

# **Integrating Wetland Ecosystem Values into Urban Planning:**

## **The Case of That Luang Marsh, Vientiane, Lao PDR**



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# STEO

Vientiane Municipality



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This project aims to develop, apply and demonstrate environmental economics techniques and measures for wetland, water resources and river basin management which will contribute to a more equitable, efficient and sustainable distribution of their economic benefits at the global level and in Africa, Asia and Latin America, especially for poorer and more vulnerable groups. The views and opinions in this document are those of the authors alone, and do not necessarily reflect those of IUCN, DFID or other institutions participating in the project.

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## Executive Summary

Despite well established assessment methods for valuing freshwater wetland goods and services, relatively little work has been carried out on developing and applying economic assessment techniques to identify concrete measures for the sustainable management of urban wetland systems.

In the mid-1990s it was estimated that Vientiane Prefecture contained almost 1,500 km<sup>2</sup> of permanent and seasonal waterbodies, floodplains, swamps and marshes. These wetland areas supply a wide range of economically valuable goods and services, including fisheries, farming and natural resource collection activities, flood attenuation, maintenance of water quality and supply, and treatment of domestic, agricultural and industrial wastes. That Luang Marsh is the largest of these urban wetlands. Situated on the outskirts of Vientiane City, it provides important resources and agricultural land for local communities both in the city and in the bordering rural areas. It also functions in flood protection and water treatment for the urban center.

Integrating Wetland Ecosystem Values into Urban Planning: The Case of That Luang Marsh, is a joint study conducted by IUCN, WWF, the Lao National Mekong Committee, and the Science Technology Environmental Office of Vientiane Municipality. The study is an economic assessment of the goods and services provided by That Luang Marsh in an attempt to examine the economic value of urban wetland biodiversity and its importance to people living around the wetland as well as the larger urban area of Vientiane. The overarching goal of the study is to demonstrate the importance of sustainable management of wetland areas and the need to incorporate them into urban planning and decision-making.

Methods included price based approaches used to measure both direct and indirect use values. Direct values were measured by applying market prices to wetland goods collected from the marsh. Wetland goods were estimated based on interviews conducted with village authorities from all of the 17 villages located around the marsh as well as through target interviews with villagers from six of the villages. Target group interviews were conducted in 2 urban villages, 2 semi-urban villagers, and two rural villages. Indirect values were measured using a variety of different techniques including examining damages avoided through flood prevention and estimating the replacement costs of water purification services.

According to the results of the study the goods and services associated with That Luang Marsh are worth just under \$US 5 million annually. The direct benefits of the wetland to local people make up 40% of the total value of the wetland, demonstrating the importance of the resource to local people and to the Poverty Eradication Goals of the Government of Lao PDR. The high value of the wetland services provided by That Luang Marsh reveal the importance of incorporating these functions into urban planning and capitalizing on wetland services for the larger area of Vientiane.

## I Introduction

Natural wetlands provide goods and services including flood control, wastewater treatment, and inputs to local subsistence livelihoods. However, human modification and extensive land use projects have resulted in interference with natural vegetation, hydrology, and water quality resulting in the potential loss of these ecosystem functions.

Economics forms an important, but often neglected, component of wetland assessment and management. Biological, ecological and hydrological assessment methods are relatively well-established, and there now exist generally accepted techniques for valuing freshwater wetland goods and services. Despite this, little work has been carried out on developing and applying economic assessment techniques to identify concrete measures for the sustainable management of urban wetland systems. An understanding of the economic value and forces underlying wetland degradation and loss is critical for planning sustainable management and wise use. Wetlands typically have a high economic value and wetland conservation often requires a range of economic management responses.

In the mid-1990s it was estimated that Vientiane Prefecture contained almost 1,500 km<sup>2</sup> of permanent and seasonal waterbodies, floodplains, swamps and marshes. These wetland areas supply a wide range of economically valuable goods and services, including fisheries, farming and natural resource collection activities, flood attenuation, maintenance of water quality and supplies, and treatment of domestic, agricultural and industrial wastes. That Luang Marsh is the largest of the urban wetlands. Situated on the outskirts of Vientiane City, it provides important resources and agricultural land for local communities both in the city and in the bordering rural areas. It also functions in flood protection and water treatment for the urban center.

Wetland biodiversity and ecosystem services make an important contribution to urban welfare and development. The economic goods obtained from wetlands often generate income and subsistence for some of the poorest and most vulnerable sectors of Vientiane's urban population. Wetland services, especially those relating to hydrology and water quality, help to fill the gap between the level of basic goods and services that government is able to provide, and those which Vientiane's rapidly increasing urban population requires.

Despite their high economic value, natural wetlands in Vientiane are continuing to be reclaimed and encroached, and there is a danger that they may soon be modified and converted completely. The loss of wetland biodiversity takes place at an immense social and economic cost, and runs the risk of undermining the very aims of urban development itself – better service provision, poverty alleviation, income and employment generation, and basic quality of life.

This study was conducted jointly by IUCN, WWF, the Lao National Mekong Committee, and the Science Technology Environmental Office of Vientiane Municipality in July 2003. The aim of the economic assessment is to articulate and demonstrate the economic value of urban wetland biodiversity in That Luang Marsh and to communicate this information in a practical and policy-relevant form, so as to point to concrete measures for integrating the sustainable management of wetland areas into urban planning and decision-making.

## II Background to That Luang Marsh

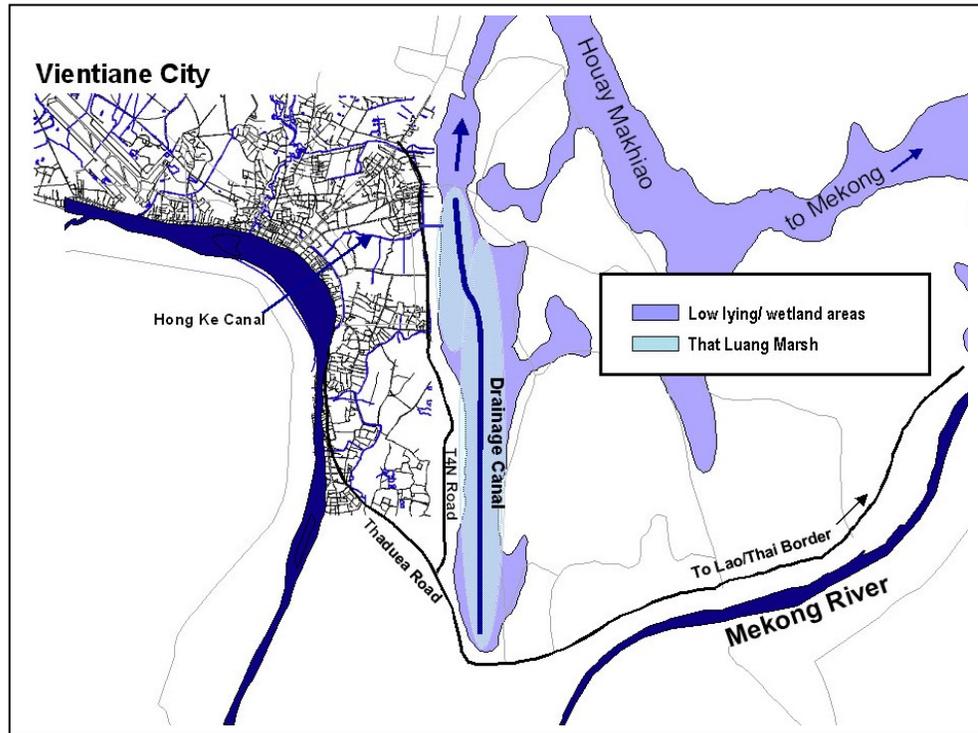


Figure 1. Drainage System Around That Luang Marsh

### 2.1 The Wetland Area

That Luang - or Salakham - marsh is the largest remaining wetland in Vientiane Municipality, located on the eastern edge of the capital city of Lao PDR. The marsh itself is roughly 20km<sup>2</sup> and is part of the That Luang Basin (Claridge, 1996) collecting water that drains from Vientiane City and surrounding areas. A large portion of the wetland has been converted to rice cultivation although changes in water regimes have resulted in annual floods and cultivation has been limited to between 700 – 1000 ha (roughly half of the wetland area) in recent years. The remaining area is covered with permanent and seasonal aquaculture ponds, shrub and grassland, and peatland (Claridge, 1996).

Water draining into That Luang Marsh comes primarily from the Hong Ke stream which collects it's water from drainage canals running throughout Vientiane. Water running out of the marsh follows Houay Mak Hiao River dumping into the Mekong 64 km south east of Vientiane.

Flora and fauna in the marsh have decreased over the past 10 years as a result of increasing agricultural and urban expansion and due to the construction of the central canal. The primary plant species are *Eichornia* sp., *Ipomea aquatica*, *Marsilea* sp., *Jussiaea* sp. and *Limnocharis flava*. There are currently approximately 20 species of fish and a variety of frogs, turtles, and snakes are still relatively common. Up until approximately 30 years ago Siamese Crocodile were found in the wetland (Claridge, 1996).

## **2.2 Settlement and Economic Activity**

The marsh stretches east of the city center falling within three districts of Vientiane Municipality. There are 17 villages (or neighborhoods) located around its outskirts, ranging from primarily rural to primarily urban and home to over 7000 households (figure 2).

Rice cultivation is the primary form of agriculture practiced in the wetland area although there is also some vegetable cultivation, primarily cucumbers and long beans, during the dry season. Many small and medium sized fish ponds are maintained along the margins of the wetland. These are either stocked or naturally fill with fish during the wet season to be trapped and raised as the water recedes. There is currently one large commercial fish farm with six ponds that total 8 ha in size.

Population growth and urban expansion in Vientiane has had a large impact on That Luang Marsh. In the early 1990s the marsh area was described as being roughly 2000 ha with 2,100 households (14000 people) living around it and involved in farming and fisheries activities (Claridge 1996). According to a study done by the Vientiane Municipality in 2000, there are now a total of 7139 households (37914 people) living in villages around the wetland, 45% of which are involved in agriculture or NTFP collection.

## **2.3 The Role of That Luang Marsh in the Vientiane Urban Environment**

Vientiane is the largest city and the capital of Lao PDR. The urban area is divided into 112 villages, or neighborhoods with a total area of approximately 30km<sup>2</sup>. The core urban population was estimated to be 161,000 in the year 2000 with a growth rate of 1% (ADB, 2001). However, the city outskirts are expanding at a much faster rate, with the growth rate in Vientiane Municipality as high as 3% in 2001 (MAF, 2002).

Vientiane city is built on the Mekong flood plain and lies on low-lying alluvial soils. A high water table and low soil permeability have had significant implications on drainage throughout the city. The monsoon season concentrates rainfall from May to September resulting in drainage problems either through inundation from extreme rainfall events, or as a result of poor drainage and surface runoff that can lead to inefficiency in septic tanks and soak ways for the percolation of wastewater (ADB, 2001).

Wetlands and marsh areas in and around the city are important physical features and provide hydrological functions such as flood control, maintaining river flows during the dry season and purification of wastewater from the surrounding urban area. In addition to That Luang Marsh there are eleven significant wetland areas within and surrounding Vientiane city (Samuelsson, 1996). Of these, That Luang Marsh is the largest in size and plays a significant role in both flood control and wastewater purification for the city (MTPC and JICA, 2002).

Drainage and sanitation system development has been based on the Vientiane Master Plan, which was written following a JICA Feasibility study and provides guidelines for urban design, drainage and wastewater quality maintenance (JICA, 1991). Currently, both flood control and wastewater sanitation are heavily reliant on the ecosystems functions of That Luang Marsh. Sanitation systems rely on infiltration of wastewater into

the ground. However, due to the low permeability of soils and the high groundwater table many soakaways fail to operate effectively resulting in discharge of sewage from tanks into drainage channels or low-lying areas many of which drain directly into the marsh. Similarly, storm water from the urban area drains into That Luang Marsh, making it the basis for flood control in Vientiane Municipality (JICA 2002).

## **2.4 Alterations to the Marsh**

Agriculture expansion has had a large impact on the wetland over the past 20 years. Up until the 1970s the area surrounding That Luang Marsh was primarily forested. At that time the district Governor of Vientiane declared that anyone who wanted to clear land could grow rice on the area they cleared (pers com. Mr. Khampong, Hong Ke village). To facilitate conversion to paddy rice and reduce flooding, Vientiane Municipality installed two drainage culverts at the north and south ends of the wetland (Claridge, 1996). By the 1980s, 700 out of a total 2000 ha were used for rice cultivation. In the mid 1980s the Government of Laos decided to further promote agriculture expansion and in 1986 a drainage canal was constructed through the entire wetland. This canal changed the natural flow regime and diverted the outflow from the south and directly into the Mekong, to the north through Houay Mak Hiao river (Samuelsson, 1998). This hydrological change facilitated dry season irrigation and resulted in conversion of the majority of the wetland into arable land.

In more recent years urban expansion and development projects have filled large areas of marsh and rice paddy for construction of business and houses. In 1999 the T4N road was improved, running the length of the west side of the wetland and connecting the center of the city to the Thaduea highway (N2) which leads to the Thai border. The improvement of this road, and the resulting increase in traffic has led to the construction of a large number of shops, restaurants, and factories along the western edge of the That Luang Marsh. This gradual development expansion has encroached on the marsh and resulted in considerable loss of wetland area.

In addition to gradual encroachment there have been a few large scale development projects over the last two years which have required considerable wetland conversion. A temple is currently being built inside the Marsh in Ban Hong Ke and the National Convention Center, initially built for the ASIAN Tourism Forum 2004, has been built inside the marsh area in Ban Phongphapao. Continued loss of wetland area will inevitably result in loss of essential wetland goods and services. If the flood control and wastewater purification functions of That Luang Marsh are compromised by reduction in wetland size, Vientiane Municipality will be forced to provide alternatives at a considerable cost.

## **III. Objectives and Methodology**

### **3.1 Objectives**

The high economic value of natural wetland biodiversity and ecosystem services has been largely ignored in Vientiane's urban planning and development processes to date. In the face of a development imperative that favors wetland conversion and reclamation for immediate short-term gains, wetlands are seen as an uneconomic use of land and resources.

That Luang Marsh brings a large variety of benefits and services both indirectly to the people of Vientiane City and directly to people living around the marsh and relying on its resources. As part of urban planning it is important to fully understand the benefits of That Luang Marsh and use them to make informed decisions that will support sustainable development and the country's poverty alleviation objectives.

The goal of this study is to calculate the economic returns of urban wetland biodiversity in That Luang Marsh by:

1. estimating the direct use benefits of That Luang Marsh in terms of its contribution to livelihoods
2. estimating the indirect use values of That Luang Marsh in terms of its contribution to flood protection, wastewater treatment, and water storage
3. drafting policy and development recommendations that maximize economic benefits of the marsh in support of improved livelihoods and urban planning

### 3.2 Economic Valuation

Economic valuation is the attempt to assign quantitative values to the goods and services provided by environmental resources. Wetlands are among the earth's most productive ecosystems. They directly support the larger landscape both as a source for biodiversity and by providing a series of goods and services. Wetlands are sources of fertile agricultural soil, rich fish diversity and productivity, and timber or aquatic plant production. Wetlands act to store water and protect the surrounding area from floods. They recycle nitrogen and store sediment and chemicals, improving water quality downstream. They are areas of natural beauty and cultural significance for which they are often given a special value (Barbier et al., 1997).

Wetland values fall into the following categories:

**Direct use values (DUV)** are benefits derived from direct use or interaction with environmental resources and services. They involve commercial, subsistence, leisure, or other activities associated with a resource. Subsistence activities in particular are often crucially important to rural populations.

Direct Wetland values in That Luang Marsh include:

- Paddy rice production
- Vegetables production - cucumber, watermelons, lettuce, beans
- Non-fish aquatic goods such as plants, snails, and frogs
- Fish both through capture fisheries and aquaculture within the wetland system

**Indirect use values (IUV)** or ecosystem functions and services relate to the indirect support and protection provided to economic activity and property by the ecosystem's natural functions, or regulatory 'environmental' services.

Indirect Wetland benefits from That Luang Marsh include:

- Flood mitigation
- Wastewater treatment

- Water Storage

**Option values (OV)** are the premium placed on possible future uses and applications of the environment. They are the value placed on the option to be able to use the environment some time in the future.

Option benefits of That Luang Marsh are:

- Future leisure and tourism

**Non-use values (NUV)** or existence values are the intrinsic significance of resources and ecosystems that are derived neither from current direct or indirect use of the environment.

Non-use benefits of That Luang Marsh are:

- Cultural significance
- aesthetic value

**Total economic value (TEV)** can be defined as the sum of all of the above listed values and can be expressed as:

$$TEV = DUV + IUV + OV + NUV$$

The scope of this study focuses only on existing direct and indirect use values of the wetland. It provides an overview of the values of these goods and services which are the most tangible and demonstrate the largest immediate benefit from wetland goods and services. The study does not try to capture option and non use values because of a lack of existing data and the extensive surveys which are required to examine these values.

### **3.3 Approaches in Measuring Direct and Indirect Use Values**

Price based approaches were used to measure both direct and indirect use values. Direct values were measured by applying market prices to wetland goods collected from the marsh. Wetland goods were estimated based on interviews conducted with village authorities from all of the 17 villages located around the marsh as well as through target interviews with villagers from six of the villages (figure 2). Target group interviews were conducted in 2 urban villages, two rural villages, and 2 villages that are partly urban and partly rural. Additional information was taken from the '*Socio Economic Survey of Villagers Living around That Luang Marsh, 2000*' conducted by the Irrigation Sector of Vientiane Municipality. All values are listed as gross benefits and do not take net costs into account.

Indirect values were measured using a variety of different techniques. The value of flood control was estimated by examining damages avoided through flood prevention. Water purification services were valued by estimating the replacement costs of these services. Water storage was valued as equal to the agriculture production made possible through irrigation. Further details of these methods are included in the results section of this report.

## IV. Study Results

### 4.1 Socio-economic Characteristics of Vientiane and That Luang Marsh

There are 17 villages situated around the outskirts of the That Luang Marsh with a total of 7,319 households and 37,914 people. The villages range from primarily urban, along the edge of Vientiane City, to rural, along the east side of the marsh. There are considerable differences between urban and rural villages both in population structure and in the proportion of people who rely on wetland resources. Despite these differences, a large proportion of all people living around the wetland rely on the goods and services that it provides.

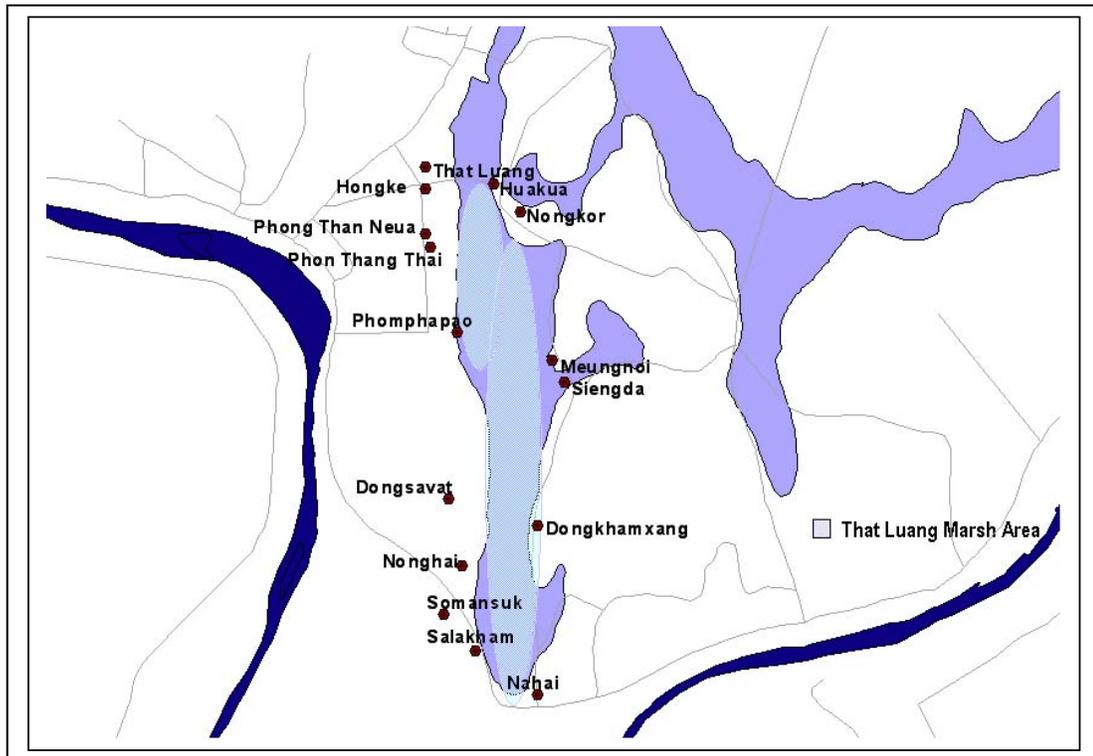


Figure 2. Target Villages around That Luang Marsh

#### Demographics

Urban and semi-urban villages have more people than the more rural villages. The demographics in all of the villages is extremely skewed towards a young population with 66% of people below 19 years of age (Figure 3).

This bottom heavy age structure will inevitably result in a population boom in coming years. Resources will be stretched across a larger number of people with lower income groups relying heavily upon agriculture and subsistence livelihoods. Increasing pressure on these resources combined with wetland reclamation due to urban growth will have the largest impact on low-income families who rely on natural resources to supplement their livelihoods.

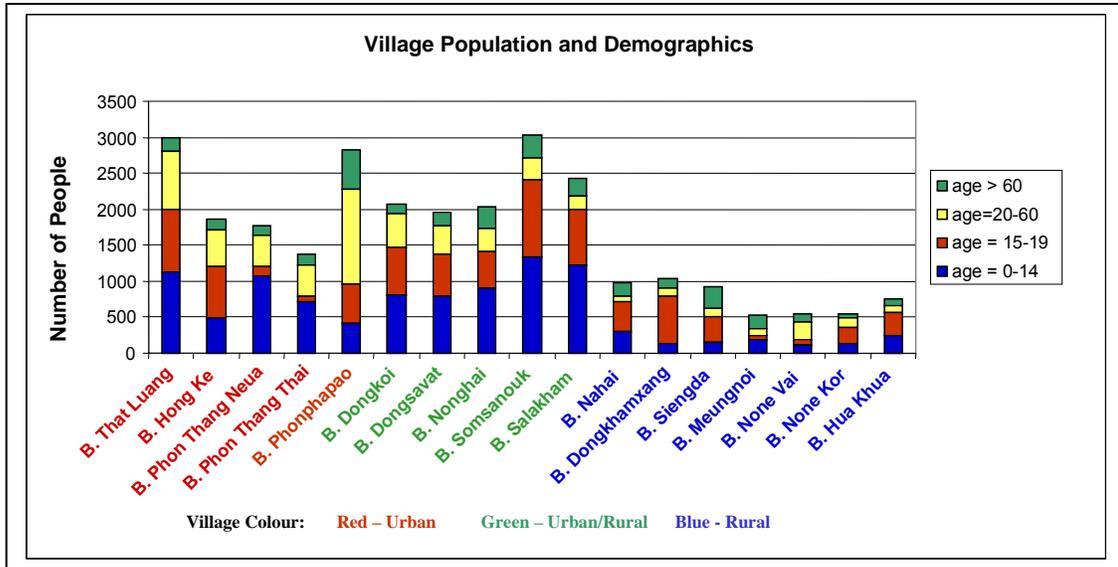


Figure 3. Demographics of Villages around That Luang Marsh

### Poverty

Lao PDR ranks 140th out of 170 countries in the UNDP Human Development Index. GDP per capita is US\$350 and many of the benefits of economic growth have yet to reach the more remote areas of the country (United Nations, 2000).

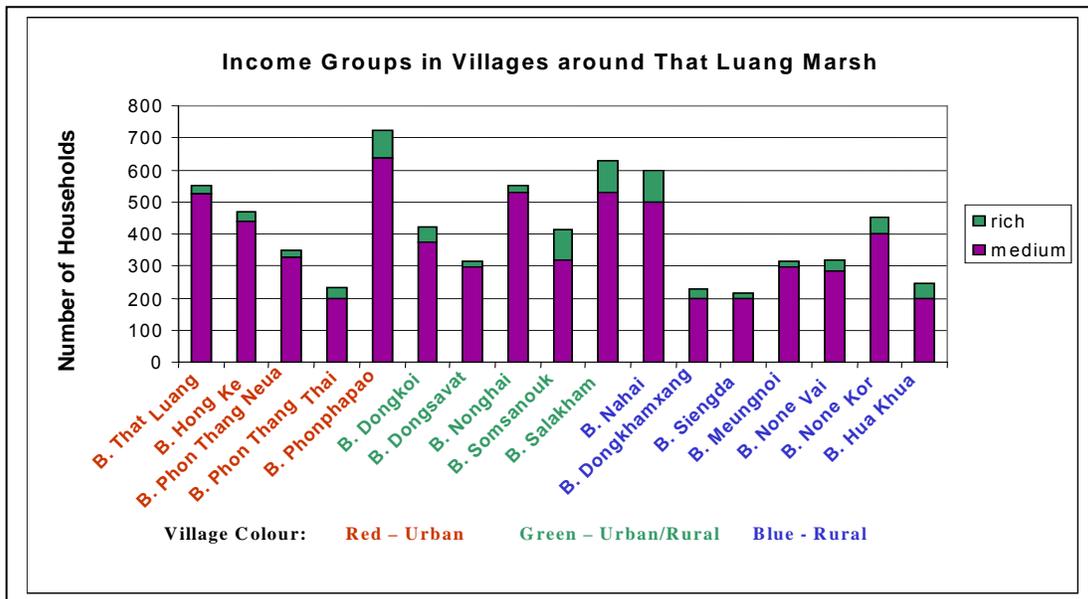


Figure 4. Income classification in villages around That Luang Marsh

Vientiane Municipality is one of the least impoverished regions of the country and the districts in and around Vientiane city are considered well off, partly because of the infrastructure, healthcare, and schooling that is available in and around the city. The Government's poverty classification system ranks poor households as those with an

annual income of below 100,000 Kip (\$US 9.6), medium households have an annual income of between 1,000,000 – 100,000 kip (\$US 96 – 9.6), and rich households have an annual income of above 1,000,000 kip (\$US 96) (GoL, 2003). (figure 2). 89 % of households in villages around That Luang Marsh are all classified as medium and 11% as rich.

## Employment

Employment in villages around That Luang Marsh is highly dependant on the marsh itself. Although there is a marked difference between rural and urban villages, agriculture and the sale of agriculture produce is the primary income generator for 71% of households around the marsh. Households in urban villages tend to be more involved in selling produce while households in semi-rural and rural villages are more likely to be agricultural producers (figure5). 7% of all households are without a primary form of income and likely rely heavily on collecting fish and aquatic produce from the marsh area (VTE Municipality, 2000).

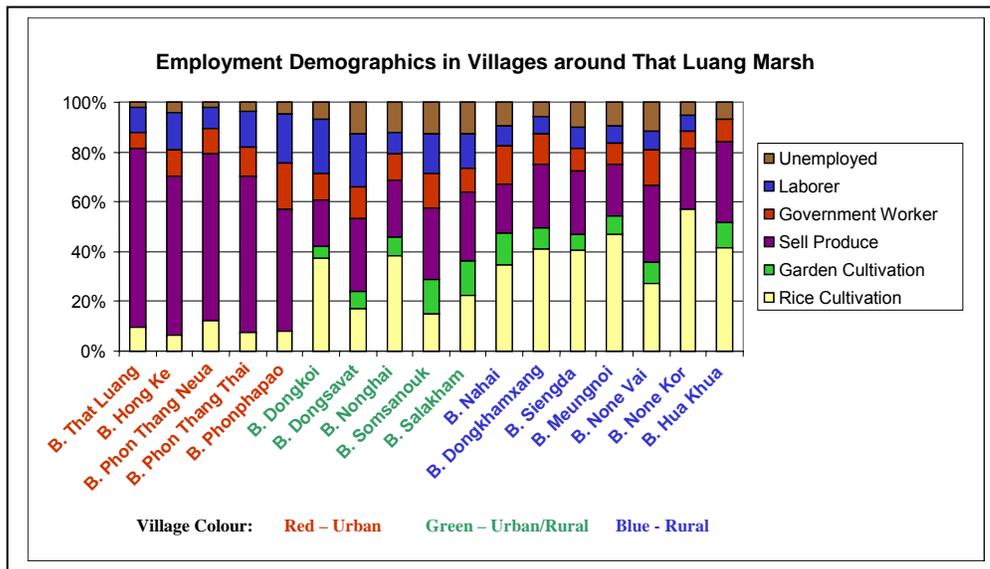


Figure 5. Employment in villages around That Luang Marsh (2000 Socio-economic Survey)

## 4.2 Direct Use Values – Wetland Goods

Wetland goods support both income generating activities and provide additional products that are essential to people in the area. The primary categories of wetland goods produced and collected from the marsh are: rice, garden products, fish, aquatic invertebrates and plants, and small mammals, reptiles and birds. The following section details the significance of each of these wetland goods to both subsistence livelihoods and as larger income generating activities.

### Rice Production

In 2002 there were 774 ha of rice cultivated inside the That Luang Marsh Area, 504 ha of dry season cultivation and 270 ha of wet season cultivation. According to village

interviews the average productivity was 4500 kg/ha in the dry season and 3600 kg/ha in the wet season and an average value of rice is 1200 kip/kg (\$ 0.11/kg). Given these figures the total annual value of rice production in That Luang Marsh is **US\$ 349,681**.

Table 1. The Value of Rice Production in That Luang Marsh

	Dry Season rice	Wet season rice	Total
Total Area (ha)	504	270	774
Yield (kg/ha)	4500	3600	
Total Produced (kg)	1815120	1215450	3030570
Average Price (kip/kg)	1200	1200	
Total Value (kip)	2,178,144,000	1,458,540,000	3636684000
Total Value (US\$)	209,436	140,244	<b>349,681</b>

While only 9% of households own land within the marsh area, 23% of households rely on rice production as their primary income (Vientiane Municipality, 2000). Many families who own land inside the marsh do not actually farm this land themselves but rather rent it to other producers. Additional value is added to the rice and income is generated for people who sell at markets in and around Vientiane. In this way there is a trickle down effect and the total income generated is spread between land owners, producers, and sellers.

The total area of rice production has decreased slightly from the 857 ha that were cultivated in 2000. Villagers in some areas reported changing flood patterns resulting in less arable land, particularly during the wet season. This may be a result of increasing infrastructure and construction within the wetland resulting in a decrease in water storage capacity.

## Gardens

Vegetable production in That Luang Marsh varies from small family gardens for local consumption to larger scale production run as a family business. The majority of large scale garden cultivation occurs in four of the rural villages on the east side of the marsh although there are small family gardens with mixed vegetables scattered through many of the other villages. Cucumbers are the most common vegetable grown in the larger scale gardens. Other common vegetables include: Chinese cabbage, long bean, and tomatoes. There is a total of 47 ha of vegetable gardens planted in the marsh during the dry season with a total annual value of **US\$ 55,017**.

Table 2. The Value of Vegetable Production in That Luang Marsh

	cucumber	long bean	cabbage	tomatoes	mixed vegetables	Total
Total Area (ha)	37	1.8	4.2	0.6	3.7	47
Total production (kg)	460491	4153	9450	528	11336	485,957
Average Price (kip/kg)	1150	1300	1300	6600	1892	
Total Value (kip)	529,564,612	5,398,250	12,285,000	3,484,800	21,447,638	572,180,299
Total Value (US\$)	50,920	519	1,181	335	2,062	55,017

## Fish

Fish are one of the most important goods provided by That Luang Marsh both because of the variety of types of aquaculture that are common throughout the wetland and because of the heavy reliance among the lower income groups on capture fisheries.

### ***Aquaculture***

Aquaculture can be divided into three categories: commercial aquaculture, household aquaculture, and household natural ponds.

There is one large scale commercial aquaculture company operating within the marsh area. They have a total of 6 ponds (8 ha). 4 of these ponds (5.32 ha) are under intensive aquaculture with 30,000 carp and tilapia fingerlings added per year. The additional two ponds are for specialty fish raised to supply restaurants and small scale sports fisheries around Vientiane. The average yield in the commercial carp and tilapia aquaculture ponds is 5625 kg/ha/year. With 5.3 ha of ponds, the total annual production is approximately 29,926 kg with a gross annual value of US\$ 34,530.

At the time of this study the operation was only in it's second year and no fish had been collected from the specialized species ponds. During the first year of operation 50,000 fingerlings were added. They will be collected after two years. No estimates were available for the value of fish that will be collected from these ponds and they were excluded from the overall value of aquaculture in the marsh.

Aquaculture is also commonly practiced at a household level by land owners inside the marsh. Household Aquaculture is practiced in two different ways. The first is relatively intensive through the addition of fingerlings into a closed off area, often during the wet season. The ponds are maintained and fish are fed over the course of the season and all of the fish are harvested after a period of approximately 8 months. Alternatively many families allow fish from the marsh to enter into a semi-structured pond area during the wet season when the water is high. As the water drops the area is closed off and the fish are trapped in the pond. These fish are then harvested over the course of the dry season or before the water rises.

In 2002 there were approximately 14 ha of family run aquaculture ponds and 25 ha of natural ponds in That Luang Marsh. According to village interviews the average yield

from these ponds is 4896 kg/ha and 3177 kg/ha/year respectively. The gross annual value of household fish culture inside the marsh is US\$ 67,418 for aquaculture and US\$ 112,253 for natural ponds.

Table 3. Value of Aquaculture in That Luang Marsh

	Commercial Aquaculture (carp and tilapia)	Family Run Aquaculture	Family Run Natural Ponds	Total
Total Area (ha)	5.32	14	24.67	38
Yield (kg/ha/ year)	5625	4896	3745	14,266
Total Produced (kg)	29,926	67,417	92,389	159,807
Average Price (kip)	12,000	10,400	12,636	35,036
Total Value (kip)	359,108,978	701,146,368	1,167,429,299	1,868,575,667
Total Value (US\$)	34,530	67,418	112,253	179,671

The gross annual value of all aquaculture in That Luang Marsh is **US\$ 179,671**.

#### Box 1. Aquaculture and Poverty Eradication

Fish culture in That Luang Marsh has grown substantially in recent years. In 2000 there were only 7.69 ha of aquaculture ponds recorded, compared with the 19.1 ha of commercial and family run aquaculture ponds in 2003. Considerable improvement in aquaculture techniques have been made throughout Lao PDR over the past 15 years and increasing fish production has been identified as directly linked with poverty eradication as part of the National Poverty Eradication Program (NPEP; 2003).

Despite this, aquaculture in That Luang Marsh is primarily conducted by upper income level households. 65% of aquaculture ponds in That Luang Marsh are managed by rich households who own their own land. The remaining 35% of households with aquaculture ponds rent land with ponds on them, only 5% of which can be classified as poor.

#### **Capture Fisheries**

Unlike aquaculture, capture fisheries is available to all income groups living around the marsh and as a result it provides an important livelihood strategy to lower income households. The variety of capture fisheries products collected from That Luang Marsh is extensive and includes fish, frogs, and aquatic invertebrates such as snails, freshwater shrimp and water beetles (Table 4).

Table 4. Capture Fisheries Products Collected From That Luang Marsh (Samuelsson, T. 1998)

Fish	Frogs	Aquatic Invertebrates
Walking catfish	Frogs	Snails
Broadhead catfish	toads	June Beetles
<i>Grass carp</i>		Freshwater Shrimp
<i>Great White Sheatfish</i>		
<i>Eel</i>		
Croaking gourami		
Glass catfish		
Swamp barb		
Asiatic snakehead		
Fighting fish		
Silver carp		
Climbing perch		
Chevron snakehead		
Common carp		
Tilapia		
Common silver barb		
Snakeskin gourami		
Striped flying barb		
Asiatic swamp eel		

The percentage of households that collect capture fisheries varies significantly by village and is more common in villages located in rural and semi-rural areas (Figure 9, Box 3). There is an estimated 3,102 households living around That Luang Marsh that collect wetland products, 90% of which collect capture fisheries.

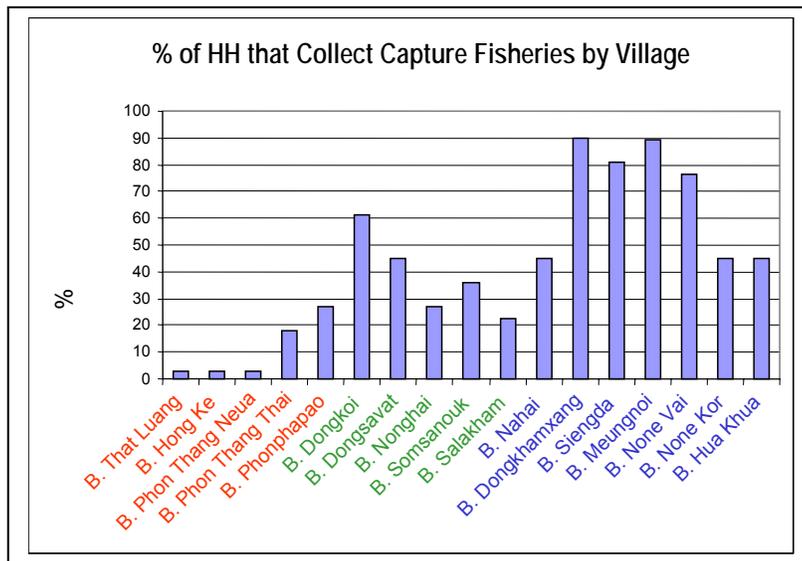


Figure 6. Number of Households that Collect Capture Fisheries in Villages around That Luang Marsh

The average price, amount collected, and value of capture fisheries products varies by product and is depicted in table 5. Fish are by far the most important capture fisheries

product collected in the marsh making up 82% of the total value of all of the products collected. According to village interviews, the average household collects 480 kg of fish from That Luang Marsh in a year giving them an annual income of \$US 466 from fish collection.

Assuming an average household size of 5 people, collection of 480 kg of fish/hh/year results in an annual collection rate of 96 kg/person/year. Other figures from the region have listed collection rates at 60 kg/person/year, or 300 kg/hh ( Sjorslev, in prep). In order to avoid overestimating the total value of capture fisheries from the wetland, they have been listed as a range from 300 – 480 kg/hh/year. Given the estimated 2792 households collecting wetland products the total value of fish collection throughout the marsh is between \$US 813,274 - 1,301,239.

Other capture fisheries products make up a significantly smaller portion of household income and total value. The average household collects 175 kg of snails, 17 kg of frogs, and 62 kg of aquatic invertebrates with a combined household value of \$US 99. The total value of these products across the marsh is \$US 278,821.

Table 5. Value of Capture Fisheries Products by HH and over the Entire Marsh

	Value Per Household				Value for the Entire Marsh		
	Price (kip/kg)	Average Collection (kg/year)	Annual Value (1,000 kip/year)	Annual Value (\$US)	Total Collection (Kg/year)	Total Value (1000,000 kip/year)	Total Value (\$US/year)
Fish	10000	300 - 480	3,000 - 4,800	391 - 466	837,672 - 1,340,275	8,376 - 13,402	813,274 - 1,301,238
Snails	1500	175	262	25	488,642	732	71,161
Frogs	12000	17	208	20	48,402	580	56,391
Inverts	9000	62	558	54	173,119	1,558	151,269
<b>Total</b>		<b>554 - 734</b>	<b>4,028 - 5,828</b>	<b>391- 565</b>	<b>1,547,836 - 2,050,439</b>	<b>11,248 -16,275</b>	<b>1,092,095 - 1,580,060</b>

The total value of all capture fisheries products across the marsh is from **\$US 1,092,095 to 1,580,060**.

## Box 2. Capture Fisheries Across Income Categories

Although capture fisheries products are collected by all income groups living around That Luang Marsh it is likely that they are more important for lower income households than for those that are well off. To better understand these differences, % of households that collect capture fisheries and total value of capture fisheries collected was compared between income groups. For the sake of this comparison, households were described as poor if they earned less than 150,000 kip in a year, medium if they earned between 150,000 – 500,000 kip, and rich if they earned more than 500,000 kip. Results showed that within poor income groups there were more households engaged in capture fisheries activities and the total value per household was higher than in medium and rich income groups (Figure 6 and 7). This reflects the reliance of these households on capture fisheries resources and the importance of incorporating capture fisheries into poverty reduction strategies in the region.

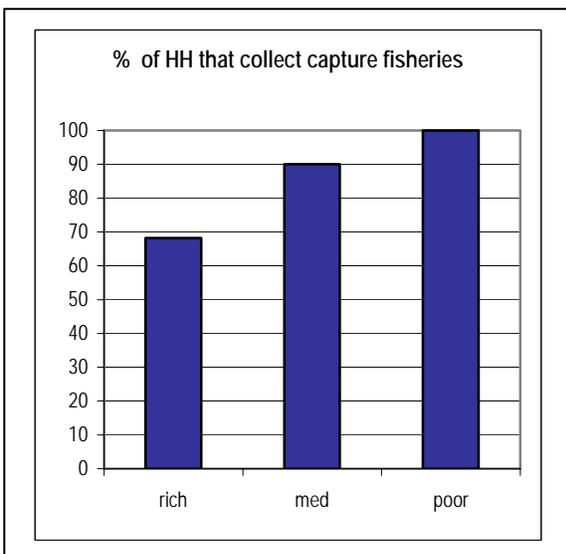


Figure 7. % of HH from different income classes that Collect Capture Fisheries

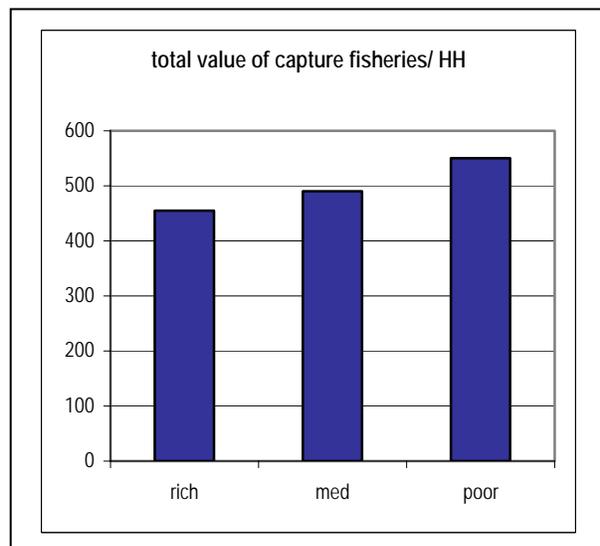


Figure 8. Total value of capture fisheries / HH in different income classes

## Non-Fisheries Wetland Products

There are a wide variety of wetland products other than fish that are commonly collected throughout the marsh. These include aquatic vegetation, terrestrial animals (birds, mammals, reptiles, and insects); and terrestrial vegetation.

Aquatic vegetation is the most important of these products because it is commonly collected by a large percentage of people living in the area. Aquatic morning glory (*Ipomea aquatica*) is a natural wetland plant that is eaten throughout Laos and grows extensively in That Luang Marsh. Culturally it is very common for people living around the wetland to collect morning glory and even high income households will collect small amounts for their own consumption or as a supplement to poultry feed. 97% of households that collect wetland products collect morning glory, much of which is sold to

markets around Vientiane. Other wetland plants that are collected include: *Eichornia sp.*, *Marsilea sp.*, *Jussiaeasp.* and *Limnocharis flava*. The annual average collection of aquatic vegetation is 300 kg/hh and has a total value of \$US 87. The total value of aquatic vegetation across the wetland is \$US 265,670.

Terrestrial animals are collected by a wide variety of people living around the marsh and range from grasshoppers to birds, mammals, and reptiles. Grasshoppers are the most commonly collected species within this category and are often collected by children in the household from June to August. Birds, mammals, and reptiles are most often collected for local consumption by poorer households. The most important species within this category is rats. The average household collects approximately 32 kg of grasshoppers and 9 kg of birds, mammals, and reptiles. The total value of terrestrial mammals across the wetland is \$US 82,111.

Terrestrial Vegetation is chiefly collected as livestock feed during the dry season and is thus primarily collected by rich households who own cows or buffalo. In the past many people collected terrestrial grasses to make floor mats, but this practice has declined significantly as plastic mats are inexpensive and readily available. The average household collecting terrestrial vegetation collects 3000 kg a year with a total value of \$US 15. The total value of terrestrial vegetation across the wetland is \$US 6,325.

Table 6. The average value of non-fish wetland products by HH and over the entire marsh.

	Value Per Household				Number of HH that Collect	Value for the Entire Marsh		
	Price (kip/kg)	Average Collection (kg/year)	Annual Value (kip)	Annual Value (\$US)		Total Collection (Kg/year)	Total Value (kip/year)	Total Value (\$US/year)
Aquatic Vegetation	3,000	300	900000	87	3040	912,132	2,736,396,180	265,670
Terrestrial Animals								
<i>Grasshoppers</i>	1,250	32	40000	4	1458	46,661	262,470,654	56,628
<i>Birds/Mammals/Reptiles</i>	20,000	9	180000	27	1458	13,124	262,470,654	25,483
Terrestrial Vegetation	50	3,000	150000	15	434	1,303,046	65,152,290	6,325
<b>Total</b>			<b>1,270,000</b>	<b>123</b>			<b>3,866,012,789</b>	<b>354,106</b>

The total value of all non-fish wetland products is **\$US 354,106**.

Box 3. Collection of non-fish wetland products across income categories.

Similar to capture fisheries, non-fish wetland products are most important to lower income households and provide a significant resource for these groups. Figure 8 below shows the difference in annual value between non-fish wetland products collected by rich, medium, and poor households around That Luang Marsh.

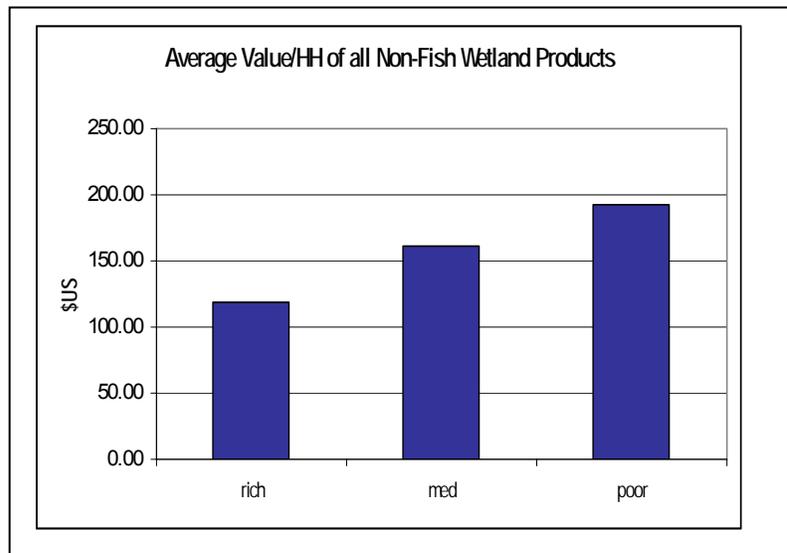


Figure 9. The Average value of non-fish wetland products for different household income categories.

#### Box 4. Wetland Products Collected by Rural vs Urban Villages

Wetland products, including capture fisheries, are collected by a wide variety of households living around the marsh and range from collection for sale to collection for household consumption. The percentage of households who collect wetland products varies significantly depending on the degree the village is urbanized. Figure 10 shows that a significantly greater percentage of households collect wetland products in villages that are more rurally located.

Despite this rural-urban divide the value/hh of wetland products collected by households from urban villages is higher than those collected from other areas (figure 11). Urban villages are characterized by households with smaller plots of land and limited space for gardens or livestock production. Given these limitations it seems likely that those households in urban areas that are collecting wetland products are relying on these products for a greater portion of their livelihood and thus spend more time and energy in their collection.

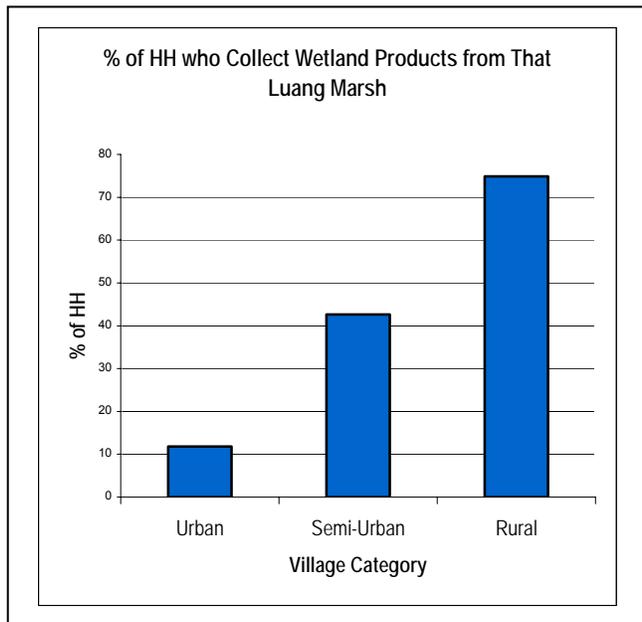


Figure 10. The %of households that collect wetland products from urban, semi-urban, and rural villages.

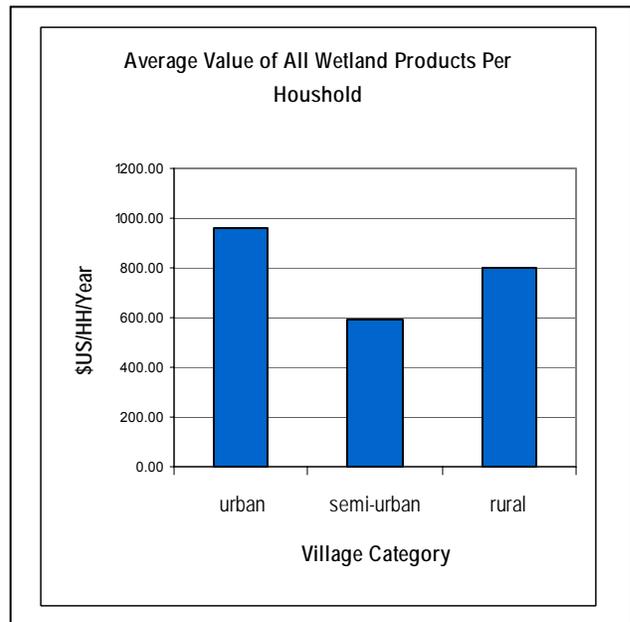


Figure 11. The average household value of all wetland products collected in urban, semi-urban, and rural villages.

As Vientiane continues to expand and there is less room for household gardens and small scale livestock production, resources from That Luang Marsh will likely become an increasingly important component of the livelihood strategies of the urban poor.

### 4.3 Indirect Wetland Use Values – Wetland Services

Wetland services result in benefits that affect a larger audience of people than those that are directly using wetland resources. That Luang Marsh provides 2 major ecosystem functions to people living in the Greater Vientiane Area. These include: (1) flood control for Vientiane City, and (2) sanitation and water purification for areas of Vientiane and villages around the Marsh. The following section gives a background to the ecosystem

services provided by That Luang Marsh and details the direct economic value that these services provide.

## Background to Sanitation, Drainage, and Wastewater management in Vientiane

Issues of sanitation and drainage are inextricably linked in Vientiane. The city itself is characterized by a high water table, low lying alluvial soils with low permeability, and a monsoon climate with frequent large rain events during the wet season. These physical conditions result in poor drainage, frequent urban flooding, and inefficiency of soakaways and septic tanks leading to leakage of wastewater directly into the waterway system.

The drainage system in Vientiane can be divided into a number of sub-catchments, which drain via a series of open and closed drains. There are two natural drainage paths that collect storm water and wastewater from throughout the city area. Hong Ke is the major drainage channel for most of urban Vientiane. It collects water from the south and central area and is connected to Nong Chanh, an urban wetland in the center of the city. Hong Ke then drains directly into the north end of That Luang Marsh. Hong Xeng drains the catchments in the north of the city and flows directly into Houay Makhiao river and eventually to the Mekong 30 km downstream from Vientiane (figure 12).

Sanitation systems throughout Vientiane rely on infiltration of wastewater into the ground. The majority of households rely on water flush latrines and are connected to a pit or chamber for containment of excreta (ADB, 2001). However due to the low permeability capacity of soils and the high groundwater table around Vientiane many soakaways fail to operate effectively resulting in discharge of sewage from tanks into drainage channels or low-lying areas and result in polluted effluent overflows, environmental degradation and health hazards.

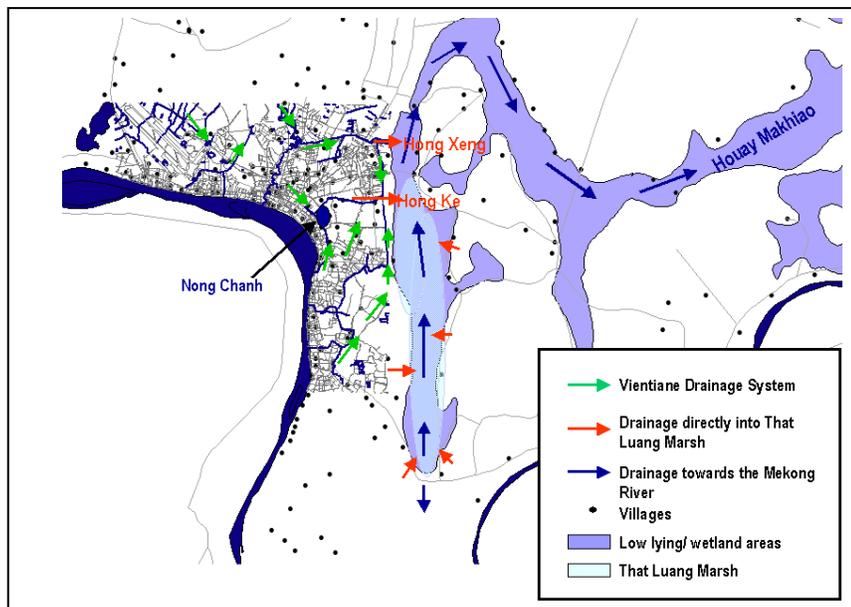


Figure 12. Drainage in That Luang Marsh

## **Past Projects**

Given the situation of flooding and sanitation systems around Vientiane there have been a series of projects aimed at improving infrastructure development, drainage and wastewater quality control. To fully understand the current situation of drainage and wastewater sanitation these projects must be examined. The four most important of these projects are:

- Rehabilitation of Sihom Area, UNCDF/UNDP, 1991-1997;
- Wastewater Management of That Luang Marsh, EU, 1993,;
- Vientiane Integrated Urban Development Project, ADB, 1996-2000,;
- Improvement of Urban Environment in Vientiane, Lao PDR, Danida, 2001-2004 (currently under completion)

All of the projects were designed based on the Vientiane Master Plan, which was developed following a JICA Feasibility study on Improvement of Drainage Systems in Vientiane and provides guidelines for urban design, drainage and wastewater quality maintenance (1991). A brief overview of these projects is provided in the following sections.

### ***Rehabilitation of Sihom Area (1991-1997)***

The Vientiane Master Plan identified priority areas suffering from environmental problems related to poor drainage, household sanitation, and access to services such as waste management. The priorities of the project were to improve living conditions of the population of the Sihom area through rehabilitation and upgrading, improve the sanitation and storm water drainage, and strengthen institutional capacity. One of the biggest successes of the project was to establish a village credit system to improve housing, small business and livelihoods.

### ***Wastewater Management of That Luang Marshes (1993)***

The That Luang wastewater management project was designed to improve wastewater treatment and drainage out of the central Vientiane area. The project built a system of stabilization ponds at That Luang Marsh designed to serve an estimated population of 44,590 for 2005 with a per capita BOD of 45g/capita/day assuming the 50% of the pollutant load would reach the treatment plant. A trunk sewer main was also constructed, intercepting sewage from Hong Thong drain to be pumped to the stabilization ponds.

### ***Vientiane Integrated Urban Development Project (1996-2000)***

The overall objective of the Vientiane Integrated Urban Development Project was to improve access to basic services and infrastructure, thus providing benefits to the urban environmental and health population of Vientiane. The project supported the formation of the Vientiane Urban Development and Management Committee (VUDMC) to institutionalize urban planning and strengthen the development control system. Project activities included construction and upgrading of primary drainage and associated secondary drainage infrastructure, provision of household septic tanks, soakage pits, and vacuum desludging trucks, construction of a sewage treatment plant adjacent to the

stabilization ponds in That Luang Marsh, and community awareness to promote community involvement in local planning and operation and maintenance.

### ***Improvement of the Urban Environment in Vientiane, Lao PDR (2001-2004)***

The project aimed to continue support to municipal planning with development of linkages between green and brown environmental issues and increased village involvement in environmental planning, implementation, and monitoring. Specific project activities included a series of small bore sewers, a number of communal septic tanks including connection of all households in the immediate project area, a new trunk bore sewer along the drainage channel connected to the existing sewer established during the above project and establishment of green park areas around Nong Chanh wetland and along the Hong Thong channel.

### **Issues and Constraints**

Despite these past projects their overall effectiveness has been limited. There has been a lack of coordination between projects and planning has not always taken the groundwater levels and soil conditions into account. Urban development throughout the city has been growing in an unplanned manner often resulting in aggravating flooding and drainage problems. There is a limited capacity at the municipal planning level and there has been very little sustainability built into project design resulting in discontinued use of the wastewater stabilization ponds and limited use of the waste treatment plant in That Luang Marsh.

### **Current Situation**

#### ***Drainage***

Although there have been considerable improvements to the drainage system since it was initially assessed by JICA in 1990, the city of Vientiane still experiences substantial urban drainage problems. Drainage of storm water from the urban area is restricted to gravitational flow and by downstream flow conditions. Drainage canals require upkeep and maintenance and there are still many tertiary canals that have not been improved and are not operating at their full potential (JICA, 2002). Additionally, increased urbanization and poor planning of new development have increased urban drainage problems (ADB, 2001).

There are currently 175 flood prone areas within the city limits, 70 of which are located in the city's core area. Flooding occurs at least 6 times a year but in many cases flood prone areas will flood every time it rains. In the urban area of Vientiane flooding is not deep but frequent flooding causes damage to buildings and roads and interrupts transportation (JICA, 2002).

The design of the city's drainage system is directly connected to the water level of That Luang Marsh and Houay Makhiao River. Storm water throughout the urban area of Vientiane drains into these drainage basins making them basis of the flood control plan for the city. The last few years have seen wet season flooding in the North of That Luang Marsh and along many parts of the Makhiao river. JICA and the Vientiane Urban

Development and Authority are considering drainage options to control flooding and allow for wet season rice production in these areas.

### ***Sanitation and Wastewater Purification***

Although drainage in Vientiane has improved somewhat as a result of the projects listed above, the situation of sanitation and wastewater purification is still very limited. Since the completion of the EU's project, 'Wastewater management of That Luang Marsh' the stabilization ponds built as part of the project have gone unused for wastewater treatment and are now being managed as aquaculture ponds (see aquaculture section above). Similarly, the sewage waste treatment plant built by the ADB was smaller than originally planned and was not properly maintained. Due to complaints of smell by local residents it was shut down and despite increased hauling cost, sewage is now disposed of at a secondary waste treatment plan 18 km outside of the city.

The Danida project, 'Improvement of the Urban Environment in Vientiane' should result in considerable improvements for urban residents in the core downtown area. The project is in the process of constructing communal septic tanks, improving the Nong Chanh marsh in the center of town, and will reestablish the use of the original EU built sewer line and stabilization ponds. However, these improvements are focused on the core downtown area and do not extend to other areas of the city or surrounding city area.

Additionally, there has been very little examination of industrial wastewater production around the city and very little is known about the extent of industrial water pollution in Vientiane. According to the country's Environmental Law (Provisions on discharge of waste water from factories, Ministry of Industry and Handicraft decree No. 180/H) industries are responsible for the treatment of all wastewater and byproducts produced as part of industrial processes. The Science Technology Environment Agency (STEA) is responsible for assessment and monitoring of wastewater quality. STEA is currently in the process of developing an environmental monitoring system for the country as a whole but at this point very little information is available about industrial waste in Vientiane.

### **Economic Value of Wetland Services provided by That Luang Marsh**

Both JICA and the ADB have conducted water flow surveys of Vientiane, examining drainage, flood control, and wastewater treatment throughout the city. The ADB's 'Vientiane Integrated Urban Development Project' identified 6 primary drainage areas within the city of Vientiane (Figure 10). According to this study drainage areas A,B,E, and F flow into That Luang Marsh via Hong Ke canal and drainage areas C and D flow into Houay Makhiao river via Hong Xeng. In estimating the economic value of the wetland services provided by That Lang Marsh this study will focus on drainage areas A,B,E, and F and villages surrounding That Luang Marsh that fall outside of the Vientiane Drainage System.

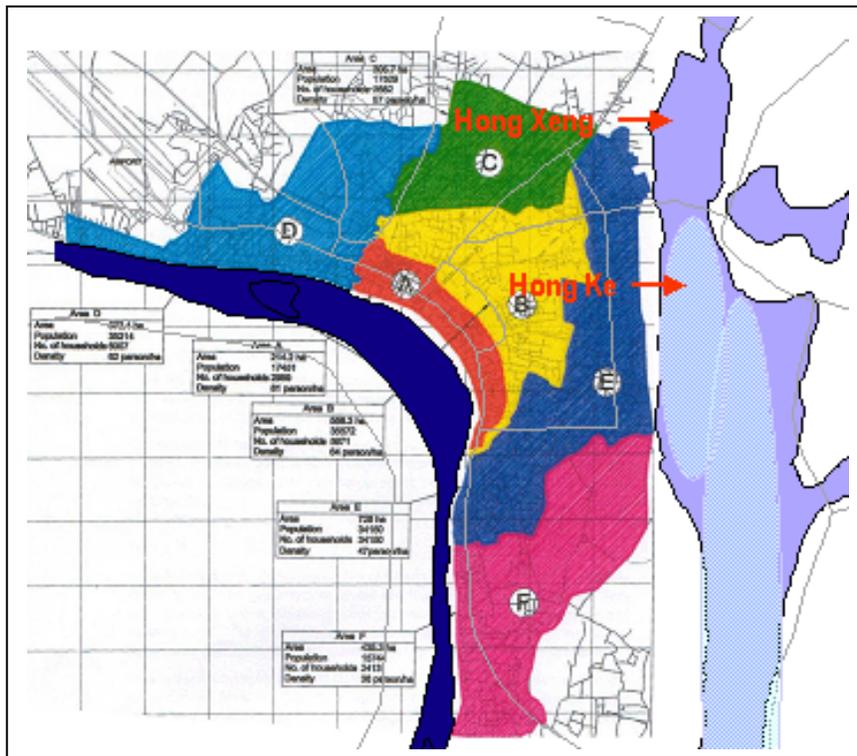


Figure 13. Drainage Areas within Vientiane City.

## Flood Control

According to JICA's Survey on Existing Road and Drainage Conditions in Vientiane Municipality (JICA, 2001), That Luang Marsh acts as a regulating basin for drainage areas A, B, E, and F (Figure 13) in Vientiane. Thus the Value of this ecosystem service can be measured by the annual value of flood damages avoided in these areas.

As part of their feasibility study on the improvement of the drainage systems in Vientiane in 1990, JICA conducted an assessment of inundation damage that would occur as a result of a 10 year flood without an improved drainage system for the city, including improved drainage into That Luang Marsh. The inundation area caused by a 10 year storm was estimated on the basis of the morphological survey map of the Mekong river basin and a field survey that was conducted during the study. The inundation area was assumed to be 2,288 ha for a 10 year storm. Inundation areas by land uses in 1989 and 2020 were estimated by superimposing inundation with present and future land use and the unit value of damage potentials were estimated based on the land use and inundation potential. The major damages and their average unit value of damage potential are summarized in table 7.

Table 7. Average unit value of inundation damage as a result of a 10 year flood in Vientiane (1\$US = 590 kip)

	Unit	Value Price (1000 kip)	1989Value 1989 Price (\$US)
House	kip/house	26,667	45.20
Household Articles	kip/house	21,333	36.16
Shop & Factory	kip/shop and factory	32,000	54.24
Public Facility	kip/m	1,300	2.20
Traffic passengers	kip/person*km	26	0.04
Traffic cargo	kip/t*km	15	0.02
Sales of shops	kip/shop	5,609	9.51
Wages	kip/house	101	0.17
Daily Life	kip/house	5	0.01
Health Conditions	kip/house	10,013	16.97
Crops	kip/ha	18,750	31.78

Future damage was estimated on the basis of land use projections and the unit value of damage potential to each item. The unit value of damage potential in each year was calculated by adopting the growth rate of the Gross Regional Domestic Product of Vientiane Municipality (GRDP), which was calculated to be as follows:

1989 – 2000	7.6%
2000 –2010	8.1%
2010 – 2020	8.4%
Over all period	8.0%

Base on these calculations an estimation was made of the economic damage of a 10 year storm in Vientiane for the years 1989 and 2020 (Table 8). According to this estimation the total estimated damages accrued through a 10 year storm in the city would have been \$US 531,280 in 1989 and would be \$US 18,566,305 in 2020.

Table 8. The economic damage caused by a 10 year storm in Vientiane in 1989 and 2020.

	1989 (1,000 kip)	1989 (\$US)	2020 (1,000 kip)	2020 (\$US)
House	121,084	205,227	4,314,230	7,312,254
Household Articles	78,284	132,685	2,866,822	4,859,020
Shop & Factory	42,072	71,308	1,779,803	3,016,615
Public Facility	309	524	3,343	5,666
Traffic	532	902	110,284	186,922
Sales	10,004	16,956	415,840	704,814
Market	3,306	5,603	35,923	60,886
Wages	365	619	13,437	22,775
Daily Life	18	31	642	1,088
Health Conditions	6,120	10,373	226,842	384,478
Crops	22,865	38,754	191,125	323,941
Sub-total	284,959	482,981	9,958,291	16,878,459
Other	28,496	48,298	995,829	1,687,846
<b>Total</b>	<b>313,455</b>	<b>531,280</b>	<b>10,954,120</b>	<b>18,566,305</b>

As part of the study JICA recognized that even with adequate drainage a complete reduction of inundation as a result of a 10 year storm would not be expected and thus all potential damages would not be avoided. In their estimation, the damage potential is assumed to be proportional to the inundated area. Based on an examination of the hydrology of the area, table 9 demonstrates the reduction rate of inundation from a series of rainfall events, as a result of an improved drainage system for the city, including construction of Hong Ke canal and increased flow into That Luang Marsh that has now been completed.

Table 9. The reduction rate of inundation as a result of improved drainage in Vientiane.

Frequency of Rainfall Events (years)	Reduction Rate (%)
2	100
5	72
10	48
20	38
50	25

Based on this reduction rate and assuming a consistent frequency of rain events, JICA estimated the annual benefits of the drainage system through savings of damages avoided. According to JICA's calculation by the year 2020 the annual benefit of the drainage system to the city of Vientiane will be \$US 4,802,000.

According to the current system for drainage in Vientiane, That Luang Marsh acts as a regulating basin for drainage areas A,B,E, and F (Figure 13; JICA 2001; ADB, 2001). According to the study described above the annual value of flood damages avoided in these areas by the year 2020 will be **\$US 2,842,000**.

## **Sanitation and Wastewater Purification**

In relation to Sanitation and Wastewater purification That Luang Marsh is currently performing waste water treatment services of domestic wastewater that is being drained into the marsh.

As stated above, drainage areas A,B,E, and F drain via primary and tertiary canals to Hong Ke canal and then into That Luang Marsh (Figure 13). That Luang Marsh is thus providing wastewater sanitation services for household wastewater and sewage draining from these areas. There are two major types of costs that would be associated with artificially replacing the waste treatment and water purification services of That Luang Marsh: (1) construction or improvement of household sanitation facilities in areas that drain directly in the Marsh and (2) extension of the waste treatment plant so that it can deal with increased waste load.

According to the ADB survey, 'Sanitation, Drainage, and Wastewater Management' (ADB, 2001) there are 1,256 households who discharge their sewage directly into the surface water and 501 households with no toilet at all within areas that are draining into Hong Ke and That Luang Marsh (table 10). Also according to this same study, drainage areas A and B are low-lying areas with high population and low soil permeability. In these areas cesspool pits do not function adequately and there is often flooding of raw sewage directly into the canal system. There are 2,952 cesspools in drainage areas A and B which are in need of upgrade.

The high water table and impermeable soils throughout Vientiane Municipality mean that sanitation using cesspools or elevated soakaways are largely inefficient and provide inadequate services. The best option for household sewage treatment has been identified as low-cost septic tanks with dual tanks to allow for settlement and anaerobic decomposition and a construction cost of approximately \$US 100 (ADB, 2001).

Given a total of 4,018 households in need of construction or improvement of adequate sewage treatment the cost of improving household sanitation facilities in areas that drain into That Luang marsh is \$US 401,769 (table 10).

Table 10. Sanitation situation and needs in Vientiane city and it's surrounding areas.

Drainage Areas in Vientiane	Area (ha)	Population	# of HH	Drain into	Septic Tank		Cesspool		Direct discharge to surface water		No toilet	
					(%)	# hh	(%)	# hh	(%)	# hh	(%)	# hh
A - Vientiane	214	17,451	2,959	Hong Ke	60	1,775	32	947	7	207	2	59
B - Vientiane	556	35,572	5,971	Hong Ke	67	4,001	22	1,314	9	537	2	119
C - Vientiane	306	17,529	2,882	Hong Xeng	69	1,989	24	692	5	144	1	29
D - Vientiane	572	35,214	6,007	Nam Pasak	66	3,965	29	1,742	4	240	2	120
E - Vientiane	728	34,150	5,281	Hong Ke	63	3,327	30	1,584	4	211	3	158
F - Vientiane	435	15,744	2,413	Hong Ke	71	1,713	23	555	3	72	3	72
Total that Drain into Hong Ke	1,933	102,917	16,624	Hong Ke	261	10,816	21	4,400	5	1,028	2	409
Villages outside of Vientiane				That Luang								
Drainage		23,217	4,566	Marsh	66	3,014	27	1,233	5	228	2	91
Total in need up upgrade								2,261		1,256		501
Cost to build Septic Tanks (\$US)								226,050		125,645		50,074
Total Cost (\$US)												401,769

Septic waste from Vientiane is currently being hauled to a small treatment plant 18km outside of the city. The cost of upgrading this plant has been estimated by the Vientiane Urban Development and Management Committee at \$US 1,000,000.

The total value of replacement costs for water sanitation services provided by That Luang Marsh is \$US 1,401,769. Assuming that the lifetime of these investments is approximately 25 years the annual value of water sanitation services provided by That Luang Marsh is **\$US 70,088**.

#### 4.4 Summary of Wetland Values

The goods and services associated with That Luang Marsh, valued as part of this study, are worth just under **\$US 5 million** to people living around the marsh and in Vientiane City (Table 12). The direct benefits of the wetland to local people make up 40% of the total value of the wetland. This demonstrates the importance of the resource to local people and to the Government of Lao PDR's Poverty Eradication Goals. The loss of these resources would have large implications for local communities, and in particular poorer households relying on wetland products. The high value of the wetland services provided by That Luang Marsh demonstrate the importance of incorporating these functions into urban planning and capitalizing on wetland services.

These figures represent a minimum estimate of the economic values provided by That Luang Marsh because they exclude consideration of other benefits such as non-use values like the conservation of biodiversity, cultural and aesthetic values. They also demonstrate only existing wetland resource values, which represent a small proportion of potential utilization opportunities.

Table 12. Summary of the Annual Value of Wetland Economic Benefits from That Luang Marsh

Wetland Resources - Direct Use	
Values	(\$US)
<i>Rice Cultivation</i>	349,681
<i>Garden Cultivation</i>	55,017
<i>Aquaculture Production</i>	179,671
<i>Capture Fisheries</i>	1,092,095
<i>Non-Fish Wetland Products</i>	354,106
Sub-Total	2,030,570
Wetland Services - Indirect Use Values	
<i>Flood protection</i>	2,842,000
<i>Wastewater Purification</i>	70,088
Sub-Total	2,912,088
<b>Total</b>	<b>4,942,658</b>

#### IV. Recommendations

Despite the high value of goods and services provided by That Luang Marsh it is under increasing threat. The most important of these threats is the rising number of reclamation projects to support residential and industrial development, in particular along the western margins of the marsh along T4N road. Urban planning in and around the That Luang Marsh Area has been ad hoc and uncoordinated and while individual projects may be relatively low impact the cumulative effect has potential to severely degrade the direct benefits and ecosystem services that the wetland provides. The city has a master plan, zoning system, and development control procedures; however, the current implementation of these procedures has limited impact on urban development and has not guided growth (ADB, 2001b). There is a crucial need to control reclamation projects that are cutting into the wetland area. These projects limit the ability of the marsh to act as a regulating basin for the city of Vientiane and will have implications on flooding in the future. They also will reduce the direct goods provided by the wetland and will have a negative impact on poorer income households living in the area. These impacts will be felt most by poor urbanized households without space for gardens or poultry production and who rely most on wetland goods.

In addition, there is a need to improve coordination between drainage and sanitation projects and consider capitalizing on wetland services as part of urban planning. There has been very poor co-ordination between urban development projects in the past, resulting in an inefficiency of services provided and in some cases increased drainage and flooding problems. There are currently two separate water treatment facilities

constructed on the edge of That Luang Marsh that have been poorly managed and as a result closed down. The Danida Project, 'Improvement of the Urban Environment in Vientiane, Lao PDR' which will be complete this year, is a step forward towards re-establishing these existing facilities and piloting an improved sewage system for a core urban area of Vientiane. It will also rehabilitate Dong Chang Wetland and demonstrate the value of a functioning wetland ecosystem to the city. Following the Danida example, existing infrastructure, wetland services and lessons learned from past projects need to be integrated into future urban planning.

In particular, the city should upgrade and re-establish use of the sewage treatment plant on the edge of That Luang Marsh. While That Luang Marsh currently plays a large role in wastewater purification, as the city continues to grow this is not a sustainable option. Increasing pollution levels will inevitably result in wetland degradation threatening other wetland goods such as aquatic resource collection. Hauling sewage to a decentralized waste treatment plant, such as the one 18km outside of Vientiane has been shown to be uneconomical for private haulers and for the city itself. In their examination of fecal sludge management, Strauss and Montangero (2001) calculated the collection costs of fecal sludge to be:

$$C_{\text{collection}} \left[ \frac{\text{US\$}}{\text{m}^3 \text{FS}} \right] = D [\text{km}] \cdot \left( \frac{\text{truck - km cost} + \frac{\text{man - hour cost}}{\text{average speed}}}{\text{truck capacity} [\text{m}^3]} \right)$$

in the case of Vientiane:      D = 18 km  
    Truck km cost (fuel, wear and tear of tires etc) = \$US 0.3  
    Man hour cost = \$US 0.5  
    Average speed = 30 km/hour  
    Truck capacity = 4 m<sup>3</sup>

The Total Collection costs are 1.4 \$US/m<sup>3</sup> of FS.

Given that there are roughly 1000 septic tanks with an average volume of 4 m<sup>3</sup> that need cleaning /month in Vientiane (ADB, 2001) the total monthly cost of hauling Fecal Sludge 18 km out side of the city is **\$US 5600**.

Instead of acquiring these costs a re-examination of the existing facilities at That Luang Marsh should be conducted. Converting the treatment plant in That Luang Marsh into a constructed wetland for wastewater purification would be a technically viable solution that would be both relatively cost effective for construction and maintenance and enhance the environment of the marsh itself.

There are a variety of examples of Constructed wetlands in South East Asia. In particular the Asian Institute of Technology (AIT) has been examining three pilot constructed wetlands since 1997 to treat septage waste from outlying areas of Bangkok (Strauss and Montangero, 2001). This study has examined design and operational guidelines that could be used to upgrade the treatment plant in Vientiane while capitalizing on eco-system services currently provided by That Luang Marsh.

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