals like birds, reptiles, mammals, and insects. However, the absolutely most important non-fisheries wetland product was morning glory (*Ipomea aquatica*), which was collected by 97% of the households. Morning glory is a delicious and popular aquatic plant that could be found at most markets in Vientiane. Children often collect grasshoppers. Poor households collect and eat birds, mammals, and reptiles for own consumption. Table 5.4-5.5 presents some direct values from agriculture, aquaculture, fisheries, and non-fisheries.

**Indirect Use Values**

IUVs often have an indirect effect on a city’s economy. Wastewater treatment and flood protection are two important IUVs. Normally, parts of the city become flooded six times per year. This causes damage to roads and buildings and disturbs the transportation. The wet season is more critical due to the city’s low drainage capacity. The marsh works as a water storage and reduces the flooding effect in the city. Irrigation is also included to the IUVs because this has improved the agriculture around TLM. The city does also rely on the TLM’s

<table>
<thead>
<tr>
<th>Aquatic Vegetation</th>
<th>Value Per Household</th>
<th>Value for the Entire Marsh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial Animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grasshoppers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birds/Mammals/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reptiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terrestrial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price (kip/kg)</th>
<th>Average Collection (kg/year)</th>
<th>Annual Value (kip)</th>
<th>Annual Value ($US)</th>
<th>Number of HH that Collect</th>
<th>Total Collection (Kg/year)</th>
<th>Total Value (kip/year)</th>
<th>Total Value ($US/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic Vegetation</td>
<td>3,000</td>
<td>300</td>
<td>900000</td>
<td>87</td>
<td>3040</td>
<td>912,132</td>
<td>2,736,363,180</td>
</tr>
<tr>
<td>Terrestrial Animals</td>
<td>1,250</td>
<td>32</td>
<td>40000</td>
<td>4</td>
<td>1458</td>
<td>46,661</td>
<td>262,470,654</td>
</tr>
<tr>
<td>Grasshoppers</td>
<td>20,000</td>
<td>9</td>
<td>180000</td>
<td>27</td>
<td>1458</td>
<td>13,124</td>
<td>262,470,654</td>
</tr>
<tr>
<td>Birds/Mammals/Reptiles</td>
<td>50</td>
<td>3,000</td>
<td>150000</td>
<td>15</td>
<td>434</td>
<td>1,303,046</td>
<td>65,152,290</td>
</tr>
<tr>
<td>Total</td>
<td>1,270,000</td>
<td>123</td>
<td>3,866,012,789</td>
<td>354,106</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 5.5: Direct use values from (a) non-fisheries and (b) capture fisheries for households and whole TLM (Based on Gerrard P, 2004).**

<table>
<thead>
<tr>
<th>Price (kip/kg)</th>
<th>Average Collection (kg/year)</th>
<th>Annual Value (1,000 kip/year)</th>
<th>Annual Value ($US)</th>
<th>Total Collection (Kg/year)</th>
<th>Total Value (1000,000 kip/year)</th>
<th>Total Value ($US/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>10000</td>
<td>300</td>
<td>480</td>
<td>3,000</td>
<td>4,800</td>
<td>391</td>
</tr>
<tr>
<td>Snails</td>
<td>1500</td>
<td>175</td>
<td>262</td>
<td>25</td>
<td>488</td>
<td>642</td>
</tr>
<tr>
<td>Frogs</td>
<td>12000</td>
<td>17</td>
<td>208</td>
<td>20</td>
<td>48</td>
<td>402</td>
</tr>
<tr>
<td>Inverts</td>
<td>9000</td>
<td>62</td>
<td>558</td>
<td>54</td>
<td>173</td>
<td>1,119</td>
</tr>
<tr>
<td>Total</td>
<td>554</td>
<td>734</td>
<td>4,026</td>
<td>5,828</td>
<td>391</td>
<td>565</td>
</tr>
</tbody>
</table>
water purification capacity, which is today much cheaper to use than constructing a conventional wastewater treatment plant. However, some of Vientiane’s polluted water enters directly to Houay Mak Hiao through the Hong Xeng canal. Today, the city relies completely on that the marsh’s wastewater treatment capacity is not reduced. Figure 5.11 illustrates the drainage zones in the capital area, and figure 5.12 how water is drained out to the Mekong River through TLM and Houay Mak Hiao.

Changing the current wastewater treatment system into a conventional solution will require:

- A more advanced sewage system than today’s open wastewater/drainage canals.
- A continuous increase in the capacity of the conventional wastewater treatment plants as the city grows.

Figure 5.11: Drainage zones in the most developed parts of Vientiane. Wastewater and stormwater from the areas C and D ends up in the Hong Xeng Canal while water from the areas A, B, E, and F are collected in the Hong Ke Canal (Gerrard P, 2004 (modified)).
IUV Example
According to ADB (Gerrard, 2004) there are 1,256 households that discharge sewage water directly into the surface water. 501 households do not use toilets at all. The waste is transported through Hong Ke out to That Luang Marsh.

The stormwater and wastewater collected from the villages in the areas C and D (figure 5.11) is dumped to Hong Xeng and later on transported to Houay Mak Hao. Hong Ke collects water from the areas A, B, E, and F and the water mass is transported to the north end of TLM. Hong Ke receives most of the sewage water and is connected to the urban wetland Nong Chan in the centre of the city. The topography in the densely populated areas A and B is flat and the soil has a low permeability. These areas often have non-working cesspool pits, which often become flooded and causes sanitation problems. ADB calculates that there are 2,952 cesspools that need to be upgraded in area A and B. However, due to the current conditions the cesspools will not become fully efficient. The best investment in this area has been cheap septic tanks (USD 100 each). These systems offer a dual chamber tank for settlement and anaerobic decomposition. Improving these into an acceptable standard would cost USD 401,769 (4,018 households). The septic waste is today transported to a small waste treatment plant, 18 km from the city because the treatment plant located at TLM is not running. The cost of upgrading the plant outside the city is estimated to USD 1,000,000. The total cost of the improvements is USD 1,401,769 and could be paid off for a period of 25 years. The current wetland wastewater treatment system at TLM saves the city USD 70,088 annually. Transporting septic waste 18 km by truck would become quite expensive. It would probably be cheaper to convert the non-working treatment plant in TLM into a CW.

Option Values and Non Use Values
OVs are services or goods that may become benefits in the future. For the case of TLM some possible future incomes could come from tourism and leisure activities. OVs are difficult to predict because they often focus on possible future incomes. Examples of NUVs are cultural and aesthetic values. However, these are difficult to valuate in monetary units.

Total Economic Value
The TEVs summarizes the values as:

\[
TEV = DUV + IUV + OV + NUV
\]

(Gerrard, 2004)

Since OVs and NUVs are very hard to predict, this report will not try to use these for economical valuation. According to these, probably underestimated calculations, the wetland would be worth USD 5 million annually. To this possible OVs and NUVs need to be included. Implementing sustainability into wetland use is important for reducing poverty because 40 % of the benefits go directly to the local people. For this case the locals, that often have a weak education and low household income, are a vulnerable group of people that would suffer much if the wetlands were destroyed. They may have problems to adapt to a rapidly changing environment. The TEV is presented in table 5.6. It is important to remember that the living around the marsh is cheaper

### Table 5.6: Total economical value of TLM
(Based on Gerrard P, 2004).

<table>
<thead>
<tr>
<th>Wetland Resources - Direct Use Values</th>
<th>($US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice Cultivation</td>
<td>349,681</td>
</tr>
<tr>
<td>Garden Cultivation</td>
<td>55,017</td>
</tr>
<tr>
<td>Aquaculture Production</td>
<td>179,671</td>
</tr>
<tr>
<td>Capture Fisheries</td>
<td>1,092,065</td>
</tr>
<tr>
<td>Non-Fish Wetland Products</td>
<td>354,106</td>
</tr>
<tr>
<td>Sub-Total</td>
<td>2,030,570</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wetland Services - Indirect Use Values</th>
<th>($US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood protection</td>
<td>2,842,000</td>
</tr>
<tr>
<td>Wastewater Purification</td>
<td>70,088</td>
</tr>
<tr>
<td>Sub-Total</td>
<td>2,972,088</td>
</tr>
</tbody>
</table>

| Total                                 | 4,901,570|
than in most Western countries. Another reason to the low TEV value could be explained by the inflation of the Lao economy.

5.5.4 Flooding in Vientiane

Today, the annual flooding in Vientiane is better controlled than before. However, some parts of the city and the surrounding villages are still affected during the wet season, which have an adverse impact on the socioeconomic. Flooding causes several deaths every year and damages rice crops, roads, and households. When the drainage/wastewater canals are flooded, the sanitary situation is worsened. Sandbags are frequently used for protecting the most vulnerable parts of the city. When the river rises above 12.5 meter in Vientiane, MRC declares that the annual flooding has started (World Bank, 2008). Except from Vientiane Municipality, the other Mekong River provinces Vientiane Province, Savannakhet, Champasak, Khammouane, Luang Prabang, and Bolikhomxay are annually affected by the flooding (World Bank, 2008).

The wet season in Vientiane starts in the middle of June and ends in the middle of November. In 2008, the water level in the Mekong River was extraordinary high due to heavy rain (MRC, 2008). The flooding in the regions that surround the river was extreme and caused much suffering this year. However, thanks to one million protective sandbags, damages on
Vientiane’s infrastructure were limited (MRC, 2008). It is difficult to tell if the extreme flooding was caused by human activity. However, the climate change seems to increase the water flow in the river as a consequence of increased glacial melting in Himalaya (MRC, 2008). 15 August 2008 the Vientiane citizens experienced the highest water level in the Mekong (13.7 meter) since 1913 (Glendinning, 2008). The photo (figure 5.13) was taken during the flooding 2008.

5.6 Ongoing projects in That Luang Marshland

There are several ongoing projects in Vientiane and That Luang Marsh that will have an impact on the capital’s drainage and sanitation situation, the population growth, and the natural functions of the wetland. This chapter will give a briefing about the WATER Project and the New Town Development Project.

5.6.1 The WATER Project

Due to an increasing population and growing sanitary problems there is a great need of finding new wastewater treatment solutions. Many previous projects have caused adverse ecological impacts, which probably are a result of bad planning and a lack of knowledge on how the ecosystem works. The purpose of the WATER Project is to create a guidance how That Luang Marsh’s eco-functions could provide optimal benefits for wildlife and people. However, this is not only done from an environmental perspective but also socioeconomical. The WATER Project wants to introduce constructed wetlands as an alternative to conventional wastewater treatment plants for treating domestic, industrial and agricultural wastewater. Domestic wastewater is mostly discharged by households, restaurants, offices, and hotels. The project wants to promote a sustainable development for That Luang Marsh and surrounding areas. Some of the goals are:

- Better environmental standards for urban planning.
- Better use of wetland functions for efficient domestic and industrial wastewater treatment by using best practice guidance and finding innovative solutions.
- Contribution to poverty reduction and maintain stakeholder’s livelihoods by good management of wetland resources.

(Project concept of WATER)

5.6.1.1 Key stakeholders and key implementing agencies

There are several key stakeholders including some governmental key implementing agencies that will be involved. These will try to find the optimal sustainable management of the marsh. Conflicts will mostly be solved internally. The key implementing agencies are:

- VUDAA
- STEO
- The Department of Public Works and Transportation
- The Department of Agriculture and Forestry
- The Department of Industry
- The Department of Land Planning
- Hatsaifong, Sisattana, and Saisettha District
- DCTPC District Offices

VUDAA is responsible for the urban planning, the Department of Public Works and Transportation will develop the wastewater management systems, and STEO are responsible for the EIA, monitoring, and planning. Other key stakeholders during this project are:

- DCTPC District Offices
During the project the institutional capacity will be increased. The wastewater treatment in the urban area will become improved and the wetland management will become strengthened. The sanitation situation will be better in areas where elevated pollution today affects 100,000 people, and 40,000 residents that work with agriculture and aquaculture will get an improved livelihood (Gerrard, 2006). Figure 5.14 describes the organization of the WATER Project. The purpose of the project is to:

- Educate staff that will work with the urban planning, wetland treatment system design (including operation and maintenance), and project staff that will work with monitoring techniques and wetland assessments.
- Create guidelines for a participatory approach to wetland and urban planning for That Luang Marsh.
- Create an adaptive management plan for the resources and services that are extracted in That Luang Marsh and a zonal urban plan for the surrounding area.
- Design a CW and create pilot studies.
- Create guidelines for treatment of industrial and domestic wastewater.
- Analyze how wetland functions are used today.
- Create an aftercare management plan, a plan for CW management and sustainable financing, and operational guidelines.

(Gerrard, 2006)

The project is economically supported by the European Union through the EU Asia Pro Eco Fund, with the purpose to improve the wetland management and maintain the multifunctionality of That Luang Marsh (Gerrard, 2006). The project is a collaboration between the government of Lao PDR, WWF Laos, WWF Germany, Wild Fowl and Wetland Trust. The project is a part of the Wetland Alliance Programme (Gerrard, 2006). Other partners that support the program are CORIN, AIT, WFC, CIDA, and Sida. An initial workshop was held for identifying local needs and for creating an integrated understanding between stakeholders how sustainability could be reached. During the meeting the Vice Governor of Vientiane Capital was chairman. Represents from VUDAA (Gerrard, 2006), the Provincial Communication, Transportation, Post and Construction Office, Provincial...
Agriculture and Forestry Office, the Division of Livestock and Fisheries, VCP, and STEO joined the workshop (Gerrard, 2006).

5.6.1.2 Why That Luang Marsh is important for wastewater treatment

That Luang Marsh is a key issue for natural wastewater treatment in Vientiane. However, the treatment process may be insufficient and the wetland can lose the self-cleaning ability in the future. The Mekong receives pollution from several communities and cities along the river, which causes ecological damages on the waterbody. 30,000 people collect wastewater in a wastewater system while 270,000 people discharge their wastewater directly to the marsh without treatment (Project concept of WATER). Since the capacity of the marsh is decreasing due to several factors, this is not sustainable for Vientiane or the Mekong River.

5.6.1.3 Description of the project

The WATER Project needs support from the Lao Government because it decides how the sanitary system will be designed. Samples of the water chemistry, flows and depths of the marsh are made on a monthly basis. The main issue is to find a way of controlling the purification process. When the CWs are created some area of That Luang Marsh needs to be reserved. Two main canals transport wastewater into That Luang Marsh with a total catchment area of 280 km$^2$. The northern canal Hong Xeng, discharges the polluted water mass into the northern part of TLM close to Houay Mak Hiao, while Hong Ke discharges the water into the middle of the marsh. As water from the lakes Nong Tha and Nong Ping flows into Hong Xeng, the water mass in this canal becomes larger and less polluted than the water in Hong Ke. In 2020, That Luang Marsh is estimated to receive wastewater from 248,100 people. The hydraulic loading will become 52,100 m$^3$/day and the BOD loading 7,810 kg/BOD/day. 700 industries are estimated to discharge 3,500 m$^3$/day. The industrial pollutants that are monitored during this project are BOD, TSS, NO$_3$, NH$_3$, Al, Cu, Fe, PO$_4$, CaCO$_3$, and Pb. Equation 5.1 shows that the needed CW-area for treating the water mass in the two canals is 61 hectare. The Government does approve that 22 hectares land could be used for constructing a CW (Pauline Gerrard). This may be located just outside the New Town Development Project area and is enough for treating the water mass in Hong Ke (Pauline Gerrard). Since Hong Xeng has a larger water mass, it will require a larger CW-area. The possibility of combining the New Town Development Project with the WATER Project has been discussed.

5.6.1.4 A centralized or de-centralized wastewater treatment system?

A centralized system collects all wastewater into one treatment facility. The system may consist of wetlands or conventional plants. The benefit from a centralized system is that the management and maintenance is easier to control (W.A.T.E.R. Project Team). However, a centralized system may become expensive and result in polluted urban canals. The sanitary situation may affect the health of citizens and reduce the aesthetics of the town. De-centralized systems use many small wastewater treatment facilities. The canals may be cleaner and people are easier motivated to reduce their own environmental impact. However, it could be difficult to construct small facilities inside the city because free space is limited in

\[
A = \frac{Q(\ln C_1 - \ln C_2)}{k_{BOD}}
\]

\(A=\text{Area (m}^2\))
\(Q=\text{Discharge (m}^3/\text{day})\)
\(C_1=\text{Daily average BOD of influent (mg/L)}\)
\(C_2=\text{Required daily average BOD of effluent (mg/L)}\)
\(k_{BOD}=\text{Rate Constant (m/day)}\)

Equation 5.1: Formula for calculating required CW-area.
developing areas (W.A.T.E.R. Project Team). It may also be difficult to make the treatment efficient as for focused centralized systems due to organizational and management problems. The WATER Project recommends a combined centralized and de-centralized treatment system. De-centralized facilities is best suitable for treating target pollutants before they enter the canals, while the centralized plants treat the wastewater that flows in the main canals. This combination may improve the sanitarian situation and simultaneously reduce the environmental impact.

5.6.1.5 Pilot study
The focus is to first plan the pilot sites for proving the possibilities of using CWs as an alternative to conventional treatment. According to Pauline Gerrard, the primary objective is not to purify the wastewater completely during the pilot study but to demonstrate the efficiency of the cheaper CWs. The pilot study will evaluate the cleaning capacity and maintenance needs. When an industry is involved, this will share the investment cost with the WATER Project when implementing the CW into their activity. There will be five pilot CWs constructed. Three will be built only for domestic use and two for industrial. The industries will supply the project with required land for constructing the CWs. The planned pilot sites are:

1) A school, three houses, and some toilets in Non Khor Village. (Domestic)
2) A small household industry in Non Khor Village that discharges blood and animal rest contaminated water. (Domestic)
3) A group of households in Vieng Chalairn Village (Domestic)
4) Beer Lao (Industrial)
5) The Mechanical Metallurgical and GAS Industry Co. LTD and Asian Paper Mill Factory Co. LTD. (Industrial)

WWF has tried to start up a dialogue and integrate Asian Paper Mill and the GAS Industry to the WATER-Project. These companies share a canal that is contaminated by their wastewater. Beer Lao has a good wastewater treatment facility but it could be improved if drainage water from roads and buildings is collected. This factory has today one of the better industrial wastewater treatment systems in Vientiane and would be an interesting partner for the WATER Project. In exchange Beer Lao would improve their reputation as an environmentally caring industry. Not far away from Beer Lao, a mobile phone company often discharges black wastewater into an irrigation canal. Tests have been taken on this water but the industry will not be a part of the pilot study. The first pilot study that will be finished is the school project in Non Khor Village. The next two projects will be in Vieng Chalairn Village and the “blood house” in Non Khor Village. There are two project proposals for the pilot study presented below.

Mechanical Metallurgical and GAS Industry Co. LTD and Asian Paper Mill Factory Co. LTD
This pilot site will treat the wastewater from both companies (Pauline Gerrard). The CW will be built on the gas factory area according to figure 5.15. There will first be several settling basins that remove large particles. This is necessary for avoiding blockage in the CW. The first basin needs to be at least 0.3 m deep. The overflowing water continues to the next basin while the particles sink to the bottom. Machinery could be installed for cleaning the basins. A 20 cm high shelter could be built for protecting the area from stormwater. The wastewater discharged from the paper mill will be lead into the three CWs outside the gas factory. If a
settlement pond (1077 m²) and a subsurface flow treatment wetland (3609 m²) are installed, the BOD content in the wastewater could be lowered from 311 to 20 mg BOD/l (Pauline Gerrard). The stormwater from the factory area could also be treated in this facility.

Vieng Chalairn Village
This pilot study is created for a 40 people (10 households) community (Pauline Gerrard). There are two ideas how the facilities could be designed. One option is that the system consists of a fish pond (16 m²), a subsurface flow wetland (85 m²), and a surface flow wetland (10 m²). The second alternative uses a solid and liquid separation where the solids are first removed. The liquid phase flows later through a subsurface wetland (96 m²) and a surface flow wetland (15 m²). The solids that are removed in the first step may be composted.

Beer Lao
The Beer Lao factory has a quite good wastewater treatment (Pauline Gerrard). However, stormwater that contains oil, washing water and waste could be treated in a 2600 m² CW before discharge to TLM. The current wastewater treatment system could also be improved with a 900 m² sub-surface flow wetland that lowers the BOD content from 30 to 20 mg BOD/l.
The first pilot study was constructed behind a school in Non Khor Village during the period Marsh-April 2009 (Pauline Gerrard). The Bounchan Company has been consulted for this project. A septic tank was built for pre-treating the wastewater. Since the CW is built on a schoolyard for smaller kids, the architect has chosen to design the wetland like an animal. The wetland is divided into four units (green formations at the map). Each of them has an area of

Figure 5.16: Pilot study at the school in Non Khor Village. The wastewater enters the primary treatment beds (Unit A) and is treated in three more steps (Unit B-D) before it ends up in the children’s splash play area (WWF Greater Mekong).
approximately 20-40 m². The wetland is a hSSF-system. Unit A (primary treatment) purifies the most polluted water. The next three ponds are used for polishing the water. The blue marked area in the CW is a splash area for the school children. The CW will be evaluated when the facility has been running for a while. WWT Consulting has produced the drawing that is presented in figure 5.16.

5.6.1.6 Situation for the industries before the pilot study

The wastewater treatment at Beer Lao is today sufficient compared other industries around TLM (Pauline Gerrard). However, the WATER Project is still interested to cooperate with Beer Lao for exchanging experience how the wastewater quality could be improved. Beer Lao’s wastewater treatment is good, but the quality of the stormwater from roads and buildings inside the industrial area could be improved. It is easy to discover the pollution from Asian Paper Mill. The water stream outside the factory area often becomes pink or white tarnished. This is connected to which process is running for the moment in the paper mill. The gas company produces acetylene (C₂H₂) and discharges their wastewater into settlement tanks and to a settlement field. The discharged solids become stable at the field during the dry season when the sediment dries (Pauline Gerrard). However, when the wet season begins, the sediment is flushed out directly into the marsh. Acetylene is produced from calcium carbide (CaC₂). This compound is produced in an electric furnace when heating a mixture of carbonaceous compounds and limestone. The raw material could be coal, charcoal or coke. During the heating process the mixture is converted into calcium carbide and carbon monoxide. The carbonaceous material and the limestone consist of different impurities. The calcium carbide that is used for the acetylene production has usually 2-5 % weight impurities like metals and metal alloys (Pauline Gerrard). These consist usually of silicon, iron, aluminium, or magnesium. The by-product becomes a lime slurry that mainly consists of calcium hydroxide, water and other impurities from previous steps (Pauline Gerrard). Due to high alkalinity (pH 12.5), calcium hydroxide may affect the environment. Laboratory tests have proved that bacterial protein structures and cell membranes may be affected (Gomes et al., 2002). A common way of producing acetylene is by mixing calcium carbide with water. During this reaction, water acts as an acid and calcium hydroxide is produced as by-product. Acetylene is a highly flammable gas that needs to be handled carefully.

\[
\text{CaC}_2(s) + 2 \text{H}_2\text{O}(l) \rightarrow \text{Ca}^{2+}(aq) + 2 \text{OH}^-(aq) + \text{C}_2\text{H}_2(g)
\]  
(Jones et al., 2003)

Formula 5.1: Production of acetylene

5.6.2 The New Town Project

According to the Master Plan, large parts of That Luang Marsh are inside the conservation area (Saythaví Envangnavong). However, the authorities have agreed to make an exception for the New Town Development Project. The project is a collaboration between the Chinese and Lao Government. The aim of the project is to improve Vientiane into a modern city. The Chinese Shouzhou City in Jiangsu Province, acts as a model for this project. Other names for this project are the Industrial Park Construction of Vientiane Capital or the Sino-Laos Vientiane Comprehensive Development Program Planning and Design. Subchapter 5.6.2 is based on interviews with Saythaví Envangnavong made during the period October 2008 – January 2009.

5.6.2.1 Decision-making process for the New Town Development Project

The mayor of Vientiane Capital is the highest responsible person during this project. The mayor is in direct contact with the chairman of the project committee. The committee members, representatives from different departments and ministries, act as advisors to the
mayor. The committee members are listed in table A9.1. Several departments are found under the project committee that will be a part of the decision-making process. Lowest in the hierarchy, involved companies, investors and NGOs are found. They will never be involved in the formal decision-making process, but may, however, contribute with valuable knowledge.

5.6.2.2 The New Town Development Project
A rapid globalization and economical growth put pressure on the less developed countries. Fast growing neighbouring countries like China, Thailand, and Vietnam encourage Laos to improve its socioeconomic situation. Today, the focus is to improve the slumbering capital Vientiane. It suffers from poverty and incomplete urban functions like traffic infrastructure, public services, and city planning. The land ownership in Laos is complex, which creates several problems during the city development because the locals have overtaken governmental land. If the socioeconomic situation in the capital is improved, the country could probably be more attractive for investors. Since Vientiane plays a key role for the socioeconomic development in Laos, improvements of the capital are necessary. The New Town Development Project will have a dramatic impact on the city.

5.6.2.3 History of the New Town Development Project
In the past, the Lao and Chinese governments decided to construct a new stadium for the Southeastern Asian Games 2009. The Lao government was also interested in assessing low-valued land into economic capital. Due to difficulties to see direct benefits from wetlands, this biotope has not been treated as valuable. The government has also difficulties to control the wetlands because private persons capture land and fill it up for own constructions. The constructed areas are later sold on the black market. Due to these robberies the government has had problems in managing the land and the weak legal system and organization has allowed these kinds of problems. One way that might reduce the illegal settlements is to create projects that keep the dishonest investors away. However, there has also been resistance among the citizens against planned projects in the area. Authorities wish that the locals would understand the positive effects that might follow from the New Town Development Project. Information campaigns have been launched in national media, seminars, and workshops. The estimated cost of the project is USD 800-1000 million.

5.6.2.4 Finding a partner for the New Town Development Project
Before the Lao-Sino agreement, the Lao government tried to find someone that surely could be able to support a development of Vientiane. There were discussions with Thai, Vietnamese, and Chinese authorities. Thailand is an economically powerful nation that might be able to support these kinds of projects. However, the differences in politics may complicate the collaboration. Vietnam and Laos have had a friendly relationship during a long time. However, the Vietnamese might stumble with the financing of the project. The relation with China has become warmer in recent years and the Chinese economy has grown very strong. The Lao government chose to accept the Chinese proposal to support the New Town Development Project. Many stakeholders fear that the Chinese will get too much influence in Laos as a result of the project. However, the Lao authorities think that the fears are overestimated because the Laotians will keep total control of the decision making process. Foreigners are bound to follow the Lao and international law when business is made in Laos.

5.6.2.5 The Lao-Sino agreement
The Lao-Sino agreement ends with that China sponsors the new stadium worth USD 100 million. In exchange, the Chinese government leases 1000 hectare land in Vientiane. The land
will be given to a Chinese investor for development. The investor will then be able to do business during a 50 year period and is free to sell the land to domestic and foreign companies. When 50 years have passed, the Lao government has the right to reclaim all land without compensation, regardless who is leasing the land. However, if the project is successful the Lao government may extend the project period with 25 years at a time. The developers are completely bound to follow the Lao legislation. If the law is seriously violated, the Lao government may reclaim all land before the project period is over. According to the agreement, the land value is USD 1/m². Because the Chinese government supports the construction of the new stadium with USD 100 million, the Chinese investor will be given 1000 hectare of land (100 million m²) for development. There have been uncertainties since the contract was signed. The investors insist that they have the right to develop 1000 hectare land for business that could generate economical benefits. However, the Lao government has demanded that constructions like public activity, roads, recreational areas, and a constructed lake should be included to the 1000 hectare agreement. The lake should be created for compensating the loss of wetland area and could prevent flooding in Vientiane Capital. The Lao government agreed later to exclude the lake from the 1000 hectare agreement. Since the constructed lake will become 200 hectare, the New Town Development Project area is extended to 1200 hectare. Uncertainties during the project planning have caused confusion among the Laotians. The authorities defend the discussions with that they are trying to find the optimal solution for promoting a sustainable development. The Jiangsu Institute of Urban Planning and Design is responsible for the feasibility study.

5.6.2.6 Location of the New Town Development Project

There are still uncertainties where the development of the new town should take place. Probably there will be some changes in the future from what is written in this report. However, That Luang Marsh will probably be affected in some way. There is a struggle to integrate the new town with the old town’s infrastructure. The New Town Development Project will be the first stage when developing Vientiane Capital into a modern city. Chinese consultants were hired for analyzing three possible candidate areas that could be developed for this project.

5.6.2.7 Site selection

The first area that was investigated is located close to Wattay Airport. The area has good connections to the main road and is located 18 km from the old town. This is a little bit too far away because these kinds of projects require that the development area is

Figure 5.17: The three development areas during the New Town Development Project (Public Works and Transport Department of Vientiane Capital).
maximum 10 km from the city. The presence of the airport creates considerable noise, which could make the area less attractive and valuable. The airport reduces the possibilities to construct high buildings. The developers of the New Town Development Project plan to construct buildings with approximately 20 floors. A second survey was made in Dongphosy forest. The area is strategically close to Friendship Bridge and could attract investors that enter from the Thai border. However, this area is even more far away from the city. The last survey was made in That Luang Marsh. Strategically this site is the best choice for the investor. The area is perfect for future expansions and could easily be connected to the main road in the north that goes to Vientiane Province and the southern main road that is linked to Friendship Bridge. Important infrastructure like roads, electricity and water supply are partly developed in the area and further improvements would be easy. The national railway will be constructed close to this area in the future. All these aspects make the location optimal for business and could easily be merged to the old town due to the close distance. There would probably be opportunities to increase the tourism in Vientiane if the marsh is developed. It is not surprising that the Lao government chose this spot because this was the best in a socioeconomic perspective. However, the Lao government requires that the area should be developed with awareness of the marsh’s multifunctionality. This is one reason why the 1200 hectare area will be divided into three districts. Figure 5.17 shows the areas of the New Town Development Project. They are located in:

- That Luang Marsh (southeast of old Vientiane City, 670 hectare)
- Dongphosy forest (southeast of old Vientiane City, 100 hectare)
- Close to the new stadium (northeast of old Vientiane City, 430 hectare)

Except from the New Town Development Project several other projects in the area, especially in Dongphosy forest (11 projects) are active. These projects will not be presented in detail in this report. The forest area is totally 1,800 hectare. A Vietnamese owned project will develop 500 hectare land in the forest for creating a business and market centre that trades with large quantities of goods.

5.6.2.7 Design of the developed area in That Luang Marsh

The new city area will be developed in a modern style with good infrastructure including housing, business, hospitals, schools and recreational areas. The area will be planned for both high and low buildings. The southern area will be designed for lower buildings like villas. Today, there are three water supply plants available in the city. These plants (Jinaimo, Kaoleo and Dongmakay) will be linked to the new town. The Chinese investor will be able to give opinions about the town project. However, they will not be a part of the decision making process. Figure 5.18 describes how the project will be planned in TLM. The lake is meant to take care of treated wastewater discharged from the wastewater treatment plant in the new town. The water is later transported into the Mekong River through a human-made canal. The yellow area in the map shows the residential area (230,2 hectare). The red area illustrates office land, and the green stand for the green areas. The upper blue square is planned to be a sewage treatment plant. This conventional plant is designed for 5000 m³ wastewater per day. The sewage will be transported throughout the projected city by 18.62 km HDPE pipe system. The New Town Development Project is designed for 250,000 people and will offer modern public installations (71,1 hectare) like culture, temples, and education. The local public transportations will consist of busses because subways and trains are very expensive. However, the planned national railway will be constructed close to TLM. The railway will be drawn both to the northern and the southern parts of Laos. The railway will be connected to
Thailand (Nong Kai) by Friendship Bridge. The project area in TLM will be the new centre of Vientiane Capital. Soil that will be used for constructing the city will be taken from the planned lake and the new district that is planned in Dongphosy forest.

5.6.2.8 Wastewater treatment and flood control in That Luang Marsh

A lake will be constructed in the middle of the planned district of TLM. The purpose is to save some of the multifunctionality that the marsh offers like flood control and wastewater treatment. The depth of the lake is not decided due to the uncertainties of the groundwater level and the flows. A barrier will be created around the lake for reducing erosion. The multi-households and office buildings will be more advanced than in the old town. These will be equipped with individual treatment facilities before the water is discharged into the lake. The buildings will probably use advanced conventional septic tanks for wastewater treatment. Industries in the area will be responsible for setting up own wastewater treatment facilities. The water quality will be monitored so the limits are not exceeded. If the households’ wastewater treatment is insufficient, there will be a conventional wastewater treatment plant available for further purification. The wastewater is later discharged into the...
constructed lake where a natural polishing of the water occurs. Probably a canal will be built for discharging the water directly into the Mekong River. The canal needs to have an effective flow for reducing the risk that Vientiane becomes flooded. The lake will also improve the beauty of the city. The aim is to make the lake so pure so it can be used for swimming and fishing. Trees and vegetation will be planted to improve the recreational value. The increased vegetation may also contribute to noise reduction from traffic and reduce the urban overtone. Figure 5.19 shows that the wastewater discharged from the old town (Hong Ke) will not be connected to the sewage system in the new town. If the WATER Project proposal is approved, the wastewater from the old town will be treated in CWs. The New Town Development Project prefers conventional wastewater treatment plants because CWs require more valuable space. The project is implemented to increase the land value so the land has to be used efficiently and in that case CWs are not possible. The conventional treatment plant will require experts. These will probably be recruited from countries like Thailand, China, or Vietnam.

5.6.2.9 Resettlement of people affected by the project
Since the government does not own all land and allows trespassing to the wetland area, several private owners and landless people will be affected. According to the government, some of the land is occupied illegally. However, some of these people that live in the “illegal” settlements are convinced that the land belongs to them. The authorities response to such arguments is that when people settled down in the marsh, they were only allowed to use the land, not to claim it as their own. There is confusion about land ownership because large land areas have been traded on the black market. To solve this problem, the authorities started to approve land certificates between the years 1994-2002. Certificates could only be given to people that have lived in TLM for at least 10 years at the same spot. However, the certificate-approved land should not be inside the conservation area. The area that is needed for the project will be reclaimed but compensated by the government. The government tries to find solutions for people that live in the areas without legal ownership. Most of the people are poor farmers and fishermen that could have problems to adapt to a new environment because the resettlement area consists mostly of apartment houses. The resettlement area will have good public service and infrastructure. The average educational level among the resettled people is low. These people will be offered educational training so they can apply for new jobs. The project will follow similar educational procedures that have been successful in China and Vietnam. If the resettled people own land in other parts of the country, they are free to move there and continue their business. The authorities think that the resettlement could be an opportunity to reduce poverty because poor people will be offered education and jobs in the new city. A rumour has been spread among the locals that the new town will only benefit Chinese people. However, the authorities deny the rumour and reply that the project is mostly created for the Laotians. Foreign experts will only be consulted if skilled people are unavailable in Laos.

Figure 5.19: Map for the project area (black border) and the resettlement area (yellow border) (Public Works and Transport Department of Vientiane Capital).
Figure 5.19 shows the borders of the project area. The yellow line marks the 35 hectare resettlement area located in the eastern part of the marsh. Some of the people that live inside the resettlement area (two villages) will also be affected by the project. 52 households in Khamsavas Village and 64 households in None Khor Village will be affected. Inside the project area, villages with an area of 452 hectares need to be moved. None Khor village is partly in the resettlement area and partly in the project area. However, it is only in the resettlement area of None Khor Village where people will become affected. The land value of the marshland differs. The most expensive land is found along the T4 road west of the marsh, which is worth approximately USD 50/m². Deeper in the marshland, cheaper land could be found valued at USD 1-50/m². The west side of the marsh has an average land value of USD 20/m². The east side is mostly used for agricultural activity and has an average value of USD 25/m². 60 % of the marsh is still owned by the government. Most of the people that are affected live within a distance of 100 m from the T4 road. The conservation area where certificates are not approved starts 150 m away from the road.

5.6.2.10 Environmental perspective during the planning
The main purpose of the project is not to conserve the current environment, but to improve and adapt it to the new situation. Socioeconomic development is more interesting for the authorities than environmental conservation. However, if a sustainable development should occur, there is a need to plan the project carefully due to the hydrological patterns and the sensitive ecosystem. Some people are worried that the lake will be non-aesthetical and become a polluted bad smelling lagoon. This has happened to several artificial lakes that receive wastewater in urbanized areas. The authorities are not very worried about the environmental consequences because they think that the project is environmentally safe. The functions of the wetland will be conserved in the 200 hectare lake and will replace the wetlands wastewater treatment and water storage capacity. However, the authorities agree that the reduced wetland area will result in less space for aquaculture and agriculture. It is difficult to predict the impact on the biodiversity due to the lack of previous studies. The authorities have decided that only low pollution industries like garment and retailer industries will be allowed in the New Town Development Project. Heavy pollution industries like paper mills and concrete factories will not get permission to settle there. Companies and investors that seriously violate the regulations will be forced away and punished. The New Town Development Project follows the guidelines of the ISO 14001 standard.

6 Discussion

6.1 Sustainable development - a utopia?
How should natural resources be used to reach a sustainable development? The question is complex because of the needs to incorporate many different issues and parameters. They could roughly be divided into economic, social, and environmentally related issues. However, social issues might be dependent on economic issues and economic by environmental. Economic issues could for example be taxes, expenditures or household incomes. Social issues could concern questions like cultural, aesthetic, education or basic living standard. Environmental issues could be different kinds of natural parameters like hydrology, geology, water chemistry, soil chemistry, temperature, or biodiversity. The environmental issues may be extra hard to handle because they may result in several complicated cumulative or significant effects. Polluted wastewater may result in environmental impacts that affect the ecosystem. Simultaneously, this may cause sanitarian problems followed by negative impacts on communities. Lacking sanitation may cause epidemics, which affects the health and social life. However, the social damage could be limited depending on accustomed pattern of life.
This could for example include food sharing or hand washing. If an epidemic breaks out, the health care system will become burdened. This will have economic effects both on individual and national level. If people become sick, their capability to work is reduced. Simultaneously, these people would pay less tax, which affects the national finances. The expenses for the health care system increase if people become more sick.

Sustainable development is aimed to create a long-term working symbiosis between the socioeconomy and the environment. This is especially important in urbanized areas because the city is strongly dependent of the ecosystem. However, is it possible to find a perfect sustainable development? Probably not, because socioeconomical interests will always be valued higher than environmental. Though, it has to be a struggle to live in harmony with the environment so the impact is reduced. By looking at the environment itself, humans may be able to mimic several biological processes. If humans can integrate these processes into modern technology, the use of natural resources will become more efficient. In several cases the ecosystem have found far more efficient solutions compared to some of human’s most high-technological inventions. Sustainable development is always about optimizing the use of resources that are needed to fulfill basic needs for people, simultaneously as the environmental impact is minimized. The challenge is to work towards a vision where all produced waste becomes new resources. This may look like a utopia, but striving towards this increases the sustainability and reduces the consumption of natural resources. Since Laos is still a beautiful country and rich in natural resources, this should be seen as an enormous potential for the country’s development. Because the consumption of natural resources in Laos is the key for the country’s development, an unsustainable use may inhibit a continuous growth. If the leaders of Laos, once and for all decides to work towards a sustainable development, the poor country in Southeastern Asia has the capability to become one of the wealthiest nations in the region. A long-term sustainable use of natural resources where a significant part of the profit goes to the public treasury could contribute to this goal. As the revenues to the state increases, the government will be able to invest in different projects and improved infrastructure. This could generate even more long-term and short-term profits. Simultaneously, the dependency of foreign aid reduces.

6.2 Sustainability in Vientiane Capital

Several cities around the world have been urbanized and developed from villages built on aquatic networks. The initial reason why people settled down at the floodplain was that the landscape was flooded annually. This enriched the land with nutrients and increased the fertility of the soil. Due to a rich wildlife, these areas also offered good fishing and hunting. However, when the villages developed into an urbanized city, the aquatic system in Vientiane suddenly became a burden.

Vientiane Capital is not the only city in the world that will experience a rapid development process. This process could be sustainable or unsustainable. Vientiane proves that the second option is possible. In the past, Vientiane was a wonderful wetland ecosystem where the environment offered several wetland services. The Vientiane citizens were probably not aware of how important the unique wetlands were for their daily life. The citizens had a natural wastewater treatment system and were able to collect large quantities of food thanks to the rich biodiversity. However, the city was primitive and the authorities wanted to promote a modernization of the capital. A great agricultural expansion followed, canals were concretized for improved drainage, and wetland areas were demolished. The hydrological patterns and the ecological functions were dramatically changed when the wetland was modified. Looking
back from now, many past decisions were unsustainable. Of course every city should have its right to develop. However, this has to be done carefully in sensitive areas.

The city suffers today from past unsustainable decisions. Hopefully lessons have been learned so the same mistakes never become repeated. If more environmentally friendly decisions had been made, the socioeconomical situation had probably been better today. However, instead of focusing on the past, the city needs to look forward. The New Town Development Project and the WATER Project will probably have a large impact on Vientiane Capital. A problem is that there are still uncertainties about how the hydrological patterns and other important ecofunctions will respond when the projects are implemented. The flat topography and the low permeability in soil cause a slow drainage of water. This creates problems during the wet season when large water masses needs to be evacuated. The inadequate sanitation situation in the canals, the illegal filling of the marshes, the high poverty and the low educational level among the population, corruption, pollution that threatens the agriculture and aquaculture, and the fact that the biodiversity may seriously become affected in the near future are some of the challenges that need to be overcome. If the wetlands lose their wastewater treatment capacity, the polluted discharged water will affect the Mekong River. A disturbance of the life in the Mekong River could indeed lead to large socioeconomical problems for Laos, because the Laotians are very dependent on the fishing industry. A collapse of the fishery would probably hit hardest on poor vulnerable groups along the Mekong River in the south because this industry may for some be the only source of food and income.

If the flooding and sanitation situation in Vientiane is even more worsened, Laos may lose its opportunity to become a developed country. This may be explained by the fact that the country’s development is dependent on a positive economic development in Vientiane. Investors are usually only attracted by countries that are able to develop. This is why Vientiane needs to avoid unnecessary human-made disasters. If the situation in Laos is worsened and becomes unattractive there will be an increased risk that the country only attracts investors that plunders the country on its natural resources. Decisions that are made today needs to be based on facts that promotes sustainability.

Laos is one of the poorest countries in Asia and need investors to develop. A good solution is to increase the land value in the capital area. China has done similar development projects, which have resulted in rapid socioeconomical growth. However, a rapid socioeconomical development may be followed by high ecological risks. It is of high concern that the New Town Development Project promotes sustainability not only in a socioeconomic but also an environmental perspective. This project could possibly be a first step to raise the country from poverty. A well-planned project in the capital may boost the national economy and reduce the unemployment in Vientiane. More industries could increase the export of goods simultaneously as the dependence of foreign donors reduces. If the development is successful, the educational level will increase as high quality schools and universities are integrated into the new infrastructure. The health situation could be improved if a more sustainable sanitation system is implemented. Better roads that are not affected by the annual floodings could be constructed. Communication and road networks are essential for attracting foreign investors.

However, some facts are worrying. Economic funding and loans are continuously pumped into Laos. Several previous projects have partly failed due to lacking organisation and widespread corruption. New constructions aimed to improve the city’s infrastructure do quickly fall apart. Inadequate maintenance results in a low lifetime of the investments in Vientiane. There is probably a great lack of knowledge how the money should be used in a
way that promotes sustainable development. It feels like many projects start from zero. One example is the drainage projects. When a new high technological solution is constructed it falls apart a couple of years later. These problems are frequently repeated. Why do not investors and authorities invest money in maintaining the systems? It is just a waste of money to let expensive solutions fall apart. Sooner or later the donors become tired of investing in a system that cannot be maintained and when that day comes, the Laotians may suffer even more. Recently, the Japanese started a drainage project in Vientiane. A suggestion is that very much of the support will be put on controlling the funding so the project does not end in failure. Much effort has to be put on maintenance, education, and intolerance against corruptive behaviours. These are probably keys to future sustainable projects in Vientiane.

6.3 Underestimation of the wetland value

In the past, the most important functions of the wetland were benefits made from agriculture and aquaculture. As the city has grown, the developments of urban infrastructure have become more important than the basic visible wetland functions. Not until recently wetland functions like wastewater treatment have increased in popularity among Laotians. Simultaneously, the protection of wetlands is still limited. This may partly be explained by the lack of knowledge. Wetland degradation is probably a result of:

- A lack of legal consequences against illegal activities.
- Corruption, which protects people that make profits on illegal activities.
- Vulnerable groups use the wetland unsustainably for own survival. Many farmers and fisherman cannot change their own situation, partly because they do not know why their activity has a negative environmental impact. Many citizens do not understand that filling and uncontrolled wastewater discharge affects the wetland functions.
- That Luang Marsh was opened in 1975. Settlers thought that they could own the land in TLM. This has created a resistance against projects in the marshland.
- Until recently decision-makers have not taken the wetland values seriously. Food production and socioeconomic development have been more prioritized.
- Draining the city has been more prioritized than treatment of sewage water.

6.4 Wetland valuation

One reason why wetland goods and services have been underestimated could be the lack of knowledge how economical values should be set on eco-functions. Still, this is a problem because there are only a few studies made in this area. A positive thing with wetland valuation is that if eco-services could be translated into monetary units, wetland values may be more appreciated in the future. The insight of wetlands’ unique multifunctionality is growing and in the future these ecosystems will probably be used more sustainably.

Why is it then so difficult to put economic values on biotopes? The problem is that many services may be close to invaluable if the service is treated as endless. Of course the valuation could be based on annual benefits. However, how many years of benefits does a lost wetland correspond to? Another difficulty is to valuate cultural, aesthetical and moral values. Direct and indirect values are easier to predict. However, the risk with wetland valuation is that only these values are considered. Option values may easily be lost if investments are based on short thinking. For the case of Vientiane, an increased tourism could be of great interest. Medicines are not only produced in laboratories but could be found in ecosystems. If they are destroyed, possible important discoveries could be lost. Indirect values are hard to predict because they may change due to cumulative or synergistic effects. For this case, caution has to be taken when wetlands are developed. Valuation is important, but not all when
considering the effects on the environment. All values cannot with fairness be translated into monetary units.

6.5 Corruption – a serious threat against sustainability

The corruption is still a big problem in Laos. Paying “commissions” for contracts sets the development organizations and the foreign companies into difficult situations. Aid agencies that promote sustainability in Laos could need to give up their work if their policies forbid bribing. In other words, serious organizations may have difficulties to work in the more corruptive areas of the country, while the dishonest will have it easier. Compared to developed countries, the governmental hierarchy is still very strong in Laos. Chiefs working for departments or institutions may use their position for promoting friends and relatives at the cost of skilled people. Because lower officials are afraid of ruining their own career, they avoid confrontation higher officials with inconvenient truths, which probably in some cases have ended up in a bad way. The corruption could by this certainly contribute to an unsustainable development. Before a decision is made, it is of highest concern that all data is uncensored and available for the decision makers. Several donors have chosen to refuse economical funding directly to authorities or national institutions because they fear they would lose the funding into the corruptive system. A solution has been to start own projects where the donor completely controls the funding. The laws are not inadequate but they need to become more efficient so criminal acts are punished. The corruption is probably one of the main reasons why the development of Laos is slow.

6.6 Causes to inadequate decision-making processes

Officially the Lao government works hard to find a sustainable development. Socioeconomic development is usually more important than environmental issues in most countries. Still, the decision-making should be prepared with enough ecological information so sustainability is secured. If the balance between socioeconomic and environmental interests is bad, there will probably be sustainability problems. Key-officials need a broad knowledge about how sustainability is maintained. Unsustainable decisions have probably been approved because:

- Laos is still one of the poorest countries in Asia and needs a quick development.
- The environmental education among decision-makers and ordinary people is very low.
- The corruption among officials is still a problem.
- The country is quite restrictive to integrate NGOs into decision-making processes.
- No real opposition is allowed to criticize decisions that have been and will be made.
- Inconvenient truths could be unwelcome among higher officials.
- A strong hierarchy where friends and family members are favoured reduces the competence of staff.

6.7 Environmental law

The author of this report was quite impressed about the environmental laws that have been adopted. However, the real consequences of breaking the law may still be weak. This is probably a result of Laos’ poor economy. Tarnished wastewater, discharged by large paper mills could be suspicious. However, there is no evidence in this report that the pink and white water discharged from the paper mill in Vientiane is breaking the law. Maybe their treatment is sufficient according to the local rules. However, in the past several Swedish paper-producing industries were rapidly forced to change their production and wastewater discharges due to some incidents that had a great impact on the ecosystem. Some pollutants like dioxins affected the environment seriously. These compounds are slowly degradable and
in general strongly poisonous. All Lao companies that violate the law need to be prosecuted in order to implement the laws in their businesses and secure that their ecological impact is reduced. Also in this area, corruption will have to be counteracted.

6.8 The New Town Development Project

The project could either be a threat or an opportunity for the sustainable development in Vientiane. If the project succeeds, this could help to boost the slow socioeconomic development in Laos. Conventional wastewater treatment plants could improve the sanitary situation in the capital and reduce the pollution in the sensitive Mekong River. There are indications that TLM already has lost some of its wastewater treatment capacity. If the city expands rapidly, conventional plants could be the only solution. However, according to the WATER-Project, CWs could improve old Vientiane’s wastewater treatment system. There are several uncertainties that need to be solved for preserving a working natural system. The project should not be stressed because rapid changes may disfavor the future of the city. Today the flooding is controllable thanks to TLM, sandbags, and several improvements of Vientiane’s drainage system. However, flooding is still a critical parameter. The elevation difference between the marsh and some parts of the city area is only two meters. The silt/clay soil reduces the permeability of water. The water evacuation during the wet season is very critical and small changes in the hydrological system could cause adverse affects. 670 hectares of TLM will be developed during the project. When the water level in the Mekong is high, water cannot be discharged through Houay Deua because this outlet has a lower elevation than the river. Technically, a cement-layered waterway could be constructed in Houay Mak Hiao to increase the water flow. This option is probably very expensive due to the long distance. Another problem is that the biodiversity in the river will be lost and the water has to be treated in conventional plants if the purifying soil layer is replaced by concrete. If polluted water leaves Houay Mak Hiao, the environmental impact in Mekong will increase. Houay Mak Hiao is probably even more important today than before due to the less effective TLM. Laos’ fishing industry is dependent of a good water quality in the Mekong River, which increases the needs to treat the water before it leaves Houay Mak Hiao. If this is done properly, Vientiane could affect the national socioeconomic and environment in a positive way. However, too much local focus on socioeconomic development could result in an ecological collapse in the valuable Mekong River. Vulnerable and poor local communities downstream rely on a stable fishing industry. A collapse may also result in that Laos does not reach the MDG for poverty reduction.

An alternative could be to construct the planned 200-hectare lake in the centre of the urbanized TLM. However, will this compensation be enough? The high ground water table could be problematic when the lake is constructed and designed. Is the plan to isolate the constructed lake with cement so ground that water cannot intrude? There is a risk that the wastewater treatment capacity then is lost. Will the constructed lake end up as a dirty unattractive water hole in the middle of a high-technological city? It is of high concern that decision-makers have insight into how the problem should be sustainably solved. A fair dialogue is necessary and inconvenient truths need to be brought to the surface. The Chinese feasibility study is important for finding sustainability in the region and should not only be based on economic interests. The project needs to solve the problem with the poor and uneducated farmers and fishermen that live inside the project area. The wetlands have been essential for food collection in several communities with high unemployment. The loss of wetland areas will strike very hard on these vulnerable groups if the government does not consider their situation. In a socioeconomic aspect a fair investigation and decision-making process during this project is necessary because:
• Flooding is already a problem for Vientiane Capital and for the surrounding villages.
• Flooding is mainly caused by the flat topography, soil properties and hydrology.
• The knowledge about the natural processes in the wetland system is still limited.
• Filling wetland area during the New Town Development Project could increase the water level in the city due to a lower water storage capacity.
• Vientiane Capital is the economic centre of Laos and more flooding would probably affect the economy of the whole country.
• Important investors will avoid areas that have sanitary and flooding problems.
• Increased sanitary problems may result in outbreaks of diseases.
• An increased discharge of polluted wastewater into the Mekong River may cause socioeconomical and environmental impacts in several areas of southern Laos.

Some local people are worried about the plans of the New Town Development Project. It is not very strange because the development plans will absolutely change the shape and function of the city. Some of them are also anxious that the Chinese will become too powerful in the region, and affect the sovereignty of Laos. It is worrying that authorities have chosen a very vulnerable location for the New Town Development Project. It is of high concern that a trustworthy non-corruptive feasibility study is made and that a proper decision-making process occurs so the project does not result in disappointment.

6.9 Resettlement in That Luang Marsh

The Decree that ensures the safety of resettled people may first seem to be a good protection for those who are affected by projects. It is good that the legislative system highlights these problems. However, these people are also included in the more vulnerable groups of the society. A family may have become completely adapted to live in an aquatic environment. They may be experienced in fishing and farming, but lacks in experience of urban jobs. Even if the authorities want to educate these people, it will probably not be successful for some of the resettlers. Many people are too old and cannot learn to survive with urban jobs. The compensation for lost land is often very low. There is probably a contradiction between theory and practise for this case when the Decree states that “project affected people are compensated and assisted to improve or maintain their pre-project incomes and living standards, and are not worse off than they would have been without the project”.

Local people in TLM are worried that they will not be compensated for lost land and work. Because people in TLM in general have a low education level they may have difficulties to rapidly change their way of living. The law guarantees that the situation should not become worsened for resettled people. Hopefully the authorities will truly support these people and not leave them in despair. According to the Lao-Sino negotiation the leased land should initially be worth 1 USD/m². When the development site was changed into TLM, the land value rose to 1-50 USD/m². This could affect the Lao economy because the government are bound to compensate the landowners for the true price. Still, this compensation is low from the perspective of the resettled people.

6.10 That Luang Marsh – A socioeconomical experiment with adverse effects.

The protection of the wetland area has been unsuccessful. Despite regulations that prohibit land titles inside this protected area, there are several people that have taken control of the land by filling up the wetland. This activity is common especially along the main and secondary roads. The land has in some cases been captured illegally and sold at the black
market. This complicates the situation for many wetland inhabitants because they could be left without compensation. Their survival may become hard. The exploitation has reduced the wetland area and caused serious impact on the wetland’s ecosystem. The government has experienced difficulties to control these illegal exploitations due to an ineffective and powerless legal system. However, this dilemma should not been seen in only one dimension. This is in reality very complex and probably the settlers would like to be a part of a sustainable development. They are not evil; they are people with own needs as everyone else. They are often poor and uneducated. However, they know farming and fishing and they have found their own niche in the wetlands. Many of them would probably not survive in the urbanized parts of Vientiane. The younger population may have easier than the older to adapt to a new environment. However, many seem to be unwilling to move because they feel secure in the wetlands. As the wetlands offer them food, money is a secondary need. If they move to the city, they will no more produce any food for own consumption. This is probably a fear for many people that live in That Luang Marsh. The people realize that if they fail to adapt, they may end up begging on the streets. This is probably the largest reason, why people want to stay in the marsh. It is important to understand that forcing these people out requires a large responsibility. Underestimating the complexity of the situation is equal to playing games with people’s life.

6.11 Flood control and wastewater management in Vientiane

The drainage and wastewater management solutions are linked together in Vientiane. The flat topography and the low permeability of soils are the main reasons why Vientiane suffers from annual flooding. The improvements of the canals have increased the drainage capacity but worsened the sanitary problems. If wastewater were separated from storm water, these problems could be treated separately. The flooding would in this case have less impact on the sanitarian situation. As long as there is a mix of storm water and wastewater in the canals the whole water mass needs to be treated before discharge. Reducing flooding in the city area could be problematic and expensive. However, the expenses from flooding may inhibit the socioeconomic development. Protecting the city with sandbags could partly mitigate the flooding. However, if the wetland area is reduced, these problems could increase. Vientiane has in several places a high ground water table, which complicates the construction of a deep lake for water storage. There has to be a more efficient way of evacuating storm water without increasing the impacts on the environment. In theory the wetland is not needed if the city can be drained with engineering. There have been thoughts of putting a cement layer in Houay Mak Hiao River for increasing the drainage speed of the city area. However, this option would most likely be very expensive and risky. First, there are uncertainties how the hydrology really work. Secondly, the wastewater needs to be treated and not discharged unpurified. Today, the wastewater is partly purified in Houay Mak Hao. Concretizing the river would increase the water speed but reduce the wastewater treatment capacity because the natural earth canal becomes demolished. This scenario will require that all water is pre-treated before it enters the Mekong River. If Houay Mak Hao River is layered with cement, the biodiversity in the river will be completely lost.

Something needs to be done in Vientiane to prevent an adverse sanitarian situation. Uncontrolled discharge of wastewater jeopardizes the health of Vientiane’s citizens and the multifunctionality of the urban wetlands. Cholera is not a very common disease in Laos. However, if the sanitarian situation is worsened, sanitation-related diseases will increase. The spreading of malaria has been connected to bad water sanitation. Inadequate water quality has also resulted in the spreading of the golden apple snail. This species is an indicator of bad water quality because it is very resistant to low DO values. As the snail is able to adapt to new
environments, other important snails may be eliminated. This causes a disturbance in the food chain, which may affect top-consumers. It is of high concern that the New Town Development Project implements a proper sanitation system where high-polluted sewage is separated from Vientiane’s population and the outer eco-system. However, this is only possible with closed systems. It is not sure whether closed or open systems are best for old Vientiane. Sunlight may activate the photosynthesis in the water canals, which increases the DO-levels. The aerobic environment may increase the degradation of several compounds like BOD. However, open systems may cause poor sanitation and smelling problems. They may also ruin the aesthetic view if the canals look polluted. If Vientiane chooses to separate wastewater from storm water, the wastewater has to be pumped in closed systems. Open systems would cause too much smell and sanitary problems because the wastewater becomes more concentrated. However, the storm water could preferably be transported through the existing open canals.

The water quality tests in TLM (table A7.1-A7.13) show that BOD, COD, TSS, NO₂, and faecal coliforms are parameters that need extra monitoring. TP, DO, Hg are also a problem in some areas. The data proves the relationship between BOD, COD, and DO. A high presence of organic matter reduces the concentration of dissolved oxygen in the water. However, if the waterbody is aerated, this effect could be reduced. The oxygen concentration is also lower during the night. In appendix 4, the relationship between low DO and mosquito-borne diseases is discussed. Malaria and dengue fever is a problem in Vientiane as for several other Southeastern Asian cities. A better water quality in TLM would probably reduce these problems. A high presence of faecal coliforms is mainly a sanitary problem that could cause epidemics.

### 6.12 CWs versus conventional wastewater treatment plants

CWs demand a larger area for wastewater treatment compared to conventional treatment plants. A CW is probably suitable for flat topography, which reduces the demand for expensive pumps. The wetland area in Vientiane has esthetical and recreational values and a recommendation is that at least a part of the wetland is conserved for future generations. Some polluted wetland areas have a reduced purification capacity but if they are restored and turned into CWs they may become efficient. However, a CW is always more or less affected by pollution, which reduces the efficiency of other wetland functions. If the CW is maintained properly some of the natural multifunctionality could be conserved. CWs become often unpopular during urbanization projects because they require more space and reduce the investor’s benefits. However, if the CW is planned and maintained properly, the area could become an attractive recreational element in the urban environment. CWs could even become tourist magnets like the CW on Phi-Phi Island in Thailand.

The CW concept has rapidly grown in interest in several developed countries as an alternative to conventional wastewater treatment plants. This is probably explained by the fact that the overall physical, chemical, biochemical, and biological processes in CWs are very effective and much cheaper than traditional technologies. While conventional wastewater treatment plants require energy and chemicals, CWs are easier and cheaper to operate. According to an investigation, the investment costs of CWs were 6-9 folds higher (Table A3.3-4) than for conventional technologies, but the ordinary maintenance costs were much lower. The same study showed that the cost differences between the different technologies were nullified after 2-3 years (Table A3.3-4). The study did not consider the land value. Constructing CWs in
cities where the land value is high could be problematic if only the economic perspective is considered. The lifetime of a conventional treatment facility is expected to be 20 years (Table A3.3-4) while CWs probably could be used for a much longer time. Should not CWs be an interesting challenger to the conventional technologies?

Since CWs could fit into a natural environment, these areas will save some biodiversity if all other wetlands are lost for urbanization projects. CWs have mostly been used in temperate areas. However, they are probably even more effective in tropical regions because biological processes are more favourable in warm climates. It is important to remember that CWs are complex and the processes are not completely known. Conventional wastewater treatment plants are technically more advanced and need skilled staff while maintaining CWs is simpler. However, conventional treatment plants are more efficient than CWs due to the shorter turnover time (Geber et al., 2000). While CWs are simpler, ill designed and maintained facilities may become health hazards. It is well known that mosquito is breeding in polluted watersheds, which may cause outbreaks of diseases. While CWs are almost too easy to maintain, this may become the mayor problem if the maintenance routine is lacking. While the maintenance of CWs is simple, this should never be underestimated. A well working organization that is responsible for the maintenance is required. How should the very hazardous or non-biodegradable compounds in CWs be handled? There is a risk that these kinds of compounds accumulate in the ecosystem. If too much solids are settled in the sediment layer, sludge has to be removed. The sludge needs to be analyzed so it may be safely deposited if the content is hazardous. However, sludge is a larger problem in conventional treatment plants. A disadvantage with conventional plants is that several chemicals normally enter the purification process, which could affect the properties and the volumes of sludge. CWs create usually a smaller sludge volume because the organic material is assimilated into the ecosystem. This could later be harvested and used as an energy resource.

A problem for wetlands in general is that these aquatic systems emit the greenhouse gas methane due to anaerobic microbiological activity. Anaerobic digestion is also a common process in most modern conventional wastewater treatment plants. In both systems the anaerobic process is often an important part of the water purification process. However, one important difference is that it is much easier to collect the methane gas from a conventional wastewater treatment plant compared to a constructed wetland. A bonus is that once the gas is collected it could be used as an energy resource (biogas). It could be difficult to defend that a valuable energy source should be emitted to the atmosphere. At the same time this gas may increase the effects of the global warming. If a water purification process should be regarded as sustainable, even this aspect needs to be evaluated. Neglecting diffuse emissions of greenhouse gases may result in that water problems are transferred to the atmosphere.

**6.13 Best choice technology**

Based on the facts that have been collected during this thesis, it is still difficult to decide how the wastewater should be managed in Vientiane Capital. These issues are complex and the different technologies have both advantages and disadvantages. It is important not only to consider wetlands for wastewater treatment, but also other important services. This is the key issue for promoting a sustainable water and wastewater management in Vientiane. The choice of wastewater treatment needs to be made by the citizens of Vientiane Capital. If the city wants to develop into a modern urban complex with little space for green areas, the land value will probably increase. A land-requiring CW could disfavour the socioeconomic development if decision-makers only focus on monetary units. However, is it possible to valuate every corner in Vientiane in monetary units? If a CW is constructed, some areas could remain as
wetland area, simultaneously as some of the wastewater management related issues are solved. It is also important to understand if the introduced technology is reasonable for its purpose. If Vientiane already have economical problems when they are maintaining the drainage system, a large conventional wastewater treatment plant would be much more difficult. Maybe a CW would in this aspect be a more reasonable option?

Probably the best solution is to build conventional treatment plants for wastewater discharged from the new town, while the rest of Vientiane uses CWs according to the WATER project. It seems that the authorities only will approve a CW for treating the water in Hong Ke. While this is the most important canal, Hong Xeng should also be considered. As the population grows, the volumes of wastewater will increase. It is better if all Vientiane’s wastewater undergoes controlled purification processes. Separation between storm water and wastewater should be one of the main issues if a conventional treatment is designed in the new town. The reason is that large water masses are more expensive to treat in conventional wastewater treatment plants. If the septic tanks are not repaired and the water quality is not improved, the authorities should also consider separated systems in the old town. Monitoring and maintenance of the sewage system and the septic tanks are essential. Today, some parts of the system are ill maintained due to an inadequate organization and insufficient funding. These issues are important to solve.

The conventional treatment plant will require more skilled people, maintenance and energy. Because the running-costs for conventional plants are much higher, it becomes very important that the decision-makers are sure about funding. Probably several consultants need to be hired abroad. It is important that all wastewater in Vientiane, especially from industries, is analyzed. Bad control may result in discharge of hazardous compounds into the environment. Hazardous compounds may also affect the processes in both CWs and conventional wastewater treatment plants. Industries have to become more responsible for their own treatment processes so they do not disturb the municipal treatment. CWs could in several cases benefit companies because they could do the mandatory wastewater treatment cheaper.

6.14 Agriculture

Due to the agricultural expansion, Laos is now self-sufficient in rice. The crop is the most important calorie source for Laotians. As the rice consumption is large, poor people are very dependent on good harvests. Good harvests are usually made in natural wetland areas. Vientiane Municipality is one of the most important rice-producing provinces in Laos. Loss of arable fields needs to be compensated if the current harvest volumes should remain. A positive nutrient management in rice fields is important. Fertilizer use and insight about the balance in rice fields when vegetation is removed are both important in a socioeconomic and an environmental perspective. Increased knowledge among farmers improves yields and reduces plant diseases. Simultaneously the use of NPKs needs to be optimized for preventing nutrients to leach from the fields. Intense leaching may cause eutrophication in water bodies. Besides eutrophication, some NPKs could contain cadmium that may accumulate in the ecosystem. An intense use of fertilizers and pesticides could harm rice plants, decrease yields, and disturb the natural biodiversity. If a pesticide-using farmer one day wants to convert the fields into organic, this could be impossible if essential natural organisms have been exterminated. Pests become often resistant to pesticides, which normally result in increased pesticide use. Toxic pesticides may accumulate in the ecosystem but also in human tissues and organs. Poor knowledge about pesticides and fertilizers needs to be met by national programs that inform farmers about the risks and how a sustainable agriculture could be
practised. To use safe wastewater with high BOD content may be an alternative to expensive fertilizers.

6.15 Analysis of the local interviews and social observations

The interviews showed that there are different opinions about the urbanization project. The local people are often more interested in improving their own situation than the national. This was noted both among local people that were positive and negative to the project. Some people that were strongly negative thought that they would lose property and living when the New Town Development Project is implemented. Some said that the project is insecure. The negative local people wanted that the city remain as it is today because their life does not need to be improved. Some local people that supported the project said that their household income would increase due to better business. Other thought that a developed city would be more beautiful and could promote national growth. These people seemed to be tired on living in one of the least developed countries in Asia. Few people considered the ecological effects as a problem. The socioeconomic issues were more interesting for the interviewed. This is probably a result of low environmental awareness. Comments like “the fish is strong” and that people are not worried as long as the rice grows, show that people are more afraid of losing income than impacts on human health and the ecosystem. Even if industries and households discharge wastewater directly into their fields and fishing ponds, the people will not reflect on the problem if the food does not change in shape or quality. Complementary questions had to be asked to reduce the educational barrier between the interviewed and the interviewer. Questions like if they had seen any dead fish, if the rice had been bad, if they had suffered from diseases, and their own explanation to the problems were given to the interviewed. It was easier to discuss with students, because some were more experienced in environmental issues. They were also more worried about environmental consequences from projects. The farmers seemed to be poorly educated about why and how pesticides should be used. The word “pesticide” seems to be a very rare word among farmers. Most of the farmers regarded pesticides as “medicines” for rice, rather than poison. There were some indications that some of the farmers did not understand the difference between pesticide and fertilizer. The farmers that spread pesticides are often unprotected. Some farmers do not spread the pesticides by themselves because they are afraid of health consequences. Instead, they hire staff for the job. The hired people are often unprotected, which have caused several diseases and deaths.

When walking around in the marshland areas the ground was in some places covered with garbage like plastics, paper, and scrap-metal. The moral of collecting trash is worse in Laos than in many European countries. A person explained that parents do not care if the children throw trash on the ground because it is a normal behaviour. Probably this could be linked to that non-biodegradable waste were quite recently introduced. However, some of the garbage was found in trees and bushes. The reason to this is that the annual floodings spread the waste over a larger area. The solid trash is probably mostly an aesthetical problem but some may be hazardous. The roads around Vientiane cause heavy pollution, which probably affects human health as well as the environment. Trucks, cars, tuk-tuks and other vehicles have often a limited exhaust emission control. People that travel along the roads, cover their mouth and nose to avoid inhaling the irritating and unhealthy gases.

6.16 Is there any need of a Strategic Environmental Assessment?

After analyzing the situation in Vientiane and particularly in That Luang Marsh, the answer if an SEA is needed is both yes and no. Some kind of serious study that integrates socioeconomic and environmental interests for promoting a sustainable development is absolutely needed. The urban planning has to be based on sustainability in a wider perspective
than today. The organization is lacking and the corruption inhibits a sustainable development. The history testifies about departments and institutions that compete to get status projects. During the project time they seem to show little interest for the projects. Simultaneously they seem to be unwilling to share the projects with other actors. Lack of cooperation between projects is a problem that needs to be overcome. Could an SEA help Vientiane to build up a working organization and increase the cooperation between different instances?

Several discussions have been held with involved people during this work. This has convinced the author, that the best way to reach a sustainable development is to use an assessment tool that is familiar among authorities and stakeholders in the target region. Practising sustainability assessments are still new for Laotians. If a CEA that seems to be more common in Thailand is easier to adapt in Laos, this method should be used rather than SEA. While the name of the assessment methods differs, the content is very similar. On the other hand, SEA could be favoured if aid agencies are more convenient with this method. Much of the support comes from Europe where SEA seems to have many followers. Bureaucracy could maybe complicate the situation if the wrong assessment tool is chosen. Hopefully this will not be the main issue when trying to create a sustainable development in poor countries. It is also important to remember that the main objective is not to create an SEA report, but informing decision-makers about sustainability.

SEA is a well-proven tool that indeed may contribute to a sustainable development in Vientiane. Because the capital has an ambition to improve the organisation and the coordination between the projects for increasing the sustainability (especially in an environmental aspect), an implementation of SEA would be valuable. A SEA could also improve the understanding about environmental issues among the key stakeholders in the region. A recommendation is that a SEA is implemented where the system borders of the tool embraces the whole capital (metropolitan area).

6.17 Vientiane, a capital with challenges and opportunities

The author cannot advise the authorities of Vientiane if the capital should develop into a top-modern complex or if it should be kept as a small sized city. This is something that the people of Vientiane need to decide. Development is always risky and may result in complications if it is done foolish. However, a small city without environmentally safe technology could also be unsustainable. Something needs to be done because the way of living may cause adverse ecological risks. The best way of developing is to start with a careful analysis of how the negative impacts on the ecosystem and socioeconomy can be reduced. This is important, because several implementations may become irreversible. Another question that needs to be asked is: Do the people of Vientiane really want to become a densely populated urban

Figure 6.1: (a) An illustrative comparison between the dense populated Argentinean city Buenos Aires and (b) the Chinese eco-city Tangshan (Windsor Schools & China Daily).
complex as several other Asian cities, or should Vientiane be known for its beauty where artificial urban design uniquely interacts with an extraordinary ecosystem? Figure 6.1(a-b) shows the contrast between these extreme scenarios. It is in some way positive that the Chinese have an ambition to lift up the beauty of Vientiane. Hopefully this vision will be transformed into reality. However, as many cities develop, some have become dense complexes, due to the increasing land value. Increased business has been prioritized at the cost of the ecosystem. Several developed cities struggle today with problems like serious air pollution, bad sanitation, poisoned lakes, unaesthetical garbage, traffic jams, and / or noise pollution. Why did these cities end up into this mess? The answer is probably that they developed too quickly and the planning was inadequate. As told before in the report there are three corners of sustainable development: Environmental, social and economic. If a city focuses too much on economic benefits, there is an increased risk that something sooner or later will go wrong. That Luang Marsh is probably the most important wetland in Vientiane Capital because most of its water ends up in this area. Having an urban wetland of this size should be treated as a privilege worth to protect. If the city needs to be expanded to That Luang Marsh, the recommendation is to integrate the wetland area with the urban infrastructure in a sustainable way. Saving a working ecosystem inside the borders of Vientiane Capital does not only preserve the vital functions of the city, but creates a unique capital that may be well-known for its beautiful eco-urban interaction. Will Vientiane become another of the cities in world that is trapped in a dead-end of regret, or will the authorities and people of Vientiane actively influence their future so the city is planned to sustainability? That is a question that will be answered by the future. However, the future will be based on decisions made today.

7 Conclusion

It is important to promote both socioeconomic and environmental sustainability in Vientiane Capital. Direct impacts on human life and economy (socioeconomic related issues) tend to be more prioritized than environmental issues. However, the gap should be minimized for optimizing the sustainability. It does not matter what kind of strategic assessment is used for creating sustainable decision-making processes. As long as it has international acceptance and promotes sustainable development. During this work, the focus has been on SEA but other assessments may be possible. However, project-oriented assessments like EIA cannot replace SEA. EIA is only valuable at the project level and is not suitable for policies, plans, or programmes. Flooding, wastewater treatment, agriculture, aquaculture, biodiversity, and conservation are main issues that have to be considered when Vientiane is developing. Indications show that past unsustainable projects have damaged TLM’ multifunctionality. The damage to the sensitive ecosystem will probably worsen if the amount of people in Vientiane increases. Increased wastewater production and further development of the marsh are the greatest threats. The high concentration of wastewater that today enters TLM has a significant impact on the ecosystem and causes an unsustainable sanitary situation for the local people in the peri-urban areas. A lacking sanitary system elevates the risks of epidemical outbreaks. The legislative system is in theory good but in practice ineffective due to the lack of economical resources and the high corruption. Corruption is probably one of the greatest threats against sustainable development. Corruption wastes money that from the beginning was meant for improving the living standard and securing environmental stability. Flooding and heavy pollution in Vientiane may inhibit the socioeconomic development and probably scare away investors from making business in Laos. If untreated wastewater is discharged into the Mekong River, the biodiversity may be affected. A collapse of the ecosystem in the Mekong would seriously affect the national economy and particularly vulnerable groups that are dependent on the fishing industry. The parameters that should be monitored in TLM are
BOD, COD, TSS, NO\textsubscript{2}, and DO. It is complicated to valuate wetlands. DUVs and IUVs are easier to valuate than OVs and NUVs. DUVs could be agricultural or aquacultural benefits, while IUVs could be economical savings for avoiding flooding or reduced wastewater treatment costs. OVs are difficult to valuate because they are only potential values. They may for example be increased tourism or discoveries of new medicines. NUVs are hardest to estimate because they are based on cultural, moral, and aesthetical values. The TEV is probably always underestimated because the NUV cannot in a fair way be translated into monetary units. The New Town Development Project could maybe promote a sustainable development in the Vientiane region. However, this requires a high quality and independently produced feasibility study. The construction of the artificial lake and the new districts in TLM need to be planned carefully. Artificial lakes could in theory replace wetland areas. However, due to the uncertainties about the hydrological conditions and costs, this option needs to be considered. A project failure could cause serious flooding and result in a sanitarian and ecological catastrophe. Wastewater could be treated conventionally in CWs. Combining these technologies could be an option for the case of Vientiane. The districts that will develop in TLM may use conventional wastewater treatment while the rest of Vientiane uses CWs. Both technologies have advantages and disadvantages.

Advantages are presented in table 7.1. The WATER-project promotes implementation of CWs in Vientiane. If their pilot studies are successful, there are good chances to treat wastewater from the drainage/sewage canals. However, it seems that the authorities will just accept treatment of water discharged from Hong Ke. Locals affected by the projects are worried that they will not get compensated for lost land and living. These people will have problems to adapt to an urban environment. Low environmental education among authorities and ordinary people has partly contributed to an unsustainable development. Educating officials about environmental issues, and increasing the cooperation between different departments and institutions is an important stage for wiser future decision-making. Farmers should be educated about sustainable agriculture. Wetland degradation is probably caused by:

1. Intense water pollution (wastewater from households and industries).
2. Physical destruction (for example housing, filling, and artificial drainage).
3. Overuse of wetland resources.
4. Invasions or introduction of new species (for example the golden apple snail).

Economical support from foreign organizations and countries are probably the only way to improve the aquatic network in Vientiane. However, it is important that local residents and authorities gets involved in the projects. When a contractor leaves the country the Laotians need to manage and maintain the systems by themselves. Therefore the Lao authorities need to be involved during the project time.

While it is important to discuss the environmental and socioeconomical issues the opportunities also has to be presented. Vientiane is growing rapidly and this will become a huge challenge for decision-makers and citizens. A sustainable development is necessary for meeting the requirements on the city. Waste and wastewater should when it is possible be

| **Table 7.1: Advantages with conventional wastewater treatment plants and CWs.** |
|---------------------------------------------------|---------------------------------------------------|
| **Conventional Wastewater Treatment** | **Constructed Wetland** |
| Advanced | Long lifetime |
| Standardized | Effective in warm climates |
| Quick turnover time | No chemical input |
| Require small space | Easy to maintain |
| Could be more sanitary | Low sludge production |
| Processes better evaluated | Aesthetical |
| | Less need to change infrastructure |
| | Low running cost (flat topography) |
treated as resources instead of rest products. Nutrient-rich wastewater may for example cause eutrophication in That Luang Marsh. However, if the nutrients instead are spread over the fields, the waste could become a resource. If it is possible, problems should be eliminated by becoming solutions to other problems. Focusing on better wastewater treatment and general sustainable development for Vientiane will have benefits on local, regional, and national level. Past lacking environmental responsibility has caused adverse impacts on the socioeconomy. It is not possible to undo these mistakes. However, new mistakes could be avoided. The watchword for this is sustainable development.

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WATER, *Project Concept*


Wetlands International – Asia Pacific, The World Bank, *Wetlands in Asia*


**Internet resources**


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**Figures**


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Tables


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