

An Uncertain Future: Biodiversity and Livelihoods along the Mekong River in Northern Lao PDR

Kate Lazarus, Pierre Dubeau, Channa Bambaradeniya, Richard Friend, Latsamay Sylavong



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Introduction



Mekong view near Muang Mom. © IUCN

The Mekong River is one of the greatest river systems on Earth. It is ranked as the twelfth-longest river in the world and eighth in terms of annual discharge. The seasonal variation in the water level and the range of wetland habitats inundated by the Mekong River provide the source of the river system's productivity. The rich biodiversity within the Mekong River basin, especially fisheries, is fundamental to the viability of natural resource-based rural livelihoods of the people living within the basin. These livelihoods are founded on the integrated use of a wide range of natural resources, and which are adapted to the seasonal changes of flooding and recession. Maintaining and improving the natural productivity of the river basin is essential to both the local populations and the national economies of those countries within the basin.

The Lao People's Democratic Republic (hereafter, the Lao PDR) lies at the heart the Mekong River basin, between China, Myanmar, Thailand, Cambodia and Viet Nam, and it has an abundance of natural resources including water, wetlands, forests and biodiversity. Managing these rich resources in a sustainable manner is essential to the efforts by the Lao PDR to meet its development objectives of reducing poverty while promoting economic growth.

Although the upper Mekong River is internationally recognised as important for biodiversity, including large, endangered migratory fish species such as the Giant Catfish, there is currently very little information about the status of

these critical resources. Thus, generating information on the condition and use of Mekong resources is crucial to the development of appropriate management of biodiversity and livelihoods in the Mekong basin.

This report presents a synthesis of the findings and key points of discussion drawn from three years (2003–2005)¹ of monitoring and assessment in the upper Mekong River region of the Lao PDR. The purpose of these assessments has been to identify key areas of concern that require further regular monitoring and assessment as well as to make recommendations for such future work.



Rocky outcrops and exposed sandbars along the Mekong River. © Richard Friend/MWBP

The original focus of the upper Mekong monitoring assessments was the impacts on the Mekong River from the Lancang-Mekong Navigation Channel Improvement Project in particular the blasting of rapids and shoals along the Mekong River.

Concern over the possible impacts of these river modifications led IUCN to urge the Governments of the countries that share the Mekong River to carefully consider the threats to biodiversity, imposed by the blasting of shoals and rapids (IUCN, 2003; Finlayson, 2002). Without thorough assessments of freshwater species, biodiversity can be lost even before it is recognised. This threat highlights the importance of carrying out detailed biodiversity surveys to determine the most critical and vulnerable areas of biodiversity along the Mekong River. As a result of this concern, IUCN provided support to its government partners in the Lao PDR in beginning a series of scoping missions to identify issues and approaches for longer-term monitoring and assessment.²

The main interest of these missions was biodiversity and livelihood changes by identifying key issues that characterise the diverse riverine ecosystems and the people that depend on the Mekong basin resources as well as elucidating the causes of the changes and the possible threats. In the course of monitoring and assessment, it became increasingly clear that the upper Mekong region was undergoing rapid changes and that there were many issues of concern beyond the Upper Mekong Navigation Improvement Project, such as downstream impacts from hydropower development in China and economic corridors. Thus, there is a pressing

need for more comprehensive and regular monitoring and assessment.

The discussions presented in this report represent a collaborative effort by an interdisciplinary team of Lao PDR government officials representing the Environment Research Institute (ERI), the Science Technology and Environment Agency (STEA), the Lao National Mekong Committee (LNMC), the Ministry of Construction, Transport, Post and Communication (MCTPC), the Living Aquatic Resource Research Centre (LARReC), and provincial governments of Luang Nam Tha and Bokeo, with support from IUCN Lao PDR, the Mekong Wetlands Biodiversity Programme (MWBP), and the IUCN Water and Nature Initiative (WANI).

The project team worked together to:

- Develop further understanding of riverine ecosystems, habitats, species and the communities that depend on natural resources for their livelihoods;
- Increase the understanding of potential changes in the upper Mekong resulting from various development initiatives; and
- Provide information concerning development decisions and increase capacity to manage and conserve the natural resources of the Lao PDR.

Understanding drivers of change and their implications requires a multidisciplinary and multisectoral approach. This partnership provides an excellent opportunity for all stakeholders to practice data collection techniques and regularly assess the current biodiversity and livelihood situation along the upper Mekong.



Fishers with their catch. © Richard Friend/MWBP

Improved awareness of the importance of the Mekong biodiversity and livelihoods will make it possible to implement sound planning and policy-making that reflect the role of natural resources and biodiversity in sustaining local livelihoods.

In following up these initial findings, conducting monitoring and assessment in a thorough, more systematic and long-term manner will be crucial to ensuring accurate data collection and analyses.

In addition, there is a need for dialogue among the many stakeholders involved in managing and utilising the rich resources of the upper Mekong, in order to ensure that the information generated can meet their diverse needs. Although this report is not intended to be the final word on the impacts of change, it does illustrate key areas of concern and highlights opportunities for improved management of this important stretch of the Mekong River.

Context

The upper Mekong³ area of the Lao PDR, from the Chinese border to Luang Prabang, is undergoing rapid ecological, economic and social changes that are driven by many disparate forces – the opening of river navigation to commercial vessels, the development of roads and the construction of hydropower dams on the mainstream in south-western China. This change and the way that it is managed have significant implications not only for the upper Mekong region itself but also for the Lao PDR and the Mekong region as a whole.



Common Bird Wing butterfly (*Troides darsius*).
© Latsamay Sylavong/IUCN

The upper Mekong is of considerable strategic importance as it links the Lao PDR, China, Thailand and Myanmar. It is an area that is rich in natural resources while also providing an access route between the lower Mekong countries and the rapidly growing economy of China. In particular, it links the urban and commercial centres of Bangkok, Phnom Penh and Ho Chi Minh City with each other as well as with international markets.

The Lao PDR is strategically positioned in the context of wider economic development. Major routes pass through the Lao PDR and the opening of trade and commerce has the potential to provide great benefits to the local and national economies. While the Lao PDR is rich in natural resources, there is concern that the country may lack the capacity to manage those resources in the face of rapid change as well as the potential economic benefits to be derived from such resources. Although the area of the upper Mekong has long been a trade route, the rural communities in the Lao PDR remain largely reliant on subsistence agriculture and the use of natural resources, and are less able to benefit from emerging market changes; in fact, local communities often appear to bear a disproportionate burden of the costs, both economic and environmental.

For example, many communities have reported evidence of unusual water fluctuation patterns, raising concern over acceleration and intensification of river bank erosion. In addition, the likely decrease in the suspended sediment load carried down river due to the cascade of dams in China could have an impact on the natural ecological functions of the river. The combined and cumulative impact of these



Figure 1. Landsat-7 ETM imagery of the Three Rivers area, showing the upper Salween, Mekong and Yangtze river gorges in Yunnan province, China

Source: US Geological Survey, EROS Data Centre (landsat7.usgs.gov).

changes remains uncertain but can be expected to alter the hydrological flow and sediment load of the river with changes in the dry and flood season regime. These changes could affect the river's overall biological productivity, particularly fisheries and aquatic resources, and in turn have a profound impact on the local economies.

Study area

The Upper Mekong Programme focuses on a stretch of the Mekong River that extends for more than 500 km, from Xieng Kok to Luang Prabang in the Lao PDR. The northern-most area surveyed was located 50 km north of Xieng Kok, some 150 km downstream from the Chinese border.

The Lancang-Mekong⁴ (hereafter referred to as the Mekong) descends from the Tibetan plateau and passes through the deep gorges in the upper reaches of Yunnan province, China. It then meanders through Xishuangbanna before entering the Lao PDR.

The last segment of the upper reaches of the Mekong River that drain the northern provinces of the Lao PDR comprises mountain headwater streams with extensive rocky outcrops and rapid systems. After a long decent through steep mountains, the Mekong's gradient lessens as it enters the Lao PDR. The water flows swiftly down steep slopes cutting through a V-shaped valley.

As the Mekong passes through the plateaus and mountains of south-eastern Tibet it comes into close proximity with other major drainage networks of southern and eastern Asia in what is known as the Three Rivers area (figure 1). This

very rugged area is characterised by the steep, parallel river gorges of the Salween, Mekong and Yangtze rivers that are separated by snow-capped mountain ranges of up to 5,000 metres. Even the valley floors of these rivers are at elevations of 1,000 to 1,500 m.

In the Landsat-7 ETM imagery (figure 1), the different colours are indicative of land cover. For example, snow-covered terrain is light blue while vegetation cover appears as pink, brown and green. The narrow river valleys are deeply incised into the rugged terrain; their orientation is from north to south. The image covers an area of approximately 185 km x 250 km.

Part of the way through its descent, the transition from a mountain stream to a midland stream is already visible, where the valley broadens and the river begins to meander. This segment covers only a relatively short stretch, from km

Figure 2. Map of the study area



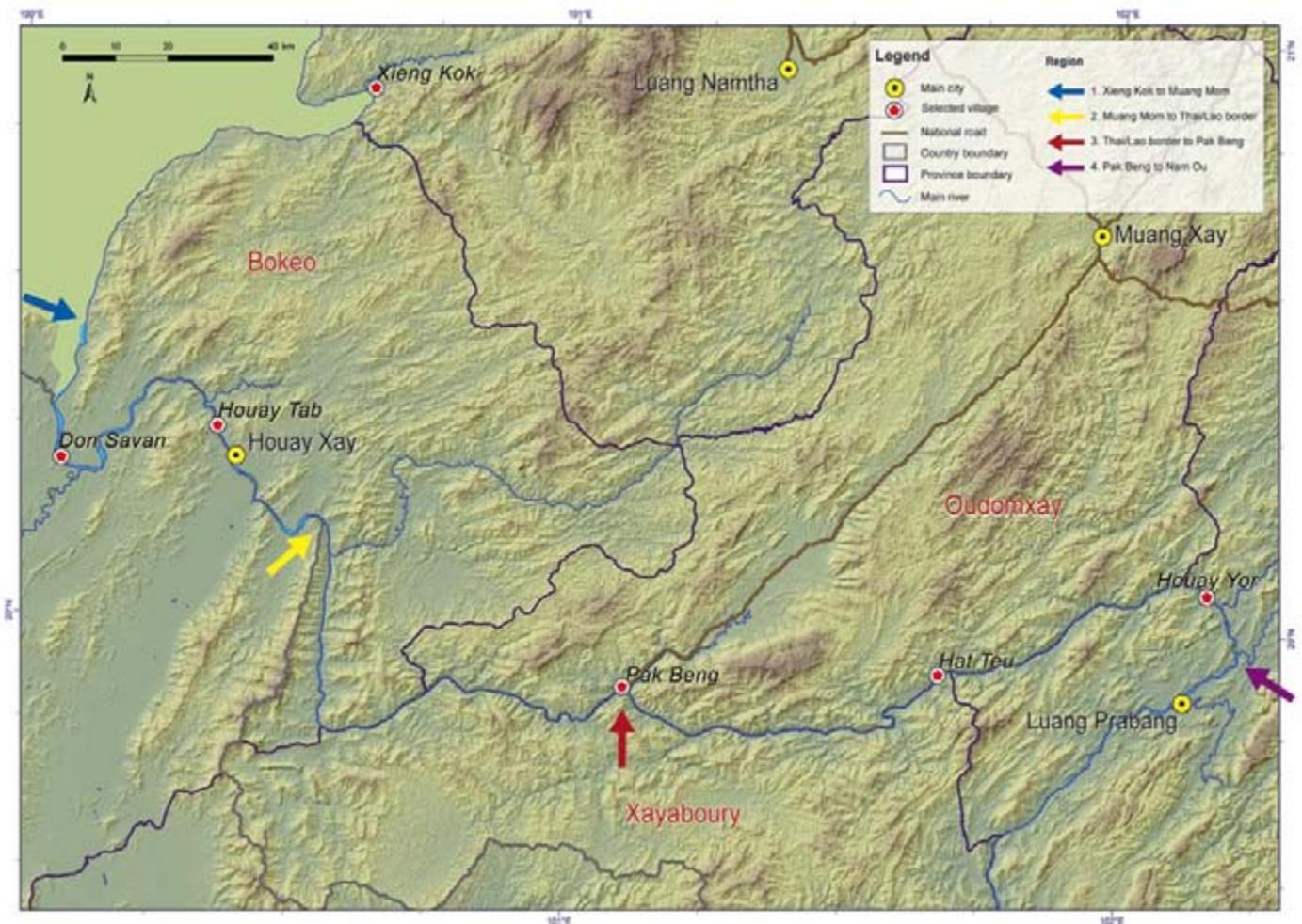
100 to km 200. The Mekong River near Houay Xay (figure 3), for example, is characterised by wide floodplains and meandering channel patterns. This segment covers about one-third of the length of the study area, with alternating short stretches through narrow mountainous passages. This distinct segment of the Mekong borders Thailand along its entirety.

As the Mekong River leaves Thailand's border to continue its journey through the mountainous landscape of the Lao PDR, characterised by the long stretch of mountain ranges that run in general from north to south, the river again becomes a narrower and faster stream. For the remaining stretch, the Mekong flows in a mainly easterly direction all the way through to Luang Prabang.

Figure 3 shows the four main sections of the study area corresponding mainly with important changes in the river

morphology, changes particularly evident for the first three segments. The first segment ends at Muang Mom, near Chiang Saen, Thailand, where the river changes from a narrow mountain stream to a wider and meandering stream passing through an open valley. The relatively brief journey through this valley ends at the point where the Mekong no longer borders Thailand. The river then flows through a mountainous landscape cutting across a number of mountain ranges all the way to its confluence with the Nam Ou. This long stretch is broken into two segments. For the last segment from Pak Beng to the Nam Ou confluence, the river maintains its easterly course through a similar landscape. However, Pak Beng is regarded as an important landmark in the area and a logical break point to keep each segment to a similar length. Progressive changes in vegetation cover can be observed, including the growing occurrence of dry dipterocarp forests.

Figure 3. Map of the upper Mekong study area from Xieng Kok to Luang Prabang



Note arrows indicate the four main regions. Projection: UTM Zone 48, Datum Indian 1960. Source: Mekong River Commission, 2005.

Dynamism and Uniqueness of the Mekong River System

The Mekong River is a complex and dynamic system. It passes through steep mountains and is characterised by an abundance of reefs and rapids, rocky outcrops and deep pools, places opening into a wider valley where stream flow is reduced. Numerous small streams and tributaries meander into and off from the Mekong mainstream.



Wooden boats at Ban Kok Kha. © Richard Friend/MWBP

The seasonal changes of the river are dramatic, with water levels increasing and decreasing as a result of the combined effect of snowmelt from the Tibetan plateau and monsoon rains. Stream levels recorded at the Chiang Saen, Thailand station can fluctuate by as much as 10 m between mid-April and mid-August. Further downstream in Luang Prabang, the seasonal changes in water levels can reach more than 15 m. As the water recedes in the dry season, a range of sub-ecosystems are revealed such as sandbars, pebble flats, reef beds and rocky outcrops; these areas become important habitat areas for migrating birds.

The seasonal changes are important contributors to the overall production of the region's rich biodiversity. Important

bird areas are found around Chiang Saen. This area also includes important habitats for fish species along stream banks, floodplains (fringing type), rapids, rocky shores and deep pools. Deep pool areas are important fishing sites. Local fishers have long known that many fish species, often large ones, gather in deep pools especially during the dry season. Deep pools are believed to be used as breeding grounds for fish (Poulsen and others, 2002). Seasonal changes in the hydrological regimes affect fish biology – their foods, movements, growth and breeding seasons. Among tropical freshwater fish species, environment changes such as rising water levels or changes in water chemistry provides important biological cues (Lowe-McConnell, 1987). Heavy monsoon rains send crucial signals to local fauna about the

impending event. Many riverine fish species move upriver to spawn. This has been well documented among a number of long-distance migratory fish species found in the upper Mekong, based on surveys of local knowledge (Poulsen and others, 2000).

Household livelihood strategies have adapted to this system, utilising the resources from the river and its banks to the uplands. Households are involved in a variety of activities depending on the season and the resources that become available. Each of these activities constitutes an essential component of the overall household livelihood strategies. This diversity of activities is a mechanism for managing seasonal change and taking advantage of diverse resource opportunities. It is also a mechanism for dealing with vulnerability.

Local people living along the banks of the Mekong River are knowledgeable about the natural environment and its rich resources. The river provides a wide range of plants, fish and aquatic animals such as shrimp, crabs, frogs and turtles. Local inhabitants use a variety of fishing gear (nets, traps and hooks) that target particular habitats and, often, specific species. For example, rows of traps are placed along the river bank in the flood season to catch fish feeding along the bank, whereas floating hooks are placed around rocky outcrops and deep pools to target larger species as they feed in deeper stretches of the river.

Local people often cover large distances when fishing, drawing on their extensive knowledge of fish habitats and migration patterns in order to engage in a wide range of fisheries. Fishing also occurs in the small streams and tributaries as well as backwater swamps to which some fish migrate to spawn. Often, women use these smaller water bodies.

In several communities around the Houay Xai area, local people collect the Mekong water weed, kai, which is an important source of food and protein, and a great local delicacy. The production of kai, as with fisheries, is dependent on the natural patterns of flooding and water recession. One impact of water fluctuations that has been reported by local people is the adverse effect on this rich resource, resulting in a decrease in kai production.

The receding water levels in the dry season reveal extensive sand bars, islands and river banks that, in turn, provide important livelihood opportunities. In several communities, gold panning is an important economic activity largely undertaken by women during the dry-season months. For some communities, gold provides the main source of savings, while for other communities, it is the main source of



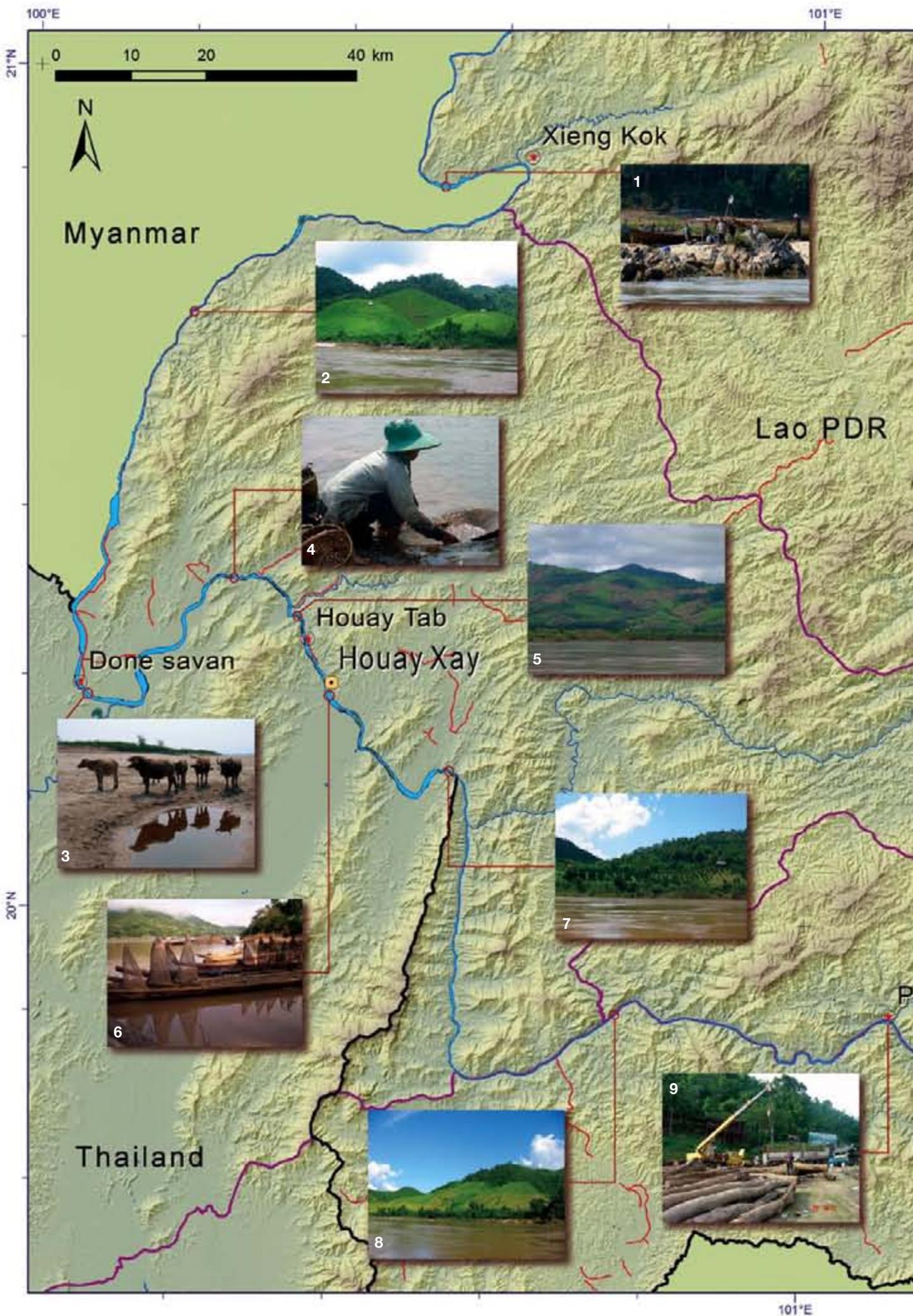
Woman tilling her land in Houay Tab village. © Kate Lazarus/IUCN



Woman collecting 'kai', Mekong water weed. © Kate Lazarus/IUCN



Gold panning near Khon Pi Luang rapids. © Kate Lazarus/IUCN



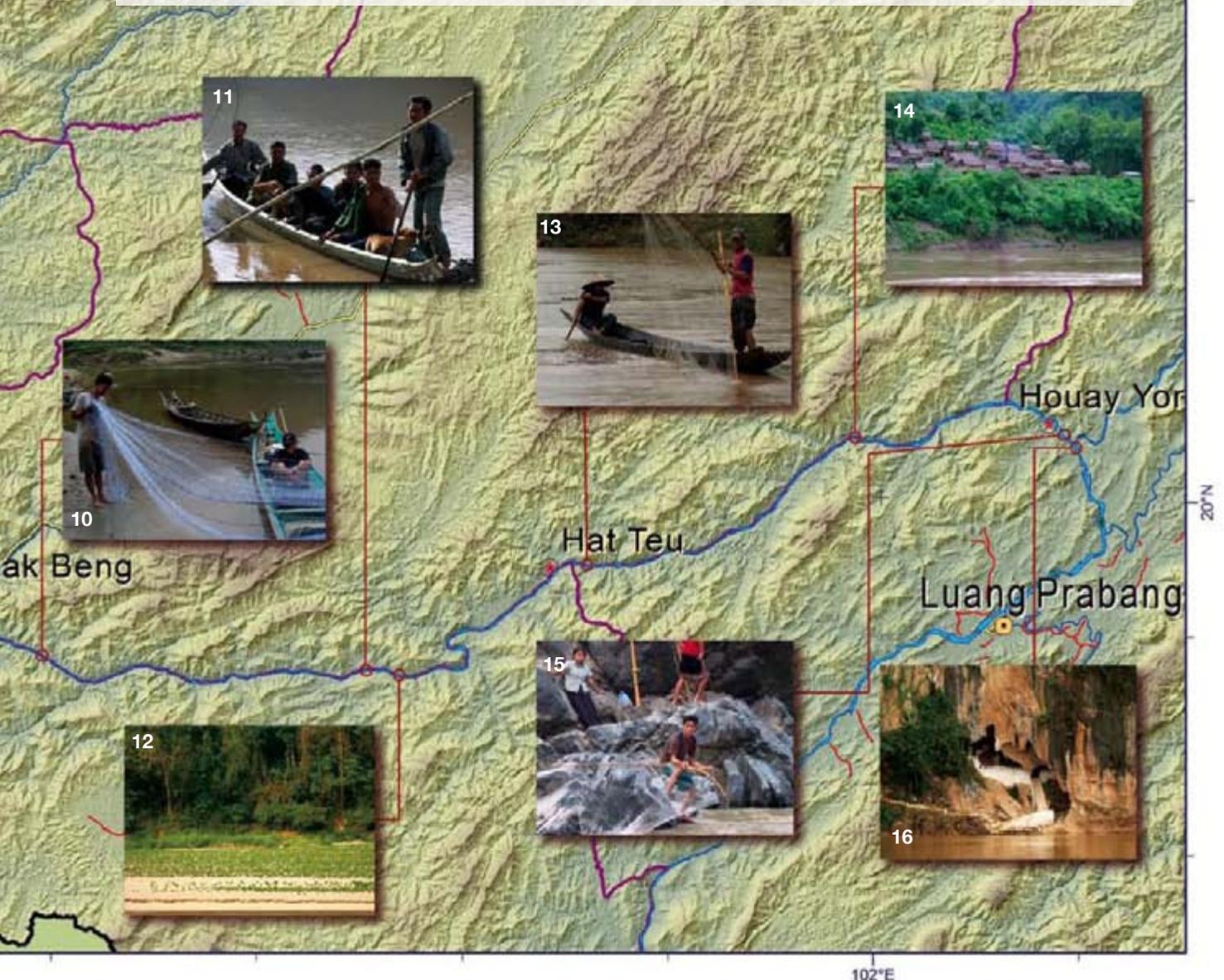
Luang Namtha

Figure 4. Map of the study area with photos identifying the various types of livelihood activities

This figure shows the diversity of livelihood strategies along the Mekong River. These include fishing, gold panning, riverbank gardening, animal husbandry, upland cultivation and tourism. Many households are engaged in a combination of livelihood activities.

This figure comprises a selection of some of the important activities observed during the study.

- | | |
|---|---|
| 1. Burmese fishing camp | 9. Loading timber on truck |
| 2. Upland rice cultivation | 10. Fisherman mending a gillnet |
| 3. Buffalo rearing in dry season | 11. Villagers hunting wild boar with dogs |
| 4. Woman gold panning, near Khon Pi Luang | 12. Riverbank garden |
| 5. Swidden-fallow landscape | 13. Fishermen using bagnet (tong) |
| 6. Bamboo fishing traps in wooden boat | 14. Small village along the Mekong |
| 7. Orchard near Thai/Lao border | 15. Fishing in fast water |
| 8. Upland rice cultivation | 16. Pak Ou Caves near Luang Prabang |



cash income as was observed near Houay Tab Village and across from the Khon Pi Luang Rapids.

The use of riverbanks for the cultivation of riverbank gardens can be seen throughout the areas of the Mekong that are settled. The riverbanks that are exposed by receding water levels provide fertile land, while the river provides water where needed. A variety of crops is grown – including corn, tobacco and ground nuts.

Among the communities of the upper Mekong, rice production is largely undertaken in the upland areas. Agricultural production in upland areas is largely dominated by subsistence cropping under a shifting cultivation or swidden (slash-and-burn) farming system.⁵

The upland forests provide sources of water, timber for construction, a range of non-timber forest products and wildlife.

In general, these livelihood strategies are precarious and a combination of household activities is essential. Any loss in

one activity – whether it be fishing, rice farming or riverbank gardening – will have significant impacts on the overall household economy.

The upper Mekong supports a rich ethnic diversity. The village economies of each of the groups differ, with some communities established in the uplands and others along the riverbanks. Many of the communities have a long history of settlement; some have been in place for well over 100 years, whereas others have more recently settled.

Importance of biodiversity (ecosystems, habitats and species)

The Mekong River in northern Lao PDR consists of numerous riverine and floodplain wetland habitats that sustain a rich aquatic biodiversity. The riverine wetland habitats in the area consist of a mosaic of different habitat types, including sand bars, mud/sediment flats, pebble flats, rock outcrops, vertical earth banks, perennial river channels, residual channel systems, rapids, deep pools and shallow ponds. The floodplain wetland habitats include seasonally wet habitats, which comprise ponds, seasonal streams, marshes,

Deep pool survey in the upper Mekong, using hydro-acoustic technology*

As part of the regular monitoring activities, a deep pool survey in the upper Mekong was carried out in the mid-dry season (March) of 2005. Nine study sites were examined along the upper Mekong, using hydro-acoustic equipment. The results showed that the depths of the deep pools varied between 15.38 m (Ban Keng Hang) and 48.17 m (Ban Keng Oil). Different ranges of water layers occurred, within which were found different species and sizes of fish. The water layers, which range between 1 m and 20 m, function as habitats for small to medium-sized fish (total body length), but the pools with a depth of >20 m are commonly used by the larger species of fish. An abundance of fish was found at the water layer nearest to the surface, within a range of 15-20 m. This is the area that is most targeted by the fishing communities.

Among the various fish habitats found in the upper Mekong, deep pools play an important role as dry-season refuges. Although these habitats are important for small to larger fish, the pelagic layer of deep pools is dominated by small to medium-sized fish species while the deeper or bottom layer is taken by the larger fish. Many navigation improvement activities, such as the blasting of reefs and rapids, and disposal of waste in deep pools, constitute significant threats to deep pools as fish habitats. In addition, subsequent changes to the water flow regime and sediment load can be expected to have further impacts



Monitoring team measuring deep pool depth.

© Douangkham Singhanouvong/MWBP

by contributing to filling up the deep pools. Since the deep pools are such important fish habitats, there is a risk that these changes may lead to serious adverse impacts on fish populations.

Deep pools are recognised as important fish habitats that have also been managed by local communities according to traditional management regimes. However, very little documented information is available about these critical fish habitats and there is an urgent need for further scientific investigation.

* Summary of Hydro-acoustic Survey findings included in the 2005 Technical Report available on the accompanying compact disc.

reed beds, and swamps. The aquatic habitats undergo continuous temporal and spatial variations. For example, the variety and extent of riverine (instream) habitats increase during the dry season decrease of water levels. Apart from the vast array of aquatic habitats, several types of terrestrial habitats are found on either side of the Mekong River, including forests, scrublands and agricultural land.

The variety of aquatic and terrestrial habitats in the upper Mekong has contributed to a high level of biodiversity. The importance of such biodiversity could be highlighted under different ecological and socio-economic aspects. Aquatic vertebrates such as fish, amphibians, reptiles and waterfowl are important indicators of the overall ecological integrity of the Mekong region. While freshwater fish form a major source of protein for local communities, other aquatic vertebrates such as amphibians, reptiles and waterfowl provide supplementary food resources for local communities. The insectivorous and carnivorous vertebrate species (e.g., amphibians and reptiles) function as important biological control agents of agricultural pests such as insects and rodent pests, especially in paddy cultivation.

The species richness and abundance of avifauna along the river could play a key role in promoting eco-tourism in the region. Several aspects related to vertebrate species make them globally and/or regionally significant.

The total number of aquatic bird species documented along the upper Mekong stretch includes about 100 species, comprising rare and nationally endangered species. Nearly 40 per cent of the aquatic birds documented from this region are annual migrants. The herpetofauna include 15 species of amphibians and 19 species of reptiles, including six globally threatened freshwater turtles. There are several globally significant sites for biodiversity conservation. Segments of the upper Mekong form part of the Indo-China Biodiversity Hotspot. Two important bird areas designated by Birdlife International are located along the upper Mekong stretch, including the river channel from Xieng Kok to Ban Bo in Lao and to Chiang Saen in Thailand. A wetland of international importance (Ramsar wetland) is located in the Chiang Saen area, on the floodplain of the upper Mekong River.



Villagers identifying local fish species.
© Douangkham Singhanouvong/MWBP

Using local ecological knowledge to understand diversity and habitat needs of upper Mekong fish species

During past years, fisheries experts working for Lao PDR government agencies developed, in close collaboration with the Mekong River Commission (MRC) Assessment of Capture Fisheries component, an effective approach to investigating fish and fisheries in the Mekong River basin.

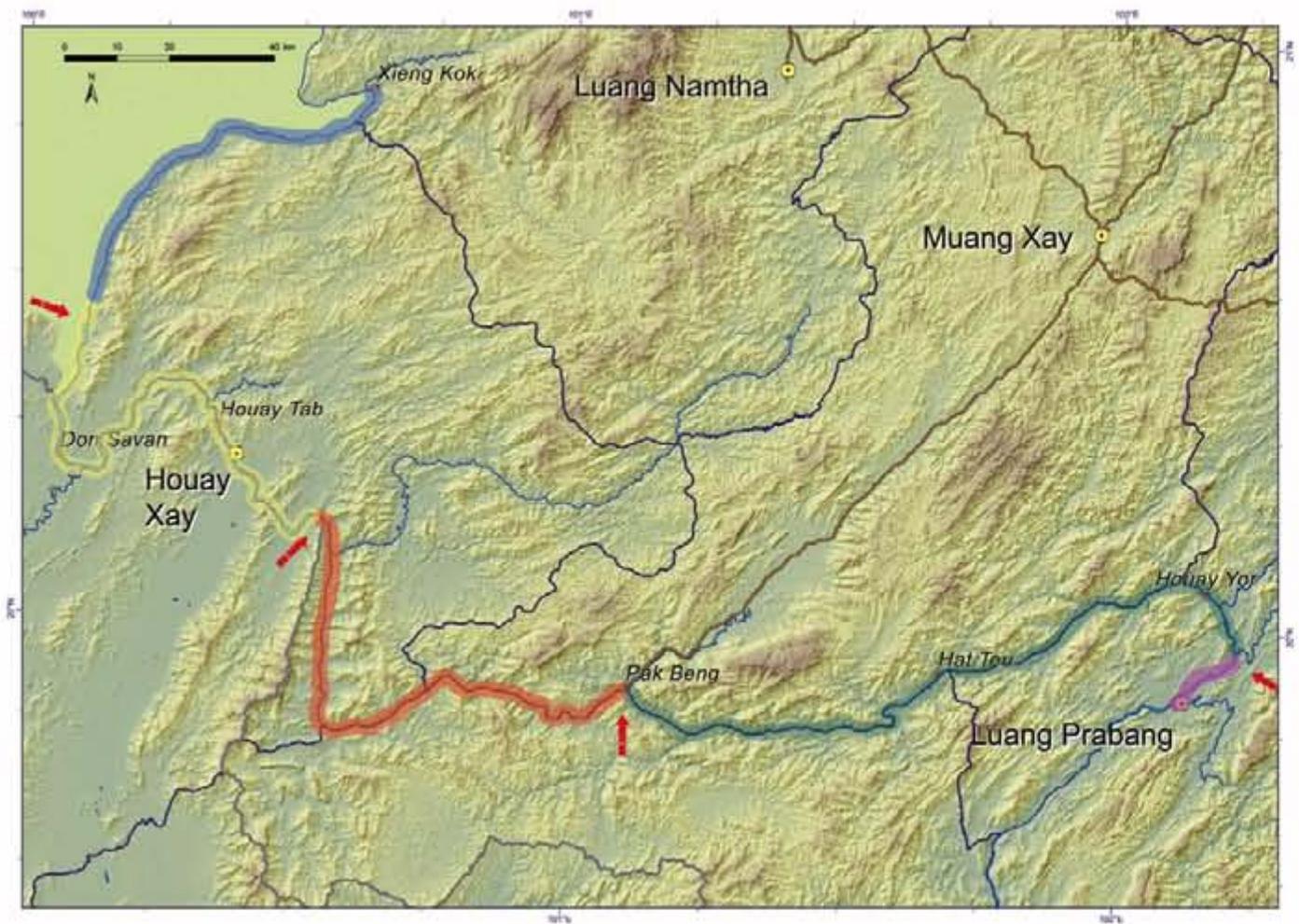
The approach mainly involves local fishing communities, traders in markets and household members. By tapping this rich source of knowledge, fisheries experts have compiled an extensive body of knowledge on Mekong River aquatic fauna.

Local ecological knowledge studies have mainly focused on the biology and ecology of fish, the composition of the population in relation to season, and the reliance on natural resources (such as fish) by local people living along the Mekong River.

Most of the local inhabitants are small-scale farmers who rely mainly on natural resources. Food self-sufficiency may be possible only through cropping (rice, cotton etc.), hunting (animals) and fishing in the Mekong River and its tributaries/streams.

Figure 5. Fishing activities in the upper Mekong region

The figure shows the types of fishing gear used by local people who were interviewed during the Upper Mekong Survey. The slice in the pie charts indicates the relative importance of the various fishing activities recorded during the Sep 2005 survey.



Fisheries

The assessments have identified more than 106 fish species as contributing to the food security of local people in the region. They include both small and large species, such as groups of cyprinids (*Morulus chrysophekadion*, *Puntioplites protozyscron*, *Cosmocheilus harmandi* and *Henicorhynchus* spp.), Bagrids (*Mystus nemurus* and *Mystus wyckoides*), Silurids (*Hemisilurius erythrospila*), and Pangasids (*Pangasius bocourti*). Fishing activities in rural communities rely on migratory fish species and utilise seasonally-specific types of traditional fishing gear.

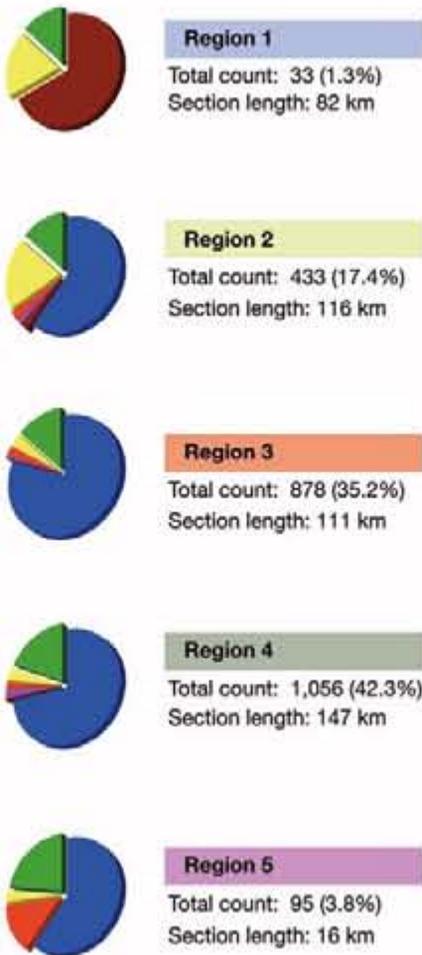
Based on the rapid boat surveys conducted in March and September 2005, during which all fishing activities from Xieng Kok to Luang Prabang were recorded, the fishing gear used during the wet season was dominated by bamboo traps (chan), longlines and bag nets. A number of other gear types were occasionally observed, including stationary gill

nets and simple hooks. Drifting gill nets and cast nets were more commonly found during the dry season. The use of the different types of gear depends on the season and habitats.

A quick assessment of the use of fishing gear along the upper Mekong stretch shows how local fishing communities adapt their fishing strategies. The changes in fishing intensity as well as the relative importance of fishing gear types recorded within the programme's four geographical sections of the upper Mekong is presented in figure 5.

Fisheries activities were recorded while travelling by boat. In addition, a rapid survey of fisheries was conducted with local fishing communities along the Mekong River at Xieng Kok Mai (Luang Nam Tha province) and Houay Lom, Pong Chomseng, Pha Khao and Phone Savang (Bokeo province).

Fishing Activities by Region



Examples of Fishing Activities



Data source: September 2005 survey

Although various fishing activities were found throughout the upper Mekong area, their abundance and distribution changed markedly, geographically. The survey made it clear that fishing was a way of life for the communities living along the Mekong River. Where there are people, there is fishing.

Figure 5 illustrates the linkage between access to various fishing grounds and the way in which local communities carry out fishing. Fishing was most intense in the mid-section of the upper Mekong (red shading) while very little fishing was recorded for the first 100 kilometres, from Xieng Kok to Don Savan.

Fishing strategies changed region by region, (as shown by the pie charts) in response to the varied landscape and access to fish habitats. During the September survey, bamboo traps (chan) as well as longlines were widely used

wherever people could fish. These types of fishing gear are easily set along the river banks. Gill nets were most widely used in the area around Houay Xai (light green shading) where the flow was slower compared with the other regions.

Case Study: 'Mae Nam Khong' Thai Baan research in Chiang Khong, Thailand⁶

Thai Baan research in Chiang Khong (from Khon Pi Luang to Pa Dai along the Mekong River) was conducted from August 2003 to June 2004. The research included 146 village researchers from 13 riverside communities in Chiang Rai province of Thailand. The research addressed the following issues: (a) fisheries, (b) river ecosystems, (c) plants and vegetation, (d) traditional fishing gear, (e) dry-season riverbank vegetable gardens and (f) social, economic and cultural issues within the local context.

The area researched comprised 11 different sub-ecosystems dependent on seasonal water levels. These included sandbars, sand or pebble beaches, ponds, larger rapids that make whirlpools, streams, riverbanks etc.

Some of these sub-ecosystems are used for fish spawning, while others are used for fishing. For example, the Kok (the same “Kok” as that in Ban Kok Ka) is a small bay that is used as a spawning ground during the dry season once water levels drop below 5 m. The sheltering aspects of the Kok are also recognised as important bird habitats.

A total of 100 fish species were found within the research area, of which 88 were native, 14 were rare and one, the Mekong Giant Catfish, was endangered.

Fishing gear provides good indications of how traditional knowledge is passed from one generation to the next as well as offering a source of knowledge about how nature and communities interact with each other. The research found that local fishing communities had 71 types of traditional

fishing gear; however, nine types of fishing gear were no longer used.

The research also recorded 201 plants, 65 species of which live in the riverine sub-ecosystems. The plants are used by locals in many ways, for example, as food, and for making herbal medicine and fishing gear. *Kai* (Mekong freshwater weed) grows on rocks and in rapids during the dry season when the water is clear and plenty of sunlight is available.

The Thai Baan researchers concluded that there were recent changes to the river as a result of “upper Mekong development”. These changes, which included altered waterways, bank erosion and water-level fluctuations, had affected local livelihoods and self-reliance, and were threatening food security and well-being. The changes had also led to the destruction of riverine ecosystems, the disruption of fish migration patterns and an associated reduction in fish populations, a 50 per cent decrease in fish catches, a decline in Mekong water-weed (*kai*) production and the disruption of riverbank cultivation.



Fishing near deep pool. © Kate Lazarus/IUCN

‘Water level changes no longer natural’ in Ban Houay Tab fishing village

Mr. Siphanh Oun-alom is the Deputy Chief of Ban Houay Tab, a small Lao Loum fishing community that is located 7 km north of Houay Xai in Bokeo province. He owns two small wooden boats that are mainly used for fishing activities. In fact, he enjoys fishing very much and spends much of his time on the Mekong River.

When interviewed on 22 March 2005, he was asked about the importance of fisheries and its relevance to the livelihood of his community, he explained that there were 50 families totalling 260 people in the village, of whom only one-third had permanent rice fields. The remainder mainly depended on fishing, riverbank gardening and gold panning, especially during the dry season.

“We fish throughout the year,” he said. “With our small boats we move from one place to another along the river. Usually, there are many good fishing grounds close to our village. However, during the past two to three years, the fish population has noticeably decreased. I don’t understand why.” The fluctuation of the Mekong River flow had become unpredictable, he noted. “Nowadays, water levels go up and down so much, you can’t be sure – the changes do not occur in the natural way that they used to do.”

Increasing Pace of Change



Embankment work in Thailand. © Phaknakhone Rattana/IUCN

The upper Mekong is undergoing significant development through various schemes in the region such as hydropower development, improved navigation and road building. While these initiatives are fundamental to the development of the Lao PDR, it is also important to place them in a wider context. The interventions in river navigation are being driven by economic forces and, in particular, the linking of production, trade and market routes between the largest economies of the region, China and Thailand. In this context, river navigation is just one of a number of developments.

Road construction via the North–South Economic Corridor (NSEC) (see figure 6) through Yunnan province, China, northern Lao PDR, Myanmar and Thailand will also have a major impact on the ecology and biodiversity of the upper Mekong region, and on the communities that live there. Dam development along the mainstream of the Mekong River in China (see figures 7 and 8 on “Dams along the Lancang-Mekong River in China”) will have a similar impact.

The impacts of these developments are not well understood by local communities. Traditional knowledge and local practices of natural resources management, such as kai collection, gold panning, and riverbank vegetable growing, are being affected and are difficult to maintain in today’s society due to rapid economic development. This is leading to poor communities becoming poorer.

Therefore, it is essential to strengthen the capacity of local people to manage their natural resource base, represent their

interests and rights, benefit from changing market forces and participate effectively in decision-making processes.

Navigation Channel Improvement Project

The Lancang-Mekong Navigation Channel Improvement Project, funded by the Government of China, is part of a grand scheme to allow large ships to navigate freely from Simao, China to Luang Prabang in the Lao PDR. The four upper Mekong countries (China, the Lao PDR, Myanmar and Thailand) signed the project Agreement on 20 April 2000 with a view towards developing international passenger and cargo transportation on the Lancang-Mekong in order to promote and facilitate trade and tourism as well as strengthen co-operation in commercial navigation. In 2001, navigation under the Agreement officially started.

According to river traffic schedules developed under the Upper Mekong Navigation Project, water fluctuation follows a three-day cycle corresponding to the schedule for blasting

Lancang–Mekong Navigation Channel Improvement Project: from conception to action

During the 1980s, the significant increase in unofficial trade between China and South-East Asia, together with the initiation of the Greater Mekong Subregion (GMS) by

Cambodia, the Lao PDR, Myanmar, Thailand, Viet Nam and Yunnan province of China, emphasises the rapidly growing need for co-ordinated action on infrastructure investments

1980s - 1993

- **1980s** The GMS focuses on the joint development of natural and human resources, and the strengthening of the interregional economic linkages through improved infrastructure.
- **1992** The Asian Development Bank (ADB) organises a series of conferences bringing together high-level government officials from the GMS countries with the aim of coordinating their infrastructure investments.
- **1993** A joint investigation on waterway transportation on the Lancang-Mekong River, organised in February, reaches the following conclusion: under natural conditions, the waterway is navigable by vessels of 60 dead weight tonnage (DWT). However, after improvement, the waterway will become navigable by vessels of 100-500 DWT for at least 95 per cent of the year.
- **1993** In May, the Governor of Yunnan province, He Zhiqiang, outlines a plan to develop the “Lancang Economic Belt”. The plan also includes opening up the lower section of the river through Xishuangbanna to international shipping.

Project information

Project implementation is divided into three phases:

Phase 1 includes the removal of 11 major rapids and shoals, and 10 scattered reefs plus the setting up of 100 navigation marks, 106 markers and 4 winches. The waterway will then be navigable by vessels of at least 100-150 DWT during at least 95 per cent of the year.

Phase 2 covers the removal of 51 rapids and shoals, allowing the waterway to be navigable by vessels of at least 300 DWT during at least 95 per cent of the year.

Phase 3 involves canalisation, after which the waterway will be navigable by vessels of 500 DWT during at least 95 per cent of the year.

1994 - 2001

- **1994** During the fourth GMS conference in September, implementation of the water transportation subsector’s “Upstream Lancang–Mekong River Navigation Improvement Project” is given high priority.
- **1994** The “Free” Navigation Agreement is signed in October by senior officials of China, Myanmar, Thailand, and the Lao PDR, officially opening ports in each of the four countries to the entry of ships from the other three countries.
- **1995** With the formal establishment of the Lao PDR–China and China–Myanmar borders, tremendous potential for the formation of the greater ‘Economic Quadrangle’ is created.
- **2000** The Transportation Ministers of China, the Lao PDR, Myanmar and Thailand officially sign an Agreement on Commercial Navigation on the Lancang-Mekong River on 20 April 2000 in Tachilek, Myanmar. The agreement stipulates that, one year after its signature, vessels of any contracting parties will be entitled to sail freely between the ports of Simao in China and Luang Prabang in the Lao PDR.
- **2000** During November, a Joint Survey Group conducts a feasibility study of the project, which concludes that:
 - (a) The project is technically feasible;
 - (b) Implementation will not change the discharge flow of the river or the boundaries along the river; and
 - (c) Implementation is imperative.
- **2001** A joint environmental impact assessment (EIA) and detailed survey team from the Chinese side is established in March and carries out site surveys along the river on the 18 and 29 April. The joint team completes the site surveys, data collection and related work on 12 June and adopts the outline for preparation of the EIA report.
- **2001** The EIA report and conceptual design for the Navigation Channel Improvement Project are finalised and submitted in September to the contracting parties for comments/improvement.

in the subregion. A brief chronological description of events related to the Lancang-Mekong Navigation Improvement Project is given below:

Source: Adapted from Lazarus (2003); Qiao and Liang (2006); China Water Transport Daily (2005); and Xiao (2006).

2002 - 2003

2002 The Thai Cabinet approves the EIA in January. The Lao PDR is the last to approve the EIA in March. Implementation of the first phase of the project begins in the dry season (April-May) and is scheduled to be completed by the end of 2004, as detailed below:

29 March to 15 April 2002 – The first stage. A Chinese construction team, accompanied by observers representing the four countries making up the Project Co-ordinating Office visits three working sites along the Myanmar-Lao PDR border to begin project implementation. Work on the Tang Ao rapids and Lower Tang Luang rapids is completed but work on the Nam Loi River Mouth Rapids cannot be finished due to early flooding.

December 2002 to March 2003 – The second stage. Blasting of 16 rapids is scheduled to start in December 2002, with completion scheduled for the beginning of the dry season in March 2003. The rapids include those at Huai La, Khai, Long Zhom, Nam Loi river mouth, Khong Tan, Tang Salum, Wang Seng Shoals, Wong Wit, Sam Zhao, Chuang Nam Tang Lan, Tha Ban Bo, Kon Mu Tai, Ton Pa Nok Yang, Huai Na Yo, Saen Pi and Lower Mong Pa Liao.

December 2003 to March 2004 – The third stage. Blasting of the Nam Lor river mouth, Tang Pang and Khon Pi Luang (Thai-Lao PDR border) rapids is scheduled for completion by March 2004.

2003 The Thai Cabinet issues a resolution on 8 April suspending a plan to blast the Khon Phi Luang Rapids to avoid further complications in Thai-Lao PDR border demarcation. The resolution requires the Office of Natural Resources and Environmental Policy and Planning, of MoNRE, to conduct a new EIA along the Thai-Lao PDR border. TEAM Consultant Engineering and Management Co., Ltd. is hired to conduct the new EIA (called the post-EIA). The post-EIA begins in September 2003 and is completed in June 2004.

2003 In June, the MRC CEO reveals to the public and the press that China will not continue with the project past the first stage of rapids blast.

2004 - 2006

2004 Officers from the Thai Harbour Department organise a public consultation on 20 January in Chiang Khong, Thailand.

2005 Local groups in Thailand released Thai Baan research carried out in Chiang Khong, Thailand. The research addresses critical environmental and social concerns of the Navigation Improvement Project.

2005 China's Yunnan province and nine provinces in northern Lao PDR hold their second working group meeting at Kunming in November. The working group recommends active preparation for removing 15 big rapids that remain as obstacles to smooth navigation along the stretch between Houay Xai and Luang Prabang in the Lao PDR.

2006 The Joint Co-ordination Committee for Commercial Navigation (JCCCN) on the Lancang-Mekong River holds its fifth meeting on 6 March 2006 to discuss commercial navigation and the promotion of trading activities among the four upper Mekong countries. In 2006, major cargo ships are expected to be upgraded from 250 DWT to 300 DWT, reducing transportation costs by about 30 per cent.

JCCCN also reaches consensus on the following nine items:

- The “upper Mekong watercourse navigation map” will be submitted to the committee by the end of June 2006;
- “Regulations for charging the commercial navigation on upper Mekong River” are approved;
- Chinese sailors will be allowed to use the Chinese sailor identity card starting from 1 August 2006;
- More water gauges will be installed in the upper Mekong navigation channel;
- The preparatory work for removing the three shoals (sandbanks) and rapids that hinder navigation in the upper Mekong navigation channel is to be speeded up;
- Capital stability and good management of the upper Mekong navigation channel is to be actively pursued;
- Navigation co-ordination and marine co-operation between the four countries will be enhanced;
- Law and order along the navigation channel will be strengthened in order to ensure the safety of commercial ships, sailors and travellers; and
- Transportation of oil products along the Lancang-Mekong navigation channel will be developed after the related regulations and review processes have been improved.

the reefs and rapids. Safety announcements addressing those navigating along the upper stretches of the Mekong River are circulated annually as posters in four languages (Chinese, Lao, Thai and Burmese), showing the navigation schedule and travel restrictions.

Mekong River Commission review of the Navigation Channel Improvement Project EIA

In 2001, concern among downstream countries of the possible impacts of the Navigation Improvement Project and the quality of the EIA prompted MRC to sponsor an independent review of the EIA. Three separate reviews were undertaken that addressed hydrology, fisheries and social issues.

The EIA reviews pointed to the extremely limited information that was available in the EIA, the narrow scope of the EIA that did not take into consideration the context of wider developments in the upper Mekong, and the weak methodology used.

With regard to fisheries, McDowell (2001) commented that only a few lines in the EIA considered fishery issues without taking into account any information of scientific substance. The report failed to make consistent identification of the correct number of species, at different stages referring to 100, 123 and 153 species; yet, none of those figures was substantiated. In fact, each of those figures was well below current scientific estimates of well over 1,000 species of fish. The EIA also failed to consider aquatic biota other than fish.

The review stressed that “from the perspective of fish fauna of the Mekong River (sic), (there is a) virtual total absence of either investigation of biological values in the river as well as lacking any quantitative data on these values in the river (sic) (and) the EIA lacks credibility”(McDowall, 2001).

The review of social impacts (Cocklin and Hain, 2001) was equally critical, stating “the summary assessment of the EIA is that it is substantively inadequate and in many places fundamentally flawed”. The EIA is criticised for not considering current or future volumes of river traffic and their implications. Criticism is also directed at the lack of consideration of cumulative or secondary impacts.

Much of the analysis that is reported in the EIA “appears to be based on little more than speculation, subjective judgments or unsubstantiated research. The EIA falls short in that it does not systematically consider alternative courses of action”. The report is further criticised for not considering the project in a wider context, for not considering the costs and benefits, for its flawed methodology and for overlooking “the essential requirement of public participation”.

Finlayson (2002) noted that “the present EIA is a seriously deficient document, which fails to acknowledge the importance of the potential consequences of this project”. This review addresses the lack of consideration of possible shipping accidents and pollution (fuel oils and cargoes). It also raises serious concerns about the need to maintain channel depth and the responsibility that falls on countries, with attached costs.

Basic concept of environmental impact assessments

The purpose of the EIA is to incorporate a planning tool into development, which identifies a plan for environmental protection and enhancement on a project-by-project basis. Briefly, this is accomplished in the following manner:

- (a) The EIA procedure identifies the possible positive and negative impacts on the environment that will result from a proposed project. This includes the “natural” and “human” environments, which in reality cannot be separated. These impacts are identified over both a “short-term” and “long-term” time frame.
- (b) An EIA provides for a plan that, on implementation, will reduce or offset the negative impacts of a project and result in a minimum level of environmental degradation. This minimisation may be a result either of implementing

a project alternative or project modifications, or of environmental protection measures that simply reduce the number or magnitude of negative impacts. The plan may also result in the utilisation of positive impacts for enhancement measures that offset negative impacts.

- (c) In order to measure the level of plan implementation and the degree of effectiveness of the above environmental protection provisions, the EIA provides a monitoring programme. This programme is also designed to enable the parameters of uncertainty to be identified and the related impacts to be measured.

Source: Economic and Social Commission for Asia and the Pacific, 1990.



Chinese cargo boats carrying goods. © Kate Lazarus/IUCN

These independent reviews of the project EIA all concluded that the EIA had not addressed adequately the concerns about the construction and post-construction phases and did not lead to any of the governments halting their decision to begin removal of the rapids for navigation in the river.

Volume and types of river traffic⁷

Tax collection from river traffic along the Mekong River in the northern part of the Lao PDR was started in 2001, with the agreement that all associated fees were to be collected as a lump sum through the Agriculture and Industry Development Project of Luang Nam Tha and Bokeo provinces (the exact fees were not specified). Thereafter, that project deducted payment for its services and operation, and the balance was deposited with the Finance Department of Luang Nam Tha and Bokeo provinces. However, due to unclear collection procedures, the collection of fees through the project was terminated in 2002.

In 2003, it was agreed that the fee for porting was Yuan 500 (Baht 2,500) per boat/vessel per trip. Navigation down from China to Thailand would port at Xieng Kok and navigation up from Thailand to China would port at Ban Muang Mom. The Provincial Financial Department is responsible for operations and collection of fees. However, the fee collection structure remained varied among the four riparian countries (China, the Lao PDR, Myanmar and Thailand). Subsequently, at the third meeting of the JCCCN in Kunming, China in December

2003, additional dialogue was planned in order to develop an agreement on the procedures for charging fees and establishing checkpoints. However, no concrete agreement was reached and the collection of tax and other associated fees has remained at the discretion of each country.

Chinese boats along the upper Mekong River

Chinese cargo boats operating along the upper Mekong River in the Lao PDR play an important role in transporting goods between China and Thailand. The results of the monitoring survey in September 2005 in the areas between Xieng Kok in Luang Nam Tha province and Pakbeng in Oudomsay province indicate that most large cargo boats come from Simao and Xishuangbanna prefectures in Yunnan province, China. These boats belong to shipping companies or are owned by individual businessmen.

The boats transport general merchandise, fruit, grains, electrical equipment, motorcycles and semi-finished industrial products to the Lao PDR and Thailand. They often return to China with tropical fruit, edible oil and other goods. Frequent runs take place during the monsoon season; fewer trips occur during the dry season due to the lower water levels. Currently, shipping is a convenient and cheap means of transportation for Chinese businessmen. However, greater opportunities will arise for transportation by land after the completion of the Asian Highway segment connecting China and South-East Asian countries.

Transporting goods and people along the upper Mekong River

- Imports from China by the Lao PDR include motorcycles, motorcycle parts assembled in the Lao PDR, lighter parts, garlic, onions, blankets and carpets.
- Imports of Chinese goods by Thailand include garlic, onions, blankets, carpets, apples and other fruit.
- Imports of goods from Thailand by China include second-hand cars and fruit (e.g., longan).
- Exports of goods by the Lao PDR to China and Thailand mainly comprise raw materials, mulberry fibre, Job's tears, sesame, palm, bon nut, corn and other non-timber forest products.
- Most of the large vessels seen on the Mekong River are Chinese-owned and controlled.

Wet season traffic

The number of large Chinese boats on the upper Mekong River stretch is more prevalent during this period, especially in the stretch from Xieng Kok to Ton Pueng opposite Chiang Saen port, Thailand. Many large Chinese boats dock at Chiang Saen port that are able to transport goods up to 200 DWT as the water level is very high in the wet season.

The number of smaller craft is much lower during the wet season as the local communities do not go fishing. However, some local people continue to catch fish with bamboo traps, longlines, hooks and stationary gill nets.

The number of speedboats is also lower during this period because of the reduction in tourists and local passengers.



Upper Mekong Navigation Project poster. Note: The poster shows the dates when boats can travel (green) and when travel is forbidden (red). Each week starts on Sunday.

Dry season

The number of large Chinese boats along the upper Mekong River decreases during the dry season, especially in the stretch from Xieng Kok to Ton Pueng opposite Chiang Saen port. They are only able to transport up to 100 DWT per boats because the water level becomes very low, exposing many rocky outcrops and rapids.

The number of small boats is much higher during the dry season as local people go fishing, especially along the stretch from Hat Teu to Pak Ou, with longlines, hooks, bamboo traps and stationary gill nets. Other small boats carry local inhabitants who are going hunting or to tend rice fields and riverbank gardens.

The number of speedboats also increases because of number of tourists and local passengers travelling on the Mekong River in the dry season, particularly in the Golden Triangle area (northern Lao PDR, northern Thailand and eastern Myanmar).

River traffic issues and problems include noise, waves, accidents and river traffic management.

River traffic/transportation data⁸

The river traffic/river transportation data for 2004/2005 can be broken down as follows:

- Goods transported – 150 trips per month during the monsoon season and 210 trips per month during the dry season, for an annual total of 2,160 trips;
- Type of boats – nearly all vessels were steel-hulled boats (99 per cent) while less than 1 per cent were wooden boats;
- Type of goods – 55 per cent of transported goods were construction materials, 40 per cent comprised timber, and the remaining 5 per cent was groceries;
- Passengers – 245 trips/month in the dry season and 450 trips/month during the monsoon season, for an annual total of 4,170 trips;
- Passenger fee for large vessels – Kip 428.57 per person (Lao)/km and Kip 607.14 per person (foreigners)/km; and
- Passenger fee for speedboats – Kip 666.66 per person (Lao)/km and Kip 1,100 per person (foreigners)/km.

The Ministry of Construction, Transport, Post and Communication has not been collecting fees for any river transportation of goods. All taxes and porting fees are paid to the Port Association. Agreement on transportation fees is mainly between the boat owner and the distributor/seller.

Management regulations of river traffic within the province are based on legislation by the Government of the Lao PDR as well as Department of Transportation regulations. Chinese



Burmese fueling station. © Douangkham Singhanouvong/MWBP

boats are also subject to the same rules from the Department of Transportation in each province.

Recent Voice of America news reports indicated river trade between the four nations had increased to more than US\$ 1 billion, of which 85 per cent was accounted for by China and Thailand, and the remaining 15 per cent by Myanmar and the Lao PDR.

More recently, at the fourth JCCCN meeting in 2004, it was agreed that for each leg navigated, a vessel/boat with a carrying capacity above 100 metric tons (mt) would be charged at US\$ 50 per vessel, while a vessel/boat with a carrying capacity of less than 100 mt would be charged US\$ 40 per vessel/boat. In addition, Myanmar and the Lao PDR agreed to have a joint checkpoint to improve efficiency through reduced processing time and the number of

checkpoints. All collected fees/tax within Lao PDR territory is deposited with the Financial Department of Luang Nam Tha and Bokeo provinces.

The Waterway Transportation Division does not appear to have compiled official data on goods traffic volume and value as such traffic is relatively insignificant. In fact, it may not be necessary to do so, as possibly less than 10 per cent of the total goods transported are usually checked through the Lao stretch. Goods are transported by boat between Kone Luei, China and Chiang Saen. Inspection, customs and quarantine checks are conducted at Park Luoi, Myanmar during the dry season and at Chiang Saen during the monsoon season. The Waterway Transportation Division indicated that detailed information on goods traffic volume and value is collected at Chiang Saen Port.



© Pierre Dubeau/IUCN

Port town of Xieng Kok*

Xieng Kok is a small port town with 77 households (398 residents) and is located 17 km from the centre of Muang Long in the Lao PDR. The town is located on the newly upgraded road No. 17B that links Xieng Kok with Muang Sing, a bustling town with a vibrant market. Xieng Kok has a bimonthly market, and the link to the Mekong River via the upgraded road has allowed an increase in the trade of goods and the movement of people from rural mountain communities as well as travellers between Myanmar and the Lao PDR.

Road No. 17B links China with the Mekong River in the Lao PDR and across the border into Myanmar. The Xieng Kok border post is an access point for Thai and Burmese traders and travellers who reach Lao PDR territory from the river. Traders from the Myanmar town of Chiang Lap (15 km upriver from Lue town) visit Xieng Kok to sell goods such as cotton, cosmetics, silks, perfume, soap, tobacco and fresh-water seaweed. Others come to purchase buffaloes and cattle in the mountain regions.

Thai traders visit Xieng Kok to purchase timber and buffaloes, while Thai businessmen have invested in guest houses/bungalows and timber processing factories. One Lao PDR trading company controls most of the exports that move along route 17B to Thailand.

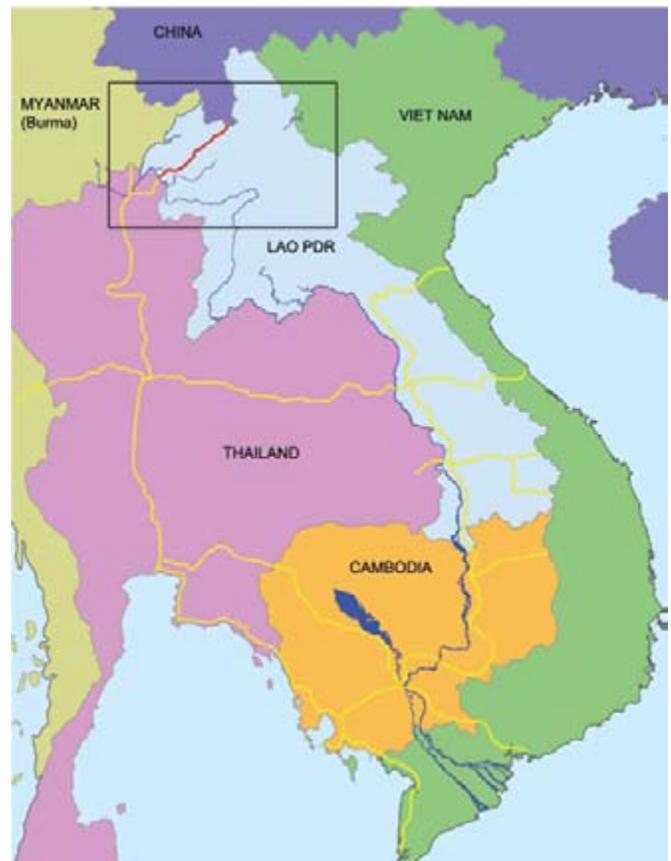
* Extracted from Lyttleton, Cohen, Rattanavong, Thongkhamhane and Sisaengrat, 2004, *Watermelons, Bars and Trucks: Dangerous Intersections in North-West Lao PDR: An Ethnographic Study of Social Change and Health Vulnerability along the Road through Muang Sing and Muang Long.*

Development of Chiang Saen Port II⁹

Chiang Saen Port 1 was developed in response to the Agreement on Commercial Navigation on the Upper Mekong signed by China, Myanmar, the Lao PDR and Thailand. It can simultaneously accommodate eight vessels of 25 m in length. However, due to the growth in trade between China and Thailand, the Marine Department of Thailand decided to carry out a study on the development of Chiang Saen Port II. The study, completed in October 2005, estimated that the volume of cargo transported via Chiang Saen Port II would reach approximately 524,628 tons/year by 2009.

Construction of the port will be carried out in two phases. Phase 1 will include 10 general cargo berths, six of which will require labourers for loading/unloading operations and four that will use cranes. There will also be one berth for petroleum products and four for service boats such as tugs, patrol boats and dredgers. Phase 2 will comprise the construction of one additional general cargo berth and eight container berths.

The total cost of the project is estimated to be Baht 1,568,518 million (US\$ 41,000). The first phase will be implemented from 2007 to 2009 and the second between 2011 and 2013. The project has been submitted to the Cabinet for approval of the first phase of construction.



Greater Mekong Subregion North-South Economic Corridor

In addition to the trade routes developed via the Mekong River, regional governments are developing additional schemes to increase economic development through a series of roads that will enhance connectivity, improve competitiveness and promote a sense of community (Asian Development Bank, 2006). However, this corridor (figure 6) is not just about subregional roads but also power transmission lines, telecommunications, transportation and trade facilitation, among others (Asian Development Bank, 2006). For example, the GMS NSEC linking Yunnan province with Bangkok via the Lao PDR and Myanmar is known as R3A and R3B. NSEC includes 66 investment projects with a total projected investment of more than US\$ 18 billion. About one-third of the projects are within the Lao PDR even though the country shares only 10 per cent of the NSEC area (Asian Development Bank, 2006).

Thailand–Lao PDR–China (R3A)

The distance along National Highway No.1 from Bangkok to Chiang Rai in the north is approximately 830 km. It has been upgraded to at least a four-lane standard highway. The last portion from Chiang Rai to Chiang Khong district is approximately 110 km and is only a two-lane highway. The Thai Department of Highways plans to improve this linkage in the next Five-Year Plan.

The 228-km connecting road, R3A, in the Lao PDR is currently being upgraded with co-financing from the Government of the Kingdom of Thailand, ADB and the Government of China. A bridge across the Mekong River connecting Houay Xai in the Lao PDR and Chiang Khong in Thailand has been proposed in order to improve connectivity along the north–south axis of the GMS. Currently, ADB is providing technical assistance for an engineering study, economic and financial analyses, and an initial social and environmental assessment. The assistance is aimed at selecting the best site for the bridge as well as preparing a preliminary bridge design including a preliminary cost estimate.

Thailand–Myanmar–China (R3B)

The distance along the four-lane National Highway No.1 from Bangkok to Mae Sai district, (on the border between Thailand and Myanmar) is approximately 890 km. In order to relieve growing traffic congestion on the existing Sai River Bridge, the new Mae Sai bypass, which is about 8 km in length, is under construction. Thailand assisted Myanmar in the construction of the Second International Bridge across the Sai River including the connecting road, R3B. The total length of the project is 1.48 km including the bridge length of 90 m. The project has been completed and is now open to the public.¹⁰

Figure 6. North–South Economic Corridor – National Highway R3, the Lao People’s Democratic Republic





Manwan Dam, the first hydropower project on the Lancang-Mekong River in China. © IUCN

Hydropower development in China

China is developing a system of hydropower schemes on the Lancang-Mekong River to address its growing needs for domestic energy supplies as well as for electric power exports. In recent years, much concern has been raised about the cascade of eight large-scale hydropower dams on the Lancang-Mekong River in south-western Yunnan province, China (figure 7 and 8). Scientists and civil society have raised questions about the potential impacts on the environment and the local communities living along the river and utilising its resources (Dore and Yu, 2004). Concern has been voiced over the potentially dramatic changes to the hydrology of the river once the series of hydropower dams in China has been completed. The full implications of this cascade of dams remain somewhat uncertain but are still very much a cause for apprehension. In fact, the hydropower schemes already appear to be having an adverse impact on the hydrology of the river.¹¹

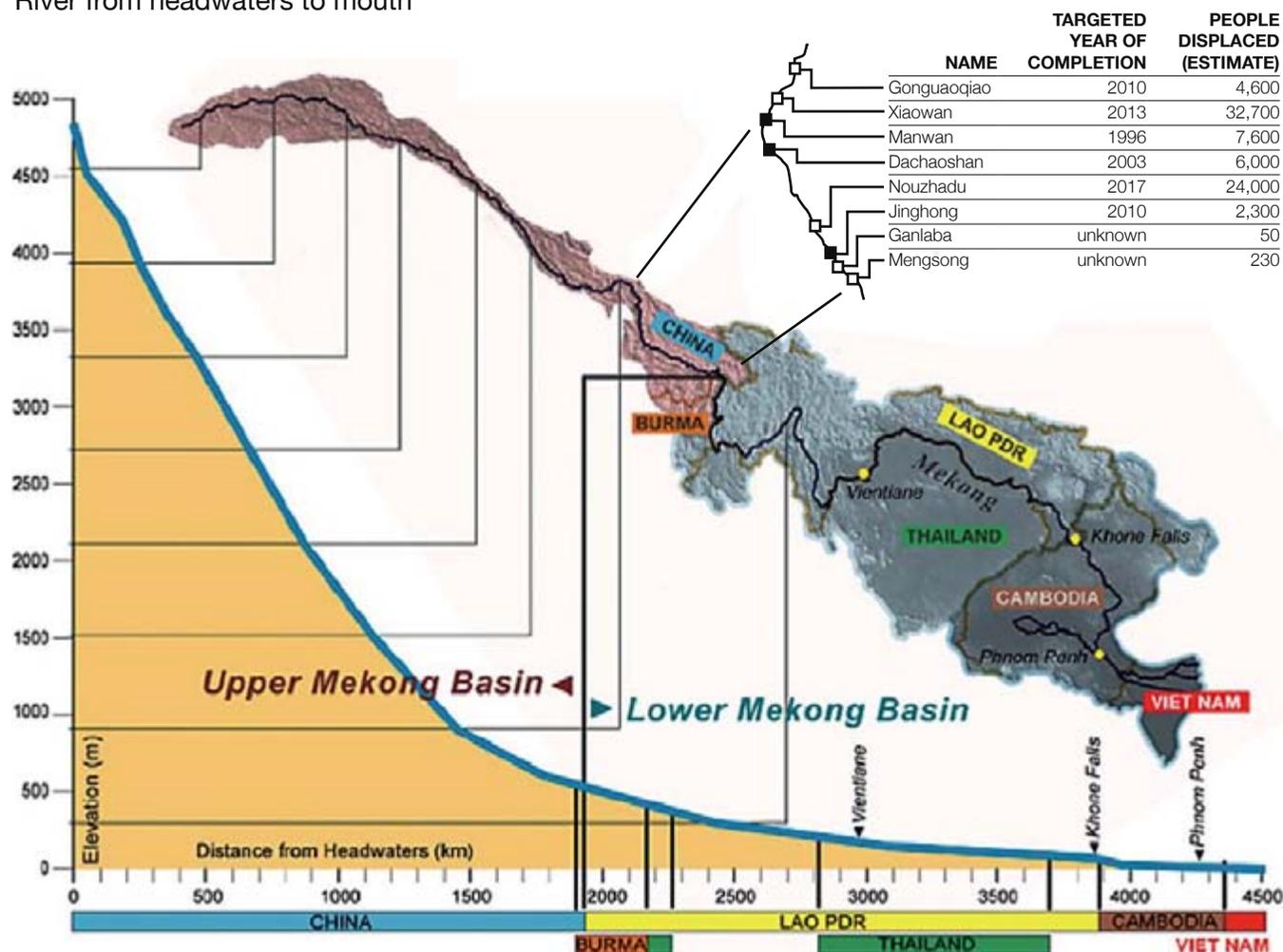
The headwaters of the Lancang-Mekong flow for nearly 800 km through Tibet before entering Yunnan, where it flows for another 1,250 km. Figure 7 provides a detailed view of the Mekong River longitudinal profile together with

its watershed boundaries country by country. The locations of the cascade of dams are indicated along the river profile. The vertical drop in the river is about 4,500 m in China. However, the river drops only about 500 m over the remaining 2,600 km to the South China Sea, and has an average slope of 0.02 per cent in the lower Mekong basin.

As part of the Yunnan hydropower expansion, the cascade of dams in China is concentrated in the lower segment of the Lancang-Mekong River. Lying at elevations between 700 m and 1,000 m, eight dams will be constructed over a 500-km stretch of the river. Starting a few kilometres upstream from the Lao PDR border, the Mingsong dam, followed closely by the Galanba, Jinghong, and Nuozhadu dams form a cluster of dams in the lower stretch, while the Dashoashan, Manwan, Xiaowan and Gongguoqiao dams are located further upstream.

The total catchment area for the eight watersheds is 105.16 ha. By the time the last reservoir is filled, the total inundated area will be 10,384 ha, or about 10 per cent of the total catchment area.

Figure 7. Location of dams and river profile along the Lancang-Mekong River from headwaters to mouth



Source: Mekong River Awareness Kit CD-ROM, MRC.

Figure 8. Chinese dams on the Lancang-Mekong River

Location	Watershed/catchment (km ²)	Total Storage (mcm)	Installed capacity (MW)	Annual energy (GWh)	Inundated area (ha)	Locally displaced people	Wall height (m)	Status
Gonguaoqiao	97,200	510	750	4,060	343	4,596	130	Due to start 08-2006
Xiaowan	113,300	14,560	4,200	18,990	3,712	32,737	292	Building 12-2001
Manwan	114,500	920	1,550	7,805	415	3,513	136	Built 1986-1996
Dachaoshan	121,000	890	1,350	7,021	826	6,100	111	Built 1996-2003
Nuozhadu	144,700	22,400	5,850	23,777	4,508	23,826	216.5	Building 2006-17
Jinghong	149,100	1,233	1,750	8,059	510	2,264	118	Building 10-2003
Ganlanba	151,800	n/a	150	780	12	58	65	Designed
Mengsong	160,000	n/a	600	3,380	58	230	n/a	Designed
Total			15,650	73,872	10,384	73,324		

Sources: Adapted from J. Dore and Yu Xiaogang, 2004, "Yunnan Hydropower Expansion: Update on China's Energy Industry Reforms and the Nu, Lancang, and Jinsha Hydropower Dams", Chiang Mai University, Chiang Mai, Thailand; and G. Ryder, "China's new hydro companies and the changing electricity regulatory framework", presented at the Mekong Region Waters Dialogue, held at Vientiane on 6 July 2006.

Washed Away

Evidence of the increasing pace of change due to various development schemes, such as improved navigation, road construction and hydropower dams, has already become apparent within the past four years.



Exposed rocky outcrop. © Pierre Dubeau/IUCN

Water fluctuations and confused fish

Throughout the upper Mekong region, local people have reported unusual water fluctuations during the past four years. Water levels have been observed to rise and fall by as much as 1 m within a 24-hour period. In some cases, the rise and fall of water levels has been in three-day cycles. Fishing traps and boats have had to be shifted as waters rise and fall. In the dry season, sandbars and banks have been subjected to unusual flooding.

Several studies have examined the impact of large-scale hydropower projects on the Mekong River. During the dry season, the reservoirs in the Lancang dams cascade will increase the regulatory function of flows leaving Yunnan, the hydrological impacts of which will be felt all the way to the Mekong delta (Adamson, 2001). Lu (2005) identified a clear link between the construction and operation of Chinese dams and the unusually low water levels observed recently.

In addition, unusual off-season water fluctuations in the Mekong River as a result of human disturbances may create difficulty for fish in adapting to their habitats. The impact of changes in hydrological regimes on river fish ecology cannot be underestimated. Unusual or sudden rises and falls in the water level may interfere with fishes' life history strategies, and may result in erratic fish migrations. In fact, local fishing communities have claimed that fish are already showing indications of becoming "confused".

Spawning fish using the stream margins may find their eggs stranded when the water level recedes suddenly or fish larvae may drift in unwelcoming habitats. The relationship between river fish ecology and hydrological regime (flow) has been described in detail by Welcomme and Halls (2004). Another key concern is the potential direct loss of fish habitats because the drying of such areas is too rapid for fish

to adapt to the sudden change. This may also occur among the larger fish species such as the Mekong Giant Catfish. Such a situation may also lead to the extinction of larger fish species. In addition, the water fluctuations may affect both the gathering of freshwater weed (kai) and traditional methods of panning for gold.

Many fishing communities along the Mekong River confirmed having observed the unusual water fluctuations. Most did not have any knowledge regarding the cause, although some people had heard information on the radio about dams being built in China. Some fishing communities claimed that when water was released from the Chinese dams, the level in the Mekong River could rise and fall by as much as 1 m in an hour. Although there is no conclusive evidence as to the particular reason for the fluctuations, they are affecting the livelihoods of local communities. Some communities have even become afraid to fish in the Mekong River due to the uncertain conditions. Other communities have noticed decreases in certain types of fish species that were formerly abundant.

Scientists from Singapore University recently conducted a study that looked at water discharge and sediment flux changes resulting from the construction of the cascade of dams along the upper part of the Mekong mainstream. The study was an attempt to establish the causes of the extremely low water levels observed in the lower Mekong River during the past few years (Lu and Siew, 2005).

The study recognised the severity of changes that would result from the ambitious Chinese plan to build the cascade of dams. The huge amount of water that would be stored

would seriously affect the downstream flood pattern and sediment load, and the potential severity of the impacts on stream morphology, biodiversity and local communities was cause for concern, according to the study.

The study also investigated the extent of the influence of the Manwan Dam and recent impacts since its completion in 1992. Changes in flow regimes before and after 1992 are measurable, as indicated by the hydrograph in Chiang Saen (figure 9). The significant disruption of the natural flow regime in downstream communities such as Chiang Khong in Thailand has been extensively reported. However, no systematic analysis of water discharge and sediment flux (load) along the series of gauging stations has been conducted.

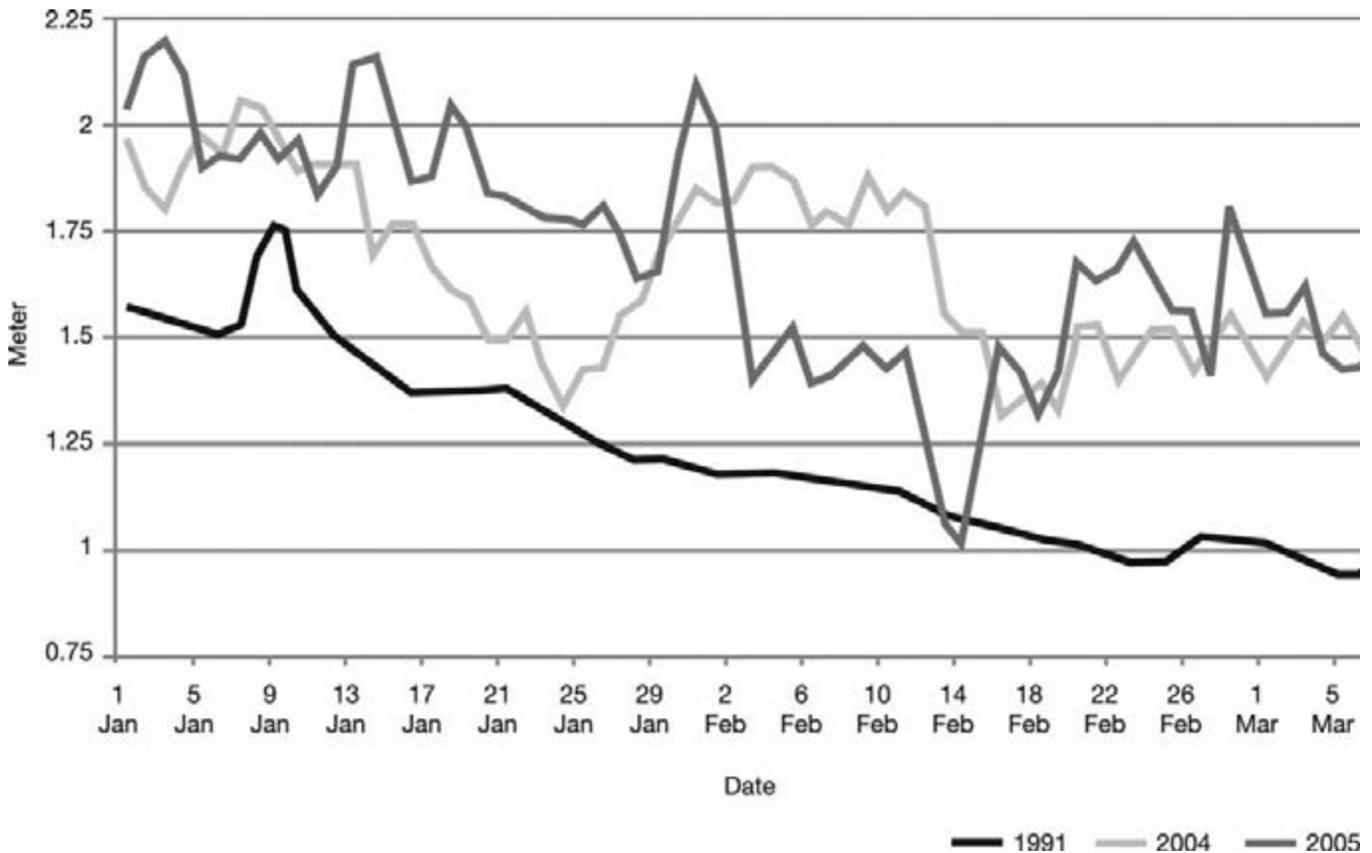
Dry season day-to-day fluctuations of up to 1 m were recorded at the Chiang Saen gauging station (figure 10). Figure 10 includes streamflow data provided by the Thai Department of Water Resources. The figure shows fluctuations within 24 hours of up to 1 m (Southeast Asia Rivers Network, 2004). This information was not included in the data released by MRC.

In a 12 February 2006 article,¹⁰ Mr Attaphan Rangsi, President of the Border Traders Association in Chiang Saen district, Thailand, indicated that “fully-loaded riverboats cannot complete their normal journeys as the river has dramatically receded to a critical level”. The falling level of the Mekong River in February 2006 had affected Thailand’s import and export trade with China, he said, as it had forced boats to reduce their cargo capacity in order to survive the journey. He indicated that although the problem now recurred



Exposed sandbar. © Richard Friend/MWBP

Figure 9. Mekong River level at Chiang Saen, Thailand, 1991, 2004 and 2005.



Source: Raw data from the Department of Water Resources, Thailand.

every year from January to April, it was difficult to pinpoint the reasons for the low levels. “Drought has been blamed by some, but large-scale dam construction in China’s Yunnan province and the resultant retention of water upstream on the river (sic) has worsened the situation”, he said, adding that it required more investigations vis-à-vis cumulative impacts.

Declining fish catches

For more than a decade, local communities have reported that fish catches in the northern part of the Mekong River in the Lao PDR have been declining, both in species and in abundance, resulting in an ever-increasing gap in food supply and income generation for rural people. Depletion of the Mekong fish populations may be attributed to the following factors:

- Poorly regulated fishing activities (using destructive fishing gear/other appliances, and blockage of fish migration pathways during the spawning season from May to July as well as dry season migration from November to February);
- A lack of proper fisheries management knowledge;
- Environmental change/degradation due to different anthropogenic perturbations (which translates as

“human intervention”, for example; dam and navigation programmes);

- Unusual fluctuations of the river, which can directly disturb and slow fish migration; and
- The impact of large cargo ships traversing the Mekong, which may leave specific fishing grounds inaccessible to local fisherfolk.

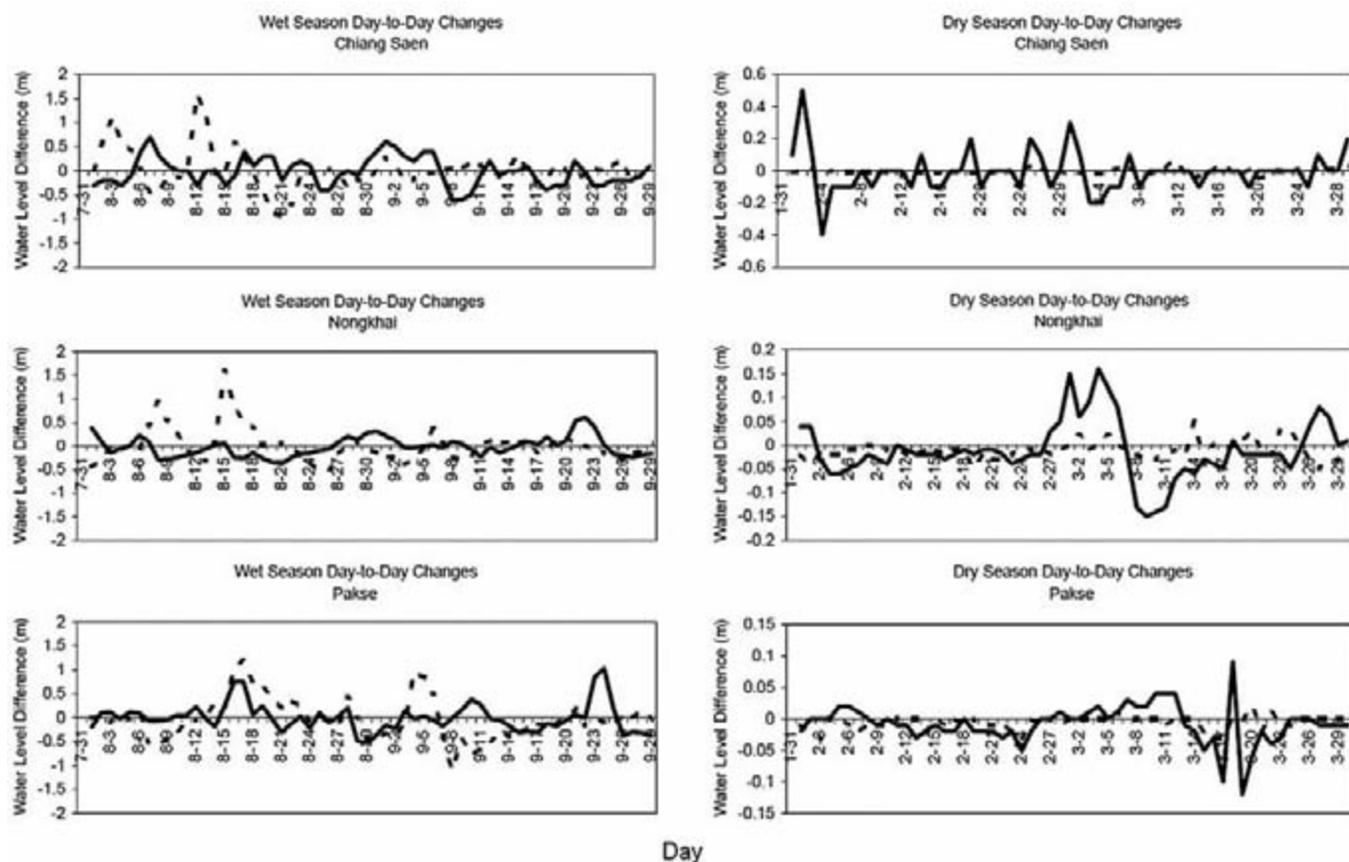
Erosion

Erosion is a natural process in all river systems. The course of the river is continuously changing, cutting through the landscape, and carrying and depositing sediment. Erosion of riverbanks is characteristic of all river systems. This is particularly evident in areas of rivers that open up into a low-lying floodplain landscape.

Although erosion is a natural process in a river, increasing signs of erosion are now being observed. While this may be part of the natural process of the Mekong River, these observations are raising concern that the extent and pace of erosion might be increasing as a result of other factors.

The main cause of erosion, particularly in Khammuane and Borikhamxay provinces, is the construction of an

Figure 10. Comparisons of day-to-day changes in water level (water level difference between Day N and Day N-1) between pre- and post-dam years.



Note: Day-to-day changes in the pre-dam year of 1991 are depicted by the solid line. Day-to-day changes in the post-dam years are indicated by the bold line. Source: Lu, 2005.

embankment on the Thai side of the river, resulting in a change in water flow and direction, forcing it towards the Lao riverbank. Other factors include river navigation and natural disasters such as flooding, according to the Lao National Mekong Committee Secretariat.¹³

The issue of erosion has been raised by many local inhabitants. Many villages have been established on the banks of the river, some for several generations. Several of those villages are located in areas of the river that are susceptible to erosion along meanders, where the eroding force of the current is most effective. The natural process that creates meanders is clearly illustrated in the area near Chiang Saen, Thailand. The Mekong River flows through an open valley, cutting deeply through the alluvial material and forming alternating eroding and depositing banks (see small diagram in figure 11). The large expenses forming sandbars (point bars) clearly appear on the Landsat image (background) (figure 11) as white/pink patches, which contrasts with the main river channel in dark blue.

Observations among local inhabitants of erosion patterns appear to indicate an increased rate and extent. For example, in the village of Hat Teu, which was established

more than 100 years ago, people spoke of observing erosion occurring at a rate of 10 m per year for the past 5-10 years. Villagers reported the loss of houses built on the riverbank as well as seasonal riverbank gardens. It is significant that erosion and its economic impacts have been raised as an issue of concern.

The case of Ban Don Savan, a village located in Bokeo province opposite the Thai port of Chiang Saen, is particularly dramatic. In 2003 and 2004, at the peak of the annual flood, the river changed its course and washed away 100 m of river bank that included most of the long-established village. Although there was no loss of life, many houses and the village temple were destroyed by the heavy water surge and the inhabitants had to relocate to another village 2 km away.

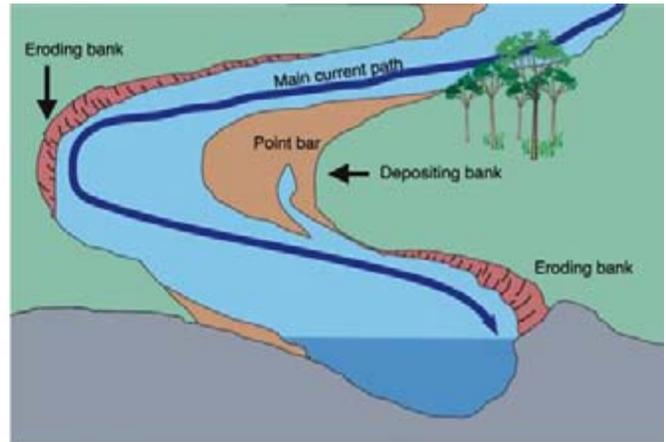
On its first visit to the village in March 2005, the monitoring team interviewed several elders who spoke of this experience (see box, "Sudden erosion at Don Savan forces resettlement"). Many of them talked about their fears of further erosion and the difficulties of coping with the relocation without any outside support. Evidence of the partly demolished and abandoned houses, school and temple

Figure 11. The meandering Mekong – alternating pattern of eroding banks and sandbars from sediment deposition

The Upper Mekong from Xieng Kok to Luang Prabang



Diagram of a meander



Inset from above. Background image: LandSAT 7 ETM+ (panchromatic / Bands 5,4,2) - UTM Zone 48, Datum: WGS 1984
Image acquired: Dec 25, 1999 - USGS/NASA



SCALE 1:150,000 0 2 4 8 km



© Phaknakhone Rattana/IUCN

Sudden erosion at Don Savan forces resettlement

A woman from Don Savan village explained the impacts of the erosion that had begun three years previously, destroying several hundred square metres of riverbank, houses, schools and the temple. This all happened very suddenly, forcing people to flee so that they were unable to collect their possessions. The whole village had to be relocated, requiring the resettlement of more than 100 households. During the emergency, many people became ill because they no longer had access to clean drinking water.

were scattered around the site. One sidewall was all that remained of the historic village temple. When the monitoring team returned in September 2005, further erosion had even swallowed the remaining vestiges of that important spiritual site.

It is difficult to determine the precise causes of erosion in every case along the upper Mekong. The construction of concrete embankments on one side of the river can have an impact on the opposite bank due to subsequent changes in the hydrodynamics of the river. Concrete embankments are specifically designed to reduce the eroding forces, which results in an increased force acting against the opposite bank. The case of Ban Don Savan highlights the vulnerability of villages in erosion-prone areas of the river. The vulnerability of Ban Don Savan appears to have been exacerbated by the development of port infrastructure in Chiang Saen.

Numerous possible factors could be contributing to erosion in the upper Mekong. Interventions such as the construction and operation of large hydropower projects, and the

modification of key natural river features such as reefs and rapids, alter the natural sediment load and flow of the river. This exacerbates vulnerability to downstream erosion.

Biodiversity changes

According to available records, major declines in large water bird populations have occurred in the upper Mekong within the past 50 years, with some species now locally absent or very rare. Many species of aquatic avifauna and herpetofauna have been subjected to commercial trade in the region, where hunting of wildlife is a widespread practice. Fisherfolk and farmers also capture birds to be sold to potential buyers who travel in trade vessels. A general increase in the exploitation and trade of herpetofauna is also evident, possibly as a result of increased navigation and the opening of markets for wildlife trade and non-timber forest products.

According to the monitoring team, degradation and loss of natural habitats is clearly evident in the upper Mekong area. The intact natural riverine forest cover is now below 10 per cent, as vast areas have been cleared for shifting cultivation. Several rapids and rock outcrops in this part of the Mekong River were subjected to blasting and dredging under the navigation improvement project during the same period. The result has been a reduction of mosaic river channel habitats, hence adversely affecting the breeding populations of river channel nesting birds such as the river lapwing and small pratincole.

The invasive alien plant, Giant Mimosa (*Mimosa pigra*) has colonised the river channel mud/sediment flats and sand bars, covering as much as 90 per cent of some islands. This has seriously affected the habitats of wading birds.

Another issue that leads to adverse impacts on birds inhabiting river-channel islands is disturbance related to fisheries and gold panning. The large islands in the Khong Phi Luang area are used for gold panning by local villagers during the dry season, resulting in the degradation of sediment/pebble flats. The reed bed habitats in the Chiang Saen area have been affected by agricultural expansion as well as by the Giant Mimosa invasion, resulting in loss of habitats for prinias, warblers and bushchats.

Increasing river traffic, especially large boats, may result in disturbances to nesting birds along the river channel. In addition, it was alarming to note that harmful biocides (such as Paraquat, which is banned in the developed world) were being freely traded and used in shifting cultivation. The persistent residues of such chemicals could lead to adverse impacts on aquatic biodiversity and adverse health impacts among local communities.

The sustenance of aquatic species in the upper Mekong River in relation to water resource development (including irrigated agriculture, navigation, hydropower schemes) depends on the quality and quantity of suitable riverine and floodplain habitats available for breeding, feeding and resting (Baran, 2004). However, continuous over-exploitation of species will result in further reductions in population numbers, and/or local extinction of species.

Several factors that are governed by flows can have a significant influence on biodiversity in the Upper Mekong ecosystem, including:

- The degree of change on a temporal and/or spatial scale in the dry-season flow regime;
- Lateral connectivity with the floodplain;
- The area of inundation on the floodplain;
- Riverbank erosion;
- The availability of floodplain wetlands;
- The availability of riverine/channel habitats (islets, sandbars, sediment/pebble flats);
- The amount of sediment and nutrient transport; and
- Water quality.

Regular cycles of water flow are being permanently altered; the river as we know it today will continue changing. This will have a lasting impact on one of the most productive freshwater fisheries in the world. The pressure is mounting and local communities will have to plan for developing alternate sources of proteins for their subsistence.

Plight of the Mekong Giant Catfish

The Mekong Giant Catfish (*Pangasianodon gigas*) symbolises the ecological integrity of the Mekong River and the abundance of other fish species that people throughout the basin have come to rely on for their livelihoods. Its huge size makes it one of the largest freshwater fish in the world and it can grow up to 3 m in length and weigh as much as 250 kg. The Giant Catfish has a strong cultural significance in the Mekong region, but its population in the wild is rapidly declining. In 2003, the IUCN Red List adjusted the status of the Giant Catfish to “Critically Endangered”.

Its plight indicates the intricate nature of the whole Mekong River basin. The complexity of the basin results in the health and population of Giant Catfish in the lower areas being affected by changes in upper areas, and vice versa. The Giant Catfish can be seen as an indicator of ecosystem health and fisheries of the Mekong River, and its current status is of great concern to the World Conservation Union (IUCN).

The Giant Catfish is a transboundary migratory species found in Cambodia, the Lao PDR and Thailand. Innovative and effective initiatives aimed at increasing the Giant Catfish population, such as the breeding programme of the Thai Department of Fisheries, are ongoing. However, the long-term success of these initiatives to strengthen and expand the wild population of the Giant Catfish depends on being able to address the major influences on the decline of the



Giant catfish caught in Chiang Khong, May 2004. © Kate Lazarus/IUCN

Giant Catfish population in the wild, and capture fisheries in general. The annual targeted “hunt” for Giant Catfish has been practiced among the fishers of Chiang Khong for several decades now. Increasing reports that overfishing is one of the key threats to the declines in catch during recent years has raised concern at all levels.

On 29 March 2006, the fate of the world’s largest freshwater fish took a turn for the better. An historic decision to end targeted hunting of the Mekong Giant Catfish in Chiang Khong was the result of years of dialogue between the relevant parties. Fishers of the Giant Catfish Club in Chiang Rai province of northern Thailand signed an agreement to give up the hunt, although certain conditions were tied to the agreement.

Arguing that fishing for the Giant Catfish was a practice embedded deep within their culture and that huge investments had been made for their nets, local fishers asked to be compensated. The price of their nets was established, and both local and international organisations raised funds to provide compensation. The fishers also requested that consideration be given to very small-scale “demonstration” Giant Catfish fishing for cultural preservation, tourism and research purposes.

Trans-boundary dialogue was recently initiated on seeking the cooperation of Lao fishers who were continuing the annual catfish hunt (although on a much smaller scale).

Unfortunately, overfishing is just one of the threats to the critically endangered Giant Catfish. While there are many other causes of the decline in Giant Catfish numbers, the rapid environmental changes in the basin have all had an impact. The relevant agencies are supporting the Chiang Khong initiative, and the moratorium on Giant Catfish hunting may remain in effect for a while. However, will this be sufficient to stop the decline in the wild population? Although the fishers have made this sacrifice, will bigger forces continue to dominate decisions on large-scale development? Construction of large-scale water infrastructure projects and river modifications for the purposes of improving navigation is another visible threat.

The natural hydrological pattern of the river is critical to the life cycles of migratory fish and the maintenance of fisheries as a whole. Changes in water levels through the operation of dams are already having negative impacts on fish populations and, consequently, the ecological integrity of the Mekong River. Will the only known spawning ground of the Giant Catfish be blasted to make way for huge commercial vessels to sail down the Mekong River from China?



Garden Fence Lizard (*Calotes versicolor*). © Pierre Dubeau/IUCN

Exploitation of wild animals

The large islands in the Chiang Saen/Houay Xai area are home to many species of aquatic and terrestrial birds, especially during the dry season, and are therefore frequently visited by hunters. During a visit to these islands on 26 September 2005, two hunters showed their most recent catch among which were five specimens of birds, including bulbuls, wagtails and drongos.

Specimens of wild animals were easily observed in the markets of suburban areas. During a visit to the morning market of Luang Prabang on 30 September 2005, at least 250 specimens displayed for sale were documented. They included ranid amphibians, including the Chinese Bull Frog (*Hoplobatrachus chinensis*), which was most common, *Rana erythraea*, *Occidozyga lima*, *Fejervarya limnocharis* and *Limnonectes* spp. Reptiles documented in the market included freshwater turtles such as *Cyclemis tcheponensis* and the endangered big-headed turtle (*Platysternon megacephalum*), while a specimen of the rare reticulated python (*Python reticulatus*) was also seen. In June 2004, the skin of a clouded leopard (*Neofelis nebulosa*) was found at a house in Pak Ou village, while a fisherman was observed trading 10 thick-billed green pigeons and two wedge-tailed green pigeons caught in the forest.

International trading of tiger frogs, Chinese bullfrogs and all species of endangered turtles in this region is regulated under the CITES Convention (Appendix I or II). Trade in wild meat has been widely documented in most places visited during the past three years. With further market penetration linking major trading routes (i.e., with China), trade pressure on wildlife can be expected to intensify.

Lao PDR in the Regional Context - Who Benefits?



Karst limestone formation. © Yu Yanhong/IUCN

The Lao PDR is endowed with rich natural resources, for which demand is increasing among its neighbouring countries. These include the waters of the Mekong and the surrounding land. With the rapid economic changes occurring in the upper Mekong region, the Lao PDR is strategically located to take advantage of potential opportunities being generated such as greater collaboration among the three upper Mekong River countries (China, Myanmar, and Thailand), investment and sustainable development. By 2003, trade accounted for over 50 per cent of the GDP of Lao PDR (Fujita, 2006). The annual GDP per capita of the Lao PDR in 2004 was US\$ 382, of which 20 per cent came from international donors.

However, the developmental changes occurring in the upper Mekong region are increasing in complexity, and the challenge is to determine the full benefits available to the Lao people. In addition, it will be necessary to resolve existing limitations in both management capability and the capacity to take full advantage of opportunities for balanced growth. Often, local communities bear the burden of the high cost of development with limited returns. In talking with various communities, it was clear that they were often unaware of government initiatives and agreements, and were unable to reap the benefits that would contribute towards the alleviation of poverty.

Foreign investment in the Lao PDR comes primarily from Asian countries, particularly Thailand (traditionally the Lao PDR's largest trade and investment partner), China, and Viet Nam (US State Department, 2006).

During 2005, the value of Thai investment licenses approved grew by 36 per cent; French investments accounted for 30 per cent of the total approved due to investment in the Nam Theun II hydropower project (US State Department, 2006). More notably in the upper Mekong region is the growing economic influence of China. Increasingly, China is providing substantial financial support, while benefiting significantly from the rich natural resources of the Lao PDR.

Chinese investment in northern Lao PDR

From 1988 to 2000, Chinese aid in grants to the Lao PDR totalled US\$ 73 million, amounting to just 2 per cent of all international aid received by the country during that period. From 2000 to 2004, China provided US\$ 125 million in aid, mostly directed towards infrastructure, health and education projects.¹⁴

Bilateral trade and Chinese investments in the Lao PDR have been growing rapidly. By the end of 2001, Chinese enterprises had won contracts in the Lao PDR worth a total US\$ 729 million, according to Chinese Ministry of Commerce figures.¹⁵

In Luang Nam Tha province, on the basis of provincial policy (with central-level approval), Chinese technical support and development experience is welcomed. This policy takes advantage of the provincial location on the Chinese border and the huge market that China represents (Wells-Dang and Simmala, 2006).

In March 2005, the survey team observed a significant increase in Chinese migrants in Luang Nam Tha province. Chinese shops had opened, selling large electrical items, car and tractor engines, televisions and other high-priced items. Shops were also observed in the port village of Pak Beng, Oudomsay province.

In September 2005, the survey team continued to observe an even greater increase in foreign commercial presence. Previously, many commercial ventures had been established with Thailand; more recently, however, commercial connections appear to have been growing with China and at times replacing previous Thai connections. For example, in Xieng Kok, bungalows that were previously built by a Thai investor in 2000 on the hillside overlooking the Mekong River and Myanmar are now owned by a Chinese family. The family, which spoke limited Lao, had recently taken ownership. The resort became a “truck stop” for Chinese cargo boats mooring in Xieng Kok and truck drivers transporting goods to the capital city.

Commercial links with China are also evident in market towns along the Mekong River. In addition to Lao entrepreneurs taking advantage of new market opportunities, Chinese entrepreneurs have established themselves in all markets. With strong connections to China, they are better placed



Transporting logs to Yunnan. © Richard Friend/MWBP

Pakbeng an important timber trade centre for China

Chinese businessmen are engaged in the trade of timber, electrical equipment and other large goods in many Lao PDR towns along the upper Mekong River. According to one Chinese trader in Pakbeng, Oudomsay province, Chinese traders had established a joint timber venture with Lao businessmen. The Chinese trader claimed that certain types of timber were not being used by the Lao people, even though such timber was plentiful.

Although the timber company has a small-sized wood processing plant, it purchases the wood felled in surrounding villages and transports most of it by road or river to China for processing because of the limited technology available in the Lao PDR. The timber is used in China to make furniture. Chinese timber traders import their equipment such as trucks and cranes from China, and carry logs to the trading site in the Lao PDR.

Currently, the Government of the Lao PDR has a logging ban in place. Wood stored at the docks was cut in the forest along the Mekong River between 10 and 20 years ago. At that time, timber was transported by local farmers to Pakbeng using elephants or via the Mekong River. The wood was then loaded onto boats and transported to China. However, in recent years, the company’s business volume has decreased due to the logging ban. On average, the wood is transported once every one to three months. Most of the exported timber is rosewood or teak.



Fisher setting up his gear. © Douangkham Singhanouvong/MWBP

Ban Kok Kha, a typical, well-established Mekong River village

The village: Located beside the Mekong River, Ban Kok Kha was established more than 200 years ago. The original village burned down in 1969 and it was subsequently moved to its current location on the other side of the Mekong River. The village has 71 households with 347 people. During the past 30 years, the village has suffered serious erosion problems and about 20 households have been lost. The villagers pay Kip 70,000 in household tax annually.

Natural resource base: Monkeys, tortoises (golden) and birds. A decrease in some wildlife, especially wild pigs and deer, has been observed.

Main human activities: Shifting cultivation, production of other crops (corn, Job's tears and sesame), livestock raising, some wildlife hunting material available (guns). The agricultural fields are located on the opposite side of the Mekong in Sayaboury province,

Additional livelihoods: Selling labour, sawing logs, spraying herbicides and selling livestock.

Changes: Problems with wild pigs, mice and birds among agricultural crops, less fish being caught (number and size), a rice deficit for the past four years, and the introduction of illegal pesticide use for improving rice production.

Date of survey: 25 September 2005. Interviewee was Mr. Savath, 60, Chief of Ban Kok Kha, Beng district, Oudomsay province.

to engage in importing Chinese goods for which there is a strong local demand. There is little local competition in this kind of trade. Chinese-owned shops tend to sell the full variety of manufactured goods that are otherwise unavailable in the Lao PDR (tractors, electrical goods, food and clothes). These cheap goods are in high demand locally.

As Chinese businessmen continue to feel the impact of the 1998 logging ban in China, they see the Lao PDR as another location from which to import forestry resources such as teak and rosewood to meet Chinese demand for furniture and construction material. This high demand for timber in China is inevitably fuelling that country's commercial interest in the rich forest resources of the Lao PDR. It is unclear, however, whether the processing of timber occurs in the Lao PDR or in China, or where the value added of timber extraction accrues. Rubber tree plantations are also expanding rapidly as China gains a hold on more and more prime land in the Lao PDR.¹⁶

China is engaged in numerous avenues of investment in the Lao PDR, via direct investment through grants and the operation of businesses. Observations indicate that many of the Chinese operations may not be benefiting the local people. Institutional arrangements and the capacity to manage the influence of outside investors as well as ensure the benefits trickle down to the local level are limited.

Community-based resource management

Local communities have developed regimes for managing their natural resources. However, opportunities remain that are within the scope of community knowledge and capability for improved management of the country's natural resources. Evidence shows that communities are well aware of the changes that are occurring due to various development schemes. They are adapting their management patterns to cope with eroded riverbank gardens and declining fish species due to changes in river flow.

With the large influx of outside investors into northern Lao PDR, new settlements are springing up along the Mekong mainstream and the potential for competition over forest and aquatic resources is growing. There is a need to strengthen the institutional capacity for extension services as well as improve the role of mass organisations in supporting local community production and responsibilities towards natural resources management.

For example, national policies related to land use and land ownership on steep slopes are essential with regard to villages along the Mekong mainstream. Such policies are particularly relevant when designating land use or protection and/or sustainable management among local communities, in order to reduce the impacts on forest cover in large watersheds.

These policies enable local communities to halt deforestation and forest degradation as well as reduce erosion along the Mekong River by using traditional knowledge.

Pesticide trade in Ban Kok Kha

Unofficial trading of agricultural chemicals between Thailand and the Lao PDR is having an adverse impact on local communities that are not adequately informed. One such example is Ban Kok Kha, located along the Mekong River in Oudomsay province (see box, “Ban Kok Kha, a typical, well-established Mekong River village”). The village is relatively small, comprising 71 households. As limited agricultural land is available, the majority of people are mainly engaged in upland farming activities. In the group discussions between the villagers and the monitoring team, many villagers requested advice on the use of pesticides.

According to the village chief, Mr. Savath, rice productivity by the farms in the village had increasingly become less. In 2001, villagers began purchasing, the pesticide Paraquat from Thailand. They were unaware of the dangers associated with Paraquat and were unfamiliar with the prescribed methods for its use. However, concern over the productivity of the upland rice fields encouraged some villagers to use the pesticide. People soon began to notice the side effects when several villagers became ill and eventually three of them died. Since then, awareness of the dangers from Paraquat has been

growing, so much so that the villagers avoid spraying their fields themselves whenever possible. Instead, they employ villagers from upland communities as day labourers; however, no evidence is available concerning the impact on the health of the latter.

“We have heard that Paraquat is a dangerous substance, both to ourselves and for the environment” Mr. Savath explained. “But we don’t know of any other good technique for improving productivity. If higher productivity is to be our aim, we decided that we will have to use it. Even so, we are very worried about the negative impacts from using Paraquat.”

Although concerned about the use of Paraquat, the villagers were not aware of safe procedures for its use and did not refer to the safety precautions on the bottle labels. This again highlights the vulnerability of rural communities in the Lao PDR when dealing with the regional markets and regional production. Although Paraquat has been banned in Thailand, surplus stocks are now being sold illegally to Lao farmers who lack the knowledge and understanding to make informed decisions about its use, or to choose alternative measures to improve production. The lack of adequate agricultural extension services also limits the opportunities for agricultural improvement that might allow farmers to compete more effectively in these emerging markets.



Small shop in Ban Kok Kha. © Richard Friend/MWBP

Population statistics for Luang Nam Tha and Bokeo provinces

Luang Nam Tha province covers an area of 9,325 km² and has a population of 145,231, of which 73,524 are females. The population density is 16 persons/km². The province has five districts, Nam Tha, Sing, Long, Vieng Phoukha, and Nalae, with an average of 76 villages per district and 69 households per village.

Bokeo province covers an area of 6,196 km² and has a population of 145,919, of which 73,606 are females. The population density is 17 persons/km². Bokeo also comprises five districts, Houay Xai, Ton Phueng, Meung, Pha Oudom, and Pak Tha, with an average of 71 villages per district and 72 households per village.

According to the National Growth and Poverty Eradication Strategy of the Government of the Lao PDR, as of June 2004, the poor accounted for 57.5 per cent of the population in Luang Nam Tha province and 37.4 per cent in Bokeo province.

Source: National Statistical Centre, Committee for Planning and Co-operation, *Population and Housing Census Year 2005, Preliminary Report*, September 2005.

Priorities

The rapid environmental changes in the Mekong River basin have resulted in impacts on the ecosystem and the livelihoods of the millions of people who rely on the resources of the river. It is therefore essential that development schemes take into consideration the potential impact across the whole basin, and that they be based on (a) a review of alternative options, (b) consultations with the local communities and (c) comprehensive environmental and social impact assessments.



Village gathering. © Douangkham Singhanouvong/MWBP

General recommendations

The general recommendations with regard to the planning and implementation of development initiatives in the upper Mekong region in the Lao PDR are:

1. Consideration of the cumulative impact of the changes within the entire Mekong region as a result of development pressures is needed during the development and implementation of policies, agreements, projects etc.
2. Systematic monitoring and in-depth assessments on the impacts from water resources development are essential.
3. Opportunities for co-ordination and collaboration among riparian Mekong communities need to be explored.
4. Capacity-building of local communities and provincial governments needs to be increased in the Lao PDR with regard to natural resource management including the utilisation of participatory approaches.
5. Improved channels for access by local authorities and communities to information about development initiatives are needed.
6. The role of local authorities and communities in planning, implementing and executing development initiatives needs to be strengthened

Follow-up action

The assessment findings show that follow-up action is essential in the four areas of biodiversity, fisheries, monitoring and livelihoods. This follow-up action should include:

Biodiversity

1. Determining management options for the river stretches from Ban Xieng Kok to Ban Bo and Chiang Saen, Thailand (1 km north of Muang Mom to Houay Xai), such as establishing a biodiversity reserve, especially for the conservation of birds. These stretches have already been identified as Important Bird Areas by Bird Life International.
2. Establishing and maintaining a national database on biodiversity and a national bio-repository (a natural history museum and a plant herbarium, in collaboration with the National University of the Lao PDR) to facilitate biodiversity monitoring activities.
3. Ensure that biodiversity and livelihood issues from the upper Mekong are shared with the MRC's Integrated Basin Flow Management (IBFM) programme.

Fisheries

1. Systematic studies of the deep pools in the upper Mekong region in order to clearly identify them and gain more information about these important habitats.
2. Studies to determine the role and importance of tributaries for maintaining upper Mekong River fisheries.
3. The development of a fisheries management plan for areas around important deep pools as well as tributary areas.
4. Follow up the cross-border dialogue on the Giant Catfish hunting ban in Thailand.
5. Build awareness of the importance of the Giant Catfish as an indicator species for the overall health of the Mekong River basin.
6. The promotion of collaborative efforts between Lao and Thai fishermen on the protection of the Giant Catfish, including the creation of the Khong Phi Luang Conversation Zone.

Monitoring

1. Build on existing linkages with partners in China, such as the Yunnan Environmental Protection Bureau and the

Centre for Biodiversity and Indigenous Knowledge, for monitoring the stretches of the river in China.

2. Identify specifically targeted monitoring sites for the continued collecting of baseline data along the Mekong River.
3. Explore opportunities for extending monitoring assessments to Siphandon in southern Lao PDR and to Stung Treng in Cambodia, as both areas are also important biodiversity hotspots.

Livelihoods

1. Create a better understanding of the importance of livelihood activities for communities and associated changes in the upper Mekong region through (a) building up awareness of monitoring and assessment findings, and (b) working with the Luang Nam Tha, Bokeo and Oudomsay provincial governments and local communities on natural resources and development planning.
2. Develop alternative livelihood options and development projects for communities in collaboration with provincial governments, such as access to health services and clean water, protection of fishing grounds, alternatives to shifting cultivation and market access.
3. Organise training on natural resource management and planning, agricultural production, handicrafts, fisheries and trade.

Notes

¹ This report focuses mainly on monitoring and assessment missions carried out in March and September 2005. Specific technical information can be found in the accompanying 2005 Technical Report. In addition, findings are also drawn from missions carried out in June 2004 and February 2003.

² Hereafter, monitoring and assessment of the upper Mekong in the Lao PDR is referred to as the Upper Mekong Programme.

³ For the purposes of this study, the upper Mekong in the Lao PDR refers to the area extending from the Chinese border to Luang Prabang.

⁴ Lancang refers to the stretch of the Mekong River in China.

⁵ Shifting cultivation is the agricultural system that involves alternating between cropping for a few years on selected and cleared plots (of forestland) and a lengthy fallow period when the soil is rested. A long fallow period (10 to 20 years) to restore soil fertility by the accumulation of biomass is a sustainable agricultural practice in mountain environments. However, in areas with increased population density, the length of fallow periods has been reduced to 4-6 years, causing rapid deterioration of soil conditions (Parisak, 2000).

⁶ SEARIN, 2004.

⁷ Waterway Transportation Division, the Ministry of Construction, Transport, Post and Communication, Lao PDR, 18 January 2006.

⁸ Bokeo Provincial Construction, Transport, Post and Communication Department data for 2004-2005.

⁹ Marine Department, Ministry of Transport, Thailand, 2006.

¹⁰ "Subregional Road Projects in the GMS Programme," Ministry of Transport, Bangkok, Thailand.

¹¹ See P. Adamson, 2001, X. X. Lu and J. J. Wang, 2005, and D. He and D. Magee, 2005 for additional background information, quotes on water flow, fluctuations and a list of impacts that can be attributed to dams.

¹² "Thai exports to China plunge with receding Mekong River", <http://etna.mcot.net/query.php?nid=6616>.

¹³ Vientiane Times (2006).

¹⁴ *China Development Brief*, vol. IX, No. 11, February 2006.

¹⁵ *Ibid.*

¹⁶ *Ibid.*

References

- Adamson, P., 2001. *Hydrological Perspectives of the Lower Mekong*, International Water Power and Dam Construction, 53 (3); pp. 16-21.
- Asian Development Bank, 2006. "Technical assistance, Greater Mekong Subregion: development study of the North-South Economic Corridor," Project No. 39084. Technical Assistance Report, Manila.
- Baran, E., 2004. "Cambodian inland fisheries: an overview", presentation at the Seventh Asian Fisheries Forum, 30 November–4 December 2004, Penang, Malaysia.
- China Water Transport Daily, 21 November 2005. "Yunnan held second meeting with representatives from the nine provinces in northern Laos".
- Cocklin, C. and M. Hain, 2001. *Evaluation of the EIA for the Proposed Upper Mekong Navigation Improvement Project*, report prepared for the Mekong River Commission Environment Programme, Monash Environment Institute, Monash University, Australia.
- Dore, J. and X. Yu, 2004. *Yunnan Hydropower Expansion: Update on China's Energy Industry Reforms and the Nu, Lancang and Jinsha Hydropower Dams*, Chiang Mai University, Chiang Mai, Thailand.
- Dubeau, P., (ed.), 2004. *Follow-up Survey for Biodiversity Assessment of the Mekong River in Northern Lao PDR*, IUCN Water and Nature Initiative and Mekong Wetlands Biodiversity and sustainable Use Programme, Bangkok Thailand.
- Economic and Social Commission for Asia and the Pacific, 1990. *Environment Impact Assessment: Guidelines for Water Resources Development*, ESCAP Environment and Development Series, Bangkok.
- Finlayson B., 2002. *Report on the Environmental Impact Assessment, the Navigation Improvement Project of the Lancang Mekong River from China–Myanmar Boundary Marker 243 to Ban Houei Sai of Laos*, prepared by the Joint Expert Group on EIA of China, Myanmar, the Lao PDR and Thailand, University of Melbourne, Victoria, Australia.
- Fujita, Y., 2006. "Understanding the History of Change in Laos: An important premise for development efforts", *Mountain Research and Development*, 26 (3), pp. 197-199.
- He, D. and D. Magee, 2005. *Transboundary Hydrological Effects of Hydropower Dam Construction on the Lancang River*, Asian International Rivers Centre, Kunming, China.
- Lazarus, K., (ed.), 2003. *Lancang-Mekong: A River of Controversy*, International Rivers Network, Berkeley, California, United States of America.
- Lowe-McConnell, R. H., 1987. *Ecological Studies in Tropical Fish Communities*, Cambridge University Press; 371 p.
- Lu, X. X. and J. J. Wang, 2005. *Are the Chinese Dams Blamed for the Lower Water Levels in the Lower Mekong*, National University of Singapore, Singapore.
- Lu, X. X. and R. Y. Siew, 2005. "Water discharge and sediment flux changes in the lower Mekong River", *Hydrology and Earth System Sciences*, vol. 2; pp. 1-39.
- Lyttleton, C., P. P. Cohen, H. Rattanavong, B. Thongkhamhane and S. Sisaengrat, 2004. *Watermelons, Bars and Trucks: Dangerous Intersections in North-West Lao PDR: An Ethnographic Study of Social Change and Health Vulnerability along the Road through Muang Sing and Muang Long*, Institute for Cultural Research of Laos and Macquarie University, Sydney.

- Marine Department of Thailand. "Marine Department's projects in the Greater Mekong Subregion (GMS)", presented at the Workshop on the Business Opportunities for Swedish Companies in the Greater Mekong Sub-region, 27-28 February 2006, Thailand.
- McDowell, R. M., 2001. Evaluation of the "Report on environmental impact assessment: The Navigation Channel Improvement Project of the Lancang-Mekong River from China- Myanmar boundary marker 243 to Ban Hay Xai of Laos, Myanmar and Thailand, September 2001 – Fisheries Impact Reviewed", National Institute of Water and Atmospheric Research Ltd., Christchurch, New Zealand.
- Meynell, P.J., (ed.), 2003. *Scoping Study for Biodiversity Assessment of the Mekong River in Northern Laos and Thailand*, IUCN Mekong Water and Nature Initiative and Mekong Wetlands Biodiversity and Sustainable Use Programme, Bangkok Thailand.
- National Statistical Centre, 2005. *Population and Housing Census Year 2005, Preliminary Report*, September 2005, Committee for Planning and Co-operation, Vientiane.
- Parisak, P., 2000. "A national advocacy for a holistic and decentralised approach to forest management in the Lao PDR", in *Decentralization and Devolution of Forest Management in Asia and the Pacific*, RAP publication, 2000/1, Food and Agriculture Organisation of the United Nations, Rome.
- Phongern, S., 2006. "Laos today: Mekong level drops considerably", Voice of America, 24 February 2006, www.voanews.com/lao/2006-2-24-voa3.cfm.
- Poulsen A. F. and others, 2000. Fish migrations and spawning habits in the Mekong mainstream - A survey using local knowledge", *Assessment of Mekong Fisheries: Fish Migrations and Spawning and the Impact of Water Management Project (AMFC)* Vientiane, Lao PDR, February 2000; 132 p.
- Qian, Tina, 2006. "China's Aid to Laos", in *China Development Brief*, vol. IX, No. 11, February 2006, Beijing.
- Qiao Xinmin and Liang Hong, 2006. "Four upper Mekong countries reach consensus in building a peaceful, friendly international watercourse", *China Water Transport Daily*, 15 March 2006.
- Ryder, G., 2006. "China's new hydro companies and the changing electricity framework", paper presented at the Mekong Region Waters Dialogue, 6 July 2006, Vientiane.
- Southeast Asia Rivers Network, 2004. *Downstream Impacts of Hydropower and Development of an International River: A Case Study of Lancang-Mekong*, November 2004, Chiang Mai, Thailand.
- "Thai exports to China plunge with receding Mekong River", 12 February 2006, <http://etna.mcot.net/query.php?nid=6616>.
- US Department of State, 2006 Investment Climate Statement – LAOS. <http://www.state.gov/e/eb/ifa/2006/62007.htm>.
- Vientiane Times, 11 January 2006. *Riverbank needs reinforcement*, Vientiane.
- Welcomme R. and A. Halls, 2004. "Dependence of tropical river fisheries on flow", in *Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries*, vol. II; R. Welcomme and T. Petr (eds.), Food and Agricultural Organisation of the United Nations, Regional Office for Asia and the Pacific, Bangkok, RAP Publication 2004/17; pp. 267-283.
- Wells-Dang, A. and B. Simmala, 2006. "Economic integration and social development of ethnic minority communities in Laos: Case studies from Luang Nam Tha and Savannakhet", in *Juth Pakai: Perspectives on Lao Development: Ecotourism, Ethnic Development, Soybeans and Organic Branding*, United Nations in the Lao PDR, Vientiane.

World Conservation Union – IUCN, 2003. “Large ships or large fish? Blasting of shoals and rapids in the upper Mekong River may seriously endanger fish species”, 13 January 2003, www.iucn.org.

Xiao Yu-hui, 2006. “Four upper Mekong countries discuss commercial navigation”, Kunming Daily, 7 March 2006.

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