



An Introduction to the Fisheries of Lao PDR



Mekong River Commission

Cambodia · Lao PDR · Thailand · Viet Nam
For sustainable development

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Fisheries of Lao PDR

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The opinions and interpretations expressed within are those of the authors
and do not necessarily reflect
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Foreword

In Lao PDR, fisheries are an integral part of the lives of rural people, providing a major part of their animal protein and micro-nutrient intakes, as well as being an important source of secondary income for a large proportion of the population. People traditionally live beside rivers and streams and grow rice nearby, providing many opportunities to fish and collect other aquatic foods in both natural and constructed habitats. Wild capture fisheries continue to provide the major part of the production for Lao people, with aquaculture and stocking playing an increasing role in supplementing the wild catch.

Lao PDR faces the challenges of raising the standard of living of a rapidly expanding population, while at the same time protecting the environment which supports people's lives and livelihoods. Fisheries management, through such measures as conserving fish habitats, controlling over-fishing and restricting use of destructive gear, plays an important role in maintaining fisheries, while stocking and aquaculture can increase the yield of fisheries. However, the development of water resources, in particular to support irrigated agriculture, hydropower and other essential industries, has great potential to impact fisheries, so the key to fisheries management is to engage effectively with other sectors and ensure that fisheries are taken into account in their planning and development.

In this respect, a key role of the MRC is to summarise and disseminate information to promote understanding and dialogue between those with an interest in the use of water resources. This report, the sixth in the Development Series, summarises key aspects of the fisheries of Lao PDR, providing an introduction and overview for a general audience. It is hoped that readers will develop a better appreciation of the diversity, size and value of this important sector, and an appreciation of the need for its conservation and sustainable development.



Hans Guttman
CEO
Mekong River Commission Secretariat



Fish and fishing activities, drawn on the gate and walls of Wat Xieng Thong in Luang Prabang (built in 1560), indicate the historic importance of fisheries in the traditional livelihoods of Lao people.



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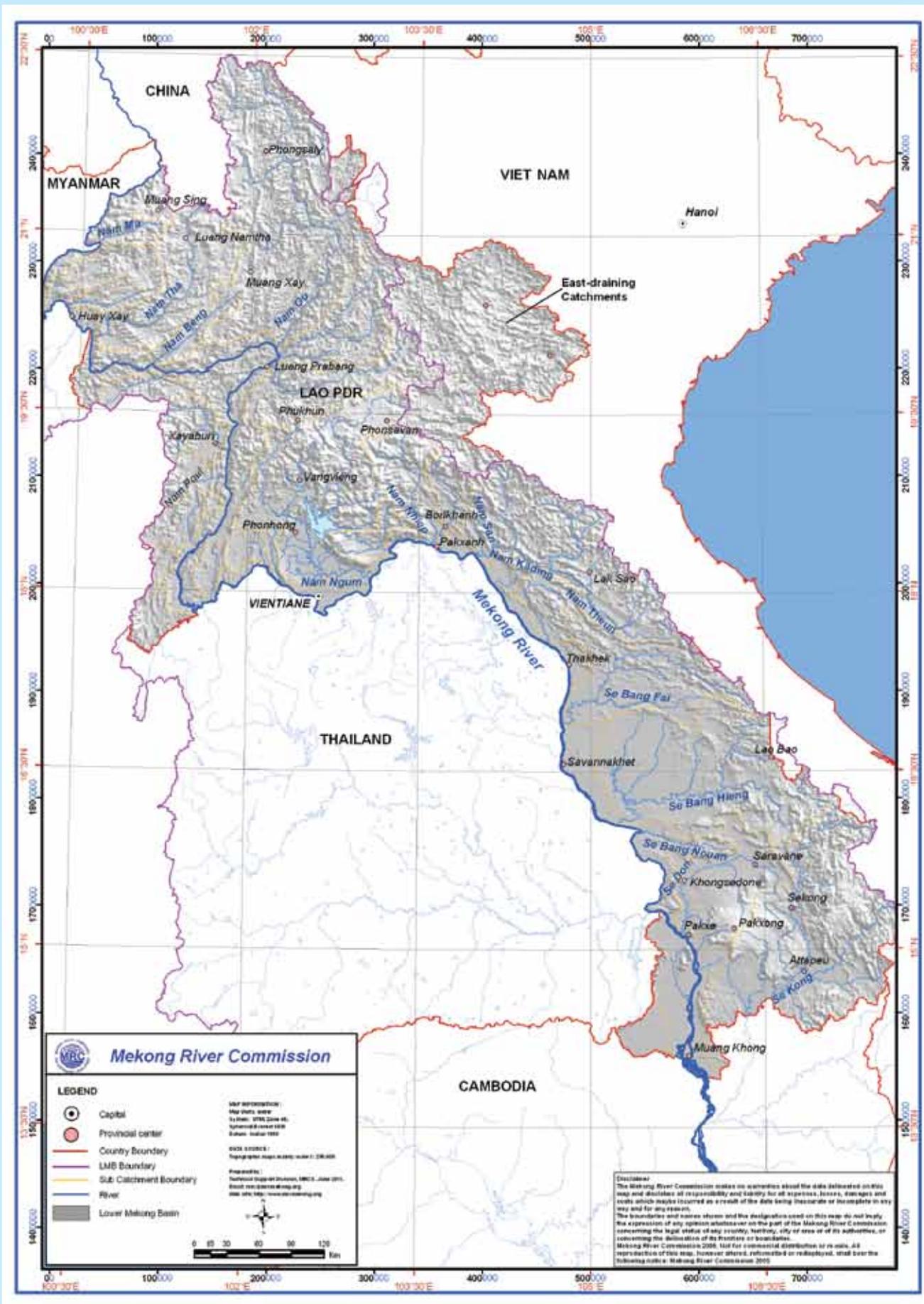
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Acronyms, Abbreviations and Lao Words

ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AIT	Asian Institute of Technology
AIMS	Aquaculture of Indigenous Mekong Fish Species Project
AQIP	Aquaculture Improvement and Extension Project
CPUE	Catch Per Unit Effort
Danida	Danish International Development Agency
DLF	Department of Livestock and Fisheries (Lao PDR)
DLV	Department of Livestock and Veterinary Services
DOF	Department of Forestry
DOI	Department of Irrigation
EIA	Environmental Impact Assessment
FWAEs	Fresh Whole Animal Equivalent Weights
FAO	Food and Agriculture Organization
FIA	Fisheries Impact Assessment
GIS	Geographic Information Systems
ICLARM	International Center for Living Aquatic Resources Management (now WorldFish Center)
IDRC	International Development Research Center
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
LECS3	Lao Expenditure and Consumption Survey 3
LMB	Lower Mekong Basin
Lao PDR	Lao People's Democratic Republic
LARReC	Living Aquatic Resources Research Centre
MAF	The Ministry of Agriculture and Forestry
Mha	Million hectares
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
NACA	Network of Aquaculture Centres in Asia-Pacific
NAFDeC	National Aquaculture and Fisheries Development Centre
<i>Nam</i>	River
NBCA	National Biodiversity Conservation Area
OAAs	Other Aquatic Animals (than fish)
<i>Pa</i>	Fish
SEAFDEC	Southeast Asian Fisheries Development Center
SIA	Social Impact Assessment
t	metric tonne, 1,000 kg
UNDP	United Nations Development Programme
UN-ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
USAID	United States Agency for International Development
WWF	World Wide Fund for Nature



Map 1: Topography and rivers of Lao PDR

Summary

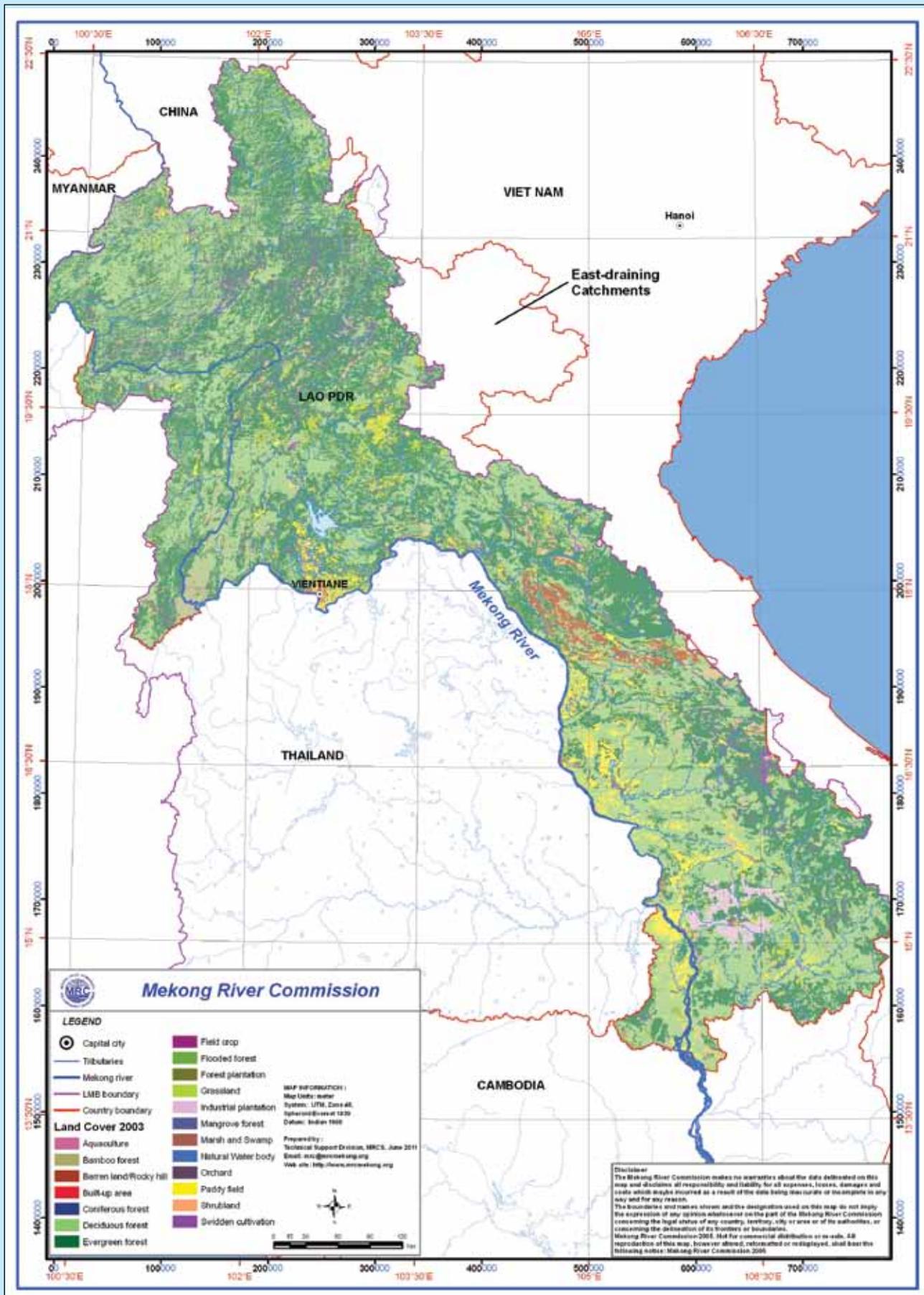
Capture fisheries and aquaculture in Lao PDR are based on water resource ecosystems mainly consisting of rivers and streams, hydropower and irrigation reservoirs, diversion weirs, small water bodies, flood plains and wet-season rice-fields. The total area of water resources for capture fisheries is believed to be more than 1.2 million ha. The estimated consumption of inland fish in Lao PDR is approximately 167,922 tonnes per year while consumption of other aquatic animals is estimated at 40,581 tonnes per year. Most of the consumption is from internal production (i.e. imports are of minor importance), so these figures represent approximate catches or yield of the fisheries. These estimated yields are conservatively valued at almost US\$150 million per year.

The people of Lao PDR, especially in the rural communities which account for more than 75 per cent of the population, still depend upon the country's fish and other aquatic animals as their most reliable sources of animal protein intake. The estimate of actual fish consumption per capita (kg/capita/year) of inland fish is 24.5 kg, while other aquatic animals account for about 4.1 kg and marine products around 0.4 kg, to make a total of 29 kg of fish and aquatic products consumed per capita per year.

More than 481 fish species have been identified in Lao PDR, including 22 exotic species, and more species are being discovered regularly. Among other aquatic animals, about 37 amphibians, 7 species of crabs and 10 species of shrimps have been recorded, but these records cover only about 15 per cent of the estimated total.

In order to understand the ecosystem diversity and species diversity, it is very important to understand the migration patterns of Mekong fish species, based upon studies of local ecological knowledge, landing site surveys, logbook migration monitoring and larvae sampling of important fish species. These will also reveal the distribution, the population structure, feeding habits, critical habitats, life cycles and the fisheries for these fish species.

Inland capture, mostly comprising subsistence or semi-subsistence fisheries, is complex and involves a wide variety of activities undertaken by people from a large spectrum of socio-economic backgrounds. The development of aquatic resources deserves to be given a higher priority by the Government of Lao PDR, as it is a key component in improving health and food security. To confront the problems and challenges in the fisheries sector, two interlinked strategic frameworks of resource assessment and management of capture fisheries should be developed in concert with the promotion of sustainability of culture fisheries. However, it is the actions of other sectors that principally threaten fisheries. Irrigated agriculture, hydroelectricity, domestic water supply and wastewater disposal all affect the aquatic environment and fisheries in many ways. Developments in other sectors should integrate fisheries and mitigate and manage negative impacts as far as possible.



Map 2: Land cover of Lao PDR

Land classed as paddy fields includes the largest area of wetlands, because small swamps, streams, canals, ponds and reservoirs mostly fall within this class.

1. Introduction



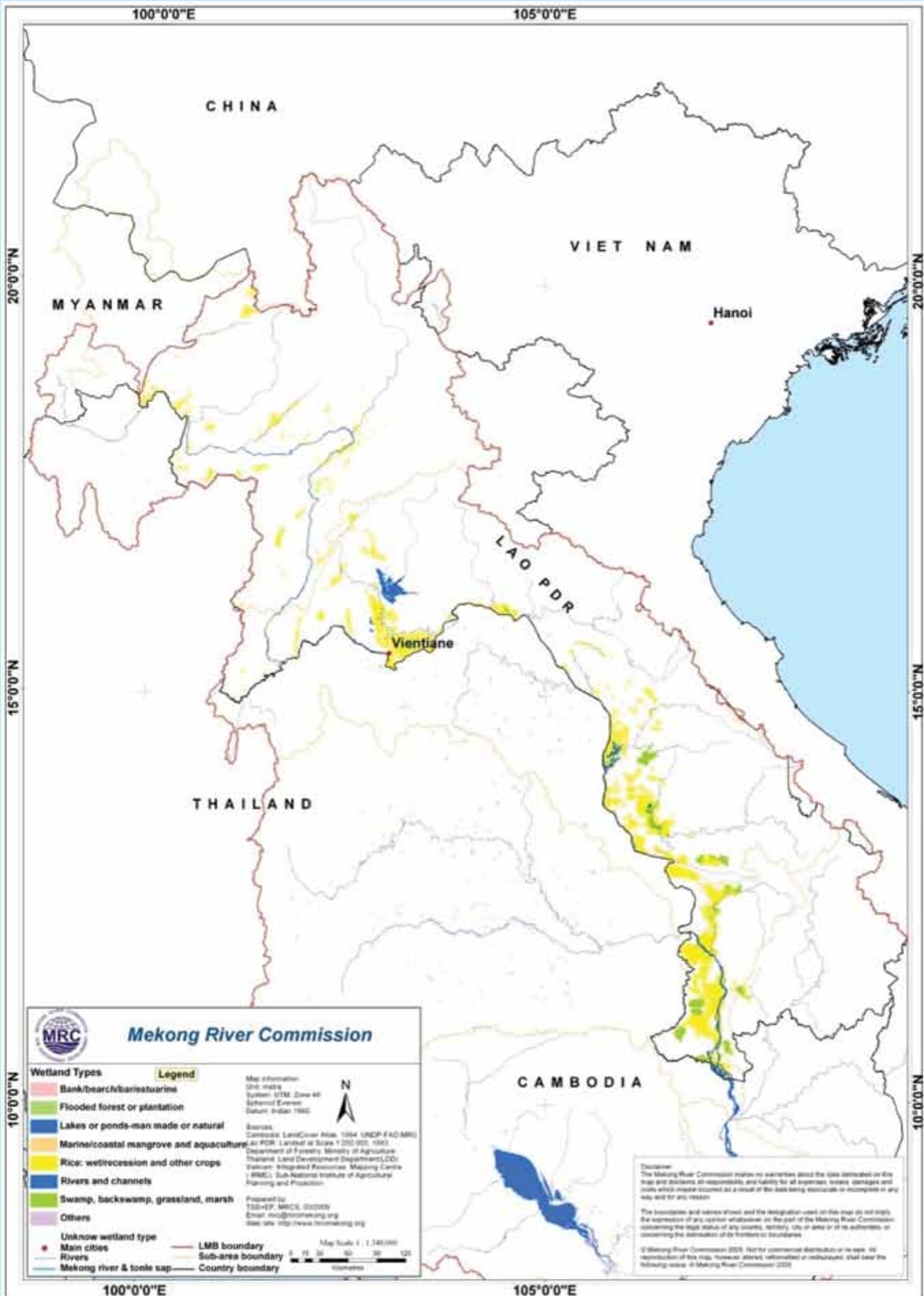
Lao PDR is a mountainous, land-linked country in the heart of Southeast Asia. Its area is 236,800 km², of which 87.7 per cent (207,674 km²) drains into the Mekong River, making up 26.1 per cent of the Mekong Basin, and contributing about 35 per cent of the Mekong River's discharge. Another 12.3 per cent in the north-eastern area drains to the north of Viet Nam into rivers that flow to the East Sea. Almost all Lao territory is of enormous importance, both for fishery resources and for its rich aquatic biodiversity.

The country has a population of about six million, of which 75 to 80 per cent still live a rural lifestyle. In 2005 it was estimated that 32.7 per cent of these people lived below the poverty line (ADB, 2008). The people of Lao

PDR, especially in the rural communities, still rely heavily on aquatic resources, i.e. fish and other aquatic animals, as the most reliable sources of animal protein. As noted by Sjorslev (2000) "fish, and other aquatic animal products, form the major component of the animal protein intake of rural communities." In Lao PDR, the most current estimated yield of inland fish amounts to 167,922 tonnes per year, while the yield of other aquatic animals comprises 40,581 tonnes per year. These figures have been based on consumption studies and expressed as Fresh Whole Animal Equivalent Weights (FWAEs) (Hortle, 2007). The estimate of actual fish consumption per capita (kg/capita/year) of inland fish was 24.5 kg, while other aquatic animals comprised about 4.1 kg and marine products contributed 0.4 kg to make a total of 29 kg/capita/year. These figures were quite consistent with the Lao Expenditure Consumption Survey 3 (LECS3) conducted by the National Statistic Center¹ in 2002 and per capita consumption has remained constant to 2007/8 based on LECS4.

Due to the diversity of aquatic ecosystems, the structure of inland fisheries as well as their production can be characterised by various types of capture and culture. Capture fisheries can be categorised by the use of various water resources such as the Mekong river and its tributaries; large hydropower reservoirs; natural pools, lakes and small wetlands; irrigation reservoirs, weirs and the large areas of wet-season rice-fields and seasonal Mekong flood plains. The majority of the catches of fish and other aquatic animals in the various water resources are still at the level of "subsistence and semi-subsistence fishing or artisanal fisheries," except in large reservoirs where the catches have been organised and normalised. As noted by Coates *et al.* (2003), the general accessibility of aquatic resources to most local communities, and the high participation in exploitation and utilisation of these resources are linked intimately. This type of catch is an integral part of the livelihood of entire communities, and most fishing effort is part-time and seasonal in nature. In contrast, although aquaculture development in Lao PDR is progressing well, it

¹ The National Statistic Center is now known as the Department of Statistics under the Ministry of Planning and Investment.



Map 3: Wetlands of Lao PDR

is still encountering many difficulties that need to be overcome. The forms of production in aquaculture include fishpond culture, community fish culture in oxbow lakes and in irrigation weirs, rice-fish culture and cage fish culture.

The aim of this report, produced under the Mekong River Commission's Development Series, is to provide general knowledge and understanding of Lao fisheries and environment to wider audiences. This report attempts to describe the water resource ecosystems, the various types of fisheries and their biodiverse environments. It also discusses the socio-economic importance of fisheries in Lao PDR (especially fish and aquatic resources for local livelihoods as source of food security), the status regarding capture and culture fisheries and the focus on collaborative research. Furthermore, the role played by the Government of Lao PDR in management interventions is discussed, including the challenges new socioeconomic development projects bring to the fisheries sector.



Fishing activities on the Mekong mainstream

Girls fishing in a seasonal stream running from rice-fields



Water resource ecosystems



A small Mekong tributary and rice-fields in a steep valley in the north



Newly flooded rice-fields provide rich habitats for aquatic animals



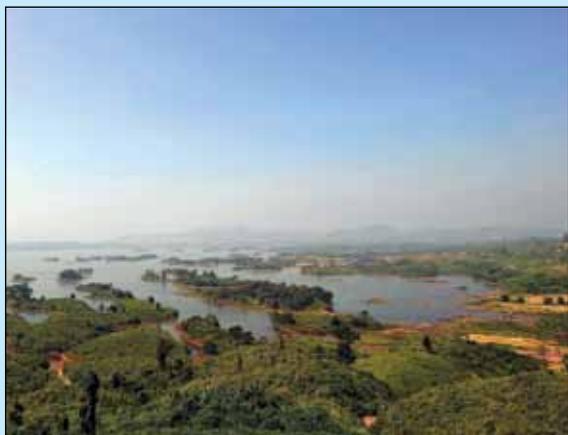
Fishing in an irrigation canal downstream of Nam Houm



Barrier fence near wet-season rice-fields



Cage culture on the Nam Houm irrigation reservoir



Nam Ngum Reservoir

2. Water resources ecosystems and fisheries

2.1 Physical landforms of Lao PDR

Lao PDR covers 236,800 km² which can be divided into three physiographic zones: the Northern Highlands, the Annamite Range (known as *Saiphou Loung* in Lao) and the Mekong Plain. These physiographic zones are parts of four biogeographic units, namely the unit of Annam, the tropical lowlands, the tropical montane and the sub-tropical transition zone (Duckworth *et al.*, 1999). About 87.7 per cent of the total surface area of Lao PDR forms the catchment of the Lower Mekong Basin while 12.3 per cent (29,126 km²) on the north-eastern side is within the catchment of the Song Ca, Song Chu and Song Ma Rivers, which flow east to Viet Nam. Several Lao provinces contribute drainage areas to Viet Nam rivers, including Houaphanh (15,741 km²), Xiengkhuang (5,723 km²), Phongsaly (1,164 km²), Khammuane (99 km²) and Bolikhamxay (38 km²) (MRC, 2003). Catchments on both sides are characterised by more than 18 high mountains averaging from 1,026 m to 2,820 m above sea level. Most of these are classed as National Biodiversity Conservation Areas (NBCAs). Phou Bia, at 2,820 m, is the highest mountain in Lao PDR (LDS, 2010). In 1999 there were 20 areas, comprising 29,000 km², declared as NBCAs and nine proposed NBCAs (Robichaud *et al.*, 2001).

As well as providing habitats for wildlife and different aquatic animals, the high mountains and NBCAs are the main origins of streams and rivers and other water resources that can be classified by their geomorphological features as freshwater habitats. These habitats include springs, hill streams, headwaters, rapids, and some peat swamps as in the Xiengkhouang Plateau (Nong Tang) and Boloven Plateau (Nong Hine) (Kottelat and Whitten, 1996).

In the Northern and North-eastern Highlands, these water sources generate a multitude of small streams and small permanent rivers that pass through small valleys before flowing to the main rivers. In the Annamite Range and the Mekong Plain, the drainage from water sources is more abrupt into the marginal and important rivers, before discharging into the tributaries of Mekong. It is also intermittent during the dry season and this is when oxbow lakes, marshes and swamps and riverine lakes emerge.



A small tributary of the Nam Ngum
Such streams are biodiverse, but most fisheries production is from extensive lowland water-bodies.

Water resource ecosystems



The Mekong in the northern region near Luang Prabang



The Nam Ou, a Mekong tributary in Luang Prabang province



The Siphandone wetland area, Mekong River, southern Lao PDR



The mouth of Nam Kading, central Lao PDR



An aerial view of the Mekong River near Luang Prabang



The Nam Hinboun in central Lao PDR

2.2 Water resources related to fisheries and aquatic biodiversity

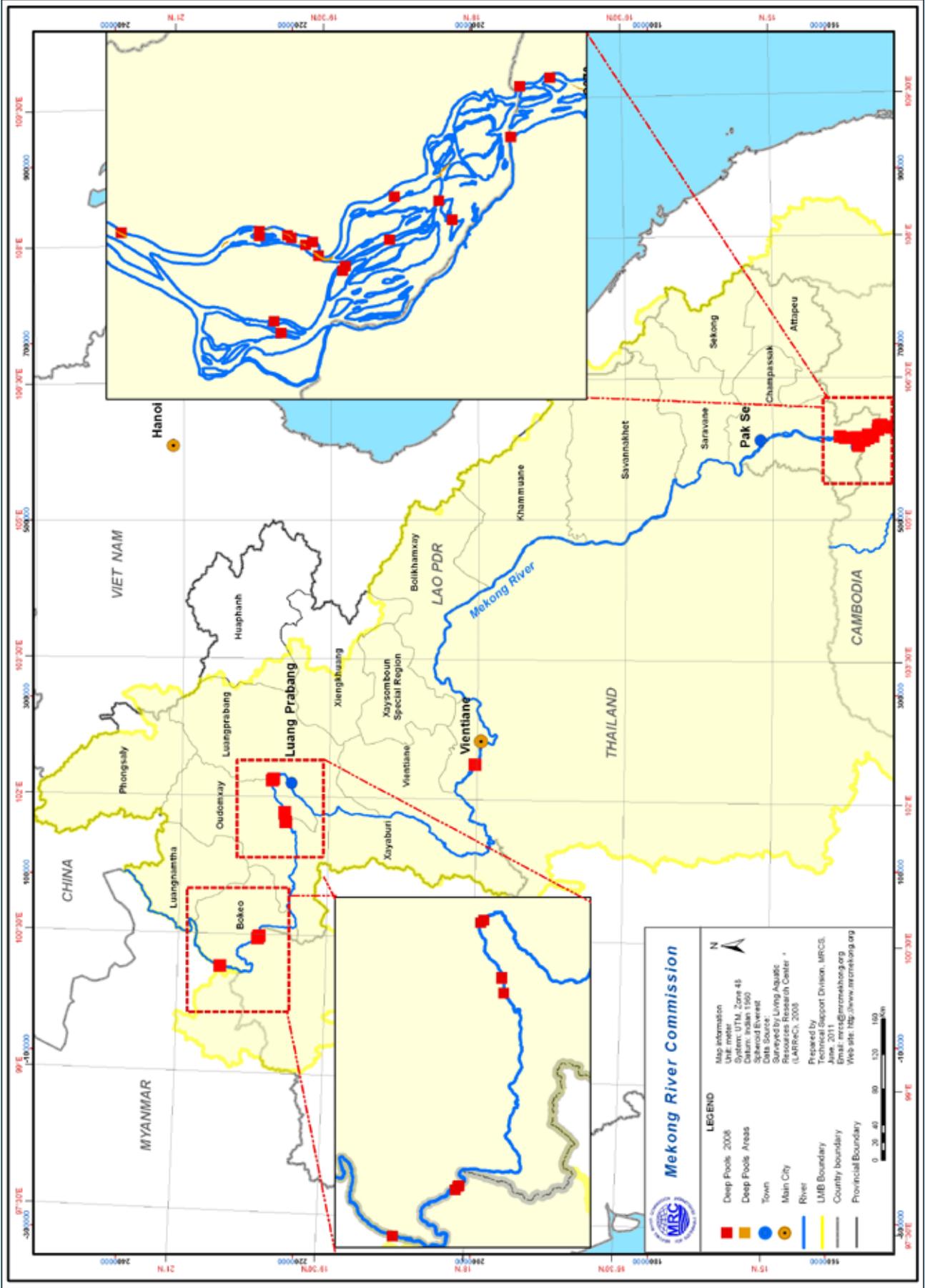
Formerly, when talking about capture fisheries, much emphasis was given to the Mekong River and its 14 main tributaries, neglecting other types of wetlands, flood plains and wet-season rice-fields that also contribute large amounts of water surface area for living aquatic resources and fishes. Following the Ramsar Convention in 1971, Chanphengxay *et al.* (2004) adopted the following definition of wetlands: “Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface of the land or the land is covered by shallow water”. This seems more suitable for the conditions in Lao PDR for classification of wetlands and for undertaking in-depth studies of their importance. The definition covers five types of wetlands: rivers and flood plains (with five sub-categories), shallow lakes (three sub-categories), marsh/swamp (four sub-categories including rice-fields), peat swamp, and swamp forest.

In 2007, for the purpose of statistical information and economic valuation of capture fisheries and aquaculture, the Department of Livestock and Fisheries and the Ministry of Agriculture and Fisheries (DLF/MAF, 2007) restructured the types of inland water resources and re-estimated fish production (see Table 1). According to this study, the Mekong River and its 14 main tributaries, and five north-eastern rivers cover an area of 304,704 ha of Lao PDR. The area of large hydropower reservoirs is estimated at 96,030 ha, while shallow lakes, natural pools, peat swamps, other swamps and wetlands occupy 114,800 ha. Irrigation reservoirs and weirs are estimated to cover 60,000 ha, whereas wet-season rice-fields total 632,850 ha. Seasonal flooded areas in the Mekong Plain are believed to cover more than 30,000 ha. Overall, this adds up to a total water resource area of 1,238,394 ha for capture fisheries. In addition, water resources used for aquaculture total about 42,000 ha. Of this total, fishponds take up 22,000 ha, man-made oxbow lakes and irrigation weirs cover 15,000 ha and rice-fish culture occupies about 5,000 ha. The total wetland (water surface) area for both capture and culture fisheries has now been re-estimated at 1,280,384 ha, in comparison with the MRC GIS database broad categories of wetlands (1992-1998), which recorded it at about 1,019,600 ha (see Annex 1). However, the MRC database did not cover all wetlands, which leads to underestimates of areas.

The Mekong and its 14 tributaries (the Nam² Tha, Nam Ou, Nam Beng, Nam Xeuang, Nam Kham, Nam Ngum, Nam Ngiep, Nam San, Nam Kading, Xe Bang Fai, Xe Bang Hieng, Xe Bang Nouan and Xe Don) have been estimated to have an approximate water surface area of 254,150 ha.)

Based on gross estimation from the 1994 Map of Lao PDR Scale 1:1,750,000, the water areas of the Nam Xam (26,950 ha), Nam Ma (13,665 ha), Nam Neun (5,974 ha), Nam Mo (2,890 ha) and Nam Mat (1,075 ha) located in the north-eastern region of the country and outside of the Lower Mekong Basin, are estimated at 50,554 ha. However there are many streams and rivers draining to the Mekong River that need to be investigated for their water resources potential and aquatic biodiversity. For example, there are more than 24 streams and rivers in Luang Prabang and Xayaburi provinces on the west bank of the Mekong. Of these, the five most important are the Nam Khop, Nam Ngum, Nam Houng, Nam Pui

²Nam in Lao means river



Map 4: Some important deep pools in the Mekong River, Lao PDR

Table 1: Structure of inland fisheries in Lao PDR and estimated fish production in 2007

Types of Fisheries	Water resource	Total area (ha)	Production (kg/ha/year)	Production (Tonnes)
Capture Fisheries	Mekong River and tributaries and five northeast tributary rivers	304,704	70	21,329
	Large Reservoirs (hydropower):	96,030		8,405
	<i>Nam Ngum Reservoir</i>	45,000	133.3	6,000
	<i>Nam Theun 2 Reservoir</i>	45,000	33.3	1,500
	<i>Others: Houy Ho: 3,750 ha Nam Leuk: 1,280 ha Nam Mang: 1,000 ha</i>	6,030	150	905
	Shallow lakes, small natural pools, peat swamps and wetlands	114,800	150	17,220
	Irrigation reservoirs and irrigation weirs	60,000	150	9,000
	Rice-fields, small streams and floodplains: <i>Wet-season rice-fields</i> <i>Dry-season irrigated rice-fields</i> <i>Wet-season irrigated rice-fields</i> <i>Flooded area</i>	632,850 153,677 344,820 30,000	50 see note see note 50	31,643 1,500
Sub – Total:	1,238,384	-	89,097	
Aquaculture	Fish ponds	22,000	1,500	33,000
	Oxbow lakes and irrigation weirs for aquaculture	15,000	600	9,000
	Rice-fish culture	5,000	250	1,500
	Cage culture	-	(4,500 cages x 2.5 tonnes)	11,250
Sub – Total:	42,000	-	54,750	
TOTAL	1,280,384	-	143,847	

Note: it is assumed that irrigated rice-fields produce few fish because of pesticide toxicity; more work is needed to test this assumption. Fisheries would benefit greatly from integrated pest management (IPM), which reduces pesticide use in rice-fields. Production figures here reflect official statistics of the government of Lao PDR; in chapter 3.3 reference is made to fish production estimated by Hortle (2007).

and Nam Heuang. There are 14 important water sources in Champassak which need to be explored, with the most important being Houy³ Kmouan and Xe Lamphao. Some rivers and streams on the east bank are still not mentioned as main tributaries, although they directly discharge into the Mekong River, namely the Nam Long, Nam Ngaou, Nam Mi, Nam Mang, Nam Hinboun, Nam Pakan, Nam Don and the Houy Tomo and Houy Banglieng. Some major streams which are important habitats for aquatic animals and plants also need to be investigated.

³Houy in Lao means small river

Species diversity and importance of indigenous fishes in aquaculture

The Mekong and its tributaries in Lao PDR are very rich in species diversity. More than 481 fish species out of 924 species in the Lower Mekong Basin have been identified in Lao PDR (Kottelat, 2001). However, other aquatic animals and plants are still poorly known in terms of systematic stock assessment.

The Aquaculture of Indigenous Mekong Fish Species Project (AIMS) of the MRC has conducted research in Lao PDR on six indigenous fish species, namely *Barbonymus gonionotus*, *Cirrhinus molitorella*, *Labeo chrysophekadion*, *Osphronemus exodon*, *Puntioplites falcifer* and *Clarias macrocephalus*. The research reveals the potential for producing fish fingerlings on farms.

More than 18 indigenous fish species have been used in various types of farming, either by collecting the fry from the wild, artificial reproduction in captivity or reproduction in fish pond culture by private farms and some government hatcheries. These indigenous species include the six above and also *Hampala macrolepidota*, *Cirrhinus microlepis*, *Probarbus jullieni*, *Puntioplites falcifer*, *Clarias batrachus*, *Hemibagrus Hemibagrus spilopterus*, *Hemibagrus wyckioides*, *Pangasius bocourti*, *Pangasius krempfi*, *Hypsibarbus* spp., *Osphronemus gouramy*, *Osteochilus melanopleurus*, *Probarbus jullieni*, *Catlocarpio siamensis*, *Channa striata*, *Channa micropeltes* and *Clarias macrocephalus*.



Silver barb *Barbonymus gonionotus* (pa pak kom)



Mud carp
Cirrhinus molitorella (pa keng)



Black sharkminnow
Labeo chrysophekadion (pa phia ii kam)



Elephant ear gouramy
Osphronemus exodon (pa men)



Puntioplites falcifer
(pa sa kang)



Hampala barb
Hampala macrolepidota (pa sood)



Broad-head walking catfish
Clarias macrocephalus (pa duk oui)



Small-scaled mud carp
Cirrhinus microlepis (pa phon)



Jullien's golden carp
Probarbus jullieni (pa ern ta deng)



Mystus catfish
Hemibagrus spilopterus (pa kot leuang)



Walking catfish
Clarias batrachus (pa duk)



Asian red-tail catfish
Hemibagrus wyckioides (pa kheung)



Krempf's catfish
Pangasius krempfi (pa suay hang leuang)



Bocourt's catfish
Pangasius bocourti (Pa phoc)



Giant gouramy
Osphronemus gouramy (pa men)



River carp
Hypsibarbus wetmorei (pa pak)



Striped snakehead
Channa striata (pa khoh)



Nilem carp
Osteochilus melanopleurus (pa nok kow)



Giant snakehead
Channa micropeltes (pa doh)

Other Aquatic Animals



Siamese crocodiles (*Crocodylus siamensis*) are now rare, but are increasingly being farmed.



Other aquatic animals including mussels, snails, turtles, frogs, shrimps and crabs, are very important, but are often overlooked in fisheries assessments.





Lao people eat many other aquatic animals such as snails, clams, frogs, and others. They are readily available at the local markets

2.3 Fish and freshwater aquatic biodiversity in Lao PDR

2.3.1 Ecosystem diversity

Natural and anthropogenic wetlands as mentioned in Section 2.2 above, support the diverse freshwater ecosystems in Lao PDR. As noted by Kottelat and Whitten (1996) when discussing freshwater biodiversity in Asia: “Ecosystem diversity is concerned with the variety of habitats and species communities, as well as the ecological processes within ecosystems.” In addition, conserving freshwater habitats and species generally requires working at the scale of the catchment (Baltzer *et al.*, 2001).

The Mekong passes through Lao PDR for a distance of 1,898 km of which 1,155 km forms the border with Thailand and Myanmar (LDS, 2010). However, for freshwater sites of exceptional biodiversity interest, most emphasis is given to the Khone Falls area, the Xe Pian catchment and the deep pools in the Mekong mainstream and its tributaries. Since 2000, the Technical Advisory Body for Fisheries Management (TAB)⁴ has been promoting the need for greater understanding of the ecology of deep pools as well as their regional significance. Halls (2008) concludes that pilot testing of methods to estimate fish abundance and biodiversity in deep pools has yielded promising results. Mapping of the deep pools being undertaken by the MRC, and the World Wide Fund for Nature (WWF) has provided its own research findings on deep pools in the tributaries of Lao PDR to assist this. A number of fisheries researchers, such as Poulsen *et al.* (2002), Baran *et al.* (2005) and Halls (2008), have postulated that deep pools are critical refuges for feeding during the dry season, and spawning and/or nursery habitats during the wet-season for many migratory species.

2.3.2 Biological diversity

Species diversity refers to the variety of living organisms, while genetic diversity refers to the total genetic information contained in the genes of an individual species (Kottelat and Whitten, 1996). Diversity also refer to the degree of difference or variation within any grouping. For example, 30 species of fish in one family is considered less diverse than 20 species in five families.

The MRC’s Mekong Fish Database in 2003 listed 26 exotic species and 898 indigenous species, ranging from the largest: the Mekong giant catfish (*Pangasianodon gigas*), the giant barb (*Catlocarpio siamensis*) and the giant stringray (*Himantura chaopraya*), to the smallest: *Boraras micros* (with a maximum length of 1.3 cm), *Oryzias pectoralis* (2.2 cm) and *Clupeichthys aesarnensis* (4.6 cm). In Lao PDR, more than 481 species have been identified by Kottelat (2001) including 22 species identified as exotic species. Additional ichthyological exploration of fishes has been completed in the Nam Theun and the Xe Bang Fai basins and has produced data showing the presence of 191 species: 130 species for the Xe Bang Fai and 61 for the Nam Theun. Kottelat also indicates that the Xe Bang Fai fish fauna is similar to that of the middle Mekong Basin while the Nam Theun fauna is characterised by the presence of several species previously known from Xishuangbanna, Yunnan, China (Kottelat, 1998, p. 128). Other aquatic animals such as frogs, shrimps,

⁴Under the Fisheries Programme of MRC

From Largest to Smallest Fish Species



Giant barb *Catlocarpio siamensis* (pa ka ho)
(Max. length 300 cm)



Giant catfish *Pangasianodon gigas* (pa beuk)
(Max. length 300 cm)



Goonch *Bagarius yarrelli* (pa khae)
(Max. length 200 cm)



Thai river sprat
Clupeichthys aesarnensis (pa keo)
(Max. length 7 cm)



Dwarf medaka
Oryzias mekongensis
(Max. length 3 cm)



Dwarf medaka *Oryzias pectoralis*
(Max. length 2.2 cm)



Boraras micros (pa sew)
(Max. length 1.3 cm)



Freshwater whipray *Himantura chaophraya*
(pa faa hang) (Max. length 240 cm)

crabs, tadpoles, snails, and aquatic plants have not been as thoroughly studied. According to Kottelat and Whitten (1996), only 37 amphibian species, seven species of crabs and 10 species of shrimps have been recorded for Lao PDR, and these records would probably cover only about 15 per cent of the estimated total.

Species cataloguing has yet to be completed in Lao PDR as well as in the Lower Mekong Basin, and further taxonomic studies are especially required in the upper reaches of Lao PDR tributaries. In Lao waters alone, the native fish fauna comprises 47 families out of the 91 recorded on the 2003 Mekong Fish Database, or more than 50 per cent of those recorded in the whole LMB (MRC, 2003).

It is very important to understand the migration patterns of Mekong fish species in relation to ecosystem and species diversity. There are four main periods of migration: the flood season (July-November), which sees lateral movement of adult fish into flood plain areas for feeding and growth; the dry season (February to April) when there is a concentration of fish in permanent water bodies; and two transitional periods (December-January) when there are lateral movements of juvenile and adult fish from seasonal to permanent water bodies and (May-June) when there are longitudinal migrations to spawning grounds for spawning (Poulsen *et al.*, 2004).

Migratory fishes are grouped into three main categories. Anadromous fish live most of their adult life in the sea, but enter freshwater to spawn (e.g. *Pangasius krempfi*). In contrast, catadromous fish show the opposite migration pattern in which they live in freshwater bodies until they are ready to spawn, then swim to estuaries or the sea to breed. Potamodromous fishes (e.g. *Helicophagus waandersii*, *Pangasius conchophilus*, *P. larnaudii* and *P. macronema*), are the most important group in the Mekong, as they live their entire life in rivers, but migrate, often for long distances, in order to spawn, feed and seek refuge. Potamodromous migrations are either longitudinal or lateral.

Poulsen *et al.* (2002) described three main migration “systems”: upper (upstream of the Loei River confluence in Thailand), middle (from the Khone Falls upstream to the Loei River confluence), and lower (from the Khone Falls downstream to the sea, including the Tonle Sap system in Cambodia). These three systems also correspond to the elevation contours of the Lower Mekong Basin: the upper from 200 to 500 m elevation, middle from 150 to 199 m elevation, and lower from 0 to 149 m elevation, suggesting that fish migrations evolve to suit the surrounding physical environment. The classification of migration systems was based upon local ecological knowledge, landing site surveys, logbook migration monitoring, and larvae sampling of 40 important fish species, and also revealed the distribution, population structure, feeding habits, critical habitats and life cycles of these fish species (Poulsen *et al.*, 2002). The status of about 11 species gauged from the IUCN “Red List” of critically endangered, endangered or vulnerable categories for the Mekong River Fishes was also cited by Poulsen *et al.* (2004).

2.3.3 Fish species suitable for stocking and for aquaculture

More than 18 indigenous fish species have been used in various types of farming, where fry

Consumption and utilisation of fish

Fish and other aquatic animals (OAAs) are used to supplement a predominantly rice-based diet, so are important for the health and food security of the Lao people, especially in rural communities. From 1993 to 2003, there was a net increase in fish, meat and fruit products where fish consumption grew up to 24.3 per cent.

In Lao PDR, the actual consumption of fish and OAAs per capita per year is estimated at about 29 kg, of which fish comprise 24.5 kg, OAAs 4.1 kg and marine products 0.4 kg (Hortle, 2007). This means that the country's total consumption is equivalent to 208,503 tonnes consisting of 85,076 tonnes of fresh fish, 82,846 tonnes of preserved fish, and 40,580 tonnes of OAAs. This total consumption is valued at approximately US\$150 million per year, based on the average price of first-hand sale. Apart from consumption of fresh fish, almost 50 per cent of fish and OAAs are transformed into preserved fish products such as salted and dried fish, smoked fish, fish paste and other kinds of fermented fish and fish sauce.

Inland fisheries are an important part of the rural livelihoods of Lao people. Fish and OAAs not only provide food security for rural people, but also generate additional income and employment through fishery-related activities. According to the Lao Expenditure and Consumption Survey 3 (LECS3), about 21 per cent of total household catch and production was traded locally. Although many studies reveal the importance of inland fisheries to rural people (more than 75 per cent of the Lao population), there needs to be more recognition of the importance of inland fisheries in Lao national planning and the priorities of the country.



Featherbacks and others species from the Mekong River



Fermented fish products

have been collected from the wild or produced through artificial reproduction in captivity or in fishpond culture in private farms and some government hatcheries. The propagation of these fishes remains limited in terms of production and the government's capacity to distribute them to provincial hatcheries. Fingerling production by private farms, the identification of appropriate and more commercially viable indigenous fish culture systems, and the promotion of stocking small water bodies and reservoirs are desirable. The MRC/AIMS Project, operating under the Living Aquatic Resources Research Centre (LARReC), has studied six indigenous fish species which it thinks might be suited for aquaculture. To date experiments have concluded with promising results in terms of producing fish fingerlings on farms.

Knowing that exotic fish species pose some threats to natural stocks and aquatic biodiversity, the Lao Government is not in a position to support the introduction of exotic fish species, but the restriction, up to now, has not been effective. More than 10 exotic fish species have been introduced into Lao PDR through various sources, mostly not formally recorded. These include: *Cyprinus carpio* (common carp or pa nai), *Carassius auratus* (gold fish or pa phek in the north), *Hypophthalmichthys molitrix* (silver carp or pa ked lap), *Ctenopharyngodon idella* (grass carp or pa kin gna), *Hypophthalmichthys nobilis* (bighead carp or pa houa nhai), *Oreochromis nilotica* (Nile tilapia or pa ninh), *Labeo rohita* (rohu), *Cirrhinus mrigala* (mrigal), *Catla catla* (catla) and *Clarias gariepinus* (African catfish or pa douk phanh). Some exotic species, such as the common carp, tilapia, gold fish and the African catfish have established their own breeding populations in the wild, as well as in ponds and reservoirs. In an attempt to reduce the spread and impact of exotic species, the development of indigenous fish species that may replace or complement the use of exotic species in aquaculture is highly recommended.



Common carp *Cyprinus carpio* (pa nai)
An exotic species, now established in the Mekong.

Rural involvement in fishing activities



3. The socio-economic importance of fisheries in Lao PDR

3.1 Importance of fishes for rural livelihoods, health and food security

In Lao PDR, fish and OAAs form an important part of the Lao diet and provide for health and food security. According to a food consumption survey (LECS3) (NSC, 2004), food groups⁵ accounted for 61 per cent of total consumption in 1992/93, and dropped to 54 per cent in 2003. There was a net decrease in rice and other food items, while there was a net increase in fish, meat and fruit products. Fish consumption grew 24.3 per cent over the 10 years from 1993 to 2003, and provided 13.3 per cent of the total food supply and almost 50 per cent of total animal protein intake for the population. More importantly, fish and OAAs are complementary to the rice-based diet⁶ because they are rich in lysine, minerals (e.g. calcium and iron) and vitamin A, especially in small fish and fish products when whole bodies are eaten.

The average Lao diet may appear to be complete with respect to energy intake, but it is often lacking in some essential amino acids such as lysine, vitamins or minerals if there is no complement from milk or fish. However, milk is not a common food and is not affordable in rural areas. And as around 4.5 million Lao people live a rural lifestyle most of them still rely on fish to complement what is lacking in their rice-based diet. Consequently, subsistence and semi-subsistence fisheries, as well as small-scale rural aquaculture, are most important for them.

The consumption of fish and OAAs varies greatly, and the provincial average consumption ranges from 15 to more than 57 kg/person/year, with an overall average for most of the provinces at 25 kg/person/year. For example, the consumption study by Bush (2004) in six villages of Savannakhet Province revealed total fish and OAA consumption of up to 82 kg/person/year in which 22.7 kg came from wild fish, 15.1 kg from culture fish and 44.8 kg from OAAs. Bush also highlights four important points:

- his figures are higher than other studies;
- the current official estimates of fish consumption may be too low;
- OAAs are very important, though not more so than fish in nutritional aspects; and
- aquaculture has not yet substituted for decrease in wild fish or fully reduced the pressure on natural stocks.

To understand the magnitude and the status of fish and OAA consumption in Lao PDR, many adjustments, extrapolations and conversion factors have been applied by Hortle (2007). The consumption of fish and OAAs in Lao PDR can be summarised as an average actual consumption of 29 kg/person/year of which 24.5 kg is fish, 4.1 kg is OAAs and 0.4 kg is marine products (see Table 2). This figure is also consistent with NSC (2004)

⁵ According to NSC (2004), food groups consists of rice, other carbohydrate crops, meat, fish, milk and eggs, fat, fruit, vegetables, sugar, drinks and beverages and other foods.

⁶ Rice is deficient in Lysine and low in Vitamine A as compared with diets based on beans and pulses like in Bangladesh.

Trading activities at fish landing sites in Khong District, Champassak Province



Table 2: Estimated per capita consumption of fish and OAAs in Lao PDR

	Inland			Marine products	Total aquatic	Other animals	Total animal consumption
	Fish	OAAs	Fish + OAAs				
As FWAEs (kg/capita/year)	34.6	8.4	43.0	0.5	43.5	-	-
As actual consumption (kg/capita/year)	24.5	4.1	28.6	0.4	29.0	33.0	62.1
As protein consumption (g/capita/day)	15.8	1.8	17.6	0.2	17.9	18.69	36.6
As percentage of total animal protein consumption	43.2%	5%	48.2%	0.6%	48.9%	51.1%	100%

Note: fresh whole animal equivalent weights

which reports average fish consumption at about 25.3 kg/capita/year, 19.1 kg for the north, 27.9 kg for Central Region and 28.0 kg for the South (see Table 3), and also consistent with figures in the more recent LECS4 study for 2007/8. If expressed as fresh whole animal equivalent weights, equivalent to “live weight” (FWAEs)⁷ used by FAO, the total aquatic animal per capita consumption is about 43.5 kg/capita/year, equivalent to aquatic animal protein consumption of 17.9 g/capita/day and represents 48.9 per cent of total animal protein consumption.

3.2 Consumption and market exploitation of fishes

The estimated annual consumption per capita of aquatic products in Lao PDR, as FWAEs evaluated by Hortle (2007) amounted to 43.5 kg/capita/year which comprised almost 80 per cent fresh fish, 19 per cent OAAs and 1 per cent marine products (Table 2). The gross value of fisheries is still difficult to quantify. NSC (2004) revealed some useful indicators required for in-depth studies. Fish provided 12 per cent of total household agricultural output, 15 per cent of total household agricultural output for own home use and 7 per cent of total household agricultural output for trade.

Few studies have been carried out regarding fish trade, and no official statistical information is available on this subject, except for the weekly fish price monitoring in the major towns by the Department of Statistics. NSC (2004) reported that only around 21 per cent of total household fish catch and production was traded locally, and in rural areas, less than 19 per cent of these products are for sale. Fish in local markets costs between US\$0.50/kg for small “trash fish,” US\$1.50 to 2.50/kg for larger fish and about one-third of household catches are small fish while the remaining two thirds are large, but both with an average price of US\$1.50/kg (Baran *et al.*, 2007). Bush (2004) gave an average capture fish price of US\$1.14/kg and culture fish price of US\$0.98/kg in three districts of Savannakhet province. He noted that in Savannakhet capture fish still dominated the market, even though aquaculture fishes were an important contribution to total fish trade. This trade

⁷ See Annex 2 for comparison of conversion factors for preserved fish to FWAEs in the LMB, see Annex 3 for conversion factors for edible portions of OAAs and percentage of protein edible portions and Annex 4 for yields estimated by different sources.

Fish markets



A stall selling large fish from the Mekong in Thonkham market, including *Probarbus jullieni* (foreground) and *Luciocyprinus striolatus* (centre)



Nile tilapia, common fish in markets



Sheatfish and barbs for sale



A stall selling aquaculture fish in Thatluang market



Thonkham Market, Vientiane, silver barbs from the Mekong River and striped snakeheads from Nam Theun 2 Reservoir



Fish trading activities in Paksan market

Table 3: Reported fish Consumption in Lao PDR 2002/03, (NSC, 2004)
(kg/capita/year actual intake)

Region	Meat	Fish	Vegetables	Fruit	Rice (cooked)
Entire Lao PDR	22.4	25.3	45.6	28.0	210.5
North	23.9	19.1	63.3	24.9	236.9
Central	21.6	27.9	39.3	28.8	198.1
South	22.4	28.0	34.3	30.8	197.1
Urban	25.3	24.1	40.3	34.0	186.3
Rural with road access	21.8	27.7	45.6	29.9	217.8
Rural without road access	20.3	19.7	53.8	22.1	216.4

Source: Hortle (2007)

is dominated by a small number of species, and capture fishes are dominated by *Channa* spp., and *Clarias macrocephalus*, whereas culture fishes are dominated by tilapia grown in intensive cage culture along the Mekong River. Overall, trade was dominated by imported horse mackerel as well as *Pangasius hypophthalmus* and *Clarias batrachus*.

A first baseline study roughly estimated fish trade from the Siphandone wetlands at 435 tonnes of fish from capture fisheries (Bush and Phonvisay, 2001). Monitoring of fish trade at eight landing sites and four boat accesses to villages reported a rough volume of 668 tonnes, of which 14.4 tonnes were sold to Thailand and about 625 tonnes valued at US\$793,000 were channelled to Pakse and Vientiane. It should be noted that these studies were implemented over a short period of time, and the annual estimates of fish trade were based on recalled knowledge of key traders and informants. Phonvisay *et al.* (2006) implemented four five-day surveys of three markets during 2004 in Vientiane and Luang Prabang. These studies revealed that total sales of aquatic animals within a five-day period⁸ in Luang Prabang were almost 3.8 tonnes, valued at about US\$5,300, and fresh fish products made up more than 95 per cent of sales. In contrast, the sources of aquatic products in Thongkhankham and Thatluang markets⁹ in Vientiane could be classified into three main sources: cultured fish mainly from Thailand and fish farms in Vientiane, wild capture fish from rural areas stretching from Vientiane to Vientiane Province, and wild capture fish from Champassak province, especially from the Siphandone wetlands.

Approximately 8 tonnes of fresh fish valued at almost US\$15,000 were sold in the five-day survey of both markets in Vientiane. Fresh fish products from wild capture fisheries accounted for almost 40 per cent of the total fresh fish products (about 3.1 tonnes) in both markets while fresh fish products from aquaculture accounted for approximately 60 per cent (about 4.9 tonnes). Fresh fish products dominated the sales accounting for about 85 per cent of total fish products.

Regarding fish species sold in the Vientiane markets, Phonvisay *et al.* (2006) found that the most common Mekong wild fish were *Pangasianodon hypophthalmus*, *Wallago*

⁸Data collected between 12-16 Jan 2004

⁹Thongkhankham and Thatluang markets appear to be the two biggest markets in providing aquatic products in Vientiane.

Khone Falls fisheries

The Siphandone (four thousand islands) wetlands, or Khone Falls area covers more than 6,000 ha, in Khong District, Champassak Province. It is a widening of the Mekong River, which divides into branches, forms a large number of islands and many rapids and channels before dropping over the Cambodian border. The biggest, highest (30 m) and widest rapid is called *Khone Pha Pheng*. The Wildlife Status Report (Duckworth *et al.*, 1999) describes the area thus: “Khone Falls is noteworthy as the world’s widest rapid.”

The Khone Falls fishery is of great importance, not only because it supports the livelihoods and income generation of about 72,000 people in Khong district (2008), but also for the large amount of quality fish it supplies to many big towns such as Pakse and Vientiane in Lao PDR and Ubon Ratchathani in Thailand. According to a rapid fisheries survey (Baird *et al.*, 1998), about 4,000 tonnes of fish are caught every year in Khong District of which 70 per cent is consumed locally as fresh or preserved fish, and 30 per cent is sold. These sales generate approximately US\$100 income per family per year.

The Khone Falls fishery is characterised by subsistence or semi-subsistence fisheries and has a strong link with aquatic biodiversity conservation by local fishers who are very knowledgeable about their resources (Phouthavongs and Soukhaseum, 2007). Their local knowledge about migration seasons, spawning grounds and fish conservation zones of different fish species throughout the year has led them to a series of management measures (Baird, 2000), such as the establishment of fish conservation zones, bans on blocking streams and bans on illegal and destructive fishing activities including restriction of use



Aerial view of the Siphandone wetlands



A li trap at Houy Som Yai

on destructive fishing gear, electricity, dynamite, and poisons. Additionally, there are management activities for juvenile fish conservation, sustainable frog harvesting and rice-field fisheries.

The Siphandone wetlands support a unique fishery and considerable aquatic biodiversity. Many international organisations and well-recognised scientists have visited this area and made valuable recommendations on research needed for understanding the life cycles, migration patterns, breeding grounds and habitats of the most important Mekong fish species. Some scientists have also offered advice on sustainable use, appropriate management and protection of the area for the well-being of aquatic resources of the Lower Mekong Basin.

Numerous biological and sociological studies have been carried out in the Khone Falls Area since 1992 by many groups of experts, and a large amount of literature has been published.

Monitoring of the main wet and dry-season migrations through Houy Som

Yai supported by the Indigenous Fisheries Development Project under IDRC, was discussed in Singhanouvong *et al.* (1996). More comprehensive and detailed comments on the fisheries bio-ecology at Khone Falls can be found in the studies of Baran *et al.* (2005), in which 110 fish species and 41 fishing methods were studied for six years. *P. jullieni* was used as reference for long migratory fish, *P. krempfi* was used as an anadromous fish which lives most of its adult life in the sea, but must enter freshwater to spawn. *P. krempfi* was used as an example of a fish which is sensitive to water discharge or hydrological triggers. The importance of deep pools for fish refuges, spawning and feeding during the dry season was also discussed.

The report by Phouthavongs and Soukhaseum (2007) on trapping migrating fish in channels at Khone Falls indicated specifically the importance of *li* traps in catching migrating fishes during the wet-season in this area. The *li* trap is a special type of Lao fishing gear used to catch upstream migrating fish, particularly in late May and late August. In 2006, Khong Island had about 600 *li* traps of various sizes, including 19 traps in Houy Som Yai. According to the most recent studies, the fishery in Siphandone is still in good shape and faces no major environmental threats. However there are some concerns about the declining numbers of large fish and large species, the causes for which are still unclear.



Pangasius catfish caught in a *li* trap

micropogon, *Channa micropeltes*, *Bagarius bagarius*, *Pangasius conchophilus*, and *Wallago attu* while *Oreochromis niloticus*, *Cirrhinus cirrhosus*, *Mystus nemurus*, *Hypophthalmichthys molitrix* and *Pangasius* spp., were the most common cultured species sold.

Overall, these studies on fish trade and markets highlight the importance of fish consumption and utilisation within the country. They also draw attention to the influence of the demand for fish in the final markets to the level of exploitation of fisheries resources; for example the illegal trade of many wild endangered Mekong fish from Lao PDR to Thailand is still common. These are mainly big fish with high prices (Bush and Phonvisay, 2001). In contrast, a large quantity of aquaculture fish from Thailand is often illegally imported into Vientiane in order to meet the high urban demand for fish (Phonvisay, 2001). Research on fish consumption and utilisation that demonstrates links between various market conditions and constraints may reveal useful outcomes for strengthening sustainable fisheries management and development.

3.3 The status of fisheries

For the purpose of this report, fisheries includes fish and other aquatic animals, and fish products comprise fresh fish, and preserved fish. As mentioned in the introduction, the fisheries yield¹⁰ in Lao PDR was estimated by Hortle (2007) as about 208,503 tonnes of which 167,922 tonnes were fish (85,076 tonnes of fresh fish and 82,846 tonnes of preserved fish), and 40,581 tonnes were OAAs. These estimates were based on consumption studies and expressed as FWAEs in tonnes/year as a surrogate of fisheries yield. Based on this yield and the average first hand sale price of US\$0.68/kg (MRC, 2003), an estimate of 208,500 tonnes of fish in Lao PDR is worth about US\$142 million per year.

In Lao PDR, river fisheries are exploited largely by local communities, each fishing in their own area. Traditional systems for managing access and fishing effort are widespread and the fishery is an integral part of the livelihood of entire communities (Coates *et al.*, 2003). The bulk of the catch is taken by part-time and subsistence fishers, rather than by those classified as full-time fishers, except in the large hydropower reservoirs such as Nam Ngum and Nam Theun 2 where commercial fishers are dominant. Subsistence fishing is carried out by almost everyone who has access to water bodies (Claridge, 1996). The resources from subsistence fishing provide at least 70 per cent of the fish consumed by members of rural households each year, and local fisheries are considered vital to poor households (Garaway, 1999).

The inland capture fisheries sector is still poorly represented in national plans and priorities in Lao PDR as well as in other countries in the region. Other living aquatic resources (prawns, shrimps, snails, frogs, shellfish, algae, wild water plants and vegetables) are absent from national statistics. In addition, inland fisheries catch statistics are much-disputed in Lao PDR. DLF (1998) estimated the total water resources at about 791,720 ha for both capture and culture fisheries. The total fish production amounted to roughly 38,000 tonnes in which aquaculture contributed 12,000 tonnes (31.5 per cent of the total production). The revised estimate of the areas and fish production by Guttman and

¹⁰ According to Hortle (2007), fisheries yield = Consumption – Imports + Exports + Animal feed + Waste + Aquaculture feed.

Funge-Smith (2000) was about 60,000 tonnes with aquaculture contributing only 26 per cent, and in 2004, the DLF estimate was updated to 90,000 tonnes. In 2007 the DLF revised the structure of inland fisheries and fish production and estimated it was up to 143,847 tonnes, of which 89,097 tonnes¹¹ came from capture fisheries and 54,750 tonnes from aquaculture (equal to 38 per cent of total production). From 1996 to 2007, there was a net increase of water resource areas due to the inclusion of the northeastern rivers, the new Nam Theun 2 hydropower reservoir, additional small irrigation reservoirs, wet-season rice-fields and seasonal flood plains. The latest production figures appear to be close to the MRC's fisheries yield estimation cited above.

In summary, fisheries provide an essential livelihood for fishers and their families, mostly in rural areas. They generate income and employment for people involved in fishing activities, and more specifically, provide additional cash income for rural households as well as contributing substantially to their diets providing food security for the majority of the Lao people. However, for more understanding and a better representation of the fisheries sector, there is a need for more reliable information on catches and on culture, especially regarding OAAs, productivity in wet-season rice-fields and small water body catches. A regular monitoring system should be established with more field-based monitoring; this would work better if it were accompanied by more in-depth research on the secondary value of fisheries, as well as the importance of different freshwater environments and various types of habitats. An inventory of potential water resources related to fisheries accompanied by in-depth assessments of fishery yield by various types of habitats would also be very useful.

3.3.1 The Mekong and its main tributaries

If we are to understand the water resources of the Mekong River and its main tributaries or even the northeastern rivers draining to Viet Nam, it is important to understand that when it comes to fish migration networks, the Mekong River Basin functions as one ecological unit. Climate and ecology are all linked to the basin's hydrological regime. Welcomme (1985) describes main river channels as comparatively unproductive, because stronger currents and shifting substrates result in lower primary production, however the quantity and quality of water in the rivers is vital for maintaining system productivity as fish must migrate along the main river to access productive floodplains and tributaries.

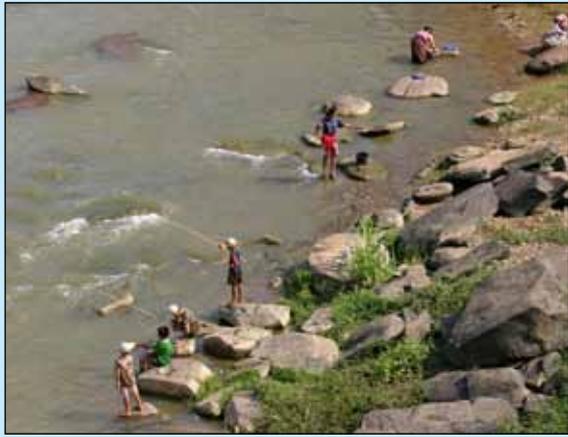
In 2007 monitoring of catches in more than 304,704 ha of the river systems showed a production of up to 21,329 tonnes. However, monitoring the fisheries in all the river systems throughout Lao PDR requires a massive amount of work on data collection and on statistical analysis and evaluation, which requires a wide range of scientific knowledge if it is to be efficient. Fortunately, with the support of MRC and other international organisations, this work can be gradually strengthened. Outside of special wetlands like the Siphandone estuary, where there have been many studies of ecology and the socio-economic environment, there is a need to establish accurate figures for catches along the Mekong river. For example, Lorenzen *et al.* (2003) raise the issue of fish catches along the border with Thailand where there is a considerable amount of catch sold (possibly due to higher market prices), but less emphasis on data collection. Furthermore, the identification of deep pools and the studies of main habitats and breeding grounds, including migration

¹¹ Excluding OAAs

Fishing activities in the Mekong and its tributaries



Fishing using gillnets in the Nam Ou, northern Lao PDR



Pole-and-line fishing in the Nam Ngum, Vientiane Province



Fishing in the Mekong in the south



Lift netting in the Nam Hinboun, central Lao PDR



Fishing using *li* traps on a stream at Khone Falls



Setting a *kha* trap in the Mekong in the south

patterns and the fishing practices, in these areas should be the subject of thorough studies to provide information for future fish catch monitoring and evaluation.

3.3.2 Large hydropower reservoirs

Large hydropower reservoirs that have fishing as their secondary use, account for about 96,030 ha. Of this, Nam Ngum occupies 45,000 ha and has an average yearly production of 6,833 tonnes of fish (see Table 4), and Nam Theun 2 covers 45,000 ha, with an estimated fish catch of 1,500 tonnes in its first year of impoundment. With combined total surface areas of 6,030 ha Houy Ho (3,750 ha), Nam Leuk (1,280 ha) and Nam Mang (1,000 ha) were estimated to produce 150 kg/ha/year. The total production from large reservoirs was about 8,405 tonnes. In the case of Nam Ngum, Mattson *et al.* (1999) noted that the fishery pattern had changed from initially being dominated by relatively large and valuable top predators to the present situation, where the amount of small, low-value planktivores was expanding and the increase in fishing effort had led to an increase in yield, but also a shift in species dominance.

Table 4: Nam Ngum Reservoir annual fish catch estimates for 1982 and 1998

Gear	1982 (tonnes)	1998 (tonnes)
Beat net	0 (0.0)	1,019 (14.9)
Cast net	31 (2.1)	117 (1.7)
Toom trap	74 (5.0)	371 (5.4)
Gill net	791 (53.7)	2,151 (31.5)
Long line	447 (30.3)	1,137 (16.6)
Pa Keo light	48 (3.3)	1,937 (28.3)
Spear gun	*82 (5.6)	101 (1.5)
Total	1,473	6,833 (4,283 - 9,383)

Source: Mattson et al. (2001),

* Includes harpoon catches. Percentage contribution to totals given in brackets.

The range following the 1998 catch is the 95 per cent confidence interval.

The monitoring of catches from a large reservoir as well as fisheries community organisation and co-management are important, not only for employing displaced people, but also to ensure there is a plentiful supply of fish for the major towns. As mentioned, reservoir fish yields vary greatly from one reservoir to another, depending on a multitude of factors, and there is a need for more understanding of the nature of reservoirs. Studies need to be undertaken over a long period in order to build a holistic approach to reservoir fisheries management.

3.3.3 Small water bodies

According to Anderson (1987), small water bodies comprise “small reservoirs and lakes less than 1000 ha, small ponds, canals including irrigation canals, small seasonal flood plains and swamps, and small rivers and streams less than 100 km in length.” Using this definition, small types of wetlands and irrigation reservoirs and weirs (estimated at about 174,800 ha (Table 1) fall into the category of small water bodies, and there is a need to make an inventory and reclassification according to their biogeographic context or by physio-ecological region for future management interventions.

Dams and fisheries

Hydropower has the potential to meet increasing national and regional demands for electricity. It is one of Lao PDR's main exploitable natural resources and represents a major source of export earnings for the country. Hydropower projects in operation in Lao PDR currently have a total installed capacity of 662 MW, while projects with a further 2,558 MW are under construction (MRC, 2009). The country has the potential for more than 17,000 MW additional installed capacity. But hydropower development can bring both benefits and adverse consequences.

Hydropower development is one of the most important issues confronting the fisheries in the Lower Mekong Basin (Barlow, 2008). Certainly, it will cause unavoidable impacts on the fisheries of Lao PDR. Hydropower dams and reservoirs can obstruct the migration paths of some species which generally migrate upstream to spawn and the passage of the juvenile fish which migrate back downstream to feed and grow on floodplains and wetlands. In addition, hydropower dams can also disturb river hydrology, resulting in modifications of the extent, length and timing of annual floods, generally occurring between May and November. This alters the availability of habitats for fish. Downstream of dams, water quality may be affected in many ways, often becoming clearer, colder and sometimes depleted in oxygen, all of which affect fish.

Hydropower reservoir developments and large projects in Lao PDR have to be implemented through the Environmental Protection Law, the Implementing Decree of the Environmental Protection Law and the Regulation on Environmental Assessment. Proposed hydropower projects must also undergo environmental impact assessments, social impact assessments and fisheries impact assessments.

However, on the plus side, hydropower dams can also create opportunities for new reservoir fisheries. Fish productivity differs markedly in different reservoirs depending on their features such as size, the age of the reservoir, the soil type of the basin, the basin shape and depth and the amount of submerged vegetation. Apart from considerations about these physical factors, fish productivity can be optimised through various management strategies, such as integrated catchment basin management, co-management measures with fisheries community involvement, regulation of property and fisheries access rights, and stock enhancement.



Aerial view of the Nam Houm Reservoir, with aquaculture ponds downstream in the left background

Small water bodies are ubiquitous in Lao PDR, from the small valleys of the Northern Highlands through the Annamite Range to the Mekong Plain. Household participation in such fisheries is almost universal (Claridge, 1996), and it is very important for almost all rural households, not only for subsistence needs but also for income generation. Individual fishing in small water bodies accounts for at least 70 per cent of the fish acquired by rural households (Garaway *et al.*, 2001 and Garaway, 2005). If the common pond is used as a culture-based fishery, but with few management interventions and low productivity (e.g. less than 150 kg/ha/year), it is better to consider this type of enhancement as a capture fishery rather than as aquaculture.

In Savannakhet and Khammuane provinces, small water bodies subject to enhancement include oxbow lakes, natural depressions and smaller man-made reservoirs (from 1 to 20 ha) with common ownership by one or two closely connected villages. Arthur (2004) with his thesis on adaptive learning and management of small water bodies in Lao PDR, has proved that “stock could increase the production potential of the fisheries, resulting in either high yields or increased returns to labour”. The species used for stocking were *Cirrhinus mrigala*, *Labeo rohita*, *Aristichthys nobilis* and *Oreochromis nilotica*. Tilapia showed a strong response to trophic status and it is believed that there was no evidence of significant negative effects on wild fish populations in water bodies from the stocking of these exotic species (Arthur, 2004).

3.3.4 Wet-season rice-fields

In Lao PDR the potential for capture fisheries production from wet-season rice-fields and associated habitats is immense, and it has been estimated these areas occupy about 632,850 ha (DLF, 2007), which constitutes the biggest habitat for subsistence fisheries throughout the country. Wet-season rice-field fisheries vary greatly from region to region, depending on a number of factors and constraints. These include the monsoon, water sources, the soil structure, the availability of wild aquatic animals, dyke protection, the ecology and the socio-cultural environment of the area.

To increase fishery production from wet-season rice-fields, modifications can include stocking fish, maintaining deep water levels, controlling predators and, in most areas, fertilising rice-fields as a means of supplementary fish feeding. Stock enhancement in rice-fields is not yet widespread, with the exception that some ethnic groups in the northern provinces keep broodstock in ponds adjoining their rice-fields and release it after the first plough, then collect fish when the field is drained. This produces small fish for preservation and household consumption. Fish species for this type of stocking are mainly *Cyprinus carpio* (common carp), *Barbonymus* spp. (silver barb), and *Carassius auratus* (goldfish). Wild animals that breed naturally include *Channa* spp. (snakehead), *Clarias* spp. (walking catfish), *Rasbora* spp. (rasbora), as well as freshwater shrimps, snails, frogs, eels and insects.

In the north, where terraces are usually on steeper slopes and soils are permeable, it is difficult to establish rice-field fisheries, whereas on lowland plains with impermeable soils and occasional flooding, fisheries can be productive even in rain-fed rice-fields. According to an ecological survey of rice-field catches in the Vientiane plain (Phomsouvanh *et al.*, 2009), more than 28 species of fish and 24 types of OAs (12 types of insects, four species

Some fishing gears



Cast net



Chan trap



Lop trap



Hook and line



Gillnet



Large gillnet for giant catfish

of frog, four species of shrimp, three types of snail and one species of crab) were collected from rice-fields after the harvest.

The overall yield from wet-season rice-field fisheries is likely to be low. Some studies noted a range from 25 to 100 kg/ha/season. A classification of wet-season rice-fields in Lao PDR, according to ecological region and form of interventions needs to be undertaken and, based on this information, more studies on yield per unit area are also desirable. In order to avoid confusion between rice-field fisheries and rice-cum-fish culture, the latter should be redefined for sound monitoring purposes.

3.3.5 Aquaculture production systems

The FAO defines aquaculture as the “farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants with some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated.” Based on this definition, we need to revise the classification of what aquaculture really is, otherwise it will fall into capture classifications. As aquaculture in Lao PDR expands, many forms of production systems are being developed, for example pond culture, communal ponds, rice-cum-fish culture and cage culture. Such forms of production systems are divided into sub-categories depending on the nature and main activity of the producers. According to the DLF, in 2007 aquaculture production accounted for 54,750 tonnes in an area of more than 42,000 ha, including cage culture in the Mekong and some tributaries. These fish culture areas need to be monitored and evaluated, but for the purposes of statistical information there is also a need to search for a common terminology for each form of production. Therefore, before monitoring and conducting any field surveys or studies, guidelines should be developed and adopted.



Feeding Nile tilapia in cages on the Mekong River near Vientiane

Aquaculture activities



Cage culture of sex-reversed Nile tilapia in Nam Ngum River



Mobile hatchery at Houy Siat Reservoir, Paksan



Fish nursery in net cages on a farmer's pond in Luang Prabang



Fish nursing tanks at the Na Luang State Hatchery in Luang Prabang



Taking sperm from *Cirrhinus microlepis* for artificial breeding at the km-8 State Station in Pakse



Artificial breeding of *Pangasius krempfi* at Don Kho in Khong District

4. Fisheries research and management interventions

Management of the fisheries sector in Lao PDR has had a chequered past. Guttman and Funge-Smith (2000) views the management interventions of fisheries as a “function of poor institutional understanding of, or indifference to, fisheries resources that is still an issue of rural development in the country.” During the old regime¹², the fishery sub-sector, including aquaculture came under the auspices of the Department of Forestry under the Ministry of National Economy in the framework of “wildlife and aquatic animal conservation.” With the new regime, which came in after 1975, aquaculture development was moved to the Department of Livestock and Veterinary Services (DLV) under the newly established Ministry of Agriculture and Forestry, while wetlands and fisheries was moved back to the Department of Forestry under the Division of Conservation and the Centre for Protected Area and Watershed Management. This state of affairs existed until 1993, and engendered conflicting roles on the management of aquatic resources that brought about a number of inharmonious cases of aquatic resources management which have existed until the present day. As a consequence, capture fisheries have been neglected and their coordination role has been misunderstood by many international development organisations.

Fisheries management measures were drafted and enforced by local communities themselves, based on the Prime Minister’s Decree 118 (5 October 1989) on “management and conservation of aquatic animals, wild animals, hunting and fishing”, but there were problems and conflicts because of a lack of, or only non-substantial, scientific information to respond to the root cause of many situations.

The shift towards a more holistic view of aquatic resources management started with the implementation of the Prime Minister’s Decree No.85/PM (31 May 1993) on “the management of livestock, including fish, assigned to the livestock and veterinary sector.” This was followed by the Ministerial Regulation No. 0004 (2 January 1997) which emphasised the increasing needs for capacity building and regional integration. Through the inception of an Indigenous Fishery Development Project (IFDP), with emphasis on fish migration, by Catch Per Unit Efforts (CPUEs) studies and capacity building and with the assistance of International Development Research Center (IDRC), the Asian Institute of Technology (AIT) outreach on enhancement of communal small water bodies started in Savannakhet in 1994. This coincided with support given by the Interim Mekong Committee to fishing communities in Nam Ngum reservoir since 1978. This, coupled with the requirement for an environmental impact assessment and/or a social impact assessment for proposed hydropower projects, instigated the recognition of the importance of fisheries management, particularly in capture fisheries. This has been gradually recognised at national level and aquatic animals are now considered as central to food security, however public opinion still perceives aquaculture as the means to offset the decline in capture fisheries production.

¹² The old regime existed before 1975

Following the MRC Agreement in 1995, the Lao Government put more emphasis on water resources and environmental management in which fisheries would be one of seven key sub-sectors. From that period, regional integration and the accessibility to international development organisations became more sound. The DLV strengthened to become the Department of Livestock and Fisheries (DLF), with the mandate to establish a research centre and build on the very low capacity and limited human resources responsible for the role and functions of the fisheries sector. In addition, there was no clearly specified legalised control of fisheries management, except that mentioned in the Water Law, Article 25 (2 November 1996), which only discussed the large-scale modification of natural resources such as hydropower reservoirs, where fish and other aquatic animals should be taken into consideration.

In March 1997 a Vientiane Workshop entitled: “Towards Policy Framework and Vision for National Aquatic Resources Institute in Lao PDR” was held and, following this, some fisheries staff were released from the DOF and the DLF to embark on another step toward better aquatic resources management, as well increased accessibility to international development organisations.

4.1 Research institutions and their collaborations

From 1999 onwards. A new era for aquatic resources research and development coordination, collaboration and cooperation started for the DLF, with the establishment of the Living Aquatic Resources Research Centre (LARReC), which was inaugurated in 1999. The centre opened with full operational support from the National Aquatic Research Institute/Danida project (1999-2005). This was followed by the establishment of the Namxuang Aquaculture Development Centre (inaugurated in 2002) through the Aquaculture Improvement and Extension Project (AQIP1 and AQIP2/JICA projects 2001-2008), which aimed to “enhance activities for aquaculture technology improvement and extension throughout the country.

The adhesion of DLF and these two centres to the MRC, AIT, ACIAR, ICLARM (now WorldFish Center), SEAFDEC, WWF and NACA as well as the assistance of Development Partners has broadened the inland fisheries’ horizons of Lao PDR and allowed them to face new challenges. The results of collaborative assessment and research projects have highlighted the importance of subsistence fisheries management and the requirement for in-depth understanding of aquatic ecosystems and the socio-economic setting for further management interventions.

These projects include in particular those of the MRC Fisheries Programme, such as the ‘Management of Reservoir Fisheries’ component (later re-named ‘Management of River and Reservoir Fisheries’ and ‘Fisheries Management and Governance’), from 1995-2010; and the ‘Assessment of Mekong Fisheries (later re-named ‘Fisheries Ecology, Valuation and Mitigation’ component) from 1997-2010. Other projects are the AIT/MRAG project on enhancement of small water bodies in southern provinces (2000-2004) and the ACIAR/IDRC project on small-scale wetland indigenous fisheries management (SWIM 1999-2002).

Growing fish in ponds and stocking rice-fields and swamps have had a long tradition in Lao PDR, particularly in Huaphanh, Xiengkhuang and other northern provinces. Fish

species commonly used for stocking are *Cyprinus carpio*, *Carassius auratus* and some carps caught from the rivers. Technical assistance for aquaculture development started in 1962, with Japanese assistance under the USAID programme, with the supervision of the Aquaculture Division of the Department of Forestry. Between 1962 and 1965 three spawning facilities were built; Nong Teng (Vientiane), Na Luang (Luang Prabang) and km 8 (Pakse). At the same time, *Oreochromis nilotica* from Thailand was introduced into Lao PDR. Additional small hatcheries were constructed by USAID at various locations in the western side of the country in the 1970s such as at Nam Tane in Xayaburi province, at Huay Xay in Bokeo and at Savannakhet, in Champassak province. Almost all of these hatcheries were abandoned during the Laotian Civil War. In the north-eastern side of the country, with the assistance of China and Viet Nam, three hatcheries were constructed according to the Chinese design for mass production: Done Keo (in Oudomxay), Houy Sa (in Huaphanh) and Khang Phoe (in Xiengkhuang). Chinese carps (silver carp, big head and grass carp) were also introduced into those regions in 1970s. These hatcheries thereafter suffered from poor water supply and limited nursery ponds and became inefficient.

Following the installation of the new regime in 1975, in 1977 the country received the first assistance through the Interim Mekong Committee to rehabilitate, with funds from the Government of the Netherlands, the Nong Teng fish station, where Chinese and Indian carps were bred for the first time in Lao PDR (Gupta, 2000). From 1978-1988, the Interim Mekong Committee provided large-scale technical assistance to the building of a 30 ha fish farm at Tha Ngone on the Nam Ngum river and its transformation into an Aquaculture Training Centre. Finally, the Mekong River Commission's Fisheries Programme resumed its aquaculture development activities with the implementation of the 'Aquaculture of Indigenous Mekong Species' component from 2000-2010.

From 1980 onwards, four FAO/UNDP technical assistance projects were provided for aquaculture development. The first two (LAO/78/014 and LAO/82/014) aimed to upgrade existing provincial hatcheries by using high pressurised filters. However these rapidly fell into disrepair, due to lack of budget for operation and maintenance or replacement, and resulted in poor water quality, requiring the installation of large pumps. Due to the restricted area for expansion and constrained by poor quality water supply, there was little scope for upgrading these hatcheries. The technical assistance (LAO/89/003) for the extension of development of fish culture using different types of fish culture systems in several areas of Lao PDR, revealed that those innovative farmers who had collaborated from the beginning had adopted the introduced aquaculture techniques successfully, but only in some particular areas. The challenge to transfer these lessons to a wider audience still remained and, at that time, the project faced difficulty with travel needs under poor road conditions.

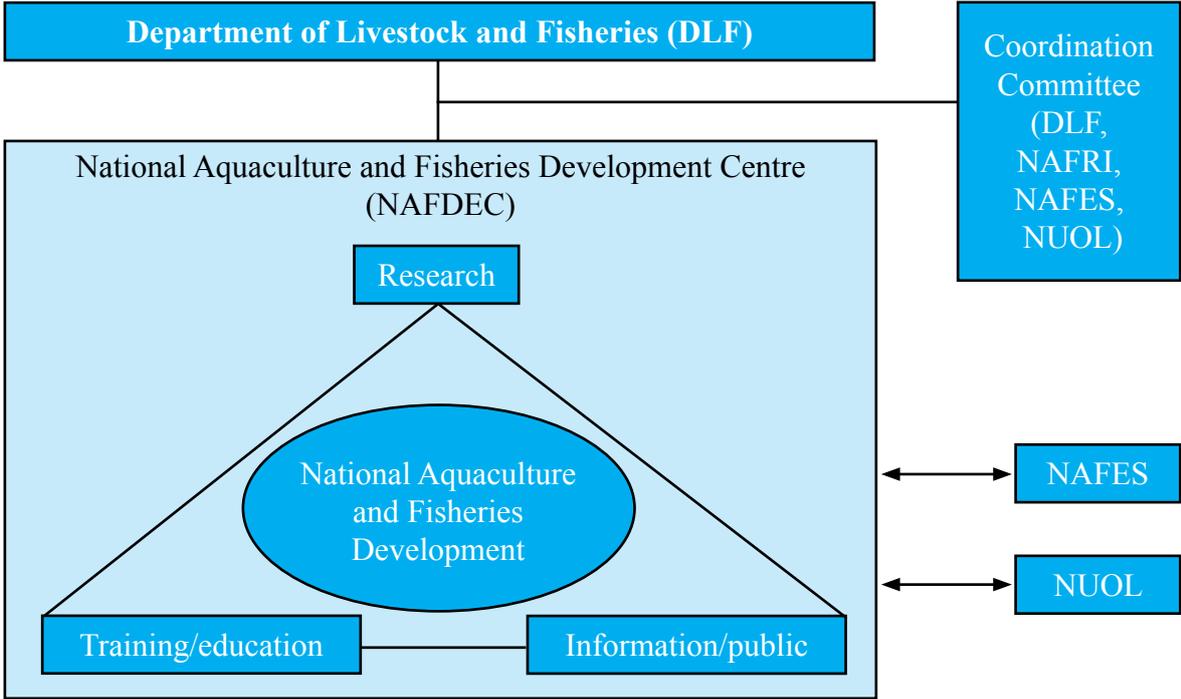
The FAO/UNDP (LAO/97/007) assistance under the Provincial Aquaculture Development Project focused on what resources were currently available to farmers as its starting point. It appeared that the resources available were not a constraint to participation. The main constraint was the timely supply of fingerlings for stocking ponds. Consequently, there was a real need for decentralising fingerling production to remote rural areas, following the example of the AIT Aquaculture Outreach project that focused on the development of spawning and nursing networks enabling technology to spread from farmer to farmer (Litdamlong *et al.*, 1998). With LAO/97/007 and according to Guttman and Funge-Smith (2000), aquaculture has been a great entry point to rural development initiatives as it is

very easy to stimulate interest in fish production among rural households. Since more than 70 per cent of rural households undertake some fishing, their interest in increasing fish production is understandable.

The Aquaculture Improvement and Extension Project (AQIP1+2) has been implemented according to its overall goal and project purpose. The Nam Xouang Aquaculture Development Centre is the first facility in Lao PDR that houses both a training and research facility and is able not only to organise international courses and workshops, but also to hold international events and collaborate on research with foreign organisations. Through AQIP2, the appropriate methodology and collaboration networks among organisations concerned for the promotion of target species, such as common carp, tilapia, *Puntius* sp., and catfish have been established. However there is still a need to strengthen technical development on aquaculture with state and private hatcheries throughout the country. In 2001 there were 31 state hatcheries and more than 13 private hatcheries.

There are various fields of fisheries activities that should be coordinated and further developed for the basis of sustainable fisheries development. Presently, these activities are carried out by separate organisations with limited human resources, finance and facilities. Collaborative use of available resources by upgrading the NADC/DLF into National Aquaculture and Fisheries Development Center (NAFDeC) would be effective and efficient for the sustainable development of the entire aquaculture and fisheries sector (Figure 1). NAFDeC should strengthen close collaboration in research, education and development with DLF, LARReC, NAFES and the National University of Laos under the coordination of the DLF. It is expected that fisheries activities including capture fisheries, aquaculture, processing, marketing and aquatic resources management can be developed with proper directions.

Figure 1: Improvement of systems for inland fisheries development



Source: DLF (2008)

4.2 Research and development issues

The development of aquatic resources deserves to be given a higher priority by the Government of Lao PDR, being a key component in improving food security. Additionally, aquatic resources have the potential to generate cash income, to provide employment opportunities and to diversify the agricultural system.

To confront the problems and challenges in the fisheries sector, two interlinked strategic frameworks of resource assessment and management of capture fisheries should be developed in concert with the promotion of sustainable aquaculture. The research and development issues require well-balanced development between aquaculture, fisheries and the aquatic environment, covering the research and survey of each sub-sector, technical development, training at all levels and the involvement of higher education as a function of NAFDeC.

Research and development issues regarding aquaculture should include development of aquaculture technology (such as seed production, fish grow-out, feed development and fish disease control), fish farming systems related to various agro-ecological regions and the extension approach as well as technological transfer. Aquatic resources research and development should cover all inventories, survey and assessments as well as socio-economic environments targeted for various types of water resources ecosystems and the exploitation of fisheries in major ecological systems, such as the Mekong mainstream and large tributaries, large hydropower reservoirs and small water bodies as defined in Section 3.3.3. The development of aquatic resources should extend to research on processing and marketing of fisheries products. In the area of the aquatic environment, it is imperative to conduct surveys and research on protection of fisheries production and biodiversity, as well as on the main threats to aquatic biodiversity, such as habitat change, overfishing, pollution and introduced species.

4.3 Government management interventions

The shift towards a more holistic view of aquatic resources management by the Government was formerly based mainly on the regulatory framework in the Agricultural Law 1998, the Penal Law 1990 and through the Natural Resources and Environment Sector's legislation such as the Forestry Law No. 125/NA (02 November 1996), the Environment Protection Law No. 09/NA (26 April 1999), the Water Resources Law No. 126/NA (2 November 1996) and the Aquatic and Wild Animals Law No. 07/NA (24 December 2007). Within this legislative framework, the MAF has developed and endorsed some regulations that are related to the management of fisheries. These include Regulation No. 360/MAF-03 (8 December 2003), entitled "Management of NBCAs, aquatic and wild animals" and Regulation No. 061/MAF (17 June 2008), "Management of fisheries, aquatic animals and biodiversity in NT2 Reservoir." These regulations have been the basis for guidelines or instructions issued by local authorities to local communities for the management of aquatic resources, as well as aquatic biodiversity of their areas. A new fishery law was endorsed in July 2009 (Phouthavongs, 2010). With 10 chapters and 72 articles, the law defines the framework for implementing, managing, monitoring and inspecting capture fisheries and aquaculture. It aims to promote aquaculture, conserve and protect fisheries resources for sustainable development, and ensure the availability

of fish and other aquatic animals for food security, contributing to the socio-economic development of the nation. The law provides for community fisheries management and control measures, indicating the right of local communities to manage and utilise their resources. In addition, the law empowers communities to establish village or community fisheries management committees for specific water-bodies. The law also covers their organisational structure and roles and responsibilities in establishing fisheries protected areas (conservation zones) and community ponds, as well as the formulation of village fishing regulations.

The law provides for protection of aquatic resources and ecosystems, and prohibits capture of designated threatened species, and for some other species provides for special management by local authorities. Some articles also prohibit destructive fishing methods and protect breeding, nursing and feeding grounds as well as other ecosystems including deep pools, fish conservation zones, important wetlands and rapids. The new fisheries law therefore provides for a very significant improvement on the former situation, bringing fisheries management within one cohesive framework. Its implementation will however be an ongoing challenge, requiring a great deal of education, monitoring and research, as well as support to community-based fisheries management.

The international legal framework, namely the Convention on Biological Diversity (1992), the MRC Agreement (1995), the FAO Code of Conduct for Responsible Fisheries (1995), the Convention on Migratory Species (1979) and Convention on International Trade in Endangered Species (1973), also highlight the need for specific legislation, regulations and measures regarding the governance and management of the fisheries sector. In the light of this, the DLF has drafted a Strategy for Fisheries, based on international and national legal frameworks, as well as the strategic vision of the MAF to 2020 proposing better governance by integrating customary rules and regulations into wider legislative frameworks (DLF, 2006). But, knowing that many problems associated with fisheries resources cannot be resolved within the fisheries sector alone, it is essential that there is inter-agency coordination through the Water Resources and Environment Administration, in the Office of the Prime Minister, particularly concerning trans-boundary management interventions and the decentralisation of fisheries management functions to local level. It is also vital that the capacity of local communities is strengthened, so they can actively participate in the management and monitoring of aquatic resources. Due to the diversity of Lao PDR's water resources ecosystems, sound management interventions should give a strong emphasis to some activities, such as the promotion of an integrated approach to river basin management, enhancement of aquatic resources co-management and the development of networks of community-based fisheries management initiatives throughout the country.

5. Challenges for the fisheries sector

Inland capture fisheries and aquaculture in Lao PDR are based on water resources ecosystems, such as rivers and streams, hydropower and irrigation reservoirs, temporary or permanent diversion weirs, gates and dykes, small water bodies, flood plains and wet-season rice-fields. In rural areas of Lao PDR, inland capture, mostly subsistence and semi-subsistence fisheries, is complex in nature and involves a wide variety of activities undertaken by people from a wide spectrum of socio-economic backgrounds (Ahmed *et al.*, 1999). This type of capture fishery is difficult to manage through control of exploitation, except in the areas where fishing activities are more centralised, such as in large reservoirs. As fish need a suitable habitat and water quality, and a certain type of hydrological regime which allows their migration from one habitat to another within a certain period of time each year, any activities or developments which cause habitat degradation, water pollution or that restrict migration may cause some impact on fisheries. These include urban developments, industrialisation, deforestation, agricultural intensification, and dam construction. Other impacts on fisheries and aquatic biodiversity may arise from overfishing, illegal fishing and the introduction of exotic species.

Hydropower dam development projects which affect fisheries include Nam Ngum, Theun Hinboun, Nam Theun 2, Houy Ho, Nam Mang, Nam Leuk and the succession of dams that are being built on the Nam Ngum, Nam Theun, and Xe Kaman. Development of hydropower and large irrigation reservoirs has positive and negative effects on the fisheries as well as on the environment. For example, migration of riverine fish is obstructed by dams, but the impact may be mitigated by proper planning, construction techniques and flow control regimes as well as provision of fish passage facilities. The construction of large reservoirs can also present significant opportunities for new fisheries (Ahmed *et al.*, 1999). Dams also cause many other impacts downstream by modifying flows and water quality, which require various measures to mitigate negative effects.

Fortunately, the hydropower reservoir developments and large projects in Lao PDR have to be implemented through the Environmental Protection Law (02/99/NA), the Decree of the Environmental Protection Law (102/PM) and the Regulation on Environmental Assessment (1770/STEA). Uniform environmental assessment requirements and procedures should improve the integration of environmental conservation in all socio-economic development projects. For example, the Nam Theun 2 Project was required to comply with various management measures, including integrated catchment basin management, property and fisheries access rights, an extension programme for stocking and harvesting techniques, private or public sector investments on hatcheries and stocking programme, and the decentralisation of fisheries management to ensure participation by fishers and primary stakeholders in implementing management measures.

Based on the MRC Management of Reservoir Fisheries Project experiences, monitoring of catches and management measures have been neglected in many important irrigation reservoirs such as Nam Tien, Nam Tin, Nam Tam, Nam Khou, Houy Sakhouang, Houy Suy, Houy Chiew, Houy Nhot Bak, Houy Khiew, Houy Toklok, and Houy Lamphanh (DOI, 2007).

In Lao PDR in 2007, there were 10,993 temporary irrigation weirs, 213 gabion dams, 1,160 permanent diversion weirs which qualified as ‘small diversion dams of various sizes across streams; and there were also 108 gates and dykes. There were also many pumping schemes, which covered 248,143 ha of paddy fields. However, the impact on fisheries from these irrigation developments is still unclear. It is necessary to undertake an assessment of impacts and mitigation measures concerning these structures and, more importantly, there is a great need for monitoring fisheries productivity and aquatic diversity in streams and in rice-field ecosystems throughout Lao PDR.

A reassessment and monitoring of impacts also needs to be undertaken in areas where fisheries are being affected by pollution from activities such as slash and burn shifting cultivation, mining, agricultural intensification using pesticides, road construction, industrial waste water discharge and fish cage culture in rivers and reservoirs.



Lift-netting downstream of an irrigation project near Vientiane

Villagers catch the few fish that manage to pass through a regulator which impedes fish migration between this small tributary and the Mekong. Fish-friendly water-gates and better design of irrigation schemes would improve fish passage.

6. Conclusion

In Lao PDR, fisheries are exploited extensively by rural communities who fish near their own land and consume most of the catch locally. Traditional systems for managing access and fishing effort are widespread and fisheries are an integral part of the livelihood of entire communities. It is estimated that national fishery production could be more than 200,000 tonnes per year, valued at approximately US\$150 million, in which fish accounts for about 80 per cent of the total production with about 20 per cent from OAAs.

Inland fisheries catch statistics are much-disputed in Lao PDR. In 2007, the Department of Livestock and Fisheries estimated the total fish production at about 144,000 tonnes in the country, of which capture fisheries (excluding OAAs) accounted for approximately 62 per cent, with 38 per cent coming from aquaculture. More reliable information on catches and on aquaculture is needed, especially for OAA catches and productivity in wet-season rice-fields and small water bodies. A regular monitoring system should be directed toward more field-based monitoring, and would be improved if the system covered the importance of secondary values from fisheries as well as the influence of biodiversity and environmental factors in various types of habitats.

The development of aquatic resources should be recognised by the Government in its development planning, as it is a key component in improving food security for many rural people, as well as providing them with additional income and employment opportunities. Two interlinked strategic frameworks of resource assessment and the management of capture fisheries should be developed, in concert with the promotion of the sustainability of aquaculture. Such research and development requires well-balanced development between aquaculture, fisheries and aquatic environments and this, in turn, requires research and surveys of each sub-sector, technical development, training at all levels and the involvement of higher education.

The shift toward a more holistic view of aquatic resources management by the Government has until recently been based mainly on the regulatory framework within the natural resources and environment sector, such as the Forestry Law, the Environment Protection Law, the Water Resources Law, and the Aquatic and Wild Animals Law. A new fishery law was endorsed in Lao PDR in July 2009, bringing fisheries management within one cohesive framework. It provides a framework for implementing, managing, monitoring and inspecting capture fisheries and aquaculture. It aims to promote aquaculture, conserve and protect fisheries resources for sustainable development, and ensure the availability of fish and other aquatic animals for food security. The law provides for community fisheries management and control measures, such as establishing conservation zones and community ponds and making fishing regulations. It also provides for protection of aquatic resources and ecosystems through various measures. Implementation will continue to be a challenge, requiring education, monitoring and research, as well as support to community-based fisheries management.

Given the importance of fish and OAA to people as food and income, there is a need for improvement of fisheries management and aquaculture development based on water

resource ecosystems and socio-economic conditions of various rural areas. The fisheries sector should be better-incorporated in integrated water catchment and basin management. Where appropriate, decentralisation of fisheries management and co-management measures should be applied, to ensure participation by and empowerment of local fishing communities and other primary stakeholders in implementing management measures.



Bag-net fisheries in the Mekong tributary



The floodplain of a small tributary near Vientiane

7. References

- ADB (2008) Basic statistics for developing member countries. Economic Research Department, Asian Development Bank. www.adb.org/statistics.
- Ahmed, M.; Delgado, C.; Sverdrup-Jensen, S. and Santos, R.A.V. (1999) Fisheries policy research in developing countries: issues, priority and needs. ICLARM, Penang, Malaysia.
- Anderson, A. (1987) The development and management of fisheries in small waterbodies. Symposium on the Development and Management of Fisheries in Small Waterbodies, Accra, Ghana. FAO Rome, Italy.
- Arthur, R.I. (2004) Adaptive learning and the management of small water bodies: a case study in Lao PDR. PhD Thesis. Imperial College of Science Technology and Medicine, London, UK.
- Baird, I.G. (2000) Towards sustainable co-Management of mekong river inland aquatic resources, including fisheries, in Southern Lao PDR. Evaluating Eden Series Discussion Paper No. 15. CESVI Cooperation and Development, Bergamon, Italy.
- Baird, I.G.; Inthaphaysi, V.; Phylaivanh, B. and Kisouvannalat, P. (1998) A Rapid Fisheries Survey in Khong District Champassak Province, Southern Lao PDR. CESVI Cooperation and Development, Bergamon, Italy.
- Baltzer, M.C.; Dao, N.T. and Shore, R.G. (2001) Towards a Vision for Biodiversity Conservation in the forests of the Lower Mekong Eco-region Complex. WWF Indochina and WWF USA, Hanoi and Washington DC.
- Baran, E.; Baird, I. and Cans, G. (2005) Fishery Bioecology at the Khone Falls (Mekong River, Southern Laos). WorldFish Center, Manila.
- Baran, E.; Jantunen, T. and Chong, C.K. (2007) Values of inland fisheries in the Mekong River Basin. WorldFish Center, Phnom Penh, Cambodia.
- Barlow, C. (2008) Dams, fish and fisheries in the Mekong River Basin. *Catch and Culture* 14(2): 4-7.
- Bush, S. (2004) A political ecology of living aquatic resources in Lao PDR. PhD Thesis, School of Geosciences, University of Sydney, Australia.
- Bush, S. and Phonvisay, A. (2001) Baseline study of the fish trade from the Siphandone Fishery, Champassak Province. LARReC Research Report No. 0004, Vientiane.
- Cacaud, P. and Latdavong, P. (2009) Fisheries and aquaculture in the Lao PDR – a legislative Review. RAP Publication 2009/05, FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

- Chanphengxay, S.; Latsasimap and Xaphakdy, B. (2004) Legal and Institutional Framework and Economic Valuation of Wetlands in Lao PDR (final draft). WorldFish Center, Phnom Penh, Cambodia.
- Claridge, G. (1996) An Inventory of Wetlands of the Lao PDR. IUCN - The World Conservation Union, UNEP Environment Assessment Programme for Asia and the Pacific, Bangkok, Thailand.
- Coates, D.; Ouch, P.; Suntornratana, U.; Nguyen, T.T. and Viravong, S. (2003) Biodiversity and fisheries in the Mekong River Basin. *Mekong Development Series 2*: 1-30.
- DLF (2001) Fisheries Development in Lao PDR, Toward Integrated Water Resources Management. DLF/MAF, Vientiane, Lao PDR.
- DLF (2006) The National Strategy for Fisheries from the Present to 2020: Action Plan for (2006 to 2010). DLF/MAF, Vientiane, Lao PDR.
- DLF (2007) Fisheries and Aquaculture Production in Lao PDR. Fisheries Division, DLF/MAF, Vientiane, Lao PDR
- DLF (2008). The project for construction of the National Aquaculture and Fisheries Development Center, DLF/MAF, Vientiane, Lao PDR.
- DLF (1998). The fisheries resources and development policy framework in the Lao PDR. DLF/MAF, Vientiane, Lao PDR.
- DOI (2007) Statistical Summary of Irrigation Projects in Lao PDR. Department of Irrigation, Vientiane, Lao PDR.
- Duckworth, J.W.; Salter, R.E. and Khounbolin, K. (1999) Wildlife in Lao PDR, 1999 Status Report. IUCN, WCS, and CPAWM, Vientiane, Lao PDR.
- Garaway, C. (2005) Fish, fishing and the rural poor. A case study of the importance of small-scale fisheries in the Lao PDR. *Aquatic Resources, Culture and Development* 1: 131-144.
- Garaway, C.; Lorenzen, K. and Chamsingh, B. (2001) Developing fisheries enhancement in small waterbodies: lessons from Lao PDR and northeast Thailand. *ACIAR Proceedings* 98: 227-234.
- Garaway, C.J. (1999) Small water fisheries and the potential for community-led enhancement: case studies from Lao PDR. PhD Thesis. University of London, UK.
- Gupta, M.V.; Saphakady, B. and Khamsivilay, L. (2000) Review of aquaculture support to Lao PDR during 1975-2000. Data & Information Unit, Living Aquatic Resources Research Center, Vientiane, Lao PDR.

- Guttman, H. and Funge-Smith, S.J. (2000) The Role of Aquaculture in Rural Subsistence Livelihoods in Lao PDR. Provincial Aquaculture Development Project Formulation Mission, FAO, Bangkok, Thailand.
- Halls, A.S. (2008) Deep pool mapping and research. *Catch and Culture* 14(2). 8-12.
- Hortle, K.G. (2007) Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin. *MRC Technical Paper* 16: 1-88.
- Kottelat, M. (1998) Fishes of the Nam Theun and Xe Bangfai basins, Laos, with diagnoses of twenty-two new species. (Teleostei: Cyprinidae, Balitoridae, Cobitidae, Coiidae and Odontobutidae). *Ichthyological Exploration of Freshwaters* 9: 1-128.
- Kottelat, M. (2001) Fishes of Laos. WHT Publications (Pte) Ltd, Colombo, Sri Lanka.
- Kottelat, M. and Whitten, T. (1996) *Freshwater* biodiversity in Asia, with special reference to Fish. *World Bank Technical Paper* 343.
- Litdamlong, D.; Meusch, E. and Innes-Taylor, N. (1998) Promoting aquaculture by building the capacity of local institutions: developing fish seed supply networks in the Lao PDR. Paper presented at the 5th Asian Fisheries Society Conference, Chiang Mai, Thailand.
- LDS (2010) Statistical Yearbook, Lao PDR. Lao Dept of Statistics, Vientiane, Lao PDR.
- Lorenzen, K.; Choulamany, X. and P. Sultana (2003) Understanding livelihoods dependent on inland fisheries in Bangladesh and Southeast Asia: Lao PDR country status report. In: Understanding Livelihoods Dependent on Fisheries. DIFD/FMSP Project R8118, MRAG, London, UK.
- Mattson, N.S.; Balavong, V.; Nilsson, H.; Phounsavath, S. and Hartmann, W.D. (2001) Changes in Fisheries Yield and Catch Composition at the Nam Ngum Reservoir. *ACIAR Proceedings* 98:48-55.
- MRC (2003) State of the Basin Report 2003. Mekong River Commission, Phnom Penh, Cambodia.
- MRC (2009) Initiative on Sustainable Hydropower Work Plan (Draft). Mekong River Commission, Vientiane, Lao PDR.
- MRCS (1995) Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin. Mekong River Commission, Phnom Penh, Cambodia.
- NSC (2004) The Households of Lao PDR, Social and Economic Indicators. Lao Expenditure and Consumption Survey 2002/03. National Statistical Centre, State Planning Committee, Vientiane, Lao PDR.

- Phomsouvanh, A. (2009) Sustainable Utilization of rice-field Ecosystem in Vientiane Plain (June 2007 - March 2009). Fisheries division, DLF/MAF.
- Phonvisay, A. (2001) Fish Marketing Study in Vientiane. LARReC Research Report No. 3, Vientiane, Lao PDR.
- Phonvisay, A.; Bualaphanh, V.; Sichanh, S.; Singhanouvong, D. and Hortle, K.G. (2006) Monitoring of fish markets in Vientiane and Luang Prabang Province, Lao PDR, using logbooks. *MRC Conference Series* 6: 47-59.
- Phouthavongs, K. (2010) Lao fisheries law promotes community management, protects resources. *Catch and Culture* 16(3): 4-7.
- Phouthavongs, K. and Soukhaseum, V. (2007) Trapping migrating catfish in channels at the Khone Falls, *Catch and Culture* 13(2): 20-21.
- Phomsouvanh, A. and Saphakdy, B. (2009) Sustainable Utilization of rice field Ecosystem in Vientiane Plain. Fisheries Division, DLF/MAF.
- Poulsen, A.F.; Ouch, P.; Viravong, S.; Suntornratana, U. and Nguyen, T.T. (2002) Fish migrations of the Lower Mekong River Basin: implications for development planning and environmental management. *MRC Technical Paper* 8: 1-62.
- Poulsen, A.F.; Hortle, K.G.; Valbo-Jorgensen, J.; Chan, S.; Chhuon, C.K.; Viravong, S.; Bouakhamvongsa, K.; Suntornratana, U.; Yoorong, N.; Nguyen, T.T. and Tran, B.Q. (2004) Distribution and Ecology of some Important Fish Species of the Mekong River Basin, *MRC Technical Paper* 10: 1-116.
- Robichaud, W.; Marsh, C.W.; Southammakoth, S. and Khounthikoummane, S. (2001) Review of the National Protected Area System of Lao PDR. Lao-Swedish Forestry Programme, Dept of Forestry and IUCN, Vientiane, Lao PDR.
- Sjorslev, J.G. (2000) Fisheries Survey, Luangprabang Province, Lao PDR. LARReC Research Report No. 1, Vientiane, Lao PDR.
- Singhanouvong, D.; Soulignavong, C.; Vonghachack, K.; Saasdy, B. and Warren, T.J. (1996) The main wet-season migration through Hoo Som Yai, a steep-gradient channel at the great fault line on the Mekong River, Champassak Province, Southern Lao PDR, Indigenous Fisheries Development Project, Fisheries Ecology Technical Report, Vientiane, Lao PDR.
- Welcomme, R.L. (1985) River fisheries. *FAO Fisheries Technical Paper* 262: 1-358.

Annex 1

Estimates of the area of wetlands in the Lower Mekong Basin in Lao PDR from the MRC GIS database, 1992-1998

Wetland Types ¹²	Wetland Area (km ²)
Rivers, channels, banks, beach bars, estuarine	1,148
Flooded forest or plantation	-
Lakes or ponds: man-made or natural	602
Marine/coastal mangrove and aquaculture	-
Rice: wet/recession and other crops	7,186
Swamps, back swamps and grassland	1,260
Marsh	-
Others	-
Total	10,196 (5.3% of total in LMB) Or 1,019,600 ha

Source: Hortle 2007, Table 32, p.70

Annex 2

Comparison of conversion factors for preserved fish to FWAEs in the Lower Mekong Basin

Product	Ahmed <i>et al.</i> , (1998)	Sjorslev. (2000)	FAO	Hortle (2007)
Salted/dried fish	2.5	3	3.5	2.82
Smoked fish	2.5	2.5	2.3	2.50
Fish paste	1.4	0.8	-	0.88
Other fermented fish	1.4	0.8	-	0.75
Fish sauce	0.8	0.1	-	0.50

Source: Hortle 2007, Table 5, p. 19

¹² Wetlands of broad categories and these may include small blocks of other habitats

Annex 3

Conversion factors for edible portions of OAAs and percentage of protein in edible portions

Taxon	% Edible portions	% Protein in edible portions	Estimate edible protein in whole animals
Frogs – <i>Rana</i> spp.	55	19	10.5
Shrimps – <i>Macrobrachium</i> spp.	70	15.6	10.9
Snakes	29	19	5.5
Crabs – <i>Somanniathelphusa</i> spp.	38	10.7	4.1
Birds	71	20.6	14.6
Insects	54	12.4	6.7
Molluscs – Clams and Snails	22	12.1	2.7

Source: Hortle 2007, Table 6, p.19

Annex 4

Yields estimated by different sources of information

Types of Fisheries	Water resource	Total area (ha)	Yield (kg/ha/year)			
			DLF (2001)	DLF (1997)*	Lorenzen <i>et al.</i> (2003)	This report (DLF/MAF)
Capture fisheries	Mekong River and 14 tributaries	304,704	70	67	70	70
	Large reservoirs Nam Theun 2: 45,000 ha Nam Ngum: 45,000 ha Others: 6,030 ha	96,030	60	23	60	150
	Shallow lakes, small natural pools, peat swamps and wetlands	114,800	30	30	50	150
	Irrigation reservoirs, and irrigation weirs	60,000	150	20	150	150
	Ricefields and flood plains DS irrigated	(153,677)				
	WS rice-fields	632,850	50	16	50	50
	WS irrigated	(344,800)				
Aquaculture	Flood plains	30,000				50
	Fish ponds	22,000	1,000	2499	-	1,500
	Oxbow lakes and irrigation weirs for aquaculture	15,000	570	573	-	600
	Rice-fish culture	5,000	150	120	-	250
	Cage culture	-	-	-	-	2,500 kg/cage

Note: * From DLF 1998



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