Hydrology, habitat and livelihoods on the floodplains of southern Lao PDR

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ABSTRACT

This paper examines the relationship between hydrology, floodplain habitat and livelihoods of people living in the catchment of the Xe Bang Hieng and Xe Kong rivers of southern Lao PDR. Healthy floodplain environments are a key factor in the food security of riverine communities as these habitats yield a rich fauna and flora on which the inhabitants' livelihoods depend. The hydrologic cycle plays a fundamental role in maintaining the health of the floodplain environment. The natural seasonal variation of flow, that includes periodic inundation of the floodplains, creates and supports a diverse range of habitats and ecological niches.

Rural people, who have lived in these environments for generations, and who are well attuned to making a livelihood on the floodplains, have adopted an impressive variety of artisenal fishing gear to target specific fish species or habitats through the changing seasons. Fish, snails, aquatic insects and plants, bamboo shoots and mushrooms are just some of the natural products, harvested from riverine environments, which form an essential part of the local diet. Therefore, healthy floodplain environments and rich biodiversity resulting from an unimpeded hydrological cycle are essential to the way of life of riverine communities in Lao PDR.

It is, however, a way of life that is under threat. As the countries of the Mekong Basin grow in population and develop their economies there is increasing competition and conflict over water resources. Demand for hydropower, irrigation, road networks, river navigation and flood mitigation are a growing challenge to the natural hydrologic cycle and the health of the floodplains. Considering the significant value of floodplain biodiversity to rural livelihoods, effective management of the hydrologic cycle and conservation of the floodplain environment will be necessary to support socio-economic development and environmental health.

KEY WORDS: Lao PDR, biodiversity, seasonally flooded habitats, rural livelihoods

INTRODUCTION

The expanding populations and growing economies of the countries within the Mekong River Basin are generating intense competition for the tremendous water resources of the region. In Lao PDR, the increasing demand on water resources means development plans must strike a balance between competing users that also protects the ecologically important habitats of the floodplains. These competing interests for water resources arise from fisheries, irrigated agriculture, hydropower and navigation. All of these sectors of the economy are important to the socio-economic development of the region.

The natural resources of capture fisheries, however, are a valuable common property and a significant component in the livelihoods of the rural poor. Regardless of age, gender or socio-economic status, capture fisheries and the collection of non-timber forest products (NTFP) are an important activity that

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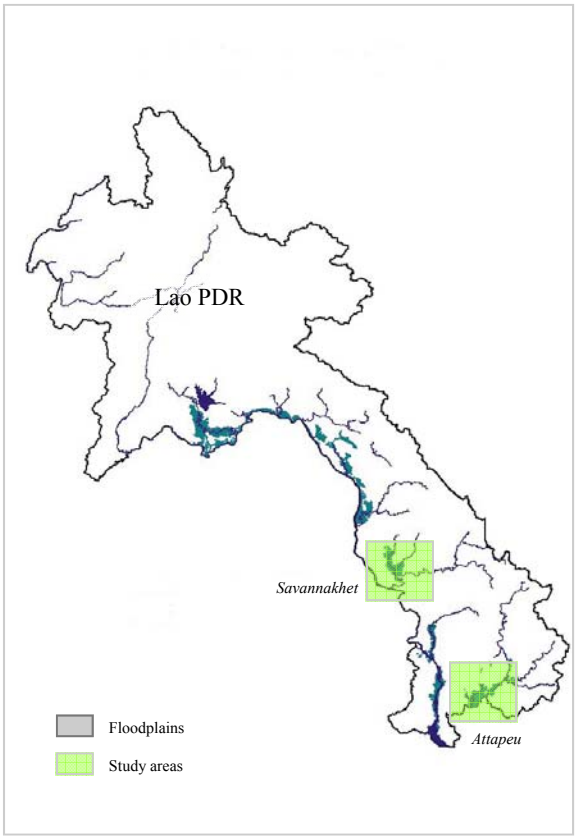


Figure 1. The extent of the floodplains of the Mekong and its major tributaries - Lao PDR

supports household food security and income. Fishing and NTFP collection are especially important to poor people who, if they do not have access to land, may not have other alternatives for food and employment. These people may not benefit directly from hydropower, irrigation and navigation improvement, but they do depend upon fish and NTFP for their livelihoods.

This paper describes one of the issues surrounding the use of these common property resources, the need for careful management of the floodplain environment and the hydrological factors that shape it. The paper illustrates this issue with reference to the extensive floodplains of Mekong and its tributaries in the southern provinces of Savannakhet and Attapeu (Figure 1) using data gathered through participatory assessments carried out by WWF, Living Aquatic Resources Research Centre (LARReC) and the provincial Livestock and Fisheries offices in both provinces.

Lao PDR is predominately a rural population with approximately 80% of people living in the countryside (UNDP 2001). The country is economically under-developed but is rich in aquatic resources from rivers, streams, floodplains and wetlands that provide necessary sustenance in times of rice shortage or crop failure. Rural people regularly collect NTFP for consumption in the home as a supplement to their staple diet of rice and livestock produce (Foppes and Khetphanh, 1997). Aquatic animals (fish, frogs, snails and insects) and plants have been important ingredients in the daily lives of Lao people for generations, providing a food source that is high in protein and rich in fat (Meusch *et al*. 2003).

As a result, the rural livelihoods in southern Lao PDR entwine closely with the seasonal rhythm of the river; the inhabitants' broad knowledge of ecology of their local environment means they are very adept at utilizing the natural resources of this dynamic ecosystem. Men, woman and children are all active in fishing and collecting NTFP, using a variety of gear types that target different fish species or habitat.

In southern Lao PDR, people value a healthy floodplain environment for the ecological role it plays in fish and NTFP production. The hydrologic regime of the river basin shapes this important environment. Alterations to river basin hydrology stemming from hydropower, irrigation development, and flood mitigation schemes potentially cut floodplains off from the mainstream river channel, severely affecting the floodplain environment, fish production and the livelihoods of people who rely upon these common property resources.

FLOODPLAIN ECOLOGY

Floodplains are an important feature of the landscape of southern Lao PDR. Characterized by rich biodiversity they are highly productive areas for agriculture and forestry. These lowland areas adjacent to rivers and streams are an integral component of a river basin and are a key element in the environmental health of a river.

The flow of rivers in southern Lao PDR fluctuates markedly between the wet and dry seasons (Table 1). This fluctuation serves to create critical habitat and food niches that support a diverse fauna and flora (Baran et al. 2001). During the period from August to November, when the flow is at its greatest, the river water inundates the floodplains and fish migrate into these flooded areas to feed and spawn (Baird and Phylavanh 1999).

Table 1. *Xe Bang Hienh and Xe Kong - mean monthly discharge (m^3/sec)*

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Xe Bang Hieng	44.9	24.0	31.2	18.4	111	131	182	194	885	309	377	194
Xe Kong	86.6	62.5	46.1	44.3	80.5	100	137	231	498	304	712	308

Note: Source: Lower Mekong Hydrological Yearbook: 1998. Mekong River Commission

The Mekong's abundant floodplain habitat is one of the key factors accounting for the river system's impressive fish productivity and diversity (Welcomme 1995) and conserving this habitat is essential not only to protect biodiversity but also to provide food security for many rural households. Floodplains are unquestionably the engine of high fish production and rich biodiversity, and serve an important ecological role for the entire river basin.

In southern Lao PDR, the floodplains of the Xe Kong and Xe Bang Hieng (Figure 2 - over page) are typical of the seasonal variation these environments display. The floodplain habitat of these rivers consists of seasonal and permanent wetlands, streams, forests, grasslands and rice paddies. High water levels during the rainy season serve to transport sediment and nutrients onto the floodplain, providing a

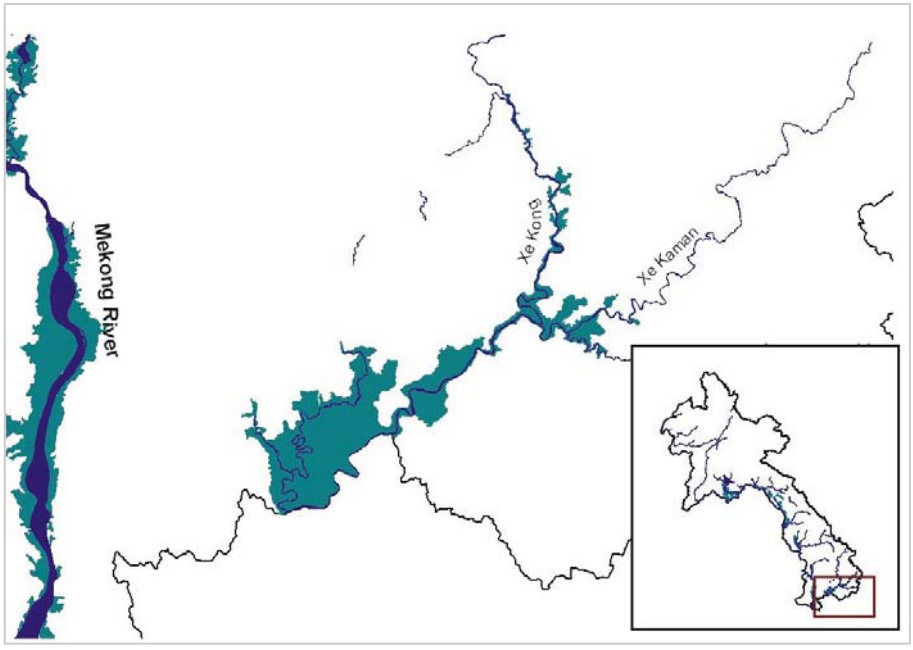


Figure 2. The floodplains of the Xe Kong and Xe Kaman river - Attapeu Province

food-rich environment for spawning fish as well as productive soil for the cultivation of rice and other cash crops. For the people living on floodplains the seasonal variations offer both inconvenience and opportunity. People rely on the rich biodiversity to provide food, income, medicine and construction materials, but seasonal floods can also damage infrastructure and hinder road transportation and livestock production.

Moreover, a healthy floodplain environment is beneficial to the entire river basin. Many fish species that spawn on the floodplain undergo long-distance seasonal migrations into the headwaters of the river system (Poulsen and Viravong 2001), suggesting that vigorous floodplain habitat has biological and socio-economic benefits for both upstream and downstream communities.

While floodplains represent a range of habitats, the type of habitat inundated by floodwaters has a direct effect on the production and diversity of fish and NTFP (Baran et al. 2001). Floodplain communities understand fully the relationship between quality floodplain habitat and high fish production and diversity and are willing to exert greater effort fishing in habitats like seasonally flooded forests than rice paddies or grasslands (Table 2).

Table 2. *Flooded habitats, effort invested and value of produce - Phouvong district, Attapeu province*

Flooded habitat	Effort per month (days)	Harvest rate (kg/day)	Market price (kip/kg)
Rice paddy	12	0.5	3,000
Flooded forest	22	3.0	6,000

The table shows how highly rural people value the high quality habitat of seasonally flooded forests for fish production. In this environment, they are not only able to catch more fish, but the species they catch fetch a higher price market.

This seasonally flooded forest environment is a complex ecosystem, rich in food resources and shelter for spawning fish and juveniles, and is an essential factor in the high fish production and diversity in the Mekong Basin (Baran et al. 2001).

THE ROLE OF THE HYDROLOGIC CYCLE

The seasonal flux of the Mekong is greater than that of any other large river in the world (Welcomme, 1979). The seasonal fluctuation in both the depth of the river and the velocity of its flow and the periodic inundation of its floodplains are key elements of the Mekong's natural hydrologic cycle. In southern Lao PDR, this flooding typically occurs during the wet season months of July to October, with the duration and timing of the flood varying from year to year. However to regard this natural phenomenon of seasonal floods solely as a threat to infrastructure, transportation and health is a mistake; rather it should be understood for the important role it plays in the environment of the river basin and the livelihoods of people who depend upon its abundant riverine natural resources.

Other hydrological factors such as water discharge, flood duration and timing, in addition to the quality of floodplain habitat, also play a role in determining fish production and supporting high biodiversity (Baran *et al.* 2001). Any development that affects the quality of floodplain habitat or alters the hydrologic cycle will have an impact on the production and diversity of fish and NTFP and the way of life of people who rely upon these natural resources.

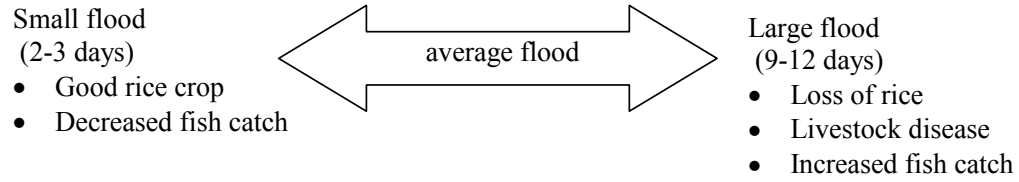
Threats to this natural cycle occur primarily from the development of infrastructure for irrigation, hydropower and flood mitigation. These types of infrastructure can alter the natural flow of a river, block long-distance fish migrations, and create reservoirs out of free flowing rivers. The cumulative impact of water resources infrastructure will lead to a dampening effect on peak flow as reservoirs holdback water during the rainy season (MRC 2003). This reduction of wet season discharge will lead to a shorter flood period that inundates a smaller area of the floodplain, thereby reducing the habitat available for fish to spawn and nurse in. The reduction, or loss, of seasonal flood events therefore is a threat to the floodplain environment that will lead to a decline in fish production and the aquatic biodiversity of the river basin.

LIVING WITH THE FLOOD

In addition to the benefits for fish production, the seasonal floods maintain the water table of the floodplain and carry sediments and nutrients onto these low-lying areas. For this reason, the people who live on the floodplains of southern Lao PDR recognize the benefits of seasonal floods to fisheries, agriculture and agro-forestry. However, they also recognize that large floods can damage infrastructure, interrupt transportation and lead to livestock disease and loss of rice crops. The box over page illustrates how people see the benefits of small to medium size floods to their overall livelihood, while recognising that large floods that may cause damage to rice crops can lead to higher fish production.

Local perception of seasonal floods

Small to average size floods are regarded as beneficial by flood plain communities. These communities have adopted livelihood strategies to cope with seasonal floods such as planting traditional varieties of flood 'tolerant' rice and utilising capture fisheries. Benefits from floods include high fish yield in the numerous rivers, streams, paddy fields, ponds and wetlands. Fish are an important food resource, high in protein and fat, thereby forming a vital component of rural food security.



Each flood is unique in terms of timing, water level, duration, and characteristics of the flooded habitat. The perception of flood benefits however may depend upon whether the person is a farmer or fisherman, land owner or landless, urban or rural, rich or poor. A good flood for fish production and capture fisheries may cause crop damage and interfere with road transportation. Rural development plans that invest in flood mitigation infrastructure in order to prevent seasonal floods altogether may benefit one sector of the economy at the expense of another.

However, from the perspective of rural villagers, many of who are dependant upon fish and NTFP for household income and food security, seasonal floods are a necessary event that supports fish production and agricultural productivity on the floodplain. These people understand 'living with the flood' is a balance between the ecological function of floodplain hydrology and the need for securing agricultural production. The development of floodplain areas and water resources infrastructure must attempt to balance the necessary role of seasonal flooding and river basin health and household economy. Promoting the concept of 'living with the flood' will improve our understanding of the benefits of floods and maintain these valuable ecosystems. Effective policy and planning will ensure that design of transportation and water resources infrastructure (roads and dams) minimises the impact on the hydrologic cycle of a river basin.

METHODOLOGY

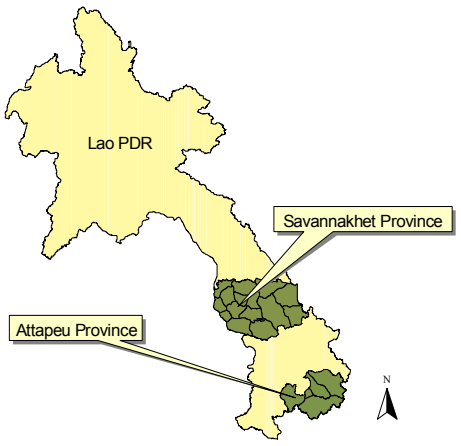
Planning for this study involved cooperation with the Lao National Mekong Committee, LARReC, Regional Development Coordination, and the Provincial Agriculture and Forestry Office and Livestock and Fisheries sections of Savannakhet and Attapeu provinces. The objective was to investigate the relationship between the hydrologic cycle, biodiversity, fish migrations and local livelihoods. To examine these themes in communities that experience different degrees of seasonal flooding this study included communities living on floodplains and in upper catchment areas.

Participatory Assessments

This study used participatory methods to analyse the local use of both habitat and biological diversity in the daily lives of rural communities. Participatory methods explore local knowledge of natural resources by inviting local communities to discuss their daily use and management. For this study, the participatory techniques used Participatory Rural Appraisal (PRA) methods to gain insight of local knowledge and encourage open discussion of the use of biodiversity. This involved asking key respondents to describe seasonal farming and capture fishery activities, compile lists of important fauna, flora and habitat as defined by local knowledge, and perform comparative ranking exercises where participants grade the importance of various types of NTFP and habitat relative to one another. Both women and men were included in the group of key informants and open-ended discussion was encouraged throughout the survey.

Site selection

The provinces of Attapeu and Savannakhet were chosen for the large flood plain areas from the Xe Kong and Xe Bang Hieng river systems respectively (see Annex 1 & 2). These rivers are two of the largest tributaries of the Mekong and serve an important ecological role in the capture fisheries of the Mekong Basin. While both rivers experience seasonal flooding during the rainy season, the size, timing and duration of floods will vary from year to year. Criteria used to select target villages were developed in cooperation with provincial and district authorities based on the socio-economic status of the village, propensity to flood and food self-sufficiency. This allowed for an analysis of the factors contributing to rural livelihoods in communities adapted to living with seasonal floods.



Attapeu province

The participatory assessments in Attapeu aimed to understand local perception of the impact and benefits of seasonal floods on biodiversity and their livelihoods. The survey included assessments in Sombpoi, Songkhon and Ta Ngao villages of Sanamxay district (Figure 3 over page). These villages located along the Xe Kong River suffer extensive seasonal flooding from the Xe Kong and Xe Pian river systems. The surveys, conducted at the household level, endeavoured to quantify household reliance on the system's rich biodiversity. On this extensive floodplain, fishing activities are not restricted to the Xe Kong, but extend across a mosaic of floodplain habitats.

Further participatory assessments, conducted in Phouvong district, examined the local perception of the quality of various floodplain habitats for capture fisheries. As an initial study into the quality of habitat, this survey compared two distinct types of floodplain habitat, rice paddies and flooded forests, to find out the value to livelihoods people attributed to each habitat with regard to capture fisheries.

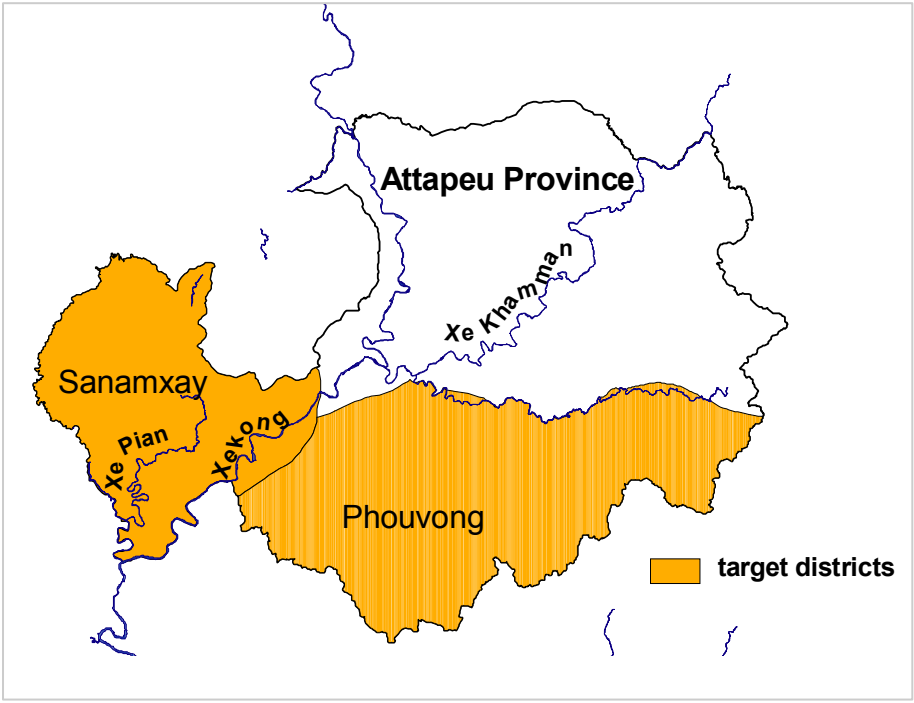


Figure 3. Targeted districts - Attapeu province

The floodplain in Sanamxay and Phouvong districts possesses a complex ecosystem of both seasonal and permanently flooded habitat that is important to local communities for fishing and harvesting NTFP. Typically, the NTFP collected in flooded areas are fish, bamboo shoots and mushrooms, with some households collecting frogs, snails, rattan, grasses and various traditional medicine (Table 3)

Table 3. *Total quantity (kg/year) and habitat of important NTFP collected in Sombpoi village of Sanamxay district*

NTFP	Habitat	Average household collection (kg/yr)	% of surveyed household collecting this NTFP
Bamboo shoots	floodplain	238	100
Mushrooms	flood plain, evergreen forest, hills, dry forest	100	100
Fish	flood plain, rivers	704	88
Ke se resin	flood plain, dry forest	67	75
Frogs	flood plain, dry forest	27	63
Yang oil	flood plain, dry forest	158	63
Monitor lizard	flood plain, dry forest	25	50
Traditional medicines (*strychnos nux vomica*)	flood plain, dry forest	118	50
Turtle	flood plain	21	50
Snails	flood plain	49	38
Bong bark	flood plain	356	25
Traditional medicine	flood plain	29	25
Yang bong	flood plain, dry forest	463	25
Fruit	flood plain	40	13

Flooding in Sanamxay predominately occurs when the Xe Pian and Xe Kong rivers overtop their banks. Villagers generally see small to average size floods as beneficial and regard flooded soil to be more productive for growing rice. Large floods, that restrict transportation, bring livestock diseases and cause the loss of rice crops, are more of a problem. However, the local rice farmers in the villages surveyed see the benefits of the floods as a trade-off between rice and fish, where large flood years damage the rice crops but result in high fish yields and small floods produce good rice but less fish. Households with little or no access to paddy land put more effort in other activities such as capture fisheries and the collection of NTFP. These households place higher value on the benefits of flooding because consequences, such as increased fish production, are a more significant component of their livelihoods.

Savannakhet province

Surveys in Savannakhet sought to compare the importance of rich biodiversity and the hydrologic cycle to the livelihoods of communities in the upper catchment and on the floodplain. The participatory assessments in Savannakhet did not focus on the household level, but rather sought a broad overview of biodiversity and livelihoods across a wider geographical range of the river. In each village, a single group of key respondents ranked the relative importance of household food resources.

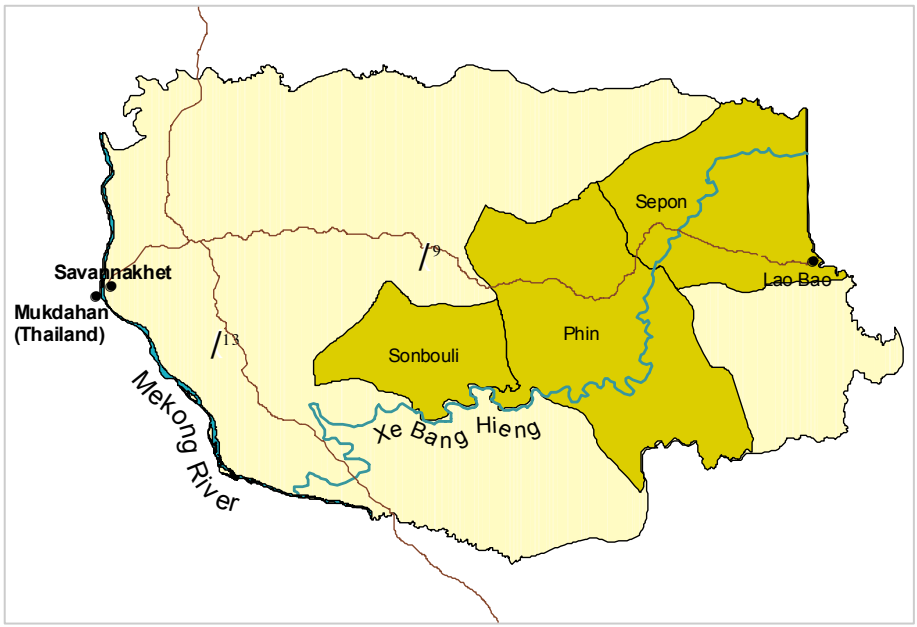


Figure 4. Targeted districts - Savannakhet province

Two field surveys collected data along the Xe Bang Hieng in the provincial districts of Sepon, Phin and Sonbouli. Sepon and Phin are located in the upper catchment where the low hills of the Annamite Mountains along the Lao-Vietnam border dominate the landscape. In these areas, the steeper gradient of the riverbanks limit the extent of seasonal floods. Conversely, in the lowland district of Sonbouli the large wet season flow in the Xe Bang Hieng causes large tributaries like the Xe Champhon and Xe Xang Xoy to back up and flood large areas (see Appendix 1). This extensive floodplain includes large forested areas, predominately bamboo and shrub forests, which, when seasonally inundated by floodwaters,

create important habitat for fish.

The first survey focused on the upper catchment area of Sepon and Phin Districts, and included participatory assessments in the villages of Kengkame, Na Huanam, Kengky, Vangkhot, Pai, Sawier, Pasiah and Nyang. The survey's objective was to determine the relative importance of capture fisheries and NTFP to the livelihoods of communities in localities subject to less severe seasonal flooding. This area does experience seasonal fluctuations in discharge, but steeper slopes limit the area of flooding. The habitats suitable for capture fisheries are therefore more restricted. Consequently, most fishing activity focuses on rivers and streams, where seasonal fish migrations triggered by hydrologic changes play a vital role in the local way of life. Because these fish migrate between the floodplains and the higher catchment, the way of life of communities living on this resource entwine intimately, even though they are geographically disconnected.

The floodplain villages of Dong Boun, Na Horlouang and Toum Nyae in the Sonbouli district were surveyed in a similar manner. Here, in contrast to the Attapeu villagers who can fish both the Xe Kong and its extensive floodplain, these communities, because of the high productivity wetlands and seasonally flooded forest habitat, invest more effort fishing on the floodplain. A single group of key respondents provided a general overview of how households value capture fisheries. The objective was to examine the relationship between seasonally flooded forests and capture fisheries and how these communities use these habitats to support their livelihoods. While floodplain communities often have access to rich aquatic resources, this study sought to highlight the importance of this diversity to livelihoods on both the floodplains and upper catchment communities and the pivotal role of an unhindered hydrologic cycle.

In each village, a group of key informants listed and then ranked the importance of floodplain habitats according to their contribution to household income and ease of catching fish. This list of aquatic habitats was grouped according to utilisation by gender. Each group then compiled a list of fish species regularly caught near their village and provided information about the habitat, migration and the importance of each species to villagers' livelihood.

LIVELIHOODS AND FLOODPLAIN BIODIVERSITY

The surveys in both provinces show how critical healthy floodplains are in shaping the environment and hence the way of life and the culture of rural people throughout southern Lao PDR. The high fish diversity and productivity of the floodplains provides an abundant food source for Lao people, accounting for the high rates of fish consumption in lowland communities of the Mekong Basin (see Table 3, also Baran and Baird, 2003; Singhanouvong and Phoutavong 2002).

For generations Lao households have consumed these riverine resources as the principle source of their protein and fat. Furthermore, these fish and NTFP resources are the 'natural capital' that rural villages rely on during periods of rice deficit or when crops fail. However, there is no similar source to rely upon during periods when fish and NTFP are limited (Meusch *et al.* 2003). The security of the food supply

and rural health therefore depends on the seasonal flooding and the vigour of floodplain habitat. Disruption of this seasonal flood pulse threatens the floodplain environment and livelihoods of the people who regularly consume fish and NTFP.

Table 4 gives a partial list of fish species regarded as important by people in three villages in the Sonbouli district of Savannakhet province. (Appendix 2 gives a complete list of fish species found near these villages.) This list, which uses local knowledge of capture fisheries rather than direct field sampling, shows just how important the diversity of habitat and aquatic organisms is to rural livelihoods.

Table 4. *List of important fish species from three villages in Sonbouli district*

Scientific name	**Market price**	**Habitat**
Belodontichthys dinema	18,000	River, deep pools
Channa spp.	8,000	River, pond, flooded area
Chitala ornata	8,000	River, pond, flooded area
Cyclocheilichthys enoplos	17,000	River, pond, flooded area
Cyprinus carpio	10,000	River, rapid, pond
Hypsibarbus malcolmi	8,000	River, flooded area
Kryptopterus cryptopterus	10,000	River, pond, flooded area
Micronema apogon	15,000	River, pond, flooded area
Morulius chrysophekadion	14,000	River, pond, flooded area
Mystus spp.	15,000	River, pond, flooded area
Notopterus notopterus	8,000	River, deep pool, flooded area
Pangasius macronema	10,000	River, pond, flooded area
Puntioplites falcifer	5,000	River, pond, flooded area
Thynnichthys thynnoides	6,000	River, pond, flooded area
Wallago attu	15,000	River, pond, flooded area

Table 5. *Factors determining the importance of fish species to local livelihoods*

Scientific Name	**Fishing**	**Eating**
Wallago attu	Difficult	Good taste
Micronema apogon	Difficult	Good taste
Belodontichthys dinema	Difficult	Good taste
Cyloscheilichthys enoplos	Difficult	Moderate
Kryptopterus cryptopterus	Moderate	Moderate
Mystus mysticetus	Difficult	Moderate
Hemibagrus filamentus	Moderate	Good taste
Chitala ornate	Easy	Moderate
Puntioplites falcifer	Easy	Good taste
Mystus mysticetus	Easy	Moderate
Pangasius macronema	Difficult	Good taste
Clarias batrachus	Easy	Good taste
Morulius chrysophekadion	Difficult	Good taste
Anabas testudineus	Easy	Good taste

A variety of factors influences the villager's perception of which fish species are important to their livelihoods (see Table 5). Fish are important for both subsistence and value their market value. Sold to traders, a large fish will provide household income, and is therefore valued for its potential to generate cash. Small fish, that are abundant and easy to catch, are valued for their regular contribution to food security. Other fish species are valued simply because of their good taste.

Strength in diversity

All the households interviewed for this study collect fish and NTFP from both permanent and seasonally flooded habitat. Permanently flooded habitat includes perennial rivers and streams, wetlands and natural ponds. Seasonally flooded habitat includes a wide range of habitat inundated by floodwaters for periods during the rainy season. This inundation may last as little as one week to several months. Examples of this habitat include the river banks and seasonal streams that are inundated as the rivers rise during the rainy season (May-October), wetlands and natural depressions on the floodplains that are inundated by floodwaters but dry out during the dry-season months, and forests on the floodplain that are flooded for varying periods of time each year. Rice fields also represent important aquatic habitat for collecting non-rice food items such as fish, frogs, molluscs and aquatic insects.

Each household relies on capture fisheries and NTFP for food and income to a different degree depending on factors such as age and gender of household members, number of individuals per household, the wealth of the family and their sufficiency of livestock and rice. While most community members are involved in the collection of fish and NTFP, the age, gender and wealth of an individual will determine the habitat they use, the gear type they employ and fish species they target. To fish in the main rivers often requires a considerable investment, in boats, motors and monofilament nets, while in habitats like flooded forests, wetlands and streams poorer people can use smaller-scale gear for collecting fish and other aquatic organisms such as frogs, snails and insects.

This diversity of habitat ensures a range of households have access to aquatic resources on a regular basis. Women and children may forage the wetland habitat nearby the village to collect plants, snails and fish for their families to eat. The men often fish the mainstream channels of the river where they can catch larger fish; they normally sell these to a trader to provide income for their household. As a rule, in rural villages the poorer the household the smaller the fish they will consume because they will sell large fish to markets in order generate some income.

Rice paddies are a multi-purpose resource utilised for both rice production and capture fisheries. Agricultural development that focuses on rice paddy production must also recognise the value of rice paddy fisheries in household food security. The loss of high quality habitat for capture fisheries, such as seasonally flooded forests and wetlands, for conversion into rice paddy may do little to strengthen food security. On the contrary, it may serve to undermine the considerable resources of food provided by healthy floodplain ecosystems.

FACTORS INFLUENCING USE OF AQUATIC RESOURCES

So far, this paper has explained how of the high biodiversity of wetland habitats support the way of life of rural communities throughout southern Lao PDR. However, how individual communities use and value these aquatic resources depends on a host of factors including their location in the basin and the hydrological regime (upper catchment or lowland floodplain), gender, household wealth and ethnicity.

Hydrological regime – upper catchment and lowland floodplains

The hydrology of the upper catchment differs in a number of significant ways from that of the lowland areas of the floodplain. In the headwaters of a river system the steeper gradient of the river banks restrict seasonal flooding, which creates different riverine habitat; as a result communities in different hydrological regimes place different emphasis on fishing.

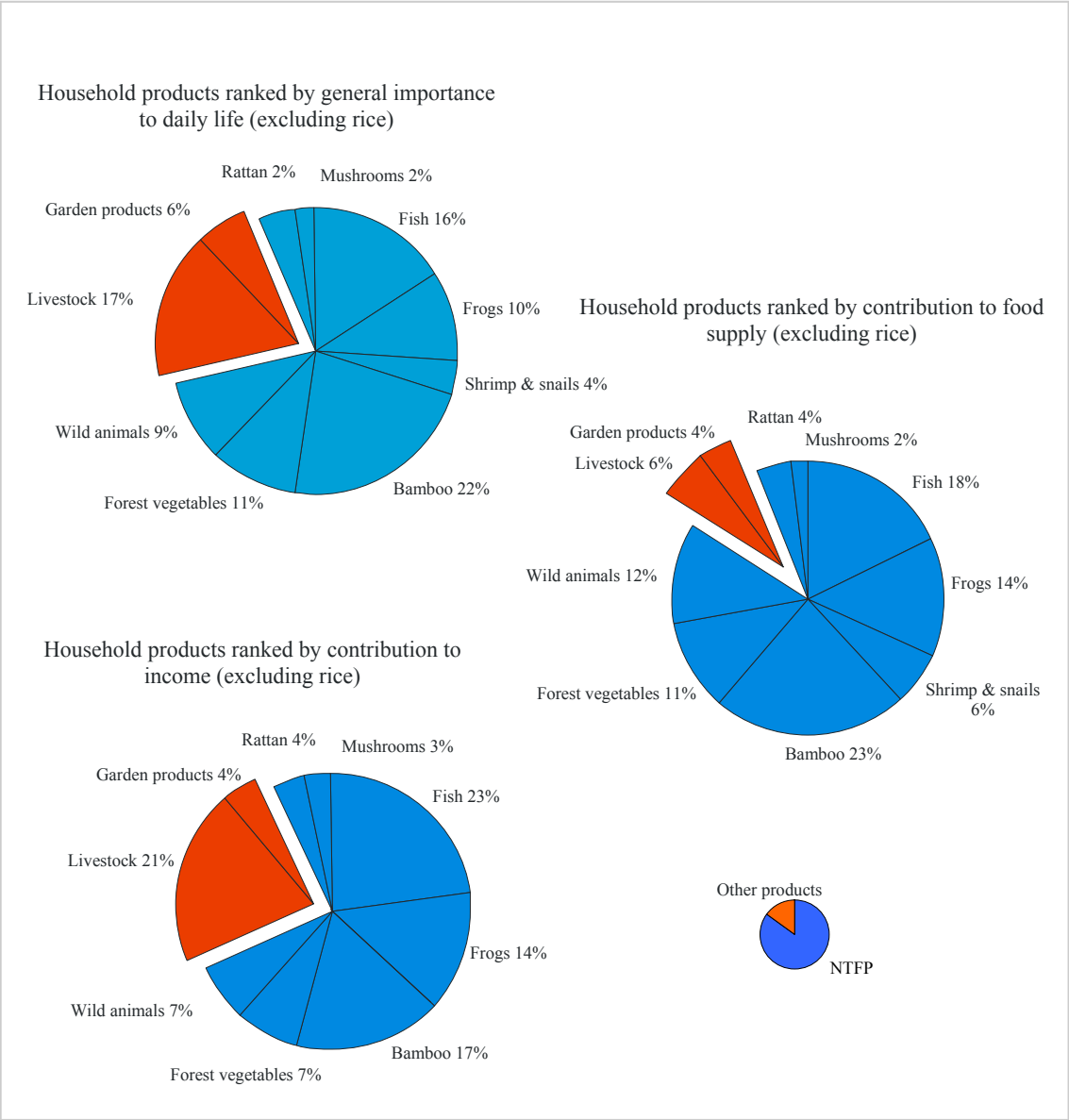


Figure 4. Ranked importance of household products in eight villages in Sepon and Phin districts, Savannakhet province

Despite a lack of floodplain habitat, fish represent a significant portion of the food and income of households in the upper catchment of a river. This lack of seasonally flooded habitat in the headwaters restricts the fishing effort to the mainstream river channels and streams. Seasonal fish migrations triggered by fluctuations in the flow remain a crucial part of the fishery. Many of the fish species that undergo these long distance migrations are dependant upon healthy floodplain habitat for spawning and feeding. In this way, the villages in the headwaters of the river to some extent rely on the same ecosystems and habitats as lowland villages from the floodplain. The hydrologic cycle is important to both maintaining critical floodplain habitat for fisheries as well as providing the environmental cue necessary to trigger seasonal fish migrations.

Table 5. *Water resources in three target villages in Sonbouli district*

	Dong Boun village	Na Horlouang village	Toum Nyae village
Perennial fishing habitat	Deep pools in river Tacham pond Tapone pond Kor swamp Xe champhone Xe Xang Xoy	Sim pond Huali wooden weir	Sim pond Xe Xang Xoy Deep pools in river
Seasonal fishing habitat	Khitha pond Khe pond Khone peung pond Khaman pond Kack het pond Edone pond Chakhe stream Lali stream	Khea pond Flood area Thomneung pond Thomleung pond	Pave pond Veun pond Sim channel Lamtheuck channel Channel small Chakhea channel

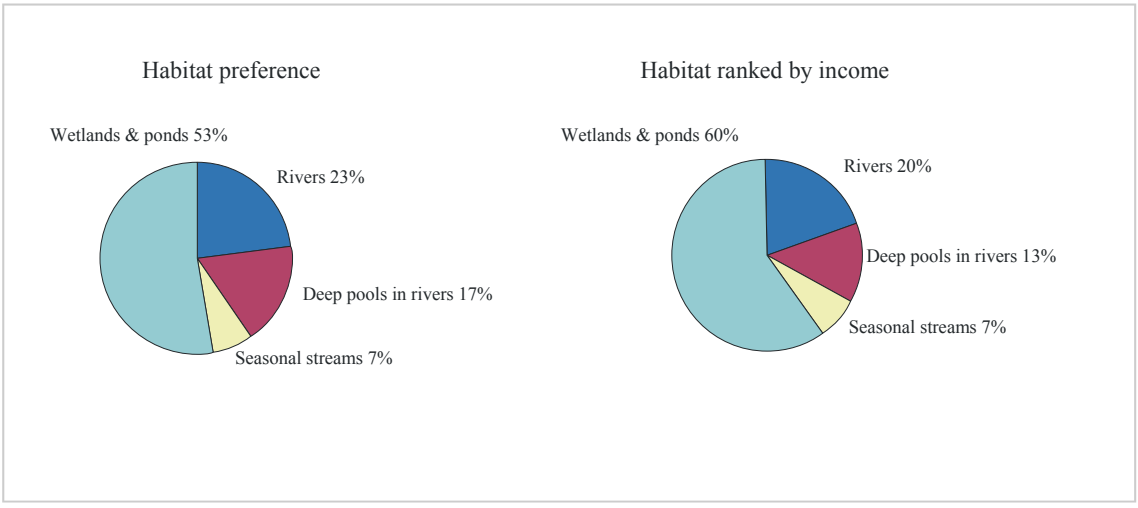


Figure 5. Preferred fishing location in Dong Boun village ranked according to habitat type

In lowland areas on the floodplain, there is more area of aquatic habitat available for fisheries. These communities are not limited to fishing mainstream rivers and streams, but have a range of floodplain habitat available (Table 5).

Table 6. *Usage of water bodies in Songkhon village, Sanamsai district*

Water Resource	Fishing Access	Purpose
Xe Pian	Year round	Income/subsistence
Xe Kong	Year round	Income/subsistence
Ta Ngao stream	Year round	Income/subsistence
Cheua stream	Rainy season	Subsistence
Ahlai stream	Year round	Subsistence
Talao stream	Year round	Subsistence
Rice paddy	Rainy season	Subsistence

Perennial and seasonal wetlands, streams, and flooded forests all offer important habitat for fisheries and livelihoods (Figure 5). These lowland communities are active participants in the fishery, targeting specific habitat for to provide subsistence or to generate income (Table 6).

Communities from the headwaters down to the floodplain regard the seasonal fluctuations in flow as positive factors in the fishery, creating seasonal habitat and triggering fish migrations. People will exert more fishing effort during the wet season months as the amount of habitat increases with the flood. Despite the larger area of habitat available, fishermen are able to catch more fish during wet season months as fish migrate across the floodplain, rice paddies, rivers and streams (Table 7).

Table 7. *Seasonal variation in capture fisheries habitat and average daily catch (kg) from three villages in Sanamsai district, Attapeu province*

Water resource	Fishing season	Dry season average daily catch (kg)	Wet season average daily catch (kg)
Xe Kong river	Year round	1.5	3.0
Seasonal stream	Rainy season		0.5
Rice paddy	Rainy season		0.4

Gender and Fisheries

Men and women will differ in their preference of habitat for capture fisheries (see Figure 6a and b over page). The gear type chosen by men compared with that used by women reflects this. Typically, the men will be fishing in the large rivers and ponds using boats and large-scale gear like monofilament gillnets. Women are responsible for many of the household duties other than fishing, and will often stay within close proximity of the village to collect fish and other NTFP using smaller gear. While this limits them in their choice of habitat, the contribution of wetland fish, molluscs, aquatic insects and plants to household food security is still significant.

Household Wealth

The wealth of the household may also determine how people value aquatic resources. To fish in the mainstream river channels often requires an investment in boats, motors, and monofilament gillnets. This may prevent some poorer households from fishing this habitat. Because fishing in wetlands and

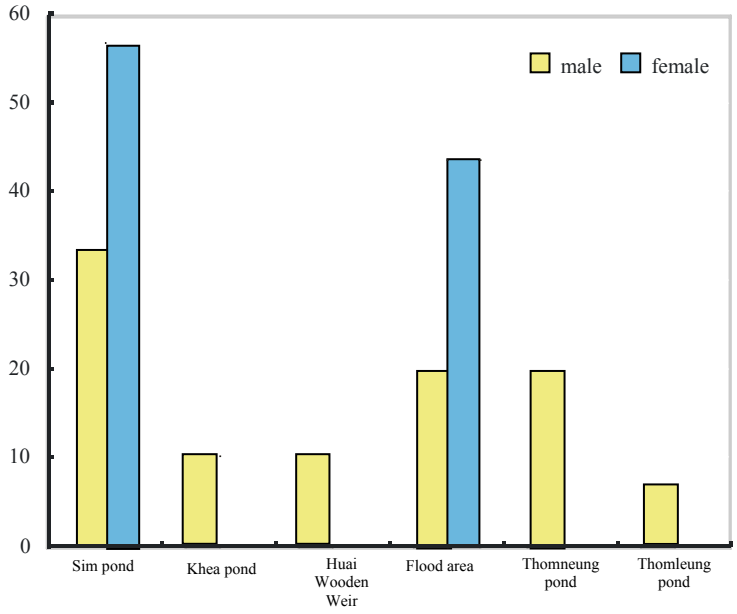


Figure 6a. Preferred fishing location in Na Horlouang village ranked by gender

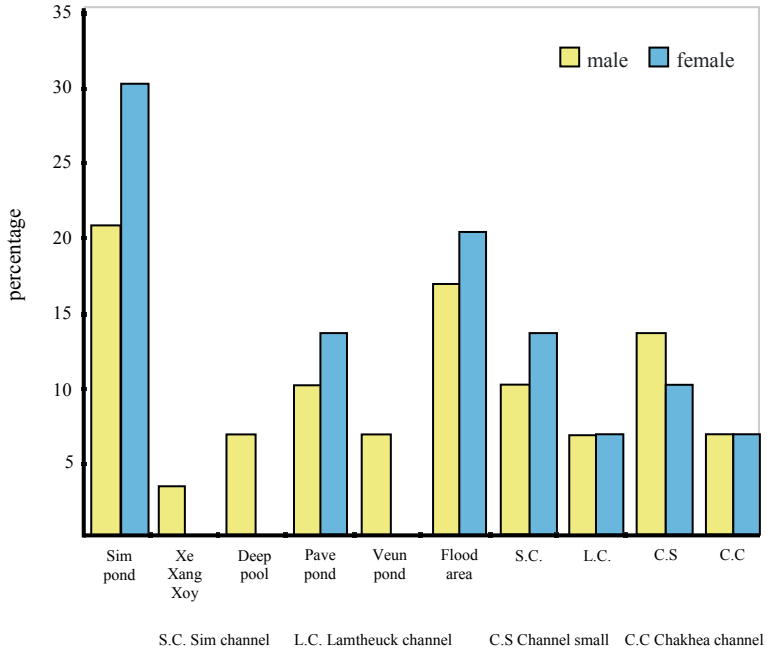


Figure 6b. Preferred fishing location Toum Nyae village ranked by gender

streams needs only inexpensive gear these habitats are available to all members of the community. To the poor and landless members of the village, a healthy fishery and floodplain environment is crucial to their household food security and income.

The type of fishing habitat may also determine the use of the fish and NTFP. Larger fish that are caught in the mainstream rivers are often sold to traders for income. Smaller fish as well as frogs, insects and wetland plants are often for consumption in the home. Rural communities will regard specific habitat as providing food for subsistence purposes or as opportunities to generate income (Table 6).

Ethnicity

Lao PDR's numerous ethnic groups may regard aquatic resources differently according to their own cultural values. The floodplains in upland areas are not extensive and ethnic groups living in these regions may not invest as much effort in fishing as do floodplain communities. However, despite having less of this habitat to fish in, upland villagers still rely on other aquatic animals such as fish and frogs to contribute a significant proportion of the protein in their diet (Figure 4).

In contrast, lowland ethnic groups living on the floodplains can access good fishing grounds and are quite skilled in capture fisheries. These communities exert greater effort on fishing and consume more fish (Table 8). Never the less many of the ethnic minorities living in these areas are very poor and are unable to buy the large-scale gear needed to fish in large rivers; poverty thus excludes some households from the fishery and they must rely instead on other NTFP.

Table 8. *Total quantity (kg/year) and habitat of important NTFP collected in Sombpoi village of Sanamxay district*

NTFP	Habitat	Average household collection (kg/yr)	% of surveyed household collecting this NTFP
Bamboo shoots	floodplain	238	100
Mushrooms	flood plain, evergreen forest, hills, dry forest	100	100
Fish	flood plain, rivers	704	88
Ke se resin	flood plain, dry forest	67	75
Frogs	flood plain, dry forest	27	63
Yang oil	flood plain, dry forest	158	63
Monitor lizard	flood plain, dry forest	25	50
Traditional medicines (*strychnos nux vomica*)	flood plain, dry forest	118	50
Turtle	flood plain	21	50
Snails	flood plain	49	38
Bong bark	flood plain	356	25
Traditional medicine	flood plain	29	25
Yang bong	flood plain, dry forest	463	25
Fruit	flood plain	40	13

Table 8 illustrates the importance of NTFP to households in Sombpoi village. This gives just a partial list of important NTFP collected by households showing the importance villagers consider items like fish, bamboo shoots, mushrooms and rattan to their way of life.

The target villages in Sanamsai district are on the floodplain of the Xe Kong, one of the largest tributaries of the Mekong and an important river system for capture fisheries. These villagers are active in the fishery, utilizing a multitude of gear in various habitats throughout the year, targeting a diverse range of aquatic organisms. Singhanouvong and Phoutavong (2002) estimate the average consumption of living aquatic resources per capita in the neighbouring Champassack province is currently 50 kg per anum. This is the average consumption across the entire province; lowland villages on the floodplain with access to an abundance of aquatic habitat are capable of harvesting a larger fish catch than average.

Floods and Capture Fisheries

The abundance of aquatic habitat on the floodplain supports a wealth of aquatic biodiversity targeted by local fishermen (see Appendix 2). Seasonal flooding plays an important role in generating and maintaining this biological diversity. This study, on the Xe Bang Hieng and Xe Kong rivers, shows the critical role of seasonal floods has on ecology of the floodplains and socio-economic benefits people living within the watershed derive from the diverse fauna and flora these habitats support.

The fishermen their families are fully attuned to the hydrologic cycle of these rivers. They can see that there are more fish in the wetlands and flooded forests than in the main river channels such as the Xe Xang Xoy and they know in years of large floods from the Xe Bang Hieng more fish migrate up the Xe Xang Xoy to the floodplains in their area. They understand the link between floods and capture fisheries. One fisherman explains, “if there is not a lot of water in the Xe Bang Hieng, there will not be fish here in our village.”

CONCLUSION

The study of the livelihoods of rural people in the wetlands of southern Lao PDR illustrates the close relationship between the hydrological cycle, the rich biodiversity of floodplain habitats and the way of life of the communities who depend on the abundance of fish and NTFP these habitats support.

However, it is a way of life that is increasingly under threat. Activities that originate outside of the influence of rural communities are challenging the riparian habitat that supports capture fisheries and NTFP production. Competition for the water resources of the Mekong Basin is putting this rich biodiversity at risk and thereby threatening the livelihoods of communities who rely on these natural resources. These threats stem from hydropower development, irrigated agriculture, flood mitigation and transportation infrastructure that may alter the hydrological cycle, as well as land conversion for agricultural development. Although development in these sectors of the economy is necessary to improve the living standards of rural people, these issues symbolise the growing conflict between urban

and rural areas, rich and poor, landowners and landless people. Rural development strategies must incorporate preservation of these ecosystems into their plans since it is these natural resources that play such a significant role in the culture and livelihoods of the very people whose standard of living these strategies aim to improve.

While clearly, there are many legitimate uses of the water resources of the Mekong Basin, development plans must find a balance between the competing demands of hydropower, irrigated agriculture, and flood mitigation and preserving the aquatic biodiversity essential to the livelihoods of the rural poor. Seasonal floods are a natural phenomenon that supports the high fish production and rich biodiversity of the Mekong Basin. An integrated approach to river basin management must understand the relationship between hydrology, biodiversity, and rural livelihoods.

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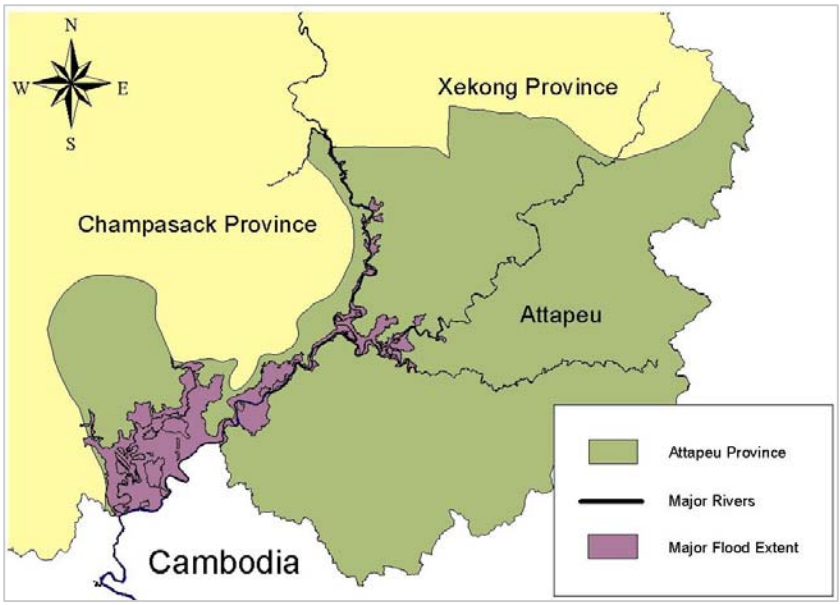
APPENDIX 1: Major flood extent, Attapeu province (Source: Mekong River Commission)



APPENDIX 2. List of fish species reported in three villages of Sonbouli district, Savannakhet province

Local name	Scientific name	Fishing season	Habitat
Pa kheng	*Anabas testudineus*	all year	Stay all area
Pa khea	*Bagarius yarrelli*	Sep-Nov	River
Pa vientfai	*Barbodes altus*	May-Jun	River
Pa khop	*Belodontichthys dinema*	Jul-Aug	River, deep pools
Pa khaman	*Catlocarpio siamensis*	Jul-Sep	River
Pa do	*Channa micropeltes*	all year	River, pond and flood
Pa khay	*Channa grandinosa*	all year	River, pond and flood
Pa khaotom	*Channa marulioides*	all year	Channel, weir
Pa khao tom	*Channa melasoma*	Apr-May	Stream, channel
Pa khor	*Channa striata*	all year	Stay all area
Pa tongdao	*Chitala ornata*	stay all area	Stay all area
Pa tasai	*Cirrhinus jullieni*	all year	River, pond, flood
Pa douck	*Clarias batrachus*	all year	River, pond
Pa chok	*Cyclocheilichthys enoplos*	Aug-Sep	River, pond, flood
Pa nai	*Cyprinus carpio*	all year	River, pond
Pa khealam	*Labiobarbus lineata*	all year	River, pond
Pa south	*Hampala dispar*	all year	River, pond, flood
Pa hoy	*Helicophagus waandersi*	Aug-Nov	River, pond and flood
Pa pak	*Hypsibarbus malcolmi*	all year	Stay all area
Pa pikkai	*Kryptopterus cryptopterus*	Sep-Oct	River, flood
Pa nang	*Micronema apogon*	Mar-May	River, pond, flood
Pa pia	*Morulius chrysophekadion*	Jun-Oct	River, pond, flood
Pa khayeng	*Mystus mysticetus*	all year	River, pond, flood
Pa koth	*Hemibagrus filamentus*	all year	River, pond, flood
Pa kheung	*Mystus wyckioides*	Sep-Nov	River, flood
Pa tong	*Notopterus notopterus*	all year	River, pond and flood
Pa seuam	*Ompok spp*	all year	River, pond, flood
Pa kapouck	*Osteochilus hasseltii*	all year	River, pond and flood
Pa nockkhao	*Osteochilus melanopleurus*	all year	River, pond
Pa bou	*Oxyeleotris marmorata*	all year	Stay all area
Payone	*Pangasius macronema*	Sep-Oct	River, pond and flood
Pa souay	*Pangasius bocourti*	Aug-Nov	River
Pa houakheng	*Poropuntius spp*	all year	River, pond, flood
Pa kar	*Pristolepis fasciata*	all year	Stay all area
Pa sakang	*Puntioplites falcifer*	all year	River, pond, flood
Pa koum	*Thynnichthys thynnoides*	all year	River, pond and flood
Pa nin	*Oreochromis nilotica*	Mar-Apr	River, pond
Pa salith	*Trichogaster pectoralis*	all year	Only pond
Pa khao	*Wallago attu*	Mar-June	River, pond, flood