

## CHAPTER 5

# Values of Inland Fisheries in the Mekong River Basin

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## ACRONYMS

ADB	=	Asian Development Bank
AMFC	=	Assessment of Mekong Fisheries project (MRC)
DOF	=	Department of Fisheries (Cambodia)
GDP	=	Gross Domestic Product
IUCN	=	World Conservation Union
LARReC	=	Living Aquatic Resources Research Center
LMB	=	Lower Mekong Basin
MRC	=	Mekong River Commission

## 1. INTRODUCTION

Asia has the most productive inland fisheries in the world. The fishery sector contributes significantly to the national economies of the region (Revenga et al. 2000). Inland fisheries also improve food security by providing a source of protein and a livelihood for millions of people in this part of the world, especially the rural poor. However, increasing competition for water resources, unregulated fishing and high population growth in riparian countries of major river basins have put mounted pressure on these resources and contributed to increasing threats to fisheries production.

The values of river fisheries are numerous (details in Cowx et al. 2004). The purpose of this report is to provide information on the biological, economic, social and cultural values of river fisheries in the Lower Mekong Basin, and to identify the main impacts of environmental changes on these values. A review of fisheries-related literature, including project reports and gray literature, was undertaken. More than 800 documents were reviewed, and original information was extracted from 270 of them. The analysis identified a large number of localized studies leading to generic conclusions.

The report addresses the basinwide issues and studies. It is then organized by nation, namely, the Chinese province of Yunnan, then Laos, Thailand, Cambodia and Vietnam. It first gives an overview of each country's economic, fisheries and social situation, then details the values documented for river fisheries in each country.

Available information is classified as much as possible according to a theoretical framework synthesized from Emerton and Bos (2004) and Neiland and Béné (2006):

- a) resource-centered approaches, including
  - i) conventional economic analyses, with the total economic value consisting of

- use values (direct use value, indirect use value, option values) and
- non-use values (bequest value, existence value)
- ii) economic efficiency analyses
- iii) economic impact analyses
- b) people-centred approaches, including
  - i) socio-economic analyses, and
  - ii) livelihood analyses

The valuation studies at the regional level as well as in each riparian country did not always match or fill in this framework. For this analysis, the Emerton and Bos framework was modified as follows:

### Economic valuation analyses

#### Direct use values

Catch values

Consumption values

Market values

#### Indirect use values

#### Economic impact analyses

Socioeconomic analyses (whenever existing)

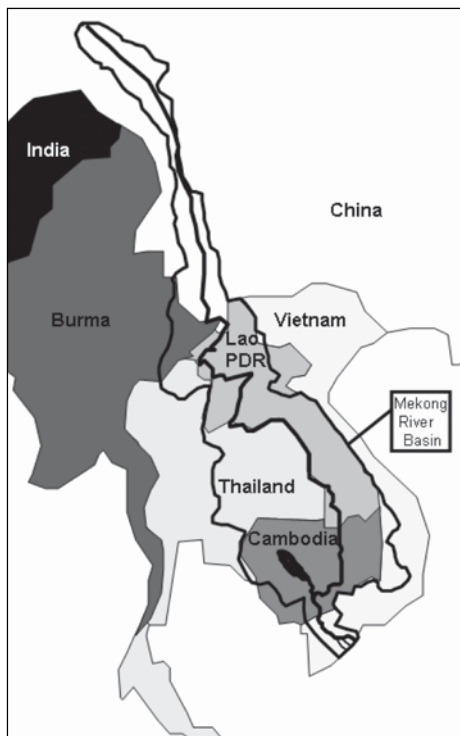
#### Livelihood analyses

This review of the values of fisheries and aquatic products in the Mekong Basin is supplemented by a brief analysis of the impact of changes in river flows and floodplain land use on the fisheries of each country.

## 2. BASINWIDE ANALYSES

### 2.1 Basin Overview

The Mekong River is the 12<sup>th</sup> longest river in the world (MRCS 1992) and the lifeline of Southeast Asia. The river flows through the riparian states of China, Myanmar, Laos, Thailand, Cambodia and Vietnam (see Figures 1 and 2).



**Figure 1: Map of the Mekong River Basin, from Tibet to the South China Sea**

In 2003, the population in the Lower Mekong Basin amounted to 53 million (MRC 2003a). Fifty per cent of this population was under 15 years of age, and it is projected to increase to as much as 90 million by the year 2025 (MRC 2003b). The basin covers nearly 795,000 km<sup>2</sup>, giving a population density of 92 person/km<sup>2</sup>. In comparison with other Asian river basins, the Mekong Basin is not densely populated at present, and land and water resources are still relatively plentiful, as only a part of its potential has so far been developed (Kristensen 2000; ADB/UNEP 2004).

However, industrial development, particularly in upstream countries, is problematic as the rural economies of the downstream countries, Cambodia and Vietnam, are especially vulnerable to upstream changes. For instance, 60 per cent of Vietnam's agricultural production comes from the Mekong Delta (Jones 1997) and 60 per cent of Cambodia's fish catch comes from the Tonle Sap Lake (Ojendal and Torell 1998).

The Mekong River has one flood pulse a year followed by a dry season. During the monsoon season (May to November), the river's discharge is the third largest in the world after the Amazon and the Brahmaputra, and can reach 54 times the minimum mean discharge (Welcomme 1985). The floods annually inundate some 84,000 km<sup>2</sup> of floodplains (Scott 1989), which creates huge breeding and spawning grounds for fish. Many Mekong fish species are migratory, crossing national boundaries during their lifecycle driven by hydrological pulses, and the fisheries are crucially dependent on the annual flooding pattern. Thus the Mekong floods and the extensive sediment, nutrient and energy transfers they generate between sub-basins and countries play a crucial role in the productivity of the system.

Compared to most international river basins, the Mekong River has a unique cooperation organization: the Mekong River Commission (MRC). The MRC is a successor of the Mekong Committee and the Interim Mekong Committee, which were in operation during the periods 1957-75 and 1978-95, respectively. The UN played an important role in achieving the cooperation in the early 1950s and the United Nations Development Programme (UNDP) provided important negotiation assistance for the drafting of the 1995 Agreement (Ringler 2001).

The mandate of the MRC 1995 Agreement signed by Laos, Thailand, Cambodia and Vietnam is "to cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin, including, but not limited to irrigation, hydro-power, navigation, flood control, fisheries, timber floating, recreation and tourism, in a manner to optimize the multiple-use and mutual benefits of all riparians and to minimize the harmful effects that might result from natural and man-made activities".

Recently, the MRC has been involved in the development of several policy, hydrological and management models, which in the near future will provide planning tools for economic valuation and management of water resources in the region. Research in the fisheries sector is also underway by the Mekong River Commission Secretariat (MRCS), including catch and market monitoring, fishery and fish larvae monitoring, consumption studies, and surveys of deep pools in the mainstream (MRC 2004a). Environmental flows, economic valuation and hydrological modeling are also high on the MRC's agenda. However, this institution is faced with the conflicting views

of the riparian countries about the value and potential of the river. Simply put, China sees it as a source of hydropower and as a trade route; Myanmar is the country with the least share and interest in the Mekong; Thailand is primarily interested in water for irrigation; Cambodia relies heavily on wild fisheries; and Vietnam values the Mekong waters for irrigation of rice fields and as a way to oppose the saline intrusion (Ratner 2003; Campbell 2005).

Marine fisheries and the aquaculture sector have been generally regarded in the Mekong Basin as important for revenue generation,



**Figure 2: Map of the Lower Mekong Basin showing major tributaries, large reservoirs and flooded areas (after Van Zalinge and Thouk 1999)**

export earnings and formal economic benefits, whereas traditionally inland fisheries have only been seen as important for rural livelihoods. Consequently, official data collection efforts have concentrated on other fisheries than inland fisheries (Coates 2002, 2003). Limited valuation studies have been conducted, and most of the values reported are direct extractive values of fisheries. Under estimation of the inland capture fisheries benefits other sectors, such as hydroelectricity, irrigation and flood control, which in turn adversely affect inland capture fisheries.

## 2.2 Economic Valuation Analyses

### 2.2.1 Direct Use Values

The Mekong contributes directly to food security in terms of fisheries production and irrigation of rice fields. Other direct use values are transportation, domestic and industrial uses as well as tourism activities. The fisheries provide not just a livelihood for fishers and their families but also an income for all those who are engaged in repairing boats, selling fishing gears, processing aquatic products, and ultimately selling these things.

#### 2.2.1.1 Catch values

Estimates of the total fisheries production in the Lower Mekong Basin have been evolving upwards as new studies, household surveys, and improvements in data collection and analysis have been achieved. Interestingly,

at the same time, reports of declining fish catches have also been reported. Baran et al. (2001a) demonstrated, however, that in Cambodia what has decreased is the catch per fisher, as the population has tripled while the fish harvest has only doubled between the 1940s and the 1990s.

Another recurrent issue has been the discrepancy between official statistics and those based on scientific surveys, as illustrated in Table 1, where national capture production figures are lower than those resulting from scientific studies. Coates (2002, 2003) has explained this discrepancy by the partial or total absence of a field-based monitoring system in most riparian countries. This even leads to the conclusion that *“unless detailed investigations indicate otherwise, with few exceptions, policies for river fisheries should not be based upon current national statistics”* (Coates et al. 2004). In this review, we focus rather on scientific estimates.

Starting in 1991-92, reports estimated the catch at 357,000 tonnes, including aquaculture. This figure was increased a few years later to 620,000 tonnes (Jensen 1996), then close to one million tonnes (Jensen 2000), then to 1.53 million tonnes (Sverdrup-Jensen 2002). At that time, Jensen (2001a) noticed that the floodplains of the Lower Mekong Basin (LMB) were producing some four times as much fish per square kilometer as the North Sea in Europe. In 2004, the estimates for the LMB rose to 2.64 million tonnes from capture fisheries in rivers alone, with an

**Table 1: Estimated inland capture fisheries production in the Mekong Basin in 2000, in tonnes**

Country	Annual catch based on scientific assessments <sup>1</sup>	Annual catch according to official country statistics <sup>2</sup>
Cambodia	289 000 – 431 000	245 600
Lao PDR	27 000	29 250
Thailand	303 000	209 404
Vietnam	190 000	161 000
Total	809 000 – 951 000	645 254

<sup>1</sup> Van Zalinge et al. 2000; <sup>2</sup> FAO data



additional 250,000 tonnes from reservoir fisheries and another 250,000 tonnes from aquaculture (MRC 2004a; Van Zalinge et al. 2004; MRC 2005). These are the main figures published and disseminated; however, other intermediate figures, often from the same authors, can be found in project reports and unpublished documents.

This evolution in figures does not reflect any periodic variability (as there has never been a monitoring of basin fish production over years) but rather the increasing acknowledgement of the importance of the Mekong fish resource. However, Dixon et al. (2003) also wonder whether a possible upward production trend is sustainable, or masks significant changes in the composition of species in the fisheries, with a strong decline of formerly important and valuable species.

Statistics on Myanmar's inland capture fisheries are not available. Although these fisheries are very developed (FAO 2003), only 2 per cent of the Mekong River Basin lies in this country in a mountainous area, and it can be reasonably assumed that the

Burmese share of Mekong fish catches is not significant.

FAO statistics record 8 million tonnes of inland fish caught per year worldwide, including 563,000 tonnes from the Mekong Basin. As noted in Baran (2005), if one acknowledges the underreporting of catches in official statistics (Jensen 2001b; Coates 2002) and accepts the latest published figure of 2.64 million tonnes from Mekong capture fisheries (Van Zalinge et al. 2004), then the total catch from inland fisheries worldwide amounts to about 10 million tonnes. The Mekong River Basin would then contribute one fourth of the world freshwater fish catches even though this relative share might be somewhat of an overestimate owing to underreporting of catches in other countries, particularly in Africa.

### 2.2.1.2 Market values

A detailed estimate of the value of Mekong inland fisheries, reproduced in Table 3, has been proposed by Barlow (2002).

**Table 2: Different estimates of LMB fish production from river capture fisheries**

Year of publication Country	1999 <sup>1</sup>	2002 <sup>2</sup>	2004 <sup>3</sup>
Cambodia	290 000 - 430 000	508 000	682 150
Lao PDR	27 000	133 000	182 700
Thailand	303 000	795 000	932 300
Vietnam	190 000	597 000	844 850
China		25 000 <sup>4</sup>	
Total LMB	810 000 - 950 000	2050 000	2 642 000

1) Van Zalinge and Thuok 1999; 2) Barlow 2002; 3) Van Zalinge et al. 2004; 4) Yunnan only, estimated by Xie and Li 2003.

**Table 3: Fish production and value in the LMB (Barlow 2002)**

Fish and aquatic product source	Quantity (tonnes)	Price (US\$ per kg)	Value (US\$ millions)
Riverine capture fisheries	1 533 000	0.68	1 042
Aquaculture	260 000	1.05	273
Reservoirs	240 000	0.68	163
Total	2 033 000		1 478

In 2004, Van Zalinge et al., citing Jensen (1996), Sjorslev (2001a), Sverdrup-Jensen (2002) and Hortle and Bush (2003), valued the total inland Mekong fish production at more than US\$ 1,700 million<sup>1</sup>, and the MRC (2005) valued it at about US\$ 2,000 million. From these assessments, it is clear that riverine capture fisheries are by far the most important contributors with more than two thirds of the total value, followed by aquaculture and fish production from man-made reservoirs (around 10%). Yet, despite the remarkable importance and economic value of fish catches in the Mekong riparian countries, the inland capture fisheries sector is poorly represented in the national plans and priorities of the Lao PDR and Vietnam.

Aquaculture in the LMB also deserves a section in this review given its close links with capture fisheries. Inland aquaculture production in the basin shows a steady recorded growth from around 60,000 tonnes in 1990 to around 260,000 tonnes in 1999-2000, which is equal to 12-13 per cent of the total LMB freshwater aquatic animal production (Sverdrup-Jensen 2002; Phillips 2002). This figure does not include considerable production of fish and shrimp in the brackish waters of the Mekong Delta.

However, both shrimp and fish aquaculture industries depend heavily on larvae and fry supplied by capture fisheries. In Cambodia in particular, aquaculture consists mainly of captured fish grown in cages (e.g., Ngor 1999), and the food that valuable carnivorous cultured species are given consists of other wild species of lesser value (Phillips 2002). Without the supply of wild fish, Cambodia, for instance, would be left with only 15,000 tonnes of aquaculture fishes whose cycle has been mastered, or just 4 per cent of its total fish harvest (Baran 2005).

The aquaculture industry is complemented

by a growing trade in ornamental fish and aquatic plants, particularly in Thailand (NACA 2000), but its value has not been documented. Recreational sport fishing is of limited scale in the LMB, even though weekend reservoir fishing is gaining popularity in Thailand and Vietnam (Van Zalinge et al. 2004). The value of this aspect of fisheries, however, has never been assessed so far.

### 2.2.1.3 Consumption values

Sverdrup-Jensen (2002) estimated the total fish consumption in the LMB at 2.03 million tonnes per year with a per capita estimate of 36 kg/person/year (ranging from 10 to 89 kg/person/year). Baran and Baird (2003), in a work presented in 2001, gave a range of per capita consumption between 26.2 and 38.4 kg/person/year and show that this is one of the highest rates of fish consumption at the national level in the world<sup>2</sup>. Hortle and Bush (2003) estimated the fish consumption at over 3 million tonnes per year, or 56 kg/person/year. This jump in the consumption figure is mainly due to the inclusion of processed fish and other aquatic animals (shrimps, crabs, frogs, etc.) that remain neglected in classical fish-centered valuation studies. Van Zalinge et al. (2004), compiling fish consumption figures from different sources, estimate it at 2.6 million tons annually for the Lower Mekong Basin (Table 4). However, conservative estimates still put the consumption of basin dwellers at just “*over one and a half million tonnes of fish per year*” (MRC 2004b).

It is impossible to overemphasize the importance of fish for food security in the Mekong Basin. According to Jensen (2001b), small fish and fish products provide necessary calcium to the diet of Mekong region people in the same way that milk does in Western countries, because rice does not contain calcium and milk is not part of the traditional

<sup>1</sup> However, the authors do not detail the estimate of the average price per kilogram basinwide.

<sup>2</sup> The record consumption of aquatic products being in Iceland with an average of 90 kg/person/year (FAO statistics) Some local communities also have very high consumption rates, reaching 200 kg/person/year, for instance, in the Amazon Basin (Batista et al. 1998).

**Table 4: Estimated annual consumption of freshwater fish products, including other aquatic animals in the Lower Mekong Basin by country and by source, in 2000, expressed in whole fresh weight equivalent (Van Zalinge et al. 2004)**

Country	Population (million)	Average fish consumption (kg/person/year)	Total fish consumption (tonnes)	Capture fisheries catch (tonnes)	Reservoirs fish catch (tonnes)
Cambodia	11.0	65.5	719 000	682 150	22 750
Lao PDR	4.9	42.2	204 800	182 700	16 700
Thailand	22.5	52.7	1 187 900	932 300 <sup>a</sup>	187 500
Vietnam	17.0	60.2	1 021 700	844 850	5 250
Total LMB	55.3	56.6	3 133 400	2 642 000	232 200

diet in Southeast Asia. Small dried fish eaten whole (as most calcium lies in the bones) give more than 1,000 mg of calcium per 100 g, i.e., more than 150 per cent of the daily needs of children (MRC 2003b). Calcium from fish can be absorbed by the human body and used in the same way as milk (Mogensen 2001). Guttman and Funge-Smith (2000) also highlighted the qualitative role of fish in the diet. Even though the bulk of the protein (76%) is derived from rice, rice is nutritionally incomplete and poor in particular in lysine, an essential amino acid. With 97.6 mg of lysine per gram of protein, fish is three times richer than rice in lysine and therefore provides a nutrient essential to growth that is lacking in a rice-based diet. Eating fish two or three times a week is encouraged as part of a healthy balanced diet during pregnancy and for all the family (Elvevoll and James 2004). In Cambodia, for instance, more than 60 per cent of all pregnant women and children below five years of age suffer from anemia. This condition can cause decreased learning capacity and retarded development in children as well as increased risk of maternal death. The economic consequences of these deficiencies are a cycle of malnutrition, low productivity and poverty. Therefore, food security is a matter related not only to quantity but also to quality.

The role of other living aquatic resources (prawns/shrimps, snails, frogs, shellfish as well as algae, wild water plants and vegetables) in the diet, household budget, and livelihoods of local populations is emphasized by several authors (e.g., Shoemaker et al. 2001; Torell et al. 2001; Thay 2002; Halwart et al. 2003; Dixon et al. 2003; Meusch et al. 2003). These resources, however, are always absent from national statistics and remain largely unnoticed in scientific surveys.

## 2.2.2 Indirect Use Values

According to Petersen (2003), no non-market or indirect use studies on environmental value attributes have been conducted in the LMB so far. Also, to our knowledge, no study or document exists on the option values of Mekong inland fisheries, as well as on the non-use values (bequest value and existence values). Similarly, no basinwide economic efficiency analysis is known to the authors. However, a number of authors, partly reviewed below, have touched upon the biodiversity and cultural value of aquatic resources in the Mekong Basin.

### 2.2.2.1 Biodiversity values

The biodiversity of the Mekong supports ecosystems and the way they function, which

in turn supports the people that depend upon these ecosystems. These services can be regarded as 'free' in that they are not traded in markets<sup>3</sup>, and Poulsen et al. (2002) highlighted the importance of these alternative values.

The Mekong system demonstrates a high level of overall biodiversity, the third worldwide after the Amazon and the Zaire (Dudgeon 2000). Estimates of inland fish biodiversity (Baran 2005) range from 758 freshwater species according to FishBase 2004<sup>4</sup> (Froese and Pauly 2000) to 1,500 species (MRC 2004a), with a high rate of endemic species and more fish families than any other river system (64 according to FishBase 2004 and 91 according to the MFD 2003). This aquatic biodiversity includes particular endemic and iconic species such as the Giant catfish (*Pangasionodon gigas*), the largest freshwater fish, which can reach 300 kg (Hogan et al. 2004), the giant Mekong carp (*Catlocarpio siamensis*), the seven-line barb (*Probarbus jullieni*), *Mekongina erythrospila*, an icon in northern Cambodia, and three freshwater dolphin species (*Orcaella brevirostris*, *Sotalia chinensis*, *Neophocaena phocaenoides*), with *O. brevirostris* being a significant tourist attraction in southern Laos and northern

Cambodia, although its number has drastically declined to about 40 individuals (Baird and Beasley 2005).

The fish biodiversity is presented in the table below.

Dudgeon (2003) showed that the Mekong freshwater biodiversity is scientifically undervalued, with less than 0.1 per cent of freshwater biology papers published in international journals dealing with the conservation of biodiversity in tropical Asian inland waters. More holistically, the WWF has recently undertaken a valuation of the positive aspects of flooding (Hardner et al. 2002; Molloy et al. 2003) while a joint IUCN/MRC/UNDP project focusing on wetlands management puts the local cultural dimension of aquatic resources at the heart of conservation efforts<sup>5</sup>. In Vietnam, Hashimoto (2001) also detailed in an extensive review the multiple ecosystem values of flooding.

#### 2.2.2.2 Cultural values

The cultural value of fish in Southeast Asia was comprehensively analyzed in Ivanoff (2003). Southeast Asia in particular is symbolized by the nutritional trilogy of rice, fish and salt (the latter two being united through brine, i.e., fish

**Table 5 Freshwater fish species richness in the Mekong riparian countries**

Location	Number of freshwater fish species	Source	Comment
Yunnan province, China	130 species	Yang 1996	See section 3.
	8 species	MFD 2003	Unrealistically low
Lao PDR	587 species	FishBase 2004	
Thailand	482 species		Calculated from FishBase; no other assessment known for the Thai Mekong Basin
Cambodia	477 species	FishBase 2004	
	440 species	MFD 2003	
Vietnam	273 species	MFD 2003	Vietnamese Mekong only; also 222 brackish and marine species
	145 fish taxa	Vo et al. 2003	Freshwater areas of the Mekong Delta. Also 14 shrimp taxa

3 As noted by Maris (2005), free ecosystem services such as clean drinking water remain unaccounted for in official statistics, whereas an increased demand for bottled water due to scarcity or pollution in streams appears as an increase in production, trade and GDP figures, in short as a progress.

4 See [www.fishbase.org](http://www.fishbase.org)

5 See [www.mekongwetlands.org](http://www.mekongwetlands.org)

sauce). The importance and omnipresence of fish is illustrated by a number of proverbs known by all: for instance, “In water there is fish; in rice fields there is rice” in Thai; “Where there is water, there is fish” in Khmer, and “Nothing is better than rice eaten with fish; nothing is better than the love of a mother” in Vietnamese. This daily contribution to life and meals paradoxically gives little value to fish and a low status in the hierarchy of values attached to foods (Levy-Ward 1993). Despite the everyday nature of fish, men have not developed a strong emotional, symbolical or mythical relationship with fish (Ivanoff 2003), which might be reflected in the recurrent claim for a better valuation of fish and aquatic resources.

In terms of religion, fish play a very limited role. Some ceremonies can be mentioned; for instance, in Thailand where snakehead fish were sacrificed in the river to call for rain, or in Laos where large catfishes including *Pangasius gigas* and *Pangasius sanitwongsei* were consumed after rituals were performed (Davidson 1975; Ivanoff 2003)<sup>6</sup>. Overall, fish is considered a very common food and as such does not enter much into the symbolic and ritual realms (buffaloes, oxen and chickens being preferred as offerings). In traditional medicine, fish is considered a *cold* meal of feminine nature.

Traditionally, freshwater fish have always been preferred to marine fish, whether in Europe or Southeast Asia. On the culinary side, freshwater fish are considered in the peninsula to be soft, sweet and subtle, in contrast to marine fish. In Cambodia, for instance, freshwater fish are said to “*mien khlanh tchngang*” (have tasty fat) whereas marine fish are considered “*ch’ap*” (not attractive) (Giteau and Martin 1995).

On the psychological side, traditional rice

farmers who master irrigation have regarded the sea as being wild, unmanageable, unpredictable and somehow devilish; thus, marine fishes are not positively connoted. On the contrary, freshwater (“*sweetwater*” as it is often translated from regional languages) is close to man and bears culture (cf. the role of irrigation in the Angkor kingdom; Kumm 2003); freshwater fishes are thus seen much more positively. In fact, fish are part of a scale of values based on geographical proximity, decreasing from the vicinity of the house (rice fields) to further surroundings (streams and lakes) and ultimately far away (the sea and then foreign countries). This decreasing value, from highly valued black floodplain fish (snakehead, climbing perch, etc., generically “*cá song*” in Vietnamese) found in nearby rice fields and ponds to somehow less valuable long-distance migrants from the Mekong (“*cá dong*” in Vietnamese) and then to marine species, can be seen as paralleled to the gradient from domesticated to wild, from the water control essential to a civilization of farmers to nature, unpredictability and danger. This symbolic gradient in values could also help to explain the strong undervaluation of Mekong River fishes, whereas aquaculture is mentioned by all even though it is quantitatively and economically much less significant.

Cambodia is probably the country where the historical and cultural importance of fish is best illustrated. The famous Chinese traveler Chou Ta Kuan noted in the 13<sup>th</sup> century the exceptional importance of fish in the life of the Angkor people, as depicted in multiple bas-reliefs particularly in Angkor Wat and Bayon temples (Voëun 2004). More recently, the notion of indirect use values underlies the 1997 declaration of the Tonle Sap area as a UNESCO biosphere reserve. These values, detailed by Bonheur (2001), and Bonheur and Lane (2002), include Khmer cultural identity and the values of biodiversity conservation.

6 Currently *P. gigas*, although extremely rare and critically endangered, is still traded from Cambodia to Thailand, where it has a high value for its supposed virilizing properties.

Touch and Todd (2003), and Torell et al. (2004) have also highlighted the non-use values of aquatic and wetland resources. Even among Cambodians who have immigrated to Brittany (France) and been exposed to abundant marine fish, freshwater fish remain much preferred, although they are in short supply



**Figure 3: Mekong catfish monument, Chau Doc, Vietnam.**

and more expensive (Simon-Barouh 1993). These immigrants even continue fishing for wild fish stranded in drying peri-urban wetlands in summer, just like in Cambodia in the dry season, as detailed by Khin (1993).

Southern Laos provides another example of how aquatic biodiversity and livelihoods can intertwine in the basin, and the activities of fishing communities driven by seasonal and ecological changes have been described in particular by Roberts and Baird (1995), Claridge et al. (1997) and Daconto (2001).

A lot can be said about the conversion of fish into fish paste (*pha-ak* in Thailand, *prahok* in Cambodia), and fish sauce (*nam pla* in Thailand, *pa dek* in Laos, *teuk Trey* in Cambodia, *nuoc mam* in Vietnam). However, this would go beyond the scope of this review. Nevertheless, it can be noted that the stronger the consumer's feeling about these foods, the closer he/she is to his/her countryside roots. (Conversely, fish sauce is not favored among those preferring a modern lifestyle.) In this sense, these fish-based foods are elements of cultural identity. Another

cultural fact is that the taste for *nuoc mam* in Vietnam is a trait anterior to the extension of the Chinese culture in this country, as the Chinese influence is traced by soy sauce, never by fish sauce (Gourou 1984). Thus, fish is an important element in the economy as it allows food self-sufficiency and then becomes a vector of trade and cultural exchange.

Although women are largely involved in fishing, aquaculture, processing and fish trade all over the Basin, the gender issues in Mekong fisheries have surprisingly almost never been addressed. This fact is highlighted by Nandeesh (2001) and Matics (2001), and further documented by Suntornratana and Visser (2003), who quantitatively show that experience in fishing for men and women is not much different, but that the knowledge of the latter is sought after in only two per cent of questionnaires at most. They also show that, unlike men, women often catch and collect fish and other aquatic animals all year round owing to their responsibilities for the food security of the family; they could thus provide a more complete and accurate picture of the inland fisheries.

Despite the paradox of high importance and low cultural recognition, the value of river fish for Mekong people is expressed by a number of monuments erected to fish or more specifically emblematic fish species. Thus, having large statues of fish in the middle of public squares is not uncommon in Cambodia; for instance, with "*Trey kolriang*", the giant barb, (*Catlocarpio siamensis*) honored in Kampong Chhnang or "*Trey pase ee*" (*Mekongina erythrospila*) iconized in Stung Treng. However, the largest monument praising a fish species in the Mekong Basin, and probably one of the biggest in the world, is certainly the fourteen-meter high stainless steel and granite monument erected in Chau Doc (Vietnam Delta), which displays eleven catfishes (two large "*Ca basa*", *Pangasius bocourti*), and nine "*Ca tra*" *Pangasius*

spp.), which serves as a symbol of the nine branches of the Mekong Delta. This monument represents “the creativity and prosperity of the Chau Doc people,” who have built up “over a hundred years a unique product famous all over the world”. This refers to the Mekong catfish species raised in the region and exported worldwide<sup>7</sup>.

### 2.3 Economic Impact Analyses

To date, scientifically underpinned, comprehensive water allocation mechanisms have not been set for the Lower Mekong Basin (Petersen 2003). Among the preliminary works, the model proposed by Ringler (2000, 2001) to determine the optimal allocation of water resources in the Mekong River Basin should be mentioned. Unfortunately, lack of data and data unreliability hampered the predictive power of the model (Johnson et al. 2003). In this approach, the impacts were assessed through the integration of utility functions for all economic activities related to the river. Ringler found that artificial diversions of water from the Mekong could readily cause negative impacts on fisheries and saltwater intrusion into the Mekong Delta

during the dry season. The author also drew two general conclusions: a) the largest user of water in the basin is the irrigated agriculture sector; b) the Mekong Delta uses the largest amount of water and obtains the highest economic benefits from the river, making it very vulnerable to water management options taken in upstream countries.

As shown in Table 6, total profits from optimal water allocation and use were estimated at US\$ 1.8 billion in 1990, with irrigated agriculture ranking first at US\$ 917 million and fisheries second at US\$ 546 million. Vietnam obtains the greatest benefits from Basin’s water uses, consisting chiefly of irrigated agriculture and fish production; profits from hydropower are largest in Laos; and fish catch and wetlands are the major water-related income sources in Cambodia. One must note that this scenario is based on data available in 1999, when total Mekong fisheries catches amounted to 1 million tons, not 2.6 or 3.2 million tonnes as per recent estimates.

To our knowledge, no socioeconomic analysis has been done for the whole Mekong Basin. At the moment, the Mekong River Commission is developing a simple resource allocation and

**Table 6 Baseline scenario profits from water use in million US\$ (Ringler 2001)**

Country/region	Irrigation	Municipal & Industrial	Hydropower	Fisheries	Wetlands	Total
Yunnan, PRC	20	11		0.05		31
Lao PDR	38	6	33	19	5	101
Thailand	320	65	10	151	4	551
- N Thailand	52	5		10		68
- NE Thailand	268	60	10	141	4	483
Cambodia	26	7	7	188	80	301
Vietnam	513	81		188	44	825
- VN, Central Highlands	29	6				35
- VN, Mekong Delta	484	75		188	44	790
<b>Total Basin</b>	<b>917</b>	<b>170</b>	<b>43</b>	<b>546</b>	<b>134</b>	<b>1 809</b>

<sup>7</sup> In particular, in the USA prior to 2002, before the Catfish Farmers of America managed to convince the Senate to forbid the use of the label “catfish” for catfishes other than *Ictaluridae*, a native North American family raised by US fish farmers. This decision had a strong negative impact on the exports of the Mekong Delta catfishes, causing great grief in Vietnam (see “The great catfish war”, New York Times, July 22, 2003), and is somehow reflected in the pride expressed by the Chau Doc monument.

optimization model (RAOM) similar to Ringler's model, but is drawing on recent hydrological information to examine how water resources in the LMB can be allocated among various water-consuming activities and functions. The values used to run the model are simply unit estimates, and integration of environmental flow requirements is in principle possible, depending upon the progress that is made with current valuation initiatives by partners (Johnston et al. 2003).

The MRC and Halcrow Ltd. have also set up a Decision Support Framework (DSF) that consists of a suite of data analysis software and models intended to assess the magnitude and impact of changes in the water-resource system (Halcrow 2004a). This suite is based on a Knowledge Base, which consists of interacting databases and GIS layers and includes environmental and socioeconomic impact analysis tools. These tools allow macro-level sustainability analyses and potentially impacted population analyses. However, the nature and contents of these tools are not detailed in the sixteen volumes of documentation about the DSF, and the *"meaningful socioeconomic assessment of future development scenarios will require a more detailed set of data"* than the current MRC social Atlas, and *"significant efforts remain to assemble data sets to support socioeconomic assessments"* (Halcrow 2004b and c).

In terms of policy, Feng et al. (2004) analyzed the conflicting needs of the riparian countries and the current problems hampering the development of a basinwide water allocation model that would include China. Fox (2004) highlighted the fact that the terms of the 1995 Mekong Agreement<sup>8</sup>, in line with international laws governing transboundary watercourses, actually refer to a watercourse rather than a watershed despite the frequency of the word "basin" and the catchment management

approach promoted by the MRC (Kristensen 2001). Thus, the watercourse definition would rely solely on the aquatic element without addressing the interdependencies between riverine and terrestrial systems, whose conservation is yet essential to sustainable production (cf. flood pulse concept) and thus sustained value.

However, the danger of focusing efforts on controlling and redirecting water, overlooking ecological processes, is that *"local communities will experience common pool resource dilemmas around provision issues long before states experience conflict over appropriation of water"* (Fox 2003). These concerns are echoed by NSF (1998) and Smith et al. (2005), who found that the diversity of fisheries-related livelihood strategies is poorly represented in practice by socioeconomic analyses and policies, and called for a more diverse and flexible range of measures that secure both the benefits of aquatic resources for poor people and conservation objectives.

Last, Bush and Hirsch (2005) show, from the example of Laos, that diverse actors provide statements of status and change in the values of fisheries *"that are both socially and politically constructed as well as contingent on the epistemological construction of their knowledge of the fishery itself"*.

## 2.4 Livelihood Analyses

*"Livelihood analysis"* is understood here as complementary to socioeconomic analysis, with a focus on people-centered, dynamic and adaptive approaches, with particular attention paid to a range of capitals including social capital and knowledge, and to non-marketed aspects.

*"Understanding livelihoods dependent on inland fisheries"* is the objective of a project led by the WorldFish Center in three Mekong

8 Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin signed by Cambodia, Laos, Thailand and Vietnam.



countries and in Bangladesh (Dixon et al. 2003). The purpose of this project (Sultana et al. 2003a) was to characterize the primary stakeholders and their livelihood strategies, identify their dependence upon aquatic resources, describe the nature and status of those resources, and emphasize the vulnerabilities of the poor in relation to loss or mismanagement.

The analyses revealed that fisheries as a common pool resource play a vital role in rural livelihoods, particularly as contributors to expenditure-saving and survival livelihood strategies of the poor. More specifically, Smith et al. (2005) think that in developing countries, fishing can either be (i) a primary livelihood of last resort, (ii) part of a diversified semi-subsistence livelihood, (iii) a specialist occupation, or (iv) part of a diversified accumulation strategy.

In the Mekong Basin, the bulk of the catch originates from part-time and subsistence fishers rather than from those classified as full-time fishers (Dixon et al. 2003). According to the WorldFish study, in the three Lower Mekong countries studied, the majority of full-time fishers view themselves as very poor and highly dependent on others for financing. However, they are considered relatively less vulnerable than the agriculture-based poor who are more subject to seasonal scarcity periods. The majority of part-time fishers also consider themselves poor or very poor. The third group of subsistence fishers includes landless laborers, women, children and small farmers. They include both the very poor and the rich and in most cases are not fully dependent upon the fisheries for income-generation or subsistence. As such, they are less likely to be deeply impacted by a degradation of the wild resource. The fact that inland fisheries are often regarded as an activity for the poor but can also be regarded as an activity for the more wealthy was noted by Béné and Neiland (2003); this led Coates

et al. (2004) to call for a better understanding of how fisheries and their management contribute to, or are affected by, wealth differentiation.

Consultations with local communities allowed the identification of two main threats to fisheries common to the three Mekong countries: unsustainably high fishing pressure, and degradation or loss of wetlands and floodplain habitat. The latter was specified as resulting from i) increased agricultural activities (including deforestation and agro-chemical pollution), and ii) modification of river flows by flood control, drainage and irrigation structures or hydropower schemes. Among ongoing conflicts mentioned are competition for fish and privatization of common property resources for aquaculture development.

The threats to fisheries take place in a context of limited knowledge, if not ignorance, about the extent and importance of natural resources in terms of overall household livelihood strategies. The lack of detailed information about the role of fisheries in livelihoods is an immense disadvantage to poor people as what is recorded is what is produced, consumed and sold by the rich or less poor people while the unrecorded products and uses are those on which poor people depend. Consequently, the resources of the poor are not included in impact assessments (be they environmental, economic or social) or taken into account when making development decisions (M. Torell, pers comm.). The usual census approach, which consists of thinking in terms of primary and secondary occupations, further conceals the importance of diversified activities, particularly of inland capture fisheries to the livelihoods of the Mekong rural poor (Dixon et al. 2003; Keskinen 2003).

In this regard, the most important initiatives in the Basin are those that 1) integrate aquatic resource values with livelihood values and aquatic resources management in the policy

development process; 2) assess the role of markets and market forces, including the impact of international trade on fisheries livelihoods; and 3) provide further in-depth analysis of livelihood outcomes and impacts related to planned and ongoing natural resource management projects.

Participatory rural appraisal results also showed that all of the above challenges and threats to inland fisheries have already reduced the livelihood base of poor people and made them more vulnerable to hazards from drought and flooding, natural declines of the fish population, inadequate market access and high population growth. However, the study also concluded that in terms of pressing issues, access to fisheries and threats to aquatic resources come after personal and communal poverty issues such as lack of rural infrastructure (roads, clean water sources, sanitation facilities, schools), lack of land for farming rice, and crop pests. Normal flooding is not a problem; only exceptional floods are.

## 2.5 Impact of Changes on Fisheries Basinwide

Several factors make the future of Mekong fisheries uncertain. These include preliminary calculations suggesting a 20 per cent increase in demand for fish in the LMB over the next 10 years (Sverdrup-Jensen 2002), combined with a major threat that fisheries habitats will be reduced due to barriers to migration, conversion of floodplains into agricultural and urban areas, and changes in natural flow regimes due to dams and irrigation. Detailed below are some of the major changes whose impacts have been at least partly documented.

### 2.5.1 Changes in Flow Regime

The degree of inundation in the Mekong depends on the strength of the annual

monsoon, as 85-90 per cent of the discharge is generated during the wet season. However, the average wet season discharge in the last twenty years (1979-98) appears to be at least 10 per cent lower than during 1924-56, while the interannual variations have become more extreme (Nam 2000). The downward trend seems to be independent of fluctuations in rainfall and therefore has been linked to dam building activities that started in the late fifties in the Basin (Van Zalinge et al. 2003). White (2000) also identified dams as the projects that pose the highest degree of systematic risk to the region, under criteria that include displacement of vulnerable people, impact irreversibility, environmental impacts on the mainstream river flow and quality, and economic impacts. In addition, although no literature was researched on this topic, climate change and possible changes in rainfall patterns could adversely affect the flow regime of the Mekong.

According to the MRC (2003b), in the Mekong Basin, thirteen hydropower dams of a capacity higher than 10 megawatts existed in 2003: two in China on the mainstream, five in Laos, four in Thailand and two in Vietnam, the latter being on tributaries, for a total production of 4,400 megawatts (15% of the Basin's hydropower potential estimated at 30,000 megawatts). Many more are under construction or being planned, including at least six in China and "a number" in Laos, and there is "a positive attitude towards hydropower development" in Vietnam (MRC 2001), as attested by the recent plans of Electricity of Vietnam to build 173 new hydroelectric power stations with a total capacity of 2,296 MW to supplement the existing 500 small and medium-sized hydroelectric power stations<sup>9</sup>. No new major dams are planned at the moment in Thailand and Cambodia.

This assessment only refers to hydropower dams of medium or large size that do not

9 Vietnam Economic Times, 4 August 2005

consume water but only alter the flow regime and fragment aquatic habitats. However, these dams are supplemented by thousands of small irrigation reservoirs and weirs that aim at extracting water from the river and thus reduce flow, among other impacts. These small schemes are not individually identified, although they are quite visible on remote-sensing maps, particularly in northeastern Thailand (see for instance MRC 2003b). In addition to existing ones, multiple smaller schemes are being considered (including 15 dams for irrigation purposes, mainly in Thailand and Vietnam). Overall, more than 130 potential sites for dams have been identified.

The impacts of dams on Mekong aquatic resources have been highly debated (e.g., Roberts 1995; Siebert 2001; TERRA 2003; FEER 2004). Hill and Hill (1994) first attempted a thorough assessment of the consequences of dams on Mekong fish and fisheries. They highlighted the exceptional ecological importance of the Khone Falls area, the devastating consequences that a dam across the Tonle Sap River would have, the need to consider true *run-of-the river* dams rather than blocking dams, and overall the absence of appropriate information. In fact, their review itself is hampered by a systematic lack of data.

Ten years later, specific information on the impacts of dams on fisheries is still lacking and/or is of poor quality. In his review of the Economic Impact Assessment of the Nam Theun 2 dam in Laos, Wegner (1997) takes note of the high value of indigenous fish species and expresses concern that these have not been considered adequately in the impact assessment. Similarly, the World Bank (in Amornsakchai et al. 2000) acknowledges the fact that, for the Pak Mun dam in Thailand, the lack of detailed baseline studies on fisheries has made it difficult to estimate fishery losses in the cost-benefit analysis of the dam (see section 5.4). Bernacsek (1997a)

notes that aquatic impact assessments were carried out before impoundment in only seven cases out of 40 dams or reservoirs surveyed in the basin.

In a scenario analysis prepared for the MRC, Halcrow (2004d) estimated that the impact of five additional large dams in the Lower Mekong Basin would reduce the maximum longitudinal fish migration network by only 1.6 per cent. However, among other flaws and biases, the distances computed include *twice* the length of large streams, with the argument that "*fishes migrate most commonly along either river bank*"! (op. cit., Appendix A). Of course, this bias minimizes the calculated impact of upstream dams on the whole river network open to migrations.

A recent study (Podger et al. 2004) assessed the impact of different water management scenarios on flows and on a number of indices, including a fish habitat availability index (HAI). The study concluded that the expected loss to the HAI ranges from 1 to 13 per cent for the area downstream from Kratie in northern Cambodia. However, going beyond benign relative values, Barlow (pers. comm.) highlighted the fact that this is a fraction of a huge resource amounting to 2.6 million tonnes (cf. Table II) and showed by a pro-rata calculation that this limited relative reduction would correspond, in Cambodia and Vietnam alone, to a loss of 15,000-199,000 tonnes with a monetary value of US\$ 10-135 million a year. The livelihood value of this fraction is not detailed.

The negative effects of dams on inland fisheries have been extensively described (WCD 2000) and alternatives or mitigation measures such as fish ladders have been proposed. Warren and Mattson (2000) expressed reservations about the efficiency of such mitigation measures in the Mekong context; Roberts (2001a) confirmed the inefficiency of the Pak Mun dam fish ladder and Baran et al. (2001b)

showed that the intensity of migrations (e.g., 30 tonnes of fish caught per hour in the Tonle Sap River during the migration peak) makes fish ways unrealistic in most main channels (Jensen 2001c).

One of the issues that has recently surfaced is the trapping of sediments and the reduced flow speed that results from dams, particularly those across the mainstream (Sarkkula et al. 2003; Kummur et al. 2005). Analyses detailed in Plinston and He (2000) showed that about half the sediment reaching the Mekong Delta derives from the Upper Mekong in China. A scenario analysis showed, particularly through mapping of sediment concentrations and sedimentation rates, that flow reduction and sediment trapping by the Chinese dams on the Mekong would have a dramatic impact on the net sedimentation and productivity of the Tonle Sap Lake (Sarkkula et al. 2003). Following additional studies, the impact of Mekong dams on sedimentation and productivity basinwide will be better quantified by 2006 (Sarkkula et al. 2005).

On the positive side of dam building, additional water reservoirs increase fish production locally (Lagler 1976, Bernacsek 1997b). The latter author gives an equation predicting the catch of a new reservoir as follows:

$$\text{Catch in tonnes.year}^{-1} = 1.877x(\text{Reservoir area in km}^2) - 12x(\text{mean depth in m}) + 0.03835x(\text{Affluent inflow volume in mcm.y}^{-1})$$

It should be noted, however, that i) this equation does not integrate the loss in wild fish production down the reservoir (as demonstrated in southern Laos by Lorenzen et al. 2000), and ii) the biological productivity generated by this environmental modification is often concomitant with significant social changes in fisheries, particularly in terms of access rights, wealth distribution and equity (WCD 2000; Hirji and Panella 2003).

Among the beneficial impacts of damming are the increased dry season flows that would oppose the annual saline intrusion hampering rice culture in the delta (Feng et al. 2004). However, the saline intrusion is also highly beneficial to fish production (abundant coastal fishes entering the delta) and shrimp aquaculture (one kilogram of shrimp being worth about 50 kg of rice), and the trade-offs between these different commodities and their underlying socioeconomic implications remain to be assessed (Baran et al. 2006).

The impact of Chinese dams is also feared in the Mekong Delta; yet, according to Nguyen (2003), the hydrologic impacts of the Manwan dam observed in northern Laos are not perceptible in the Mekong Delta. However, the impact of reduced flows and sediment input on the productivity of Vietnamese coastal fisheries is surprisingly never mentioned, although it was already highlighted by Chevey (1933) seventy years ago. The impacts of dams on coastal fisheries have proven very significant in a number of countries, and assessing them in the case of new damming plans is a recurrent recommendation (Vidy et al. 2000; Blaber 2002; Dugan et al. 2002; Arthington et al. 2004).

## 2.5.2 Changes in Fishing Patterns

Disruptive fishing methods, such as explosives, mosquito nets, electric fishing and poisoning, as well as overfishing are commonly reported in the region, and their actual impact is heavily debated. Bao et al. (2001) claimed that most Mekong fish species reach sexual maturity early, lay a great amount of rapidly developing eggs, and are more sensitive to environmental change than to overfishing. In Cambodia, however, the dominance of these low-value opportunists is thought to be increasing as a result of overexploitation (Srun Lim Song pers. comm.).

It should also be noted that the evolution of the size of fish caught is a parameter that should be integrated into valuation studies (Van Zalinge and Nao 1999). Year after year, total catches seem to contain a higher proportion of less valuable small fish and a lower proportion of medium- and large-sized fish of high economic value. This evolution is similar to that of other freshwater fisheries (Welcomme 1995), but the economic impact of this evolution, invisible in global statistics, has never been assessed. The positive consequences for food security of a larger share of small fish of high nutritional value (as detailed in section 2.2.1.3) have likewise never been assessed.

Fishing patterns are also driven by the demand for fish, which is itself partly driven by aquaculture, whose activities are net consumers of fish (fry and feed of carnivores coming from the wild; Phillips 2002). Small-scale aquaculture can contribute to environmental improvement; for example, aquaculture ponds contribute to dry season water storage and recycling of agricultural wastes. However, under dual environmental and exploitation constraints, the Basin capture fisheries are likely to decline much faster than aquaculture can expand. This would obliterate gains made by expanding fish farming (Coates et al. 2003). It should also be noted that small scale aquaculture is generally not an activity taken up by the poorest because of fundamental limits of capital (Bush 2003a; Keskinen 2003; Vo et al. 2003)

### 2.5.3 Changes in Political Agendas

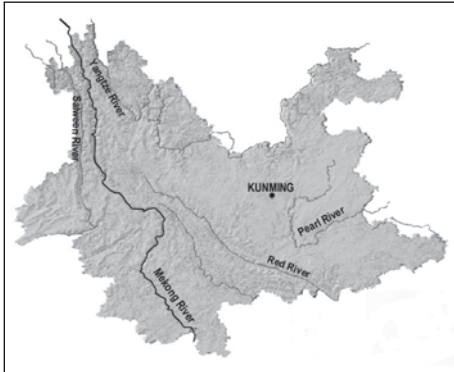
Inland capture fisheries are characterized by diversity not only in the range of gears and target species but also in social and cultural environments. This complexity is reflected in the nature of the data collected and then analyzed in view of management.

According to Coates (2002, 2003), most published figures for inland capture fisheries in Southeast Asia do not actually qualify as *statistics* because they are not based upon data. Inland capture fisheries are clearly seriously underreported by 250 to 360 per cent in all countries in the Mekong Basin. Major sources of bias in official statistics include underestimates of the importance of small-scale fishing activities and misreporting by government officials. Other biases include inadequacies in recording the level of participation in capture fisheries and lack of attention to biodiversity considerations and livelihood aspects. In addition, there is a general disinterest in accuracy. More generally, Hirsch (2004) highlighted the different and often conflicting values inherent to the environmental, biological, economic, social or political approach to fisheries, and similarly the opposing values conveyed by governments, institutions, the private sector or NGOs.

Bush (2004a) studied three fisheries production meta-statistics from the Association of Southeast Asian Nations, the MRC and the Lao government. He concluded that the three examples of fishery production meta-statistics highlighted the differences in the political agendas of the different organizations with a stake in the management of the resource. The estimates were not sensitive to the causes of deficit or surplus and, therefore, promoted policy responses that were inappropriate and potentially damaging.

## 3. YUNNAN PROVINCE, PEOPLE'S REPUBLIC OF CHINA

Yunnan Province has a surface area of 397,000 km<sup>2</sup> and a population of about 42 million, 81.7 per cent of it being rural (population density: 107 persons/km<sup>2</sup>). The



**Figure 4: Map of the Yunnan province, in China**

province remains poorly developed, with a per capita GDP of US\$ 565 in 2000 (but only US\$ 180/year for rural dwellers). The population growth reaches 1.2 per cent per year (2000 data in ADB/UNEP 2004<sup>10</sup>). With 10 per cent of the total Lancang River Basin population living below or just above the poverty line, this region is one of the poorest areas in Yunnan and in China (ADB 2000). In fact, the productivity and standard of living in the seven prefectures of Yunnan along the Mekong River are below the provincial average, itself below the national average (Makkonen 2005).

This mountainous province (from 6,740 meters down to 76 meters in altitude (MRC 1997) is considered the biodiversity-rich garden of China, with 18,000 plant species (more than half China's total), extensive forest cover (32.4% of the land area) and a large number of protected areas as well (6.9% of the province surface). One can note, however, that these protected areas are terrestrial and that the Mekong mainstream and its banks are systematically excluded from these areas<sup>11</sup>.

Statistics and figures for Yunnan and the Upper Mekong are difficult to find (NSF 1998; Chapman and He 2000; Buncha Apai 2003), as confirmed by the brief description above. There is not enough information available in English about the Chinese section of the

Mekong River (named Lancang or Lancang Jiang in Mandarin) to develop a full chapter similar to those on the other riparian countries. Most of the information about the hydrological characteristics of the river, its biodiversity, fisheries and development plans are supposedly in Chinese languages, and apart from a number of articles originating from conservation NGOs, very few scientific documents could be found<sup>12</sup>.

Twenty-one per cent of the Mekong Basin area lies in China (Feng et al. 2004), and the Chinese section of the Mekong River contributes 45 per cent of the dry season flow in Cambodia (Goh 2004). But for Yunnan alone, the Mekong Basin covers 165,000 km<sup>2</sup> or 38 per cent of the province, and this section of the river contributes 16 per cent of the average annual flow of the whole Mekong volume (MRC 2003b).

He and Hsiang (1997) gave a geographical and hydrological description of the Lancang River. In its most upper part, the river is small and often flows through deep valleys. Development targets are mainly animal husbandry, forestry and, to a certain extent, tourism, whereas the development targets for the middle and upper reaches of the river are hydropower generation and mining, supplemented by irrigation and tourism. Fishing is not a dominant activity in this region (personal obs.; Heinonen and Vainio-Mattila 1999). The overall fish production in Yunnan has been estimated at approximately to 25,000 tonnes (Xie and Li 2003) and capture fishery labor in this province involves about 15,000 persons (ibid.).

Four hundred and thirty-two fish species are recorded in Yunnan, and 130 species are found in the Chinese section of the Mekong River (Yang 1996). These species are characteristic of headwaters, rapids and high streams. Most of them are short-distance migrants. A strong decline in fish biodiversity is noted; 280 species have become rare or

11 Map of existing and proposed nature reserves in Yunnan by the Nature Conservancy and the Yunnan Provincial Government; brochure of the project "Yunnan great rivers action plan"; Yunnan eco-network, Kunming, China (2001).

12 See, however, the Asian International Rivers Center: <http://www.lancang-mekong.org>.

have not been found in the past five years (ibid.). This region is also characterized by massive introduction programs, of 34 species overall, that have had a strong negative impact on native species, particularly in lakes.

The Mekong River Commission (2003b) detailed the hydropower development plans in the Lancang River Basin, which consist of a cascade of eight dams totaling 15,550 megawatts (dam characteristics in Plinston and He 2000). The possible consequences of these dams on fishery production have been mentioned in the above section. Other environmental impacts were reviewed in Roberts (1995), NSF (1998), Roberts (2001b), He and Chen (2002), and Osborne (2004). However, it is also argued that the development of the Lancang mainstream cascade dams would have a much higher economic benefit and lower impact on ecosystems than a (hypothetical) series of dams on the lower Mekong (He and Hsiang 1997; He and Chen 2002).

In addition to the dams, China has initiated a navigation improvement project in the Upper Mekong River that includes dredging and blasting rapids of the Upper Mekong River (21 reefs and rapids to be blasted in phase 1 along a 360 km stretch to provide access to 100-tonne ships, and 90 to 100 additional reefs and rapids to be blasted in phase 2 for 300-tonne ships). The project has been heavily criticized in particular for incomplete and

biased assessment of the potential impacts on the river's fisheries (McDowall 2002) and its biodiversity (Campbell 2003). Regarding fisheries, the first concrete evidence of changes consists of a drastic increase in water fluctuation in northern Thailand. These large daily fluctuations prevent fishers from operating their gears normally, alter migration patterns, and have reportedly reduced the fish catch in the area by 50 per cent (Sretthachau and Deetes 2004).

## 4. LAO PEOPLE'S DEMOCRATIC REPUBLIC

### 4.1 Country Overview

The Lao PDR has a population of about 5.1 million. Approximately 77 per cent of this population lives in rural areas, and 40 per cent lives below the World Bank poverty line. Annual per capita GDP was estimated at US\$ 280 in 1999. The main economic sector in the Lao PDR is agriculture, accounting for 52.6 per cent of the national GDP. However, the overall importance of agriculture is declining as industry and services increase. Selected economic indicators for the Lao PDR are summarized in Table 7.

Wood products contributed 34 per cent and manufactures 23 per cent to the total exports of US\$ 337 million in 1998. By contrast, the agricultural sector contributed only 2.4 per cent

**Table 7: Selected economic indicators for the Lao PDR from 2000 to 2003 (World Bank web site)**

Economic indicator	2000	2001	2002	2003
Agriculture (% of GDP)	52.81	50.89		
Industry (% of GDP)	23.01	23.44		
Services (% of GDP)	24.17	25.67		
GDP (billion US\$)	1.71	1.75	1.83	2.04
GDP growth (%)	5.81	5.68	5.00	5.00
Aid per capita (US\$)	53.38	45.38	50.32	
Population growth (%)	2.32	2.32	2.32	2.32
Population total (millions)	5.28	5.40	5.53	5.66



**Figure 5: Map of the Lao PDR (cities and provinces mentioned in the text are highlighted)**

or US\$ 8 million. The export of hydropower to Thailand and China is expected to be a major source of foreign exchange earnings. However, according to Rigg and Jerndal (1996), serious environmental and social issues are linked to hydropower development (population displacement, downstream impacts on flow regimes and fisheries) and to the exploitation of timber resources (deforestation, loss of soil and biodiversity, siltation).

The Mekong Basin covers 97 per cent of the country (202,000 km<sup>2</sup>) and Laos contributes

35 per cent of the average annual flow of the Mekong. Therefore, it has a major role to play in basinwide water resource management, especially as the country is now keenly developing hydropower.

## 4.2 Economic Valuation Analyses

### 4.2.1 Direct Use Values

Laos, like most Mekong Basin countries, has seen its river capture fisheries reassessed and their value revised upward several times in recent years. Interestingly, fish production is not even mentioned in the 2001 statistical yearbook (NSC 2002), and nor is the importance of the fish resource to the population in the 2001 Lao PDR state of the environment report (UNEP 2001).

#### 4.2.1.1 Catch values

Inland fisheries catch statistics are much disputed in the Lao PDR. In 1997, national fisheries catches amounted to 37,825 tonnes (Guttman and Funge-Smith 2000). However, Jensen (2000) suggested that catch figures were underestimated. Guttman and Funge-Smith (2000) upgraded the annual fish catch figure to 59,774 tonnes. In 2002, capture fisheries production alone was estimated at 29,250 tonnes (Table 8).

**Table 8: Lao PDR inland fisheries production and productivity in 2000 (Souvannaphanh et al. 2003). The totals have been recalculated.**

Type of water resources	Area in (ha)	Productivity (kg/ha/year)	Total production (tonnes/year)	% of total fisheries production
Mekong and tributaries	254 150	70	17 790	
Reservoirs (stocked)	57 025	60	3 421	
Irrigation and small reservoirs (natural and stocked)	34 460	150	5 169	40.4
Swamps and wetlands	95 686	30	2 870	
Total for capture fisheries	441 321		29 250	
Total for aquaculture	503 460		42 066	59.6
Grand total (capture + aquaculture)	944 781		71 316	100.0



**Table 9: Estimates of capture fisheries and aquaculture production in the Lao PDR (Lorenzen et al. 2003b)**

Type of water resources	Area in (ha)	Productivity (kg/ha/year)	Total production (tonnes/year)	% of total fisheries production
Mekong and tributaries	254 150	70	17 790	
Reservoirs (stocked)	57 025	60	3 421	
Irrigation and small reservoir (natural and stocked)	34 460	150	5 169	78
Swamps and wetlands	95 686	150	14 352	
Rice paddies and floodplain	477 176	50	23 858	
Total for capture fisheries	441 321		64 593	
Total for aquaculture	503 460		17 911	22
Grand total (Capture + aquaculture)	944 781		82 504	100

The latest estimates, integrating rice paddies, amount to 82,500 tonnes, including 64,600 tonnes from capture fisheries (Lorenzen et al. 2003b), which accounts for 78 per cent of the country's fish production (Table 9). The authors believe the share of aquaculture remains grossly overestimated<sup>13</sup>.

The highest estimate of fish production is given by Sjorslev (2001a), who concluded that fish consumption alone (excluding trade with neighboring countries) amounts to 204,800 tonnes annually. This figure, based on raw consumption studies, is much higher than that of other authors.

#### 4.2.1.2 Market values

The gross value of fisheries output is estimated at around US\$ 48 million, commercial capture fisheries contributing approximately four per cent of GDP and subsistence fisheries another two per cent (Lorenzen et al. 2003a and 2003b). Souvannaphanh et al. (2003) consider that fisheries account for about eight per cent of national GDP. According to Emerton and Bos (2004) quoting STEA (2003), fish and other aquatic animals are

worth US\$ 100 million a year. The LARReC Medium Term Plan 2000-2005 estimates the value of total annual aquatic production to be approximately US\$ 66 million, excluding aquatic plants.

This estimate is based on the average market value of fish/frog/turtle (wet weight) at US\$ 0.66 per kg. According to Lorenzen et al. (2000), fish in local markets costs between US\$ 0.5 per kg for small *trash* fish and US\$ 1.5-2.5 per kg for larger fish. As household catches consist of about one third *small* and two-thirds of *large* fish, the average value reaches US\$ 1.5 per kg. More recently, Bush (2003b) gave a value for the overall average price of capture species in three lowland districts at US\$ 1.14 per kg, which was superior to the average value of aquaculture species (US\$ 0.98 per kg).

An alternative value of the fish consumed in Laos is detailed in Table 10.

The fish trade analysis was pioneered in Laos by Baird (1994), who monitored the local and seasonal trade of *Probarbus julleni* and *Probarbus labeamajor* (two highly migratory protected species) between southern Laos

<sup>13</sup> The 1998/99 Lao Agricultural Census estimated that 8.3 per cent of agricultural holdings were engaged in aquaculture (ACO 2000). However, according to Lorenzen et al. (2003b), "Household surveys in different rural areas of Lao PDR have yielded a consistent estimate of about 2% of households engaging in private aquaculture, with an average pond size of 0.12 ha. Scaled up to about 1 million households, this gives a pond area estimate of just 2,400 ha that, with a realistic average production estimate of 650 kg/ha/year, gives a total production of no more than 1,560 tonnes."

**Table 10: Value of the fish consumed in Laos (1997-98), cited in Souvannaphanh et al. 2003) (The figures have been recalculated because currently US\$ 1 is worth approximately 10,000 kip, but early in 1998 US\$ 1 was worth approximately 1,300 kip.)**

	Consumption value, in million kip	Consumption value, in US\$ (2005 change rate)
Fresh fish	30 750	3 075 000
Canned fish	1 237	124 000
Frozen fish	1 351	135 000
Dried fish	2 183	218 000
Prawns, crabs etc.	1 853	185 000
Fermented fish	2 934	293 000
Preserved fish	755	76 000
Others	4 995	500 000
<b>Total (rounded up)</b>	<b>46 000</b>	<b>4 600 000</b>

(Champassak), northern Cambodia and Thailand. Baird estimated the value of fish traded in the district at US\$1 million per year. However, Phonvisay and Bush (2001) deepened the study and concluded that 435 tonnes of fish are traded annually from Siphandone district to the main markets in Pakse and Thailand. At an average value of 9,500 kip/kg, they valued this trade at around US\$ 440,000. The study also led to the conclusion that about 87 tonnes of fish is imported every year from northern Cambodia to southern Laos.

In a study of five Vientiane markets, Phonvisay (2001) found that nearly 6 tonnes of fresh fish are traded daily. Out of this, nearly 1.8 tonnes come from Thailand, for a value of up to 5.188 billion kip or US\$ 576,700 per year. At least 405 kg of fermented or processed fish is also traded daily and supplemented by about 146 kg of dry fish. Still in Vientiane, Gerrard (2004) showed in her analysis of the values of an urban wetland that the capture fisheries component of this wetland alone is worth US\$ 1.1 million a year (more than half of its use value). The value of these resources in more urban villages also tends to be greater in both relative and absolute terms.

#### 4.2.1.3 Consumption values

The fish catch is important for consumption, particularly in the southern Lao provinces, and fermented fish (*pa dek*) is a significant staple diet in all villages, particularly during periods of low fish abundance or peak agricultural labor requirements.

The consumption of aquatic products in Laos has been addressed in a number of studies. Available figures are summarized in the following Table 11.

A quick analysis of the data in Table 11 shows that i) figures related to consumption of living aquatic resources in Laos have increased considerably over the years, reflecting an increasing knowledge illustrated by a growing number of studies; ii) official figures are much lower than those based on scientific studies<sup>14</sup>; and iii) that fish consumption seems to be highest in Champassak Province, characterized by extensive wetlands, although other central and northern provinces also exhibit relatively high consumption figures.

In Khong District (Champasack Province), Baird et al. (1998) estimated the average

<sup>14</sup> Bush and Hirsch (2005) pointed out a certain confusion in statistics or assessments by the Department of Livestock and Fisheries, which are not based on field surveys and hard data.

**Table 11: Per capita consumption of fish and other aquatic resources**

Figure	Source	Comment
7 kg of fish/person/year	Phonvisay 1994, cited in Bush 2002	Early government estimate originating from a figure provided by USAID in 1972
4.7 kg of fish/person/year in urban areas	Household surveys (1992-93 and 1997)	Figures based on a sampling of 2,940 households from 147 villages. Three facts make these figures very unlikely: i) in countries with rich natural resources and limited communication networks, consumption of aquatic resources is usually higher in rural areas than in urban areas; ii) these figures are extremely low compared to all other estimates; and iii) fish is usually much more abundant than other aquatic animals such as shrimps, frog, etc.
4.4 kg of aquatic animals/person/year in urban areas	National Statistics Center 1998; cited in Souvannaphanh et al. 2003	
2.5 kg of fish /person/year in rural areas		
2.8 kg of aquatic animals/person/year in rural areas		
17.1 kg of aquatic products/person/year	FAO PADP 1998 cited in Guttman and Funge-Smith 2000	Oudomxay Province (northern hilly province bordering the Mekong)
24.2 kg of aquatic products/person/year		Savannakhet Province (southern province bordering the Mekong)
15.1 kg of aquatic products/person/year		Sayaboury Province (central province bordering the Mekong)
21.2 kg of aquatic products/person/year		Sekong Province (southern province away from the Mekong mainstream)
25.6 kg of aquatic products/person/year		Xieng Khouang Province (central hilly province away from the Mekong mainstream)
42 kg of fish/person/year	Baird et al. 1998	Khong District, Champassak Province (in the Khone Falls area)
8.5 kg of fish/person/year	FAO 1999	Based on national statistics
17.5 kg of fish/person/year	Garaway 1999	Savannakhet Province (southern province bordering the Mekong)
29 kg of fish and other aquatic animals/person/year	Sjorslev 2000	Luangprabang Province (northern hilly area)
61.1 kg of fresh fish/person/year	Mattson et al. 2001	Around the Nam Ngum dam reservoir
50 kg/person/year of living aquatic resources	Singhanouvong and Phoutavong 2002.	Champassak Province (southern area including extensive wetlands)
19.9 kg of aquatic resources/person/year	Bush 2003b	Figure based on a brief survey in Savannakhet Province. Annual figure inferred from the average daily consumption of 54.7g/day/person during the survey. Fresh fish makes 75 per cent of these aquatic resources, other aquatic organisms 23 per cent and processed fish 2 per cent.
11.8 kg of fish/person/year	Calculated from Garaway 2005	Based on a one-year survey (103 households) in Savannakhet province in 1997-98

annual catch for a family at about 355 kg, of which 249 kg was consumed. Mollot et al. (2003) found an average household collection of fish amounting to 704 kg per year in Attapeu and Savannakhet Provinces.

The role of fish and other aquatic resources in the diet of the Lao rural population was detailed in Guttman and Funge-Smith (2000) and Meusch et al. (2003) also highlighted the deplorable nutritional status of the people in Attapeu Province, as well as the importance

of aquatic resources in supplementing a nutrient-poor diet. A table summarizing available studies is provided in Table 12.

### 4.3 Socioeconomic Analyses

In Laos, 2.7 million people live along a river (MRC 2003b). The Agricultural Census indicated that more than half the population of the Lao PDR was engaged in capture fisheries in one way or another<sup>15</sup>. In a detailed study, Lorenzen et al. (2000) reported that wild fish were more highly priced for their taste than

cultured species, and that participation in fishing was predominant in rural households, with more than 80 per cent of the households in southern Lao PDR being involved (Lorenzen et al. 2003). The same author (2000) showed that in an average household, the use of aquatic resources (with an estimated value of US\$ 90) accounted for about 20 per cent of gross income (Lorenzen et al. 2003). On average, 70 per cent of household fish supply is caught by households themselves; less than 20 per cent is purchased; and 10 per cent is received as gifts, reciprocal exchange,

**Table 12: Contribution of fish and aquatic resources to diet in the Lao PDR**

Percentage in the diet	Source	Note
Fish accounts for approximately 78 per cent of the animal protein consumed.	Baird et al. 1998	Khong District, Champassak Province
Fish contributes 42.5 per cent of the animal proteins consumed.	FAO 1999	I.e., 8.5 kg of fish out of 20 kg of proteins. Average figure based on national statistics; however, this proportion can vary between 10 per cent among hill tribes and 90 per cent among the Lower Lao population.
Fish contributes 17 per cent of the agricultural production intended for home use.	LECS 2 (1999) cited in Guttman and Funge-Smith (2000)	
Aquatic products contribute from 26.6 to 57.1 per cent of the total protein.	Guttman and Funge Smith 2000	Range over 6 rural provinces; average: 40.6 per cent
Fish and other aquatic animals account for 43 per cent of the total animal product consumption.	Sjorslev 2000	The study specifies that aquatic resources actually account for 55-59 per cent of the total animal intake if differences in the protein contents of various foods are integrated.
Fish is present in 52-95 per cent of all meals.	Baird 2001; Baird and Flaherty 2000	In Khong District, Champassak Province. Fish is also the largest source of cash income.
Fresh and processed fish contribute 56.3 per cent of the total animal protein intake.	Mattson et al. 2001	Around the Nam Ngum reservoir
Fish and other aquatic animals are present in 85 per cent of all meals.	Bush 2003b	Savannakhet Province; figure based on a brief survey
Fish and other aquatic animals comprise between one-third and one-half of the total protein consumption at the national level.	Emerton and Bos (2004), quoting STEA (2003)	
Fish contributes 18 per cent of food supply.	Mollot et al. 2003	Attapeu and Savannakhet Provinces

<sup>15</sup> This figure is probably an underestimate as most rural people in the Lao PDR primarily consider themselves to be rice farmers, and this leaves fishing unnoticed although it is widely practiced by all. The fact that the importance of fisheries remains unnoticed by rural people themselves while it is objectively their major source of protein deserves greater attention (Bush, pers. comm.).

or payment in kind for labor (Lorenzen et al. 2003b; Garaway 2005).

Nguyen Khoa et al. (2003) showed that the average household fishing effort was consistent at about five hours per week, but household catches were lower in weirs (0.77 kg/week) than in dams (2.07 kg/week). The authors indicated that the difference in catches was likely to reflect differences in the hydrology of weirs and dams depending upon their location within watersheds.

On the trade side, the FAO (1999) reported that almost the entire aquatic resource production in the Lao PDR is consumed within the country, with little or no fish exports. However, Baird and Flaherty (2000) and Bush (2002, 2004b) highlighted the fact that the fisheries, until recently practiced by remote, isolated and subsistence-oriented people, are in fact becoming embedded in a regional trade network that increasingly drives local fishing pressure. In fact, a considerable amount of catch from the Mekong River may be landed in Thailand, where market prices are higher (Lorenzen et al. 2003).

#### 4.4 Livelihood Analyses

The livelihood dimension of fisheries in central and southern Laos has been highlighted by several authors, particularly Roberts and Baird (1995), Shoemaker et al. (2001), Friend (2001) and Bush (2003a and web site<sup>16</sup>). Shoemaker et al. (2001) showed how important the contribution of the river to livelihoods was, thanks to fishing, riverbank gardening, edible and medicinal plants from river wetlands and flooded areas, transportation in the wet season, and drinking water in the dry season.

Emerton and Bos (2004) highlighted the fact that ecosystem goods have high levels of substitution or complementarity with other goods, and can be used when other products

are unavailable or unaffordable. Fish can also provide a small amount of cash at a crucial time to buy rice seeds at the end of a long dry season, for instance (Béné, pers. comm.), thus securing both the food and the livelihood of the following year. In view of this diversity and seasonality, Friend (2001) highlighted the flaws and “*limited value of socioeconomic surveys*”, as they assume a level of uniformity or regularity and cannot reveal the dynamic aspect of relative values of natural resources in rural livelihoods. Bush and Hirsch (2005) showed that, following environmental changes, local fishing communities might experience higher fluctuations in catches without economists noticing a variation in the value of the fish, while fishers might experience fishing constraints and changes in the species composition without biologists noticing a change in the value of the fish biomass.

Laos is a very poor country, as illustrated by the fact that agriculture accounts for more than half of the GDP, while only around three per cent of the country's land area is cultivated, partly because much of the country is mountainous. In this context, natural resources are of considerable importance to a major proportion of the population; hunting, fishing, and gathering play an important role in the household economy. In fact, aquatic resources also constitute the main coping strategy for periods of rice deficit, but there are no coping strategies for periods of aquatic resource deficit (Meusch et al. 2003).

Fishing ranks as the second or third most important activity after rice farming and animal husbandry, and contributes on average about 20 per cent to rural household income (Lorenzen et al. 2003b). Full-time fishers account for only a few percent of the Lao population, but fishing is central to livelihoods in the southern provinces of the country (e.g., Roberts and Baird 1995; Baird 1996; MRAG 2002), and reliance on fishing is

16 See [www.mekong.es.usyd.edu.au/case\\_studies/fisheries/index.html](http://www.mekong.es.usyd.edu.au/case_studies/fisheries/index.html)

a common characteristic of all wealth groups within villages (Garaway 2005).

Guttman and Funge-Smith (2000) detailed the time spent by Lao people in rural occupations. Fishing takes up around 10 per cent of the time spent on income generating activities in rural areas that are dominated by rice cultivation, followed by fishing and tending animals. They also showed, like Garaway (2005), that the poor spend more time fishing than the other categories of the population. Fishing as an activity is not gender specific (Lorenzen et al. 2003b).

In an urban context (a wetland in Vientiane), Gerrard (2004) showed that incidence of fishing and its total value increases as household income status declines, underlining the importance of incorporating capture fisheries into local poverty reduction strategies.

#### **4.5 Impact of Changes on Fisheries in Laos**

The main issue regarding river changes and fisheries in Laos is hydropower development. The impact of Lao hydropower dams on the environment and poor communities has been addressed for a number of years by multiple NGOs, but few scientists have undertaken detailed impact studies. An overview of the issues inherent to each major dam is provided, with a pro-poor, pro-conservation perspective in IRN (1999).

We review below some fisheries-related issues in the case of Nam Ngum and Nam Theun 2 dams.

##### **4.5.1 Example of Nam Ngum Dam**

The Nam Ngum reservoir, covering an area of 477 km<sup>2</sup>, was created by a hydropower dam located 90 km from the capital, Vientiane. Several studies have been conducted to estimate the fisheries production in the

reservoir, but none has been done on the environmental impacts of the dam. A study done in 1982 by the MRC estimated the total fish production at 1,470 tonnes while another study found it to be 6,833 tonnes (Mattson et al. 2001). According to Mattson et al. (2001), the increase could be the result of reduced predation pressure, the initial high-value predator species having been fished out. Other studies on reservoir fisheries in the dam indicated that the initial catch was low due to problems in water quality; but since the flooded trees in the reservoir were cut, the water quality has improved. The fisheries landings are said to have increased by a factor of four between 1982 and 1998 (cited in Mattson et al. 2002a), in correlation with an increase in fishing effort, particularly gillnets. The total estimated landings (6,833 tonnes) correspond to a 143kg/ha/year yield. Annual registered yield amounted to US\$ 800,000 in 1997 (Ringle 2000). However, Roberts (2004) pointed out that during 1971-79 the reservoir was largely anoxic with very low fish catch, and after a peak in fisheries production in 1985-90, the catch declined. Careful management of the reservoir fishery is obviously essential. Lorenzen et al. (2000) found in their study that dam schemes in Laos are associated with declines of about 60 per cent in fishing effort and catch for rural households. However, no literature was found on the impact of the dam on migratory species or the effect on downstream fisheries except that of Schouten (1998), who showed that the water released from the Nam Ngum reservoir has a much lower dissolved oxygen level than that in natural rivers and is unfavorable for aquatic life most of the year, especially during the wet season.

##### **4.5.2 Example of Nam Theun 2 Dam**

Nam Theun 2 is the largest and most controversial hydropower project being planned in the Lao PDR (IRN 1999). The

project, planned for central Laos, consists of a 50-meter-high dam on the Theun River, the fourth largest tributary of the Mekong. The river provides habitat for 85 species of fish 16 of which are endemic (Roberts 2004), and 33-55 per cent of these species are strongly migratory. Out of the 85 species, only 27 are likely to become established in the reservoir, and 14 of these are small species with little or no commercial value (Roberts 2004). Several environmental impact assessments have highlighted the fact that the dam would have a serious negative impact on fisheries by disturbing migration, creating a large body of still water to which most of the species could not adapt and degrading water quality downstream (IRN 1999). Cumulative impacts have also been envisioned, and a significant negative impact on fisheries and aquatic biodiversity has been foreseen, although not detailed (NORPLAN 2004). The reservoir fishery can be expected to increase during the first 5-10 years, but then it will decline (Roberts 2004).

## 5. KINGDOM OF THAILAND

### 5.1 Country Overview

Thailand is the richest country in the region, with a GDP of US\$ 7,400 per inhabitant for a population of 64.8 million. About 10 per cent of the population lives below the poverty line. However, there is a great disparity between

regions, and the northeastern provinces bordering the Mekong River are among the driest and poorest in the country.

Agriculture contributes less than 10 per cent to the national economy while industry and services contribute 40 and 50 per cent, respectively (Table 13). Out of all the LMB countries, Thailand is least economically dependent on the Mekong River. However, fisheries have huge importance for rural food security and employment in the northeastern provinces. The population growth of the country is low compared to its neighbors and very similar to that of developed countries.

Water resources are managed intensely in Thailand for hydropower, irrigation, industrial and domestic uses. However, problems of availability and adequacy of water resources are created by inefficient use of water in various sectors, deteriorating water quality due to urban sewage and industrial waste, and excessive use of fertilizers and pesticides. The present water demand for irrigable areas and other uses is estimated to be 68,000 mcm (million cubic meters) per year for the whole country. This figure is expected to increase to 86,000 mcm/year in 2006, or 43 per cent of the total annual runoff. Within Thailand, 1,872 reservoirs are located in the Mekong River Basin, with a total surface area of 2,120 km<sup>2</sup> and an estimated total fish catch of 25,428 tonnes per year (Virapat and Mattson 2001).

**Table 13: Selected economic indicators for Thailand from 2000 to 2003 (World Bank web site)**

Economic indicator	2000	2001	2002	2003
Agriculture (% of GDP)	9.02	9.12	9.37	8.77
Industry (% of GDP)	41.97	42.12	42.67	41.44
Services (% of GDP)	49.01	48.76	47.96	49.79
GDP (billion US\$)	123	116	127	143
GDP growth (%)	4.76	2.14	5.41	6.74
Aid per capita (US\$)	11.50	4.59	4.80	
Population growth (%)	0.80	0.75	0.70	0.65
Population total (millions)	60.70	61.20	61.60	62.00

Inland capture fisheries in Thailand usually operate in major rivers and their floodplains, canals, swamps, wetlands, paddy fields, lakes and reservoirs. Pawaputanon (2003) reported a total area of 4.9 million hectares for inland fish habitat. This area consists of 4.5 million hectares of wetlands and 47 rivers and 400,000 hectares in the form of 21 large reservoirs. The fisheries are mainly subsistence-based, but commercial fishing, especially aquaculture, is increasing rapidly. Inland freshwater and brackishwater ponds and tanks constitute 320,000 hectares of production area in the country. However, most of the freshwater ponds are operated for various purposes (e.g., school and village ponds are operated for food and income for poor families).

## 5.2 Economic Valuation Analyses

The review indicates that Thailand is the LMB country for which published literature in English on fisheries is least available. Possible explanations for this situation are i) the high priority given by the Thai Department of Fisheries to aquaculture, with some studies on reservoirs following up fish stockings; ii) the fact that most reports and publications are written in Thai, and iii) the relatively low level of research done in Thailand by the MRC. Therefore, some gaps in the economic valuation of river fisheries in Thailand remain in this section.

### 5.2.1 Direct Use Values

#### 5.2.1.1 Catch values

Inland fisheries contribute approximately six per cent (about 200,000 tonnes) to the total fisheries production in Thailand (Pawaputanon 2003). Indeed, in 1996, the Department of Fisheries reported this contribution at 5.8 per cent, with the northeastern region that lies in the Mekong Basin contributing 122,000 tonnes (cited in Prapertchob 1999). Marine and aquaculture production seem to outweigh inland fisheries production considerably (Table 14), with marine production of over 3 million tonnes dominating the fisheries sector.

This assessment of freshwater fish catches for the 1997-99 period is 2.6 times higher than that available for the year 1996 (Table 15).

#### 5.2.1.2 Market values

Surprisingly, it was possible to find only one study in English that details the value of inland capture fisheries production in Thailand, as shown in Table 16.

Should the 1996-price-per-kilogram figure (US\$ 0.77/kg) be applied to the 1997-99 assessment detailed in Table 14, it would result in a total value of US\$ 157.5 million for Thailand's inland fisheries production. As a comparison, the value of all fish and fish

**Table 14: Capture fisheries production in 1997-99 in Thailand (tonnes; adjusted from Pawaputanon 2003)**

Year	Capture fisheries production (t)			Total
	Freshwater	Marine	Others	
1997	205 000	2 679 500	499 900	3 384 400
1998	202 300	2 709 000	594 600	3 505 900
1999	206 900	3 166 400	252 600	3 625 900



products in Thailand is estimated at US\$ 3.6 billion in 1995 (NACA 2000).

Given the problems in small-scale fisheries data collection in Thailand (Coates 2002), it can be assumed that the figure for open waters is seriously underestimated. According to Coates (2002), *“It is widely held that dams have significantly reduced fisheries in major rivers in Thailand. This is probably true and has certainly been used as a major reason to devote most attention to reservoir fisheries and aquaculture”*. An analysis by Pawaputanon (2003) revealed that inland capture fisheries production reported by the Department of Statistics reflected only the production in reservoirs and large wetland water bodies, covering up to 2.7 million hectares. Virapat et al. (1999) supported the view that statistics reported by the DOF referred almost exclusively to reservoirs and noted, *“... this confirms that the perception of inland capture fisheries in Thailand is one*

**Table 15: Inland fish production per water-body type in Thailand in 1996 (cited in Virapat and Mattson 2001)**

Category	Area (ha)	Production (kg/ha)	Total (t)
Reservoirs	432 176	83	35 818
Public waters	185 527	199	36 843
Fish ponds	22 163	273	6 050
Total	63 ,866		78 711

**Table 16: Inland fish value per water-body type in Thailand in 1996 (cited in Virapat and Mattson 2001).**

Category	Total (t)	Value (USD)
Reservoirs	35 818	27 469 000
Public waters	36 843	28 255 000
Fish ponds	6 050	4 640 000
Total	78 711	60 364 000

*of reservoirs. Whilst reservoirs are obviously important ... Thailand in fact does still have considerable river and swamp fisheries, plus*



**Figure 6: Map of northeast part of Thailand, bordered by the Mekong**

*some production from rice-fields*" (cited in Coates, 2002).

### 5.2.1.3 Consumption values

The main source of information about fish consumption in Thailand is the review by Prapertchob (1999). According to this review, based on a 500-household survey by Prapertchob et al. (1989), the author cited the amount of freshwater fish consumption in northeastern Thailand as 21.3 kg/person/year on average, with a variability between 13.3 kg/person/year in dry areas and 36.4 kg/person/year in areas rich in water resources. The annual consumption of freshwater fish in northeastern Thailand was subsequently estimated at 395,000 tonnes (i.e., almost twice the 207,000 tonnes estimated in Table 14). Fish was by far the dominant food item in the diet of the people surveyed, followed by chicken and pork (half and one-third of the consumption of fish, respectively). Seventy-one per cent of the fish consumed was captured from the wild. Little et al. (1996) also showed that poor people and those living far from water resources tended to rely more on other aquatic animals, such as crabs and frogs, than on fish. In 1995, the fish consumption was estimated at 27 kg/person/year by the Department of Fisheries, with the central and northern regions importing fish from other provinces due to insufficient local supply.

## 5.3 Socioeconomic Analyses

Inland fisheries play a significant role in Thailand in terms of providing food security and employment to fishing communities and rural populations. According to Virapat and Mattson (2001), about 825,000 labor households earned their living from both agriculture and inland fisheries, and an additional 47,000 households earned their living from inland fisheries alone. More than 80 per cent of the total households that rely

on agriculture and/or inland fisheries live in the Mekong River Basin.

## 5.4 Impact of Changes on Fisheries in Thailand

A large body of journalistic literature addresses the impact of dams on aquatic resources and the people who depend on them; however, there are few scientific studies to back up these journalistic articles. Presented below is an example of the famous and controversial Pak Mun dam, which has generated more scientific studies than any other case of river modification in Thailand.

### 5.4.1 Example of Pak Mun Dam

This analysis of the impacts of Pak Mun dam is mainly based on a report of the World Commission on Dams by Amornsakchai et al. (2000).

The Pak Mun dam is a run-of-the-river dam built on the Mun River, 5.5 km upstream from its confluence with the Mekong, in northeastern Thailand. The dam has a maximum height of 17 m, and a total length of 300 m. The budget for the project was 3.88 billion Baht, but the unanticipated cost of compensation for the loss of fisheries increased the total cost.

The environmental impact assessment done in 1981 predicted that fish production from the reservoir would increase considerably, although some fish species would be affected by the blockage of river flows by the dam. The fish yield expected was 100 kg/ha/year without fish stocking and 220 kg/ha/year with a fish-stocking program. However, in Thailand, even storage reservoirs that perform better under fish-stocking programs have a fish yield of only about 19 to 38 kg/ha/year. There has been no evidence that the fish productivity of the Pak Mun reservoir has reached anywhere near the anticipated 100 kg/ha/year, and the value of the total annual headpond fishing

yield has been estimated at 0.9 million Baht, instead of the expected 19.7 million Baht (US\$ 69,000).

Regarding biodiversity, Roberts (1993) reported that the number of fish species in the Mun River declined from 121 species in 1967 to 66 species in 1981, and 31 in 1990.

After the completion of Pak Mun dam, the lower Mun River experienced a decline in fishing yields with an estimated value of US\$ 1.4 million per annum at 20 Baht/kg. In addition, the decline in fish species upstream led to the closure of 70 Tum Pla Yon traps. At the end of the 1980s, the value of the annual catch from this single fishery amounted to US\$ 212,000 per annum (at a rate of 38 Baht per US\$ 1), and the reservoir fisheries created did not match the losses generated by the dam construction.

In the post Pak Mun dam period, fishing communities located upstream and downstream of the dam reported a 50-100 per cent decline in fish catch and the disappearance of many fish species. The number of households that were dependent on fisheries in the upstream region declined from 95.6 per cent to 66.7 per cent, and the villagers who were dependent on fisheries for income found no viable, alternative means of livelihood. These conclusions have been largely confirmed by the Thai Baan research initiative (SEARIN 2004), which provides additional insights on the consequences of the dam on the livelihoods of the local population. By March 2000, 488.5 million Baht (US\$ 19.5 million) had been paid to 6,202 households as compensation by the Thai government for the loss of fisheries and livelihoods.

Because of its location, this dam is a greater barrier to fish migrations than reservoirs and

dams built on low order tributaries further up in the catchment areas. Out of the 265 fish species recorded in the Mun-Chi watershed before 1994, 77 species were migratory and 35 species were dependent on habitat associated with rapids. Out of 169 species found in the present catch, 51 species were significantly less abundant since the completion of the project, while at least another 50 species of fish that were dependent on upstream rapids had disappeared. Nowadays, only 50 migratory species are left. The decline has been higher in the region upstream from the dam where the catch has declined by 60-80 per cent since the completion of the run-of-the-river hydropower project. Amornsakchai et al. (2000) conclude that the difference in the number of species in fish surveys before and after dam construction may well be exacerbated by the cumulative impact of many different developments in the watershed. Therefore, the Pak Mun dam cannot be solely blamed for the apparent decline of some of the fish species.

As the fish ladder built on Pak Mun to mitigate the impact of the dam on migrating fish has proven inefficient (too steep, dry six months a year, not used by fish; Roberts 2004), changes following a lengthy conflict were ultimately made to the operation of the dam in order to reduce its impact on fisheries and livelihoods. In January 2003, it was agreed that the sluice gates would remain open four months a year.

## **6. KINGDOM OF CAMBODIA**

### **6.1 Country Overview**

Cambodia is the poorest country in Southeast Asia with a GDP per capita of US\$ 297 (UNDP 2004). The population of Cambodia

has tripled over the past couple of decades from approximately 4 million people in 1979 to about 13.8 million in 2003. It is estimated that the population will further increase to 16.6 million by 2010 and to over 20 million by 2020. With an annual population growth rate of 1.6 per cent, about 300,000 jobs need to be created each year (Degen et al. 2000) in the future, considerably straining the country's already weak economy (see Table 17 for details).

The rural population comprises about 90 per cent of the nation's poor, 43 per cent of whom live below the poverty line (cited in Zurbrügg 2004). According to Keskinen (2003), while the role of agriculture has great significance to employment because it provides jobs for almost 80 per cent of the population, the economic importance of the whole agricultural sector is decreasing, accounting for only 34 per cent of the national economy in 2000, compared with more than 50 per cent in 1990. However, the author noted that the proportion of the agricultural and fishery sectors' contribution to GDP might be considerably underestimated, partly because of their subsistence nature (Keskinen 2003).

## 6.2 Economic Valuation Analyses

### 6.2.1 Direct Use Values

On his way to Angkor Wat in 1858, Henri Mouhot noted, "*the Great Lake is in itself a*

*source of wealth for a whole nation; it is so full of fish that at the time of low waters they are crushed under boats; and rowing is often hampered by their number*" (Mouhot 1868). Today, inland fisheries contribute 90 per cent of Cambodia's total fish catch (Sam et al. 2003) of which the Tonle Sap Lake provides about 60 per cent, or 179,500-246,000 tonnes annual harvest over the 1995-2000 period (Ahmed et al. 1998; Lieng and Van Zalinge 2001). In 1998, according to the DOF (2001a), 35 per cent of the Cambodian population was living in fishing dependent communities.

#### 6.2.1.1 Catch values

Similar to fish consumption figures in the Lao PDR, fish catch figures in Cambodia have been evolving a lot over the past 10 years, with a strong initial mismatch between official statistics and scientific assessments. Although multiple project reports mention various figures, estimates all rely on only three basic sources: i) official national statistics; ii) catch statistics of the MRC project "Management of the Freshwater Capture Fisheries of Cambodia," partly based on field sampling; and iii) estimates based on consumption studies led by the MRC in particular in 1995-96. Both official and MRC statistics have themselves been reconsidered over time, with several confusing recalculations tentatively reviewed in Baran et al. (2001b) and Baran (2005). The resulting production figures originating from these three main sources are reviewed in Table 18.

**Table 17: Selected economic indicators for Cambodia from 2000 to 2003 (World Bank web site)**

Economic indicator	2000	2001	2002	2003
Agriculture (% of GDP)	39.65	37.56	35.58	
Industry (% of GDP)	23.27	25.62	27.98	
Services (% of GDP)	37.08	36.82	36.44	
GDP (billion US\$)	3.60	3.71	4.00	4.30
GDP growth (%)	7.03	5.67	5.48	7.64
Aid per capita (US\$)	31.38	32.46	36.96	
Population growth (%)	2.22	2.01	1.79	1.58
Population total (millions)	12.70	12.90	13.20	13.40

In fact, these figures result from an aggregation of various localized studies (e.g., bagnet fishery, rice-field fisheries, consumption studies, etc.) but not from a comprehensive assessment. The major fisheries remain too profitable for scientific monitoring to be allowed by operators (case of the lot fishery; CNMC/Nedeco 1998; Degen and Nao Thuok 2000) or too dispersed to be efficiently monitored (case of the mobile gear fisheries). Similarly, the evolution of the production figure over time reflects the progressive integration of previously neglected catches (e.g., from rice fields, subsistence fisheries, etc.) but does not result from long-term scientific monitoring, which still does not exist in Cambodia despite the efforts of the MRC over the past ten years (Coates 2002; Baran 2005)<sup>17</sup>.

Assuming an annual production of 300,000-400,000 tonnes, Cambodia's freshwater capture fisheries rank fourth worldwide after China, India and Bangladesh. Furthermore, as shown by Baran (2005), when the catch is divided by the population (i.e., the number of people who can realize the harvest), Cambodia's inland fishery is the most intense in the world, with 20 kg of fish caught per inhabitant per year (Figure 7).

Baran et al. (2001b), and Lieng and Van Zalinge (2001) provide estimates of the fish yield of the Cambodian floodplains, which amount to between 139 and 230 kg/ha/year. This is the highest amount when compared with figures from the other tropical floodplains (i.e., Thailand, Laos, Indonesia, Bangladesh, Amazon), which range from 24 to 173 kg/ha/year (the latter figure being in Laos, within the Mekong Basin). At a specific site of the Tonle Sap Basin, the fish yield amounted to 243-532 kg/ha/year (Dubeau et al. 2001) and the average catch to 2.4 kg/fisher/day (Ouch and Dubeau 2004). The exceptional productivity of the Cambodian floodplains is explained by

three interconnected factors: high biodiversity, accessibility of the floodplains and a very high exploitation rate over decades (Baran 2005).

### 6.2.1.2 Market values

In a recent large-scale study conducted on 540 households in three provinces (Stung Treng, Siem Reap and Takeo), Israel et al. (2005) calculated that the annual net economic value (NEV) of aquatic resource-based activities is US\$ 190,000 for an average village community, less the cost of labor that is generally not accounted for. This NEV, however, varies from US\$ 6,106 to 440,895 per village per year depending upon the degree of dependence on aquatic resources and market access. The annual return to labor (i.e., the amount the communities earn from aquatic activities) reaches US\$ 108,614 per village per year on average.

On the macroeconomic side, the perception of this resource's importance has evolved dramatically. Before 2000, the total revenue generated from the fisheries sector was estimated at US\$ 2.4 million per year (Gum 2000). However, the evolution in the catch assessment led to radical revisions. Van Zalinge et al. (2000) estimated the monetary value of the catch at the landing site to range from US\$ 100 to 200 million, and to increase in the marketing chain up to US\$ 250 to 500 million. Nowadays, official statements estimate the fishery at 300,000-450,000 tonnes per year, with a value of US\$ 150-225 million<sup>18</sup>. Hortle et al. (2004a) valued the total catch at US\$ 300 million. Nao and Ly (1998) estimated that the value of fisheries in 1995 made up 3.2 to 7.4 per cent of GDP. However, the contribution of fisheries to the GDP has recently been estimated at 11.7 per cent (Starr 2003) and 16 per cent (Van Zalinge et al. 2004). This represents more than half the

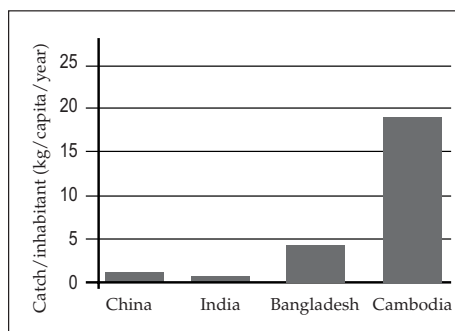
<sup>17</sup> The only fishery scientifically monitored in the basin is the bagnet ("*dai*") fishery, which accounts for 15,000 tonnes/year, or approximately 4% of the total catch in Cambodia and 0.6% of the catch basinwide.

**Table 18: Cambodian inland fisheries catches, according to various authors**

Figure (tonnes of inland fish per year)	Source	Note
130 000 tonnes	Chevey and Le Poulain 1939	Earliest scientific assessment, preceded by a rough estimate of 200 000 tonnes by Chevey (1938)
Catch varying between 50 500 and 75 700 tonnes between 1981 and 1998	Department of Fisheries data and (DOF 2001b)	Statistics not based on any scientific monitoring (Coates 2002, 2003)
255 000-380 000 tonnes	Van Zalinge et al. 1998a	First post-war assessment partly based on a scientific monitoring
289 000-431 000 tonnes	Van Zalinge and Nao Tuok 1999; Van Zalinge et al. 2000; Hortle et al. 2004a	Most commonly agreed figure, including results from scientific studies about catches of the dai fishery and rice field fisheries, and "guesstimates" about middle-scale and lot fisheries
Catch varying between 231 000 and 385 000 tonnes between 1999 and 2002	Department of Fisheries data	Upgraded national statistics (still not based on extensive monitoring) integrating catches of subsistence fisheries
500 000 tonnes	Van Zalinge 2002	Upgrading by 20% of the previous figure to integrate the population growth in order to reflect today's situation
600 000 tonnes	Hortle et al. 2004a	
682 000 tonnes	Van Zalinge et al. 2004	Most recent estimates, integrating the results of fish consumption studies



**Figure 7: Map of Cambodia**



**Figure 8: Fish catch per inhabitant in the four countries having the biggest inland fish catch (Baran 2005)**

share of the whole country's industry (21.9% in 2001).

Inferring value from catch is highly dependent upon the average price-per-kg factor used, and very few studies detail this factor. Rab et al. (2004a) detailed the evolution of the price along the trade chain (Table 19) and showed that the price at the landing site can be five times that received by the fisher.

**Table 19: Average price of a kilo of fish at each level of the trade chain (Rab et al. 2004a)**

	US\$/kg
Price received by fishers	0.39
Price paid by the households	0.60
Retail market price	1.84
Landing site price	2.16
Export house price	4.26
Border price	5.28

**Table 20: Average price per kilogram of fish (US\$) per quality ("grade") at various retail markets during the closed season (Rab et al. 2005)**

Average price (US\$/kg)	Phnom Penh	Kampong Chhnang	Siem Reap
Grade 1	3.48	5.83	0.74
Grade 2	2.50	3.20	0.51
Grade 3	1.92	1.81	0.48

In a similar study, Yim and McKenny (2003a) found that the marketing margin (profit share in the retail price) varies from 65 to 75 per cent (i.e., a price multiplied by 2.8 to 4.2 between the fisher and the local consumer), depending on species. The geographic variability of prices in retail markets as well as the variability by meat quality were also highlighted by Rab et al. (2004b, 2005; table 20), while Ker et al. (2001) outlined their temporal variability (fish prices being generally highest from June to August and lowest from December to February).

Ker et al. (2001) also showed that the mean price of other animal protein is generally higher than that of cultured and wild fish, making the latter a more affordable staple for the poor. Touch and Todd (2003) estimated the total value of processed and exported inland fish commodities, such as fish sauce, dried fish, smoked fish, etc. at US\$ 23.7 to 29.4 million.

The export market is particularly informal, difficult to monitor and undervalued. As noted by the DOF (2001c) "the trade statistics published by the Ministry of Commerce reported only 517 tonnes of exports in 1998 at a value of US\$ 4.34 million. On the other hand, statistics prepared by the Department of Fisheries (DOF) under the Ministry of Agriculture, Forestry and Fisheries indicated 40,240 tonnes of exports of fishery products in that year, which seems more realistic". Officially, Cambodia exported 23,700 tonnes of inland fish in 2001 (Nao et al. 2001, cited in Hortle et al. 2004a)<sup>18</sup>. By comparison, in the 1940s, under a strong colonial administration backed by extensive studies of the fisheries sector, the fish export was estimated at 28,000 tonnes per year (Le Poulain 1942), for a total population three times smaller than nowadays (Baran et al. 2001a).

Yim and McKenny (2003a, 2003b and 2003c) found that fish exports registered by

<sup>18</sup> Minister of Agriculture, Forestry and Fisheries, National Fish Day 2004.

<sup>19</sup> Out of a total of 38,100 tonnes of fish exported for a total value of US\$ 31.14 million, according to DOF statistics.

the Department of Fisheries were often one third or even one tenth of their real weight. Yim and McKenney (2003b) also showed that official and above all informal fees add more than 50 per cent to the cost of exporting a tonne of fish to Thailand. For example, a shipment of fish sent by road from the Tonle Sap Lake to Thailand is subject to 27 different fees by 15 institutions, 19 per cent of which are unofficial fees. Overall, the value of fees represents more than twice the profit margin of the trader, and thus fish resources benefit a number of institutions that have in theory nothing to do with fisheries. The authors do not view investment and business growth as possible in the current situation.

Taxes and fines from the fisheries system are primarily supposed to benefit the Department of Fisheries in charge of monitoring and management of the resource. However, the corresponding government revenue in the year 2000 was less than US\$ 3 million (FACT 2001). Thus, the official revenue collection from an estimated US\$ 300 million worth resources amounts to taxation of only one per cent. This can be compared to the taxation rate under the French Protectorate, which ranged from 1 to 10 per cent depending on the gear (average: 5.6% among 6 gears, calculated from Chevey and Le Poulain 1939). In fact, the supposedly very low current taxation rate rather highlights a governance and reallocation issue (Ratner et al. 2004) and does not necessarily leave the Department of Fisheries with sufficient resources to efficiently face the challenge of properly monitoring and managing the fish resource.

In the informal sector, bribery in relation to the fishing lot licenses has been estimated at US\$ 3-4 million (Touch and Todd 2003).

### 6.2.1.3 Consumption values

Fresh fish consumption is important among people living close to fish production areas

and markets, but in rural areas far from natural water bodies or markets, processed fish is more important (Deap 1999). At peak periods when catches are very large, most fish is processed into fish paste (*prahoc*), fermented fish (*phaok*), sweet fish (*mum*), smoked fish and fish sauce. Surplus fish is dried for pig feed or fertilizer. McKenney and Tola (2004) estimated the average consumption of processed fish paste (*prahoc*) at 62 kg/household in 2002, or 10.1 kg/person. For 2003, surveyed farmers consumed, on average, 95 kg/household (15.7 kg/person). The cost of *prahoc* was US\$ 0.09 per kg, whereas low quality pork cost US\$ 1-2 per kg. The cost of *prahoc* rose by 60 per cent between 2001 and 2003 due to low fish catch. If similar rises follow, food security for many Cambodians could be severely threatened as no substitute for *prahoc* exists.

Rab et al. (2004a, 2006), in an extensive study of 410 households in 3 provinces bordering the Tonle Sap Lake and River, detailed the use of fishery resources; they showed that in the area surveyed, three quarters of the fish caught was sold for cash, while a quarter was used locally for consumption or aquaculture (Table 22). This is to be related to the per capita consumption in Table 21: can 75 kg/person/year really represent only one fourth of the overall catch?

The consumption of fisheries products is extremely high in Cambodia, as illustrated in Table 21.

Hap et al. (2006) have dedicated a specific study to the values of Tonle Sap fisheries. In 2003, there were approximately 1.25 million people living by the Tonle Sap Lake. The majority of these people were involved in small-scale, non-commercial fishing. Although fishing is central to the lives of Tonle Sap people, it is important to recognise that their livelihood strategies are pluralistic in nature, and that the whole aquatic ecosystem and its



**Table 21: Fish consumption and contribution of aquatic resources to diet in Cambodia**

Figure	Source	Comment
13.5-40 kg of fish are consumed per person per year	Kim and Hav 2004	Consumption estimated before the study by Ahmed et al. (1998)
75.6 kg of fish are consumed per person per year	Ahmed et al. 1998	Large-scale study of in the provinces bordering the Tonle Sap Lake. Detailed consumption figures are: - 43.5 kg of fresh fish/person/year, - 14 kg of processed fish paste (= 27.5 kg of fresh fish), - fish sauce, fish oil and transformed products (= 4.6 kg of fresh fish/person/year). - 8 kg/person/year of other animal proteins (chicken, pork, beef, duck, etc.)
Small-scale fisheries provide 65-75% of the animal protein requirements of households.	Ahmed et al. 1998	
79% of the animal protein consumed originates from fish.	Israel et al. 2005	Large-scale study (540 households in a northern, a western and a southern province)
On average, 53% of the vegetables consumed are sourced from aquatic plants; the figure reaches 61% among the lower wealth groups.	Israel et al. 2005	
5.2 kg of other aquatic organisms (non-fish) are consumed per person per year.	Hortle et al. 2004a	Other aquatic animals include shrimps, crabs, mollusks, frogs, etc.
4.5 kg of other aquatic organisms (non fish) are consumed per person and per year.	Mogensen 2001	

diversity of resources contribute to them. The gross annual income for these communities is estimated at US\$ 233 million. Of this, home consumption of fisheries products is worth US\$ 13 million and the collection of aquatic plants and animals is worth US\$ 5 million. Yet, there is a stark contrast in income levels among households around the lake. The poorest households, with an annual income of less than US\$ 1,000 make up 72 per cent of all households but capture only about one-third of this total wealth. These households are

engaged mainly in small-scale, subsistence fishing, and they are particularly dependent on the Tonle Sap Lake for their livelihoods. Also, it must be remembered that estimates of direct “consumption” use value focus exclusively on the economic value of the system and ignore the ecological and social values of these resources, as well as the total wetlands ecosystem of the area, which is comprised of lakes, rivers, streams, rice fields, and inundated areas.

**Table 22: Average catch and utilization of fish in Tonle Sap villages (Rab et al. 2006)**

	Average among all villages	
	Open season 2002	Closed season 2003
Total catch (kg)	3 501.0	488.0
Consumption (%)	5.0	12.5
Sold (%)	74.9	73.9
Processed (%)	9.3	1.2
Fish feed (%)	10.8	12.3

### 6.3 Socioeconomic Analyses

The first socioeconomic study of Cambodian fisheries after those of Le Poulain in the forties (Chevey and Le Poulain 1939, 1940; Le Poulain 1942) is that of Ahmed et al. (1998), which surveyed 83 fishing dependent communes in eight provinces of Cambodia and provided a detailed assessment of the socioeconomic status of these communes, particularly fish consumption and the role of fisheries in the local economy. This study showed that fishing was the primary occupation of 10.5 per cent of the households while another 34.1 per cent were engaged part-time in fishing. Several other results originating in this study have been detailed above. The most recent and comprehensive analysis is that of Keskinen (2003), which also focused on the Tonle Sap Lake. The originality of the latter study is that it is based on altitudinal zoning, which actually defines the access of people to open water and the role of aquatic resources versus agriculture in their livelihoods. Both studies focus on an area that produces 60 per cent of the Cambodian inland fish production and includes 1.18 million inhabitants.

In terms of the involvement of households in income-generating activities, Ahmed et al. (1998) found that 90 per cent of the households had access to common property resources, and nearly 80 per cent used big rivers and lakes for fishing and irrigation. Households primarily involved in fishing amounted to 39 per cent, compared to 77 per cent in farming.

In official statistics, however, the 1998 Population Census pretends that only 5.7 per cent of the people living in the Tonle Sap floodplain are involved in fishing. According to Keskinen (2003), this gross underestimation of the importance of fishing is due to the fact that “*the subsistence nature of fishing and wide part-time involvement*

*in it remains unnoticed because statistics simply do not offer tools to include these into their classifications. For example, the Census records only major occupations, secondary or tertiary occupations are not included in it. This kind of simplified approach misrepresents the essence of Cambodian’s subsistence production, where agriculture and fisheries are two tightly intertwined main components”*. The figures proposed by Keskinen are detailed in Table 23:

**Table 23: Proportions of primary and secondary occupations around the Tonle Sap Lake (Keskinen 2003, after Ahmed et al. 1998)**

	Primary occupation	Secondary occupation
Fishing	15.5%	20.0%
Fishing-related activities (fish selling, fish processing, fish culture, fishing-gear making)	1.6%	8.5%

The income of fishing households in the Tonle Sap area was also found to be significantly lower than the income of non-fishing households (Keskinen 2003); this might help explain a negative migration rate in four of the five provinces surrounding the Lake (Haapala 2003).

Rab et al. (2004a, 2006) showed that fish-related activities make up to two-thirds of income in the villages of the Tonle Sap system (Table 24). They also highlighted the fact that households collect on average 2,355 kg of common pool resources per year (mainly aquatic plants and firewood) that have a value of US\$ 132.

The socioeconomic report by the Royal Government of Cambodia (RGC 2001) states: “*There is a strong correlation between sound Natural Resource Management and Poverty Reduction. The plight of poor can be improved by widening their access to*

forest, fisheries, water resources and other public goods, which is critical to improve the living standards of the people living in the Tonle Sap and riparian regions". However, if the productivity of the fishery declines, it will create immediate and tangible social problems for those who obtain part or all of their income from fish.

One of the most interesting attempts to determine the trade-offs inherent to three major national development goals (economic growth, poverty reduction and environmental sustainability) is the WUP-FIN policy model (Varis 2003, Varis and Keskinen 2005). This approach, based on Bayesian networks, allows an analysis of scenarios, with a quantification of the relative impacts of each development goal on 11 factors such as education, urban and rural development, agriculture, fisheries, and conservation. This preliminary approach, which remains to be developed further, led to the following conclusions:

- an "economic growth scenario" contains the highest degree of uncertainties;
- a "conservation scenario" obviously ignores the villages and their development;
- a "poverty reduction scenario" gives relatively good results in all respects; and
- the optimized trade-offs are achieved by an "integrated scenario" that also encompasses additional issues such as institutional development.

## 6.4 Livelihood Analyses

Several of the studies cited above under various headings have addressed livelihood issues. Fishing, fish culture, fish processing, fish selling and fishing gear making are all activities related to fisheries and livelihoods in Cambodia.

McKenny and Tola (2002) provided a summary of the role of fisheries in Cambodian rural livelihoods: fisheries diversify livelihood activities and thereby *insure* against the risk of agricultural failures, provide easy access to income generating activities with very little capital investment and no land, and play a vital role in food security, maintaining and improving nutrition.

Among the studies that explicitly claim to employ a livelihood approach, that of Roudy (2002) detailed community structures and livelihood profiles; community development and resource utilization; natural resource uses; use values; and their unquantified values. Fisheries-based livelihoods are also discussed in a series of STREAM provincial workshops proceedings and localized studies (e.g., STREAM 2001). Israel et al. (2005) substantiated these discussions by showing on a large scale that, in the three provinces studied, 89 per cent of the households harvested aquatic resources for consumption, 76 per cent sold fish and 61 per cent processed it. According to this study, aquatic resources also played a medicinal role for 10 per cent of the respondents (who do not have access to health services), and a

**Table 24: Average annual household income by source type (Rab et al. 2006)**

	Fishing	Fish culture	Fish processing	Fish trade	Farming	Wage income	Govt/ NGO jobs	Small trading	Other	Total
Value (USD)	495.57	207.09	19.74	24.61	230.55	25.11	32.86	51.34	141.87	1 158.5
Percentage	40.30	16.90	1.60	2.00	18.80	2.00	2.70	4.20	11.50	
	Two-thirds				One-fifth		One-fifth			

social and recreational role for 74 per cent of the households (festivals, ceremonies, etc.).

Another project focusing on fisheries-dependent livelihoods (Kaing et al. 2003) demonstrated that Cambodia's fishing-dependent population falls into two distinct groups: those who combine fishing and farming or depend on fishing in the seasonally flooded areas, and those who can afford to buy fishing rights in the fishing lots and employ poor people as workers in industrial-style fishing operations.

The livelihood approach is at the heart of a portfolio of projects funded by the Asian Development Bank (ADB), focusing on the Tonle Sap system<sup>20</sup>. In a detailed study focusing on policy options for the Tonle Sap communities (Agrisystems/CamConsult/MRAG 2004), ADB consultants demonstrated that priorities were different among communities, with those of the flooded areas being most concerned with renewable natural assets, while those in the transition zone focus more on agriculture, irrigation and income diversification. In a similarly complex fashion, fishing lot operators are disliked by all villagers although they offer many employment opportunities, and some villagers desire control over access to resources. The study underlines the fact that, in this floodplain environment, it is not possible to address problems by focusing only on either land-based or fishery-based livelihood assets. Going one step further, Israel et al. (2005) conclude that the success or failure of efforts at improving resource management is dependent on addressing all the dimensions of vulnerability faced by rural households, in particular the lack of basic health services consistently cited as reasons turning families to illegal fishing or destructive resource harvesting.

## 6.5 Impact of Changes on Fisheries in Cambodia

### 6.5.1 Changes in Flow Regime

Habitat and flow variability are widely accepted as major determining factors in the biodiversity of a system, and fish populations may require years to recover from a single extreme habitat event (Hickey and Diaz 1999). According to Starr (2004), very low water levels in 2003 caused the fish catch to decrease by as much as 50 per cent and caused fish prices to double around the Tonle Sap Lake. Observations on the *Dai* fishery for migrating fish in the Tonle Sap River during 1995-2002 indicate that year-to-year variations in maximum Mekong river flood levels strongly affect the yield of this fishery (Van Zalinge et al. 2003; Hurtle et al. 2004b), which is dominated by about 40 per cent of short-lived opportunistic species (Baran et al. 2001c; van Zalinge et al. 2004). Regional developments utilizing the Mekong water, such as irrigation schemes, may lead to lower downstream flood levels and thereby have a negative effect on the fertility of the Tonle Sap system, which appears to depend on high flood levels.

The dramatic impact of dams on fisheries in Cambodia has been illustrated by the Yali dam located in Vietnam on a river flowing down to Cambodia. McKenney (2001) estimated that the erratic flow release of this dam in 1999 resulted in over US\$ 2.5 million in lost income for 3,434 households. On average, livelihood income per household decreased from about US\$ 109 to US\$ 46 per month (-57%). Non-quantified impacts of this dam include deaths and illnesses, livestock losses due to suspected water quality problems, and rarefaction of some natural resources. The Fisheries Office of Ratanakiri Province

<sup>20</sup> See [http://www.adb.org/Projects/Tonle\\_Sap/](http://www.adb.org/Projects/Tonle_Sap/)

(Fisheries Office 2000) as well as Baird et al. (2002) confirmed these impacts while emphasizing the losses in fish catches and water quality, and the total disruption of local livelihoods.

### 6.5.2 Habitat Quality Loss

Although fish stocks are possibly overexploited, a degree of protection is provided by keeping poachers out and preventing large-scale destruction of the flooded forest. The designated fish sanctuaries around the Tonle Sap Lake might provide protection for the fish, even though monitoring of the sanctuaries is inadequate and the location of these sanctuaries probably suboptimal. In non-guarded areas outside the fishing lots, flooded forest coverage is continuously being reduced by cutting, burning, and conversion into rice fields and other crop lands (Jantunen 2004). This causes a loss in biodiversity and a decline in the economic value of these lands that are thought to be of marginal value for agriculture and crucially important for fish production (Van Zalinge 1998a).

Among the threats to fisheries are chemicals that are widely used in and around the Tonle Sap Lake. Sixty-seven per cent of the farmers surveyed used pesticides in 2000 (EJF 2002), with volumes as high as 72 l/ha/year for vegetables, and 1.3 million liters of pesticides were used in the Tonle Sap catchment area (Yang et al. 2001). Many of them are highly hazardous chemicals (including DDT and methyl-parathion) imported from neighboring countries and used indiscriminately, for instance, to harvest fish or to preserve dry fish (FACT 2001; Touch and Todd 2003). Although one study of organochlorine residue levels based on 48 freshwater fishes concluded that Cambodian fishes are among the less contaminated in the region (In et al. 1999), the possible consequences of chemical pollution for the population's health, as well as on the

environment, have never been quantified on a large scale in Cambodia. These possible consequences were detailed in EJF (2002). Considering the ongoing large-scale development of irrigation around the lake, this issue needs to be urgently addressed.

Finally, the concentration of suspended solids has been recently highlighted as important to the productivity of the Mekong waters (Van Zalinge et al. 2003; Sarkkula et al. 2004; Kummu et al. 2005). This often-neglected fact may have a huge impact on the Tonle Sap's fisheries. As more than half of the Mekong's suspended solid load comes from China, this proportion will thus decrease significantly when China has finished building its dams on the Mekong mainstream.

### 6.5.3 Changes in Fishing Patterns

Several commentators on the fisheries in the Tonle Sap believe that the amount of fish in the lake is dramatically decreasing (e.g., Mak 2000; FACT 2001). But there is also strong evidence that fish stocks have not declined; on the contrary, the overall catches at the moment are higher than any time in the past (Baran et al. 2001a; Van Zalinge et al. 2001). According to these researchers, the population has increased much faster than the harvest; as a result, the catch per unit of effort or per fisher is falling, and medium- and large-size species are becoming rare while small opportunistic species (of low market price but high nutritional value) are becoming more abundant.

The causes of the perceived decline are believed to be widespread illegal fishing and overfishing caused by an increasing number of fishers, together with ineffective fishing management by the government. Fishers themselves also state that illegal fishing and overexploitation are the main reasons for the decrease (e.g., Keskinen et al. 2002).

Fishing lots provide an example of changes in fishing patterns and conflicting interests. Fishing lots that are auctioned for exclusive exploitation of fish resources (Van Zalinge et al. 1998b) represent large-scale commercial fishing. In 1996, these fishing lots covered 80 per cent of the Tonle Sap's shoreline (Gum 2000). Following social pressure, 56 per cent of the total area of the private fishing lots was converted in 2000 into open access areas to allow the poor to benefit from the fisheries (Royal Government of Cambodia cited in Keskinen 2003). However, fishing lots are regarded by biologists as a good way to combine exploitation, environmental protection (Chheng 1999), and even biodiversity conservation (Coates et al. 2003). Hence, there is a dilemma between a "*socially unjust*" management system (as the fruits of the resource are captured by a few operators) that somehow contributes to conservation and a "*socially fairer*" open access system that is likely to result in unrestricted exploitation levels and thus jeopardize the resource.

## 7. SOCIALIST REPUBLIC OF VIETNAM

### 7.1 Country Overview

Vietnam is among the most densely populated countries in Southeast Asia, with the highest densities in the Mekong Delta,

which is also the country's most important agricultural area. The Mekong Delta covers 369 million hectares, i.e., about 12 per cent of the whole country.

Vietnam still has a high percentage of its population (32 per cent of the total) living below the national poverty level according to World Bank estimates in 2002. The percentage of child malnutrition is 34 per cent of all children under five years old. Although many are living close to water resources, only 56 per cent of the total population has access to an improved domestic water system. The illiteracy rate is 6 per cent. The percentages of rural population with access to clean water and electricity are as low as 17 per cent and 48 per cent, respectively (Vo et al. 2003).

Agriculture contributed 23.6 per cent to Vietnam's GDP (US\$ 32.7 billion) in 2001. From 1994 to 1997, the fisheries sector contributed about three per cent to the national GDP (Vo et al. 2003). However, Thai (2003) commented that the fisheries sector has developed rapidly and now contributes seven per cent to national GDP. Almost all freshwater body areas are heavily exploited for fisheries. Thus, the number of fishers in the Mekong Delta has increased by 5.3 per cent per year, i.e., faster than in the rest of the country and four times faster than the population growth (Table 26).

**Table 25: Selected economic indicators for Vietnam from 2000 to 2003 (World Bank web site)**

Economic indicator	2000	2001	2002	2003
Agriculture (% of GDP)	24.53	23.24	22.99	
Industry (% of GDP)	36.73	38.13	38.55	
Services (% of GDP)	38.73	38.63	38.46	
GDP (billion US\$)	31.20	32.70	35.10	39.20
GDP growth (%)	6.79	6.89	7.04	7.24
Aid per capita (US\$)	21.42	18.25	15.88	
Population growth (%)	1.29	1.23	1.16	1.10
Population total (millions)	78.5	79.50	80.40	81.30

**Table 26: Number of fishers in Vietnam and in the Mekong Delta in 1990 and 1998 (after Vo et al. 2003)**

Region/ Year	Number of Fishers		% increment per year over 8 years
	1990	1998	
Mekong Delta	314 802	448 564	5.3
Whole Country	1 171 130	1 557 921	4.1

However, this analysis only focuses on professional fishers and does not reflect the importance of fishing as a part-time activity for a very large share of the population of the delta.

With a growing population, Vietnam's water resources are also facing potential shortages. At the moment, 90 per cent of the water is used for agriculture, but industrial and domestic usages are increasing rapidly while food production is at the same time expected to increase in order to meet the demands of the growing population. Vietnam has extensive water resource management structures, especially in the Vietnam Delta. According to statistics from the Water Resources and Hydraulic Works Department, 75 large- and medium-scale irrigation systems, 743 large and medium reservoirs, 1,017 dams, and 4,712 sluices were recorded in 1996.

## 7.2 Economic Valuation Analyses

### 7.2.1 Direct Use Value

#### 7.2.1.1 Catch values

National statistics for the inland provinces of the Mekong Delta, where fisheries are exclusively freshwater and brackishwater, detail the catch and the labor force as shown in Table 27.

However, scientific estimates once again contradict official statistics. On the basis of household consumption surveys that remain controversial, the MRC estimated the total fish production for Tra Vinh Province (Mekong Delta near the sea) alone to be roughly 87,559 tonnes/year, of which 22,971 tonnes/year was from aquaculture and 64,587 tonnes/year from capture fisheries (AMFC 2002). In An Giang, near the Cambodian border, a study in 1999 estimated the annual production at 194,678 tonnes and consumption at 92,202 tonnes/year (Sjorslev 2001b). Jensen (2000) set An Giang total annual production at 180,000 tonnes, and stated that there is reason to believe that the fish catches in the Vietnamese part of the Mekong Delta may be even higher than the total production in Cambodia. Indeed, Phan and Pham (1999) put the catch in An Giang Province at 190.7 kg/person/year (40 per cent of the catch

**Table 27: Inland fish catch and labor force in two provinces of the freshwater area of the delta (General Statistical Office 1999)**

Year	Catch Dong Thap (tonnes)	Catch An Giang (tonnes)	Effort Dong Thap (number of fishers)	Effort An Giang (number of fishers)	Tonnes/man Dong Thap	Tonnes/man An Giang
1995	16 194	68 047	4 853	8 518	3.34	7.99
1996	28 292	72 004	5 109	8 967	5.58	8.03
1997	26 705	74 300	5 989	9 023	4.46	8.23
1998	27 118	76 577	7 092	8 899	3.82	8.61

coming from rice fields and 53 per cent from rivers and canals, with high variability depending upon profession and distance from waterways).

The productivity of Vietnamese inland waters is supplemented by that of reservoirs, acknowledging that most species originate from wild stocks. According to a study done in 1995 and cited in Vo et al. 2003), the average fish productivity of the reservoirs amounts to 24.5 kg/ha/yr. The fish yields of reservoirs depend on nutrients, biomass, and the quality and quantity of stocked fingerlings. In Vietnam, the lowest yield (11.1 kg/ha) is found in large-size reservoirs (over 10,000 ha), middle yield (34.8–48.1 kg/ha) from medium reservoirs (about 10,000 to 1,000 ha) and the highest yield (83.0 kg/ha) from small reservoirs (Ngo and Le 2001). Inland freshwater and brackishwater aquaculture ponds and tanks have 392,000 hectares of production area in Vietnam. However, most of the area is in the form of brackishwater ponds. Van Zalinge et al. (2004) estimated the total production of Mekong Delta aquaculture at 171,600 tonnes in 1999.

#### 7.2.1.2 Consumption values

On the official side, wild and cultured fish account for about 40 per cent of the total

**Table 28: Consumption of rice, fish and meat in the Mekong Delta in 2000 (after Vo Tong Anh et al. 2003)**

	Mekong Delta
Per capita rice consumption (kg/month)	13.37
Per capita fish consumption (kg/month)	2.44
Per capita meat consumption (kg/month)	0.98
Malnutrition rate (%)	42.19

animal protein intake of the population, and the per capita availability of fish has increased from 11.8 kg in 1993 to 15.0 kg in 2000. During 1994–97, the contribution of the fisheries sector to national GDP was about three per cent (Vo et al. 2003)

As mentioned above, scientific assessments at a more local level contradict the estimate of the overall fish consumption in the Vietnamese part of the Lower Mekong Basin, cited at 1,021,700 tonnes annually (Sjorslev 2001a). The average annual consumption of fish in Tra Vinh Province is 58.35 kg/person/year, of which fresh fish accounts for 41.86 kg/person, and fisheries products such as fish paste, dried fish and fermented fish account for 16.49 kg/person. An Giang Province has a very similar consumption figure, 58 kg/person/year, and Long An Province shows a slightly higher figure, 64 kg/person/year. In comparison, the average consumption of other animal products, such as pork, chicken and wildlife, is 35.58 kg/person/year in Tra Vinh.

### 7.3 Socioeconomic Analyses

As is the case with Cambodia, fisheries play a much more important role in food security than in income generation in the Mekong Delta in Vietnam. This is evident in a fisheries household survey (AMFC 2002) that found that, in Tra Vinh Province in 2000, capture fisheries contributed 28 per cent to food supply but only 4.5 per cent to income, after rice farming, gardening and aquaculture. Similarly, in An Giang, rice farming was ranked as the most important activity by 52 per cent of the households while fishing was ranked as most important by 29 per cent, and as second most important by 32 per cent.

Capture fisheries are of particular importance in the livelihoods of poorer people. The Vietnam Living Standard Study indicates



that the poor spend more time on capture fisheries (in rivers, lakes and coastal areas) than on aquaculture in all regions of Vietnam except the South Central Coast (Vo et al. 2003). However, fish production in this region has fallen by 10-15 per cent compared to 20 years ago (Sinh 1995, cited in Vo et al. 2003). Poor knowledge of fishery technology and the use of harmful gears (electric fishing, chemicals, small mesh-size nets, harvesting of breeders, etc.) were among the reasons given for this decline.

#### 7.4 Livelihood Analyses

Aquaculture is very developed in Vietnam, with 407,000 tonnes reported as the national production in 1999. However, there is some indication that intensive aquaculture systems such as coastal shrimp farming have caused inequity (DFID 2000). Capture fisheries remain of considerable importance for both poor and rich rural people in the Mekong Delta, and not only for full-time fishers but also for households in which fishing is a component of wider livelihood strategies. More specifically, Phan and Pham (1999) found that while only three per cent of the 1,002 persons interviewed in An Giang Province were professional fishers, 37 per cent of the people were involved in fish-related activities. According to Sjorslev (2001b), however, in the same province, 7 per cent of the households were involved in professional fishing, 66 per cent in part-time fishing, and a further 5.7 per cent in fish processing and trading. Carl Bro (1996) concluded from a survey of three regions (northern, central and southern) that the majority of surveyed households were involved in some form of fisheries or aquacultural activities. At the national level, Vo et al. (2003) concluded that capture fisheries form an important livelihood strategy for both poor and rich rural people in many parts of Vietnam.

Nho and Guttman (1999) reported from Tay Ninh Province that most households are involved in some form of capture fisheries, but that the importance decreases from poor to rich households. Their study showed that 84 per cent of *low-income* households and 88 per cent of *very low-income* households were involved in fishing, as compared with only 58 and 44 per cent of *medium-income* and *high-income* households, respectively. The livelihood analysis conducted by the WorldFish project "Understanding Livelihoods Dependent on Fisheries" (Sultana et al. 2003b) identified, through Participatory Rural Appraisals, four categories of people who depend on fish for their livelihoods: full-time fishers, part-time fishers, landless subsistence fishers, and fish traders. These groups and their respective dependency upon fisheries resources were detailed, as well as their vulnerabilities, and capital assets. The study showed that inland capture fisheries remain of considerable importance to rural livelihoods in the Mekong Delta. The government actively supports aquaculture development but has tended to ignore inland capture fisheries. In terms of poverty, the wild inland fishery is of greater importance than aquaculture and poor people have tended to become more reliant on wild aquatic resources as a result of growing indebtedness, landlessness and displacement. The study also highlighted the fact that the use of aquatic resources is unsustainable at the current exploitation rate. Capture fish production is declining due to overfishing and use of damaging fishing methods; natural fish habitats and niches in the area have been reduced due to rice farming expansion and intensification; and there is great concern about the direct discharge of effluents and pathogens from factories, hospitals and farms directly into canals and rivers.

## 7.5 Impact of Changes on Fisheries in Vietnam

The major concern in Vietnam is the fact that reduced freshwater flows from the Mekong would allow a larger extension of the brackishwater inland, the saline intrusion being incompatible with intensive rice production. However, the complex and much documented saline intrusion issue is not the subject of this review focusing on fisheries.

The changes in river basin management have similar impacts on fisheries to those detailed for Cambodia. These changes similarly consist of modifications (or obstruction) of the flow regime, loss of habitat and changes in fishing patterns (overfishing). Hashimoto (2001) extensively reviewed the consequences of infrastructure development on the environment of the Mekong Delta. The main negative elements, analyzed in relation to inland fish production, consist of segmentation and reduction of the aquatic habitat by dykes and levees, and the reduction of the flushing effect of the flood. Flushing benefits the habitat and fish production by reducing the level of acidity and aluminum in the area, and by washing away pesticides and pollution accumulated in waterways during the dry season. However, the significant increase in suspended sediment during the flood is detrimental to fish aquaculture production, and sometimes the sudden and large fluctuation in physico-chemical parameters also causes mass mortalities among aquatic animals.

An element specific to Vietnam is the relationship between Mekong River discharge and the productivity of the coastal zone. This positive relationship is clearly demonstrated for most large rivers of the world, particularly in the Northern hemisphere, but it has never been studied in the case of the Mekong River and is surprisingly absent from discussions about the impact of reduced flows, although its importance has been highlighted several

times in the scientific literature focusing on estuarine fisheries, and also during the Second Large Rivers Symposium held in Phnom Penh in 2003.

## 8. CONCLUSIONS

The Greater Mekong inland fisheries are exceptionally important by global standards, with Cambodian fisheries being the most intensive worldwide in terms of catch per person. These aquatic resources are crucial to the income, livelihoods, and subsistence of the population; they not only provide the last resort of security for the poorest people but are also important to wealthier groups of the society. The importance of the fisheries in the Lower Mekong is not, however, reflected in the level of attention paid to it by the scientific community and governments. Aquatic resources suffer a shortfall in research initiatives, and this leads in turn to a lack of recognition of the importance of fisheries to food security and national economies.

Although development and investment opportunities might improve living conditions for the people of the Mekong River Basin, the majority of these people are still living in a rural subsistence economy and depend on the ecological system to supplement rice crops with fish, aquatic animals and plants. Among the multiple threats to Mekong fisheries is the uncontrolled modification of flows, particularly through dams that are coming back in regional energy strategies. Ill-advised flow modifications threaten to disrupt the livelihoods of those who depend on aquatic resources. Such disruption might involve the need to relocate and/or consider alternatives to fishing as a source of income, and none of these options can be achieved in the short-term. If the ecological system suffers from a hasty development process carried out at the expense of the natural resources supply, most fishers or farmers will be unable to cope with a rapid change in their livelihood when they

have neither the education nor the capital to shift to non-rural resource generating options. The most vulnerable would then be left worse off than they are now, with no other choice than migration to urban centers.

Although the value of inland capture fisheries is probably much better documented in the Mekong Basin than in Africa or South America, the accuracy of the data and lack of up-to-date data remain a major gap that must be addressed in order to provide more reliable information and contribute to policymaking processes. Acknowledging the efforts and success of the MRC and other fisheries partners in increasing both knowledge and the political recognition of the importance of fisheries in the Mekong system, much remains to be done to i) accurately value the fisheries and ii) better communicate scientific and monitoring results so that fisheries are properly placed in regional planning and in weighting of development options.

In the face of these various threats to natural resources, what opportunity does aquaculture present to improve security of fish supply? As aquaculture fish represents only 12 per cent of the fish resources basinwide

and cannot grow quickly without extensive use of wild fish fry or the introduction of alien species, the priority for the region should be to protect and optimize the exploitation of a huge natural capital rather than counting on the development of an aquaculture sector dependent on capture fisheries. In Cambodia, for instance, without the supply of wild fish, aquaculture would produce only 15,000 tonnes – just four percent of the fish that people consume.

That is not to say that aquaculture will not have a significant role in the future, but during the coming decade the emphasis should be on protecting the existing wild fish supply: slowing down rarefaction is crucial in order to avoid disruption of the natural food supply to the poor. More generally, sound management of aquatic resources requires a balanced four-fold strategy: improved valuation of natural resources, protection and management of wild resources, aquaculture improvement, and better policies and governance. Without the development and effective implementation of such a strategy, the future of the most intense inland fisheries in the world will be uncertain.

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