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Fishery productivity and its contribution to overall agricultural production in the Lower Mekong River Basin

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Acronyms

CPWF CGIAR	Challenge Program on Water and Food
FAO	United Nations Food and Agriculture Organization
FAOSTAT	FAO Statistical Database
LECS	Lao Expenditure and Consumption Survey
GVP	Gross Value of Production
MRC	Mekong River Commission



Source: Bill Bailey, Wikipedia

Houseboat rafts with cages under for rearing fish. Near My Tho, Mekong Delta, Viet Nam

Executive summary

The Mekong River and its ecosystems have one of the most diverse and abundant fisheries in the world. The fisheries are a major factor in the well-being and livelihoods of the nearly 70 million people especially in the lower Mekong Basin who derive their livelihood from fishery and also depend on fish and other aquatic animals for nutrition and food security.

Fishery production and value have been the subject of many studies and some data are available from national and international statistical databases. None of these, however, offer a reliable, consistent set of data on the spatial and temporal trends at a similar level of resolution across the basin. Because of the shortcomings in the data, there are major uncertainties in estimates of fishery production and its value in the four countries of the lower Mekong Basin: Cambodia, Lao PDR, Thailand and Viet Nam. Catch surveys tend to underestimate the production, while consumption-based estimates are regarded as more reliable indicators.

We combined official statistics with several consumption-based estimates to examine the spatial and temporal trends in production and value of capture fish and aquaculture. The highest estimates of production range from 42 kg/capita/year in the Lao PDR to 65 kg/capita/year in Cambodia, the latter figure being comparable to consumption in Japan. Production is dominated by capture fisheries in Cambodia (where it is concentrated around the Tonle Sap and the Mekong River), Laos and Thailand. In Viet Nam, aquaculture dominates production and is concentrated around the main rivers in the delta and along the coastal strip.

While there are uncertainties in the data, it appears that production until 2005 from capture fisheries has not increased significantly in all the four lower Mekong countries. In aquaculture, there has been a large increase in production in the Mekong Delta region of Viet Nam since about 2000.

The highest estimates of value, using consumption-based estimates of production, mainly from capture fisheries, give an annual value of about US\$3 billion. Other estimates place the overall value somewhat lower.

The value is probably not changing greatly with time. Aquaculture in Viet Nam is rapidly increasing in value, matching the increase in production, and in 2005 was worth over US\$1 billion.

The contribution of the fishing sector to overall agricultural production (crops, livestock and fish) is small in the Lao PDR and Thailand, but larger in Cambodia and growing in Viet Nam.

The demand for fish products will rise in the future, partly as a result of increasing population in the region and partly as a result of increasing incomes. Moreover, there may also be a continuing rise in the export of fish products. The lower Mekong fisheries face threats to production from changed water availability and quality, dams and other barriers affecting fish migration and productivity, and over-fishing. If the increased demand is to be met, these threats must be managed so that production, especially of wild capture fish, does not decline.

The increasing demand appears unlikely to be met through an increase in production of capture fisheries. The current rapid growth of aquaculture, if it can be maintained, does appear capable of meeting the demand. There are neither quantitative estimates of the limits to growth of this industry, however, nor whether it will pose risks for the capture fisheries since aquaculture needs huge quantities of fish fry as feed. Rice-fish farming may also contribute to increased fish production, but again the impact appears not to have been quantified.

1. Introduction

The Mekong River basin is a dynamic, productive, and diverse river basin. Over 70 million people live in the Mekong River Basin (Mekong River Commission, 2006), most of whom are rural poor with livelihoods directly dependent on the availability of water for the production of food. Agriculture, together with fishing and forestry, employs 85% of the people living in the basin, many at subsistence level (Mekong River Commission, 2003). Whilst living standards have generally increased markedly across the basin, there remain important areas of poverty.

The Mekong River and its ecosystems have one of the most diverse and abundant fisheries in the world (Mekong River Commission, 2003). The lower Mekong River ecosystems with its extensive associated floodplains and wetlands supports important inland fisheries (Baran et al., 2007). The fisheries are a major factor in the well-being and livelihoods of the people who live in the lower Mekong Basin (Mekong River Commission, 2005). Some 40 million people or two-thirds of the basin's population are involved in fishing, at least part-time or seasonally. Not only do they derive their livelihood from fishing, they also depend on fish and other aquatic animals for food security (Mekong River Commission, 2003). Fish and other aquatic animals are the most important sources of animal protein, and thus a major support to food security, in particular for the rural population in the lower Mekong Basin (Van Zalinge et al., 2003).

Fishing is important for the basin economics and productivity analysis, particularly for Cambodia and Viet Nam. In the Lao PDR, fish is second only to rice for food security and income (Nguyen-Khoa et al., 2005). However, increasing competition for the use of water resources and high population growth in riparian countries have increased pressure on the distribution of these resources and reduced fisheries production (Chong et al., undated).

There are many studies of the fisheries of the Mekong, but there no precise estimates of the total fishery production (Rab et al., 2005). Moreover, there are no studies on fishery productivity for the whole lower Mekong basin below the country level, or at least none that compare the contribution of this sector to overall agricultural production, and even fewer that give trends, and again, none for the whole of the lower basin. Most of the studies provide aggregated, country-level information for a season or for a year. Few examine to what extent the likely increase in demand for fish in future decades might be met by the basin's fisheries. Furthermore, many estimates in the literature, such as those reviewed recently by Baran et al. (2007), appear to use data only up to 2000, and miss the recent developments in aquaculture.

This working paper analyses the fishery productivity of the basin both spatially and temporally. We compare the contribution of fisheries to the overall agricultural production with those of the crop and the livestock sectors, and we discuss the level of likely future demand and the prospects for the fisheries of the basin to meet the demand.

The remainder of the paper consists of four more sections. In Section 2, we review the available literature and data, including official statistics of production. In Section 3 we discuss the information on fish production and consumption, and the spatial and temporal trends. In Section 4 we review future demand, and the threats to and opportunities for fish production. In Section 5 we draw conclusions.

1.1 A note on definitions: production, productivity and the gross value of production

Production of fish can sometimes mean biological production, i.e. the total biomass of fish and other aquatic animals. More often it refers to the yield, that is the amount of fish removed from a fishery by fishing (Hortle and Bush, 2003). Here we use production in the latter sense, to mean the amount of fish and other aquatic animals removed from a fishery.

Productivity, in general terms, is the ratio between a unit of output and a unit of input. The most encompassing measure of productivity used by economists is total factor productivity, which is defined as the value of all outputs

divided by the value of all inputs. However, partial factor productivity is more widely used by both economists and non-economists alike. Partial factor productivity is relatively easy to measure and is commonly used to measure the return to scarce or limited resources, such as land or labour (Barker et al., 2003).

In case of river fisheries, the total catch is the output, which in principle is well defined and measurable. But there is no defined or measurable input. Production from river fisheries is influenced by a number of factors of which the most important are water level, the duration and timing of the flood, the regulation of flooding, the characteristics of the flooded zone, migration routes, and dry season refuges (Welcomme, 1985; Baran and Cain, 2001). For aquaculture, the inputs such as water, feed, land and labour are well defined and in principle, easy to measure. Due to lack of data, however, we were unable to estimate the water requirements and other inputs for aquaculture production.

In this study, we define fishery productivity as production and gross value of production (GVP) per capita. GVP can be defined as in equation (i):

$$\text{GVP (\$)} = \text{Production of the fishery (tonne)} \times \text{Landing price of fish (\$/tonne)} \quad (i)$$

Fisheries comprise both inland capture fisheries and aquaculture and we have estimated GVP for both. We give all economic data in US dollars.

Generally, we distinguish three domains where river fisheries accrue benefits: economic, social and ecological (Cowx et al., 2003). Total economic value of river fisheries can be divided into the value of direct use and the value of non-use/preservation (Cowx et al., 2003). In this study, we consider only the direct use values of fisheries.



Source: Mohammed Mainuddin

The Lower Mekong River

2. Data sources

There are estimates of fish production in the countries of the lower Mekong Basin in statistical databases and in various reports and papers. The databases give production statistics and often economic information. In the case of Cambodia and Viet Nam, these also give a provincial breakdown of the data. The papers and reports, particularly the more recent ones, tend to use different methods of estimation, and give different and often much higher values of production. They generally have fewer temporal and spatial trend data (usually a single production figure for a whole country for one year), and often give production with less attention to economic data.

There are three main methods to estimate fishery production (Hortle and Bush, 2003):

- catch surveys (catch per fisher multiplied by the number of fishers) may give accurate estimates in fisheries dominated by single species, but in fisheries such as the Mekong, large errors result from the diversity of species, fishers and their gear, and the variability of the fishery temporally and spatially;
- trade and marketing surveys, which are problematic in the Mekong because many fish are consumed locally without being formally marketed and traded may anyway be under-reported;
- habitat and yield surveys (area of habitat multiplied by the yield per area), which suffer from difficulties in measuring the area flooded (an important factor in fish production in the Mekong), the diversity of habitats, and confounding factors such as fishing intensity; and
- consumption surveys, which may be accurate when wild-capture fish are all caught and consumed locally, but which require care in accounting for wastage, imports, exports, and aquaculture production (especially if the latter uses fish from elsewhere as feed).

The statistical databases generally are based on catch surveys, and are thought to ignore much of the production (Coates, 2002; Hortle and Bush, 2003). According to Coates (2002) and Sverdrup-Jensen (2002) existing official statistics on inland fisheries grossly under-report catches, are often not based on field work and may not consider small-scale family fishing since these fisheries have always been considered of minor importance to the national economy. Most large-scale capture fisheries data are also inaccurate (Coates, 2002; Sverdrup-Jensen, 2002). In the case of Cambodia, Coates (2002) shows that data before 1999 are effectively meaningless. Much of the earlier literature was also based on catch surveys, often using the database information. More recent literature is based mainly on consumption surveys (e.g. Hortle, 2007; Hortle and Suntornratana, 2008). This has led to production estimates that are higher than in both the older literature and the statistical databases.

Notwithstanding the difficulties in the available national statistics, they do give information about spatial and temporal trends, and also about economics, which are generally lacking in the published literature. Therefore, aiming to combine the better estimates of the recent literature with other information from the statistics, we present data from both sources, although we stress the difficulties with the statistics. We shall use figures only from 1999 onwards from the national statistics, since figures earlier than that, at least in the case of Cambodia, are meaningless (Coates, 2002). We shall also make two salient points with the national statistics. Firstly, they appear to be the only source of information that demonstrates quantitatively the recent rapid and large expansion of aquaculture in the delta. Also, while there is agreement that they are underestimates of the true production, and probably gross underestimates, even these underestimates point to a food production that is more important than livestock production in the region. In this section, we list both principal sources of data. In the case of the statistical databases, we also describe our methods of analyzing them.

2.1 Literature sources of data

The Fisheries Program of the Mekong River Commission (MRC) is a major source of information. It concentrates on knowledge generation, raising the awareness of fisheries in the Mekong and improving fishery management, particularly promoting community involvement in the management processes. It also has a strong emphasis on implementation, uptake and impact of fishery information into planning and development decisions in the basin (<http://www.mrcmekong.org/programmes/fisheries.htm>). The programme researches into capture fisheries and produces papers, technical reports, development series reports, fishery newsletters and films and Technical Advisory Body management briefs. The papers and reports are available in the MRC website (www.mrcmekong.org) and in 'Fisheries Information in the lower Mekong Basin Version 1' (CD) published by the MRC. We concentrate on the subset of reports and papers that are concerned with aspects of fishery production.

There is no system in the Lower Mekong River Basin for effective collection of basin-wide statistical data on fisheries and therefore very limited data are available on fishery production. To address this, the MRC undertook socio-economic surveys (to estimate production using fish consumption) and catch assessment surveys. According to Van Zalinge (2002), the latest and most comprehensive independent data are largely based on these surveys. More recent reviews include Baran et al., (2007) and Hortle (2007).

Although official production data are generally unreliable, Van Zalinge et al. (2000) made estimates based on official data for the inland capture fisheries for 2000 in the lower Mekong Basin. More recent (consumption-based) estimates include Sverdrup-Jensen (2002), Van Zalinge et al. (2003) (also reported in Hortle and Bush, 2003) and Hortle (2007). Sverdrup-Jensen (2002) and MRC (2005) give estimates of the monetary value of fisheries in the countries of the lower Mekong Basin. Hortle (2007) reviewed estimates for the whole lower Mekong Basin. Phillips (2002) examined aquaculture in all the countries of the Mekong Basin, based on official government statistics and household consumption surveys, and gives the estimated total production and value in 1999/2000.

Apart from those reports that discuss fish production across the lower Mekong Basin, several studies discuss aspects in more detail in the individual countries. Phonvisay et al. (2005) and Bouakhamvongsa et al. (2005) describe fisheries in the Lao PDR in more detail, noting the importance of fish both as sources of food and of income, but give no data on production or economic value. Coates (2002) noted the general difficulty with official statistics in the Lao PDR, describing them as relatively meaningless, and reviewed evidence that the actual production was far higher than the official estimates. Bouakhamvongsa et al. (2005) describe a survey of eighteen typical fishers who recorded their daily catches over one year in 2004. However, the data from this programme has not yet been released. Meusch et al. (2003), in a study aimed primarily at nutrition and health, reported the consumption in the Lao PDR of various food groups including fish. The number of farmers involved in aquaculture in the Lao PDR has increased since then (Phimmachak and Chanthavong, 2005).

Khumsri et al. (2005), Sjorslev (2001) and Hortle and Suntornratana (2008) discussed the importance of fish for households and communities as sources of food and income in the Nam Songkhram Basin in northeast Thailand and Sjorslev et al. (2000) estimated the catch in the basin. Nachaipherm et al. (2002) studied the fishing activities and made a catch assessment of three reservoirs (Nam Oon, Kaeng Lawa and Huai Muk) to obtain data on which to develop management plans. Nakkaew et al. (2001) reported the fishing activities and catch in Huai Luang reservoir in Udon Thani province of northeast Thailand. Prapertchop (1989) reported fish consumption in northeast Thailand, and Coates (2002) reported both average catch per capita and the estimated total production. Mahasarakarm (2007) gave production figures based on consumption estimates, and also noted the value of fisheries in northeast Thailand. Not all fish consumed in the region are from the local production: they are also imported from other regions of Thailand and from Cambodia (often smuggled) (Van Zalinge et al., 2001; Yim and McKenney, 2003a, 2003b, 2003c; Bush, 2004).

Van Zalinge and Touch (1996) and Diep et al. (1998) assessed the Cambodian inland catch based on stratified random sampling of the catch (by species and gear) and provide survey information on fishing gear.

Ahmed et al. (1998) undertook a baseline socio-economic survey of households covering eight fishing provinces around the Tonle Sap Lake during 1995-1996, and provided estimates for the total inland catch of Cambodia. Petracchi (1999a), in a study aimed primarily at nutrition and health, reported the consumption in Cambodia of various food groups including fish. Navy and Bhattarai (2006) evaluated the economic cost, profitability and sustainability of small-scale inland capture fisheries of three selected fishing communities in three provinces of Cambodia. Nam (2000) studied the contribution of inland fisheries to the Cambodian economy. Hortle et al. (2004) also studied the value of the catch, and suggested that both its size and value were underestimated due to poor and incomplete figures.

Lam et al. (2002) carried out a household survey of inland fisheries activities and fish consumption in Tra Vinh province, Viet Nam, as part of the MRC coordinated surveys. Tien et al. (2005) reported a study that monitored the catches of 13 fishers, carried out as a trial over a one-year period from key sites in the Mekong Delta. Kaufmann (2003), in a study aimed primarily at nutrition and health, reported the consumption in the Lao PDR of various food groups including fish.

2.2 Official statistics

2.2.1 Capture-fishery production

As discussed in Data Sources in section 2, there are uncertainties in the production data of capture fisheries published by government agencies of the respective countries, and doubts exist as to their usefulness particularly prior to 1999 in Cambodia (e.g. Coates, 2002). However, they are the only source of information that demonstrates quantitatively the recent rapid and large expansion of aquaculture in the delta. Nevertheless, under-estimates as they may be, they still show that fish are a more important source of food than livestock. We shall therefore present the figures from 1999 onwards, but with a caution that the figures do not represent the true production.

Lao PDR: The Lao PDR has a weak system of statistical data collection, with information based entirely on estimates, which under-reports the catches at village level (Coates, 2002). Historic country-wide freshwater capture-fish production is available in the FAOSTAT database (FAOSTAT, 2007). Household-level data of fish production (in local currency) by province are available in The Lao Expenditure and Consumption Survey (LECS) (National Statistics Centre, 2004b). LECS is the largest and most important survey that the National Statistical Centre undertakes. Its sample size is large, and it also covers a wide range of subjects related to household livelihoods, and is carried out over the whole year. The results in this report are based on data obtained from sample villages and extrapolated to provide an estimate of all households in the Lao PDR.

Thailand: Coates (2002) reports that the statistical survey methods in Thailand ignore rivers and wetlands, and are thus biased towards reservoirs. In addition, even those estimates are likely to underestimate the actual production.

Fresh water capture fish production for the whole country is taken from the FAOSTAT database (FAOSTAT, 2007). The areas of Thailand within the Mekong Basin are only 36% (Mekong River Commission, 2003) of the total country area. In the absence of the data by province, we consider the country average production per capita as equal to the production per capita of the Mekong region of Thailand.

Cambodia: Coates (2002) reports that the collection of statistics in Cambodia is inadequate, with widespread under-reporting. The problem was particularly serious before 1999, after which the extent of the underestimates was reduced, but subsequent estimates are still believed to be significant underestimates.

We used historical production data available by province in the Statistical Yearbook 2005 (National Institute of Statistics, 2005) in the analysis. Freshwater fisheries in Cambodia are organized at three levels: (1) family (subsistence) fishing or small-scale fishing, (2) middle-scale (artisanal) fishing, (3) large-scale (industrial fishing) (Department of Fisheries, 2001a). Family and rice field fisheries were not considered in the official statistics until 1998 (Department of Fisheries, 2001b). Therefore the reported total fish production before 1999 was considerably lower than post-1999.

Viet Nam: Coates (2002) reports that the statistical surveys in Viet Nam are biased strongly towards aquaculture, and mostly under-report capture-fishery production. There are major discrepancies in capture-fishery production figures amongst provinces, with the extremely unlikely reporting in 1999 that one province accounted for 86% of the total national freshwater capture-fish production. According to Tien et al. (2005), official statistics for capture fishery production cover large commercial gear, for which catches may be under-reported.

Viet Nam fisheries production is available from the General Statistical Office of Viet Nam (http://www.gso.gov.vn/default_en.aspx?tabid=469&idmid=3). The database includes different types of fisheries production by province, and the value of their combined output. Fisheries in Viet Nam are divided into two major categories: caught aquatic product and farmed aquatic product. Total fishery production, which is referred to as the total aquatic product, is the sum of caught aquatic product and farmed aquatic product. Caught aquatic product and farmed aquatic product are further classified as follows:

- Caught aquatic product = Caught fish from sea + Caught other aquatic product from sea + Inland catch (fish and others)
- Farmed aquatic product = Farmed fish + Shrimp + Others (other than fish and shrimp)

Cambodia, the Lao PDR and Thailand do not have any coastal provinces within the Mekong River Basin. Therefore, for cross-country comparison of the indicators, we did not consider the capture marine fisheries (fish and other aquatic products caught from the sea) of Viet Nam for the main analysis. However, we shall discuss separately the contribution of marine fisheries to the overall production.

2.2.2 Aquaculture production

Lao PDR: Few data are available on the farmed fish or aquaculture in the Lao PDR. Nonetheless, there are aquaculture farms as a large number of cultured fish are sold in the markets in Vientiane from aquaculture farms close to the city or imported from Thailand (Phonvisay et al., 2005). Data on the number of agricultural holdings engaged in aquaculture according to the first agricultural census undertaken in the Lao PDR in 1998/99 (<http://www.maf.gov.la/Census/Aquaculture/aquaculture.html>). No other data are available on aquaculture production in the Lao PDR. In the productivity analysis, therefore, we did not consider aquaculture production.

Thailand: Aquaculture in Thailand is very well developed. However, data on production were not available at the time when the analysis was done.

Cambodia: In the analysis, we used historical production data, which are available by province in the Statistical Yearbook 2005 (National Institute of Statistics, 2005). Presently, small-scale aquaculture is being developed rapidly in Cambodia (Ngeth et al., 2005).

Viet Nam: We considered aquaculture production in Viet Nam as the farmed aquatic products available in the website of the General Statistical Office (http://www.gso.gov.vn/default_en.aspx?tabid=469&idmid=3).

2.2.3 Fish price

We used fish price estimates to calculate the economic value (gross value of production) from the fish production data, where the gross value of production was not given directly in the data we consulted.

Lao PDR: the National Statistical Centre of the Lao PDR publishes market price of fresh and fermented fish with the price of other commodities in the Statistical Yearbook (National Statistics Centre, 2003, 2004a and 2005).

There has never been a full study of fish marketing in the Lao PDR (Phonvisay, 2001). Phonvisay (2001) conducted an initial fish marketing survey in Thongkhankham and Thatluang markets, but it was only done for one day, and was generalized. Phonvisay (2003) further studied fish marketing operations in Luang Prabang

Province, but again, this was just a snapshot survey. Phonvisay et al. (2005) later tried a more systematic approach by monitoring fish sales at the three markets in Vientiane and Luang Prabang in 2004.

For the economic analysis of fisheries, we considered the landing price of fish, not the retail market price. In estimating the total value of fisheries based on the FAO production data, we used the following assumptions:

- The average of the 8 provinces as described in the Statistical Yearbook published by the National Statistical Centre of Lao PDR;
- The retail or market price is 50% higher than the landing price (Van Zalinge 2002);
- The landing price given by the National Statistics Centre; and
- The price in 1999 was the same as that in 2000.

Thailand: Fish Marketing Organization of Thailand monitors the freshwater fish prices auctioned at the Bangkok fish market. These data are available in the Statistical Yearbooks published by the Office of the Agricultural Economics of the Ministry of Agriculture and Cooperative of the Royal Thai Government <http://www.oae.go.th/English/statE.htm>. We considered the average price of the common fish species in the markets (snakehead, cat fish, white spotted fish, swamp eel, climbing perch, carp and cat fish) in the analysis.

Cambodia: Unlike the production data, there are no data on fish prices in the Statistical Year Books. Official statistics on average monthly market (retail) price of capture fish is available only in a report (Department of Fisheries, 2001a) published by the Department of Fisheries from January 1996 to June 2000. Some more information on fish price is available in different published papers as shown in Table 1.

Table 1: Source of capture fish price in Cambodia

Source	Description
Ngor et al. (2005)	Price of dai trey linh (bag-net or stationary trawl fishery) fishery on the Tonle Touch (Touch River) during the 2003 season.
Rab et al. (2006)	Landing price of capture fish in Kampong Chhnang, Kandal, Phnom Penh and Siem Reap provinces for the closed season of 2003 (August 2003) and open season of 2004 (February 2004) (see Box 1).
Khay and Hortle (2003)	Open season retail price in Phnom Penh market in 2003.
Naret et al. (2000)	Landing price of fish in Kandal, Takeo and Prey Veng provinces for 1999.
Pengbun et al. (2005)	Landing price of 2003 in Prey Veng province

Box 1. Season of operation

The fishing calendar in Cambodia is divided into two seasons: open (October-May) and closed (June-September). The small-scale fishing is allowed at all times of the year, but some with restrictions imposed, mainly on fishing types and gears. In contrast, middle and large-scale fishing are allowed only in the open season and require licenses issued by the Department of Fisheries (DoF, 2001a).

Fish prices in Cambodia vary from season to season. All species sell for a higher price in the closed season from June to September than the open season (Rab et al., 2006). Among the species, larger species are generally more valuable than the smaller species (Ngor et al., 2005). However, in estimating gross value of production we used the average annual price. Using the data from all these sources, we estimated the average fish price by province based on the following assumptions:

- The landing price of capture fisheries in 2000 were estimated from the average price from Department of Fisheries (2001a), taking the retail or market price as 50% higher than the landing price (Van Zalinge 2002). Van Zalinge (2002) estimated the landing price of fish in Cambodia as \$200 million and the retail price as \$300 million i.e. the retail price is 50% higher than the landing price;
- The price is same in all the provinces;
- The landing price of fish in Kandal, Takeo and Prey Veng provinces for 1999 was assumed to be the same as that in Naret et al. (2000). The price in the remaining provinces was considered as the average of the prices available;
- The landing price for 2003 and 2004 in Kompong Chhnang, Kompong Thom, Siem Reap and Pursat provinces was taken from Rab et al. (2006). The price in Banteay Meanchey, Battambang, Oudor Meanchey and Krong Pailin provinces were considered the same as that in Siem Reap. The price in Kampot, Takeo, and Prey Veng provinces were considered the same as that in Phnom Penh. The price in Kompong Cham was considered to be the average of that in Kompong Chhnang and Phnom Penh. The price in the remaining provinces was considered to be average of that in Kompong Chhnang and Siem Reap; and
- The price in 2002 was considered equal to the average of the 2001 and 2003 prices.

Viet Nam: Details of fish production and output value of fishing are available in the website of the General Statistical Office of Viet Nam. No fish price data are directly available in that site. However, our purpose is to review the total value, so we use the total value data directly.

2.2.4 Population

The sources of the provincial population of the countries used in the analysis are given in Table 2.

Table 2: Sources for provincial population data used in the analysis

Country	Source
Lao PDR	National Statistics Centre (National Statistics Centre, 2003, 2004a, and 2005)
Cambodia	Provincial population of 1998: Cambodian Government website (http://www.cambodia.gov.kh/unisql1/egov/english/organ.admin.html) Provincial population of 2001: Fertilizer Advisory, Development and Information Network for Asia and the Pacific (FADINAP) website (http://www.fadinap.org/cambodia/Agstat20002001/population.htm) Provincial population growth rate: Ministry of Agriculture, Forestry and Fisheries of Cambodia (http://www.maff.gov.kh/statistics/index.html)
Thailand	Provincial population for 1990 and 2000 and the growth rate: National Statistical Office of Thailand (http://web.nso.go.th/pop2000/table/tab2.pdf)
Viet Nam	Yearly provincial population: General Statistical Office of Viet Nam (http://www.gso.gov.vn)

The population of Cambodia and Thailand for other years was estimated from the available data using equation (ii), which is used by the National Statistical Office of Thailand.

$$r = \frac{\ln(P_{n+t} / P_n)}{t} * 100 \quad (\text{ii})$$

Where,

r = Population growth rate (percent per year)

P_n = Population in year n

P_{n+t} = Population in year $n + t$

2.2.5 Currency exchange rates

The source of currency conversions to US\$ used in the analysis is given in Table 3.

Table 3: Sources for currency conversions to US\$ used in the analysis

Country	Unit	Source
Cambodia	Riel	The General Statistical Office of Viet Nam (http://www.gso.gov.vn/default_en.aspx?tabid=491)
Lao PDR	Kip	
Thailand	Baht	http://fx.sauder.ubc.ca/etc/USDpages.pdf
Viet Nam	Dong	The Economic and Social Commission for Asia and the Pacific of the United Nations (UNESCAP) (http://www.unescap.org/stat/data/statind/datatable.aspx) and from: http://en.wikipedia.org/wiki/List_of_historical_exchange_rates#Table http://www.jeico.com/cnc57vtn.html

2.2.6 Crop and livestock productivity

We compared the fisheries productivity with the productivity of crops and livestock to see the relative contribution of different sectors to overall agricultural production at the country level. Mainuddin et al. (2008) estimated detail crop and livestock productivity by province for the lower Mekong Basin. We used the results from that report to compare with the fishery productivity.

2.3 Concluding remarks

There are many methods of estimating fishery production based on catch surveys, consumption surveys, trade and marketing surveys, and estimates of production per unit area of different water bodies. In the lower Mekong Basin, national statistics, which are generally based on local assessment and reporting of catches, have been shown to be gross underestimates of the true production and often biased towards some fishing sectors, such as reservoir catch in Thailand and aquaculture in Viet Nam. Coates (2002) reported in 1999 that the ratio of the best estimate to the officially reported value was 1.25-1.86 in Cambodia, 5.9-7.8 in the Lao PDR, 0.5-1.4 in Thailand and 8.0-10.6 in Viet Nam. Cambodia corrected the fisheries production after 1998 with better reporting and by including the small-scale fisheries.

The better estimates based on consumption surveys are, unfortunately, available mainly based on surveys in 2000 only, and trends in production cannot be gauged from this information alone. The situation is highly unsatisfactory. On the one hand, the trend information, the only information consistently available at province level, is highly dubious. On the other hand, the only information regarded as reasonably reliable contains little trend or spatial content.

Faced with this highly unsatisfactory situation, we have elected to consider both main sources of information, the national statistics (but only from 1999 onwards), and the literature-based consumption surveys. We suggest that, notwithstanding the highly dubious nature of the national statistics, one or two observations emerge from them that are much harder to discern from the literature of consumption surveys, in particular the recent rapid rise of aquaculture in the delta.

The final key point to emerge simply from a survey of the methods (without even considering the data) is that the estimation of production and its trend is an area in urgent need of more frequent surveys and better data. Fishery management and policy will both benefit from increased effort.

3. Results and discussion

In this section, we discuss the price, production and gross value of production by country, and compare the fishery sector to the crop and livestock sectors. We then compare the productivity amongst the different countries of the lower Mekong Basin.

3.1 Fish price, production and gross value of production in the Lao PDR

Market price of fresh fish, according to the national statistics, is presented in Table 4. Though it looks like the price of fish rose more than tenfold from 1995 to 2000 in local currency, but in dollar terms, the price fell by about 35% between 1995 and 2000 and remained fairly stable since. The change in price in kip reflected inflation of the currency.

Table 4: Market price of fresh fish in the Lao PDR, average of eight provinces

Year	1990	1995	2000	2001	2002	2003	2004
Price, kip/kg	707.8	804.7	7887.6	8954.6	10056.3	10569	10585.5
Price, \$/kg	2.67	3.24	2.09	1.87	1.78	1.78	2.01

Source: National Statistics Centre, 2003, 2004a, 2005

Phonvisay et al. (2005) aimed at a systematic approach to check fish price by monitoring of fish sales at the three markets in Vientiane and Luang Prabang in 2004. A summary of the data collected during a five-day survey on the sale of fish in main markets in Vientiane from January 12 to 16, 2004 and in Luang Prabang from 2 to 6 March 2004 is given in Table 5. The survey carried out by Phonvisay et al. (2005) also found that fresh fish from aquaculture were considerably more important in the urban markets than wild captured fish from rural areas and the Mekong River. However, wild captured fish are still preferred to cultured fish, as is shown by the higher price of these fish in urban markets (Phonvisay et al. 2005).

Table 5: Fish price in the markets of Vientiane and Luang Prabang

Province	Market	Price, \$/kg
Vientiane	Thongkhankham	1.6
	Thatluang	1.4
Luang Prabang	Luang Prabang	1.4

Source: Phonvisay et al., 2005



Basa fish, Vinh Long market, Viet Nam

Source: Wikipedia

Noting again that the national statistics for production are very doubtful and very likely a gross underestimate, we show in Table 6 the production and GVP per capita for the Lao PDR since 1999 from the FAOSTAT database. The apparent decrease in the gross value of production per capita is mainly because of increase in population while the production remained static and a decrease in fish price in US dollar (Table 6).

Table 6: Production and GVP of capture fisheries in Laos according to FAOSTAT (2007)

Year	Production	Production value	Production per capita	Gross value of production per capita
	<i>tonne</i>	<i>million \$</i>	<i>kg/capita</i>	<i>\$/capita</i>
1999	30041	41.82	5.90	8.22
2000	29250	40.72	5.60	7.80
2001	31000	38.57	5.77	7.17
2002	33440	39.77	6.05	7.20
2003	29800	35.36	5.25	6.23
2004	29800	39.92	5.11	6.84

According to the National Statistics Centre (2004b), the total production value of fisheries for the Lao PDR for 2002-03 was \$63 million. The country average per capita production was about \$12.0, and ranges from \$27.33 per capita in Borikhamxay province to \$6.71 per capita in Luang Prabang province (Table 7). Given the uncertainties in estimates, these values broadly agree with those in the FAOSTAT database given above. Baran et al (2007) gave a range of estimates from \$48 million to \$100 million.

Table 7: Production of fisheries by province based on the LECS survey (2002-03)

Province	Value of production	No of households	Household size	Total value of production	Production value
	<i>\$/household</i>	<i>thousands</i>		<i>million \$</i>	<i>\$/capita</i>
Phongsaly	52.6	25	6.5	1.32	8.09
Luangnamtha	45.8	23	6.0	1.05	7.64
Oudomaxy	53.1	38	6.5	2.02	8.17
Bokeo	82.4	25	5.4	2.06	15.27
Luang Prabang	42.3	61	6.3	2.58	6.71
Huaphanh	71.1	37	7.3	2.63	9.74
Xayaboury	65.3	58	5.6	3.79	11.67
Vientiane Capital	43.3	111	5.7	4.80	7.59
Xiengkhuang	59.9	30	7.4	1.80	8.09
Vientiane Province	80.6	62	5.9	5.00	13.67
Borikhamxay	153.0	38	5.6	5.82	27.33
Khammuane	124.7	55	5.8	6.86	21.50
Savannakhet	80.2	122	6.3	9.79	12.74
Xaysomboon SR	75.7	6	5.8	0.45	13.05
Saravane	46.6	51	6.0	2.38	7.77
Sekong	46.3	12	6.4	0.56	7.24
Champasack	78.2	97	5.9	7.58	13.25
Attapeu	121.4	17	5.9	2.06	20.58
Lao PDR	72.8	868	6.1	62.54	11.93

Recent consumption-based estimates yield much larger values ranging from 10 to 44 kg/person/year, with a probable best estimate of about 30 kg/person/year (Hortle, 2007). The upper figures give much higher estimates of total fish production of around 183,000 tonnes/year (Hortle and Bush, 2003; Van Zalinge et al., 2003). Baran et al. (2007) review estimates range from about 70,000 to 204,000 tonnes/year. Hortle (2007) also gives an estimate of about 208,000 tonnes/year. The gross value of production implied by the higher estimates is perhaps about \$200 million per year. On the other hand, FAO (2003) consumption estimates undertaken for health and nutrition surveys give values of about 10 kg/person/year, although this may be an underestimate (Dyg, 2006) on which we shall comment further below (Section 3.5).

Figure 1 shows the comparison of gross value of production (GVP) for agriculture and livestock with the GVP from fisheries using both the lowest estimates from the national statistics and the highest estimate from the literature. The GVP from cropping has gradually increased over the last 5 years, while the contribution from livestock remains static. The contribution from fisheries is, according to the lowest, national figures, at least as important as that from livestock, and seemingly static. The upper figures put the contribution from fisheries as several times that of livestock and as more important than most crops other than rice, with which it was roughly equal in 2000 (Figure 2).

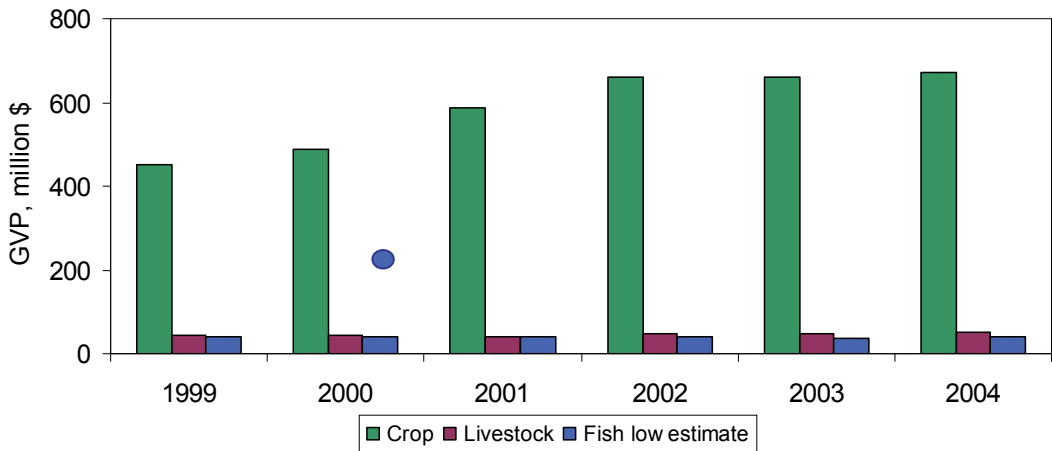


Figure 1: Contribution of different sectors to overall production in the Lao PDR. The low fish estimate are data from FAOSTAT (2007) (Table 6) and the dark blue point is from Van Zalinge et al. (2003)

Figure 2 shows the GVP per capita of inland fisheries compared with rice, other crops, and livestock. There is a significant increase in per capita income from other crops while all the other sectors remained static or declined. The GVP per capita from capture fisheries is about 15% of the GVP from rice in recent years, and is similar to that from livestock.

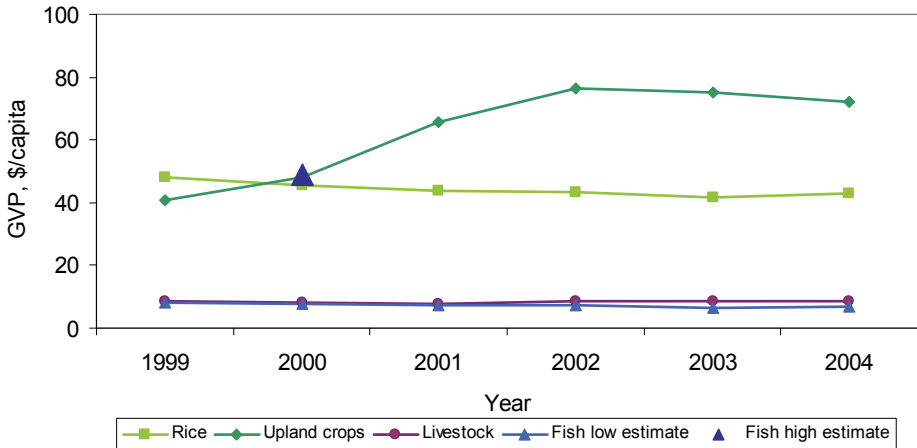


Figure 2: Comparison of GVP per capita of different production sectors of the Lao PDR. The low fish estimate is from FAOSTAT (2007) (Table 6) and the high fish estimate is from Van Zalinge et al. (2003)

3.2 Fish price, production and GVP in Thailand

The official Statistical Yearbook published by the Office of the Agricultural Economics gives the price of fish in Bangkok (Table 8).

Table 8: Average price of fish in the Bangkok auction market

Year	1999	2000	2001	2002	2003	2004
Price, baht/kg	41.9	41.1	41.5	41.5	40.7	40.7

Noting again that the national statistics for production are very doubtful and very likely a gross underestimate, we show in Table 9 the production and GVP per capita for Thailand since 1999 from the FAOSTAT database. Production and GVP per capita were available only for the whole country. This leads to difficulties in interpreting the production in the Mekong Basin part of Thailand.

Table 9: Production of freshwater capture fisheries of Thailand, from FAOSTAT (2007)

Year	Production	Price,	Gross value of production,	Production,	GVP
	<i>tonne</i>	<i>\$/kg</i>	<i>million \$</i>	<i>kg/capita</i>	<i>\$/capita</i>
1999	206434	1.11	228.5	3.44	3.81
2000	201205	1.03	206.4	3.32	3.41
2001	202200	0.93	188.9	3.30	3.08
2002	198200	0.97	191.5	3.20	3.09
2003	197493	0.98	193.6	3.15	3.09
2004	202600	1.01	204.8	3.20	3.24

Prapertchop (1989) reported a registered production in northeast Thailand of 59,000 tonnes, but gave a consumption-based estimate of 322,000 tonnes, or 5-6 times the production estimate. As with the Lao PDR, we see a consumption-based estimate that is far higher than the official production figures.

Other estimates include: Coates (2002) - annual production of 200,000 to 500,000 tonnes based on an average catch of 20 to 50 kg per capita per year by 10 million rural people; Van Zalinge et al. (2003) - 932,300 tonnes, based on per capita consumption of 52.7 kg; Mahasarakarm (2007) - 795,000 tonnes, based on per capita consumption of 30-35 kg. FAOSTAT (2007) gives the consumption in Thailand of about 30 kg/person/year, showing little change from 1995 to 2005, though the figure is for the whole of Thailand, and includes marine products.

At a conservative first sale price, of about \$1/kg, the freshwater fisheries (both capture fisheries and aquaculture) of the Mekong in Thailand are worth about \$700 million per year (Mahasarakarm, 2007). Not all the fish consumed in the region are from local production, but are also imported from other regions of Thailand and smuggled from Cambodia (Van Zalinge et al., 2001).

Figure 3 compares the GVP of freshwater capture fisheries production from 1999 with the GVP of crop and livestock for the Mekong part of Thailand. The GVP of capture fisheries for the whole of Thailand, based on the lower national statistics was less than that of livestock from the Mekong Basin areas alone. However, this estimate is both a gross underestimate and leaves out much of the fishery resource (in particular, rivers and aquaculture). The larger, more recent estimates of production in 2000 (see section 2.1.2) of between about 500,000 and 900,000 tonnes for the Thai Mekong capture fishery, and a first-sale price of about \$1/kg, gives a much larger GVP of between about \$500 and

\$900 million. With this estimate, the capture fisheries sector in the Mekong Basin in Thailand in terms of GVP is larger than the livestock sector, and perhaps about 20–40 % that of the crop sector.

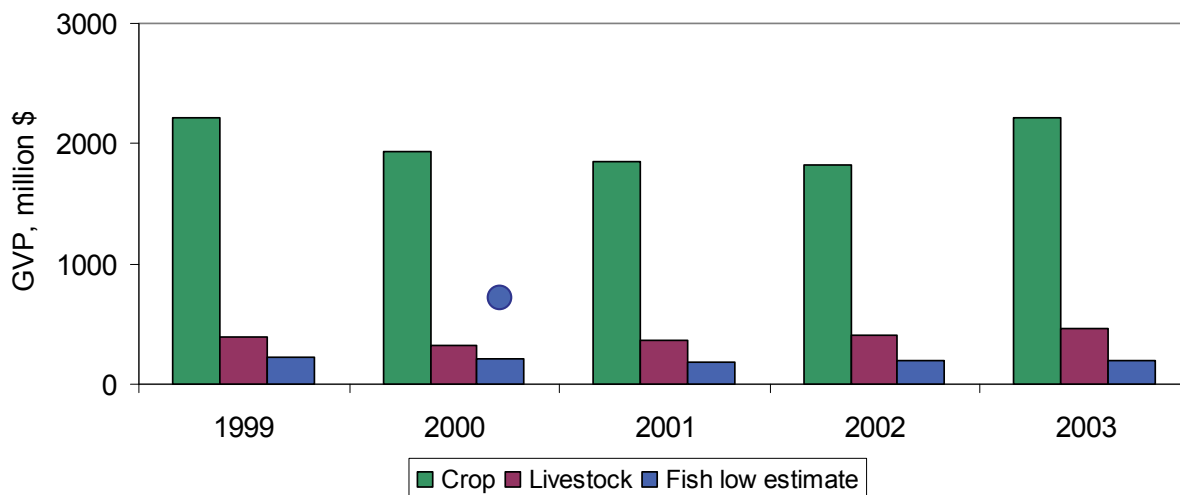


Figure 3: GVP from different sectors of Thailand. GVP of crop and livestock in this figure is for the Mekong part of Thailand whereas the GVP of capture fisheries is for the whole of Thailand. The low fish estimate is from FAOSTAT (2007) and the high fish estimate (dark blue point) is from Van Zalinge et al. (2003)

Figure 4 compares the GVP per capita of different sectors of Thailand. The higher recent estimates of fishery production lead to a GVP for fisheries greater than that of other crops, and a little less than that of rice. The higher estimate for 2000 is plotted on Figure 4.

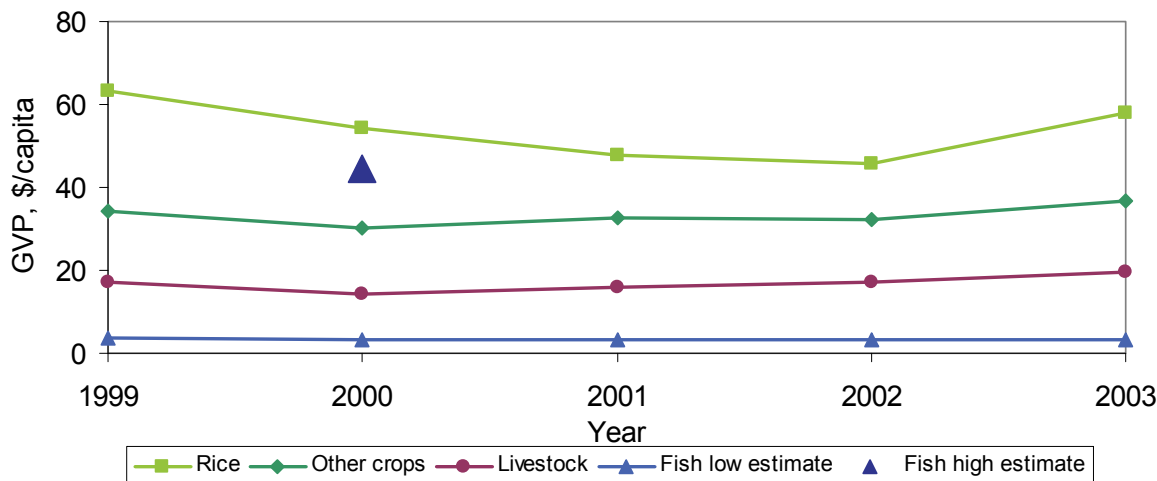


Figure 4: Comparison of GVP per capita of different production sectors of Thailand. Shows the low fish estimate from FAOSTAT (2007) and the high fish estimate from Van Zalinge et al. (2003)

Aquaculture has expanded significantly over the past 10 years in northeast Thailand (Phillips, 2002). Fish culture in ponds, rice fields, ditches and cages contributed over 38,000 tonnes in 1998 (Department of Fisheries, 2001a). Phillips (2002) argues that these statistics underestimate the contribution made by the large numbers of small-scale producers.

There may be more than 200,000 households involved in small-scale aquaculture and annual production from these small scale households is estimated as 30,000 tonnes or more (Phillips, 2002). The total production comes to about 68,000 tonnes per year.

3.3 Fish price, production and GVP in Cambodia

Several studies surveyed the price of fish in Cambodia (section 2.2.3). Hortle et al., (2004) reported the average price of fish as \$0.75/kg. Other studies note that the price in Cambodia varies from season to season, and Figure 5 shows figures from Department of Fisheries (2001a).

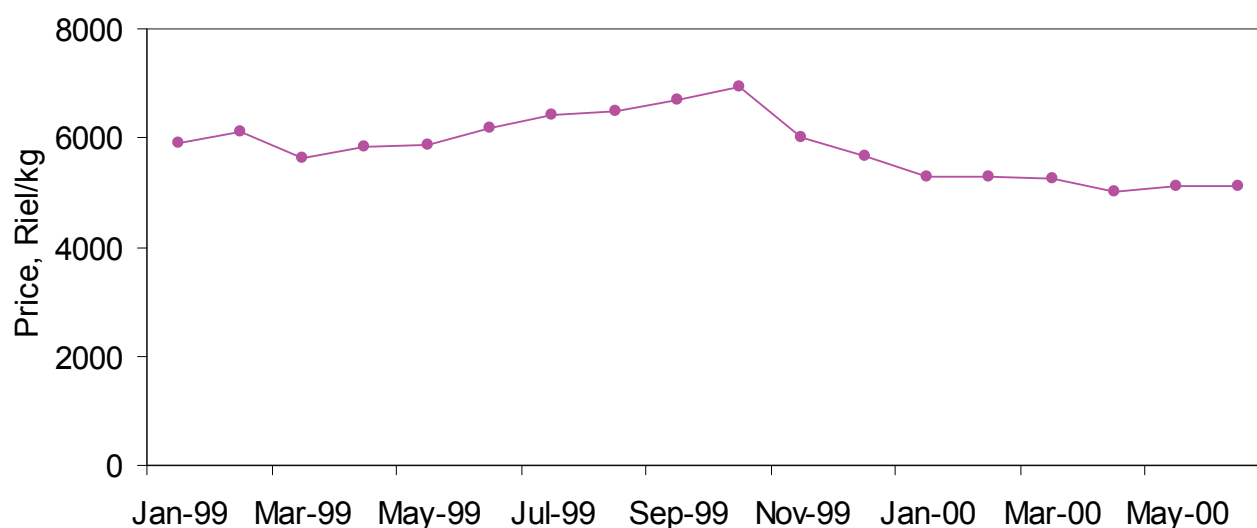


Figure 5: Monthly average catch fish price for Cambodia. Constructed using the data available in Department of Fisheries (2001a)

As with the Lao PDR and Thailand, the official statistics seriously underestimate fish production. Referring to data from 1999 onwards, Coates (2002) reports that the official recorded production was about 230,000 tonnes in 1999 (a large increase on the meaningless figures of earlier years, brought about by improved surveys), but the data available from the official websites show this jump to the higher figure only in 2002.

Other estimates of fishery production range from similar to higher than the official statistics in recent years. These include: Van Zalinge and Touch (1996) and Diep et al. (1998) - 255,000 to 380,000 tonnes; Van Zalinge (2002) - 400,000 tonnes in 2000, which was still believed to be an under-estimate, and of which the Tonle Sap annual catch was about 235,000 tonnes; Ahmed et al. (1998) - between 290,000 tonnes to 430,000 tonnes; Van Zalinge et al. (2003) - about 680,000 tonnes for 2000; Hortle (2007) - 590,000 tonnes. This estimate of Van Zalinge et al. (2003) assumes consumption (all fish products) at about 65 kg/person/year, which is within the range given by Hortle and Bush (2003). A lower estimate of consumption, of about 10 kg/person/year was given by Petracchi (1999a), based on health and nutrition surveys, but this figure is now superseded by FAOSTAT (2007) which gives consumption that varies from 17 to 29 kg/person/year for 1990-1998 and from 49 to 80 kg/person/year for 1999-2005. Although this includes all fish over all of Cambodia, it is reasonable to suppose the figure is dominated by the Mekong region and so may be taken as a broad indication of consumption of Mekong fish. Thus, the FAO figures, like other figures, have been revised upwards in recent years, by a factor of between 2 and 3 in the late 1990s. The recent figures broadly agree with those given by Van Zalinge et al. (2003).

Estimates of GVP show a similar range, with upward revisions in recent years, and include: Van Zalinge et al. (1998) - between \$130 to 200 million at the landing sites; Jensen (2000a, 2000b) - \$150-200 million, increasing in the market chain to \$250-500 million; Van Zalinge (2002) - \$300 million; Hortle et al. (2004) - \$300 million, probably all under-estimates. The official statistics give the monetary value of the total fish catch as between \$250-300 million in recent years, and the contribution of the fishery sector as 8% to 10% of the total national GDP of \$2,800 million. According to Nam (2000), the contribution of inland fisheries ranges from 5-7% to 9-18% of the total national GDP

of \$2,800 million. Van Zalinge et al. (2003) did not give a figure for the value of fisheries, but implied the total value to be about \$500 m.

Figure 6 shows the comparison of GVP for agriculture and livestock and the GVP from fisheries using both the lowest estimates from the national statistics and the highest estimate of Van Zalinge et al. (2003). The GVP from crop cultivation shows an increasing trend, while the contribution from livestock has decreased up to 2001 and increased to the level of 1999 in 2003. The contribution from fisheries is, according to the lowest, national figures, more important in recent years than that from livestock. The upper figures put the contribution from fisheries as several times that of livestock and as more important than most crops other than rice, with which it was roughly equal in 2000 (Figure 7).

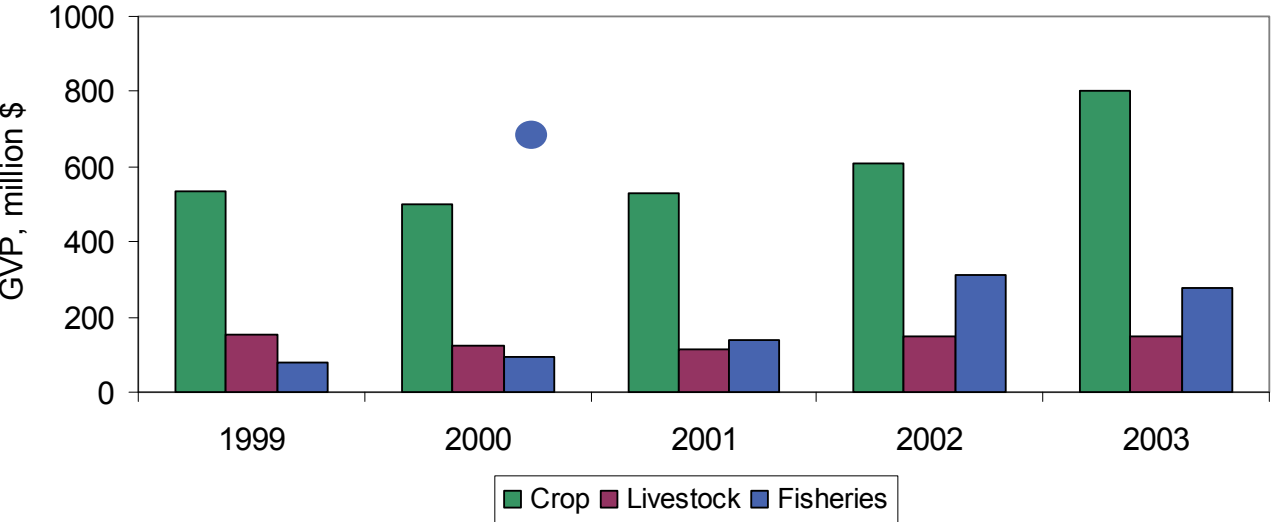


Figure 6: Contribution of different sectors to the overall agricultural production of Cambodia. The blue point is the high estimate of Van Zalinge et al. (2003)

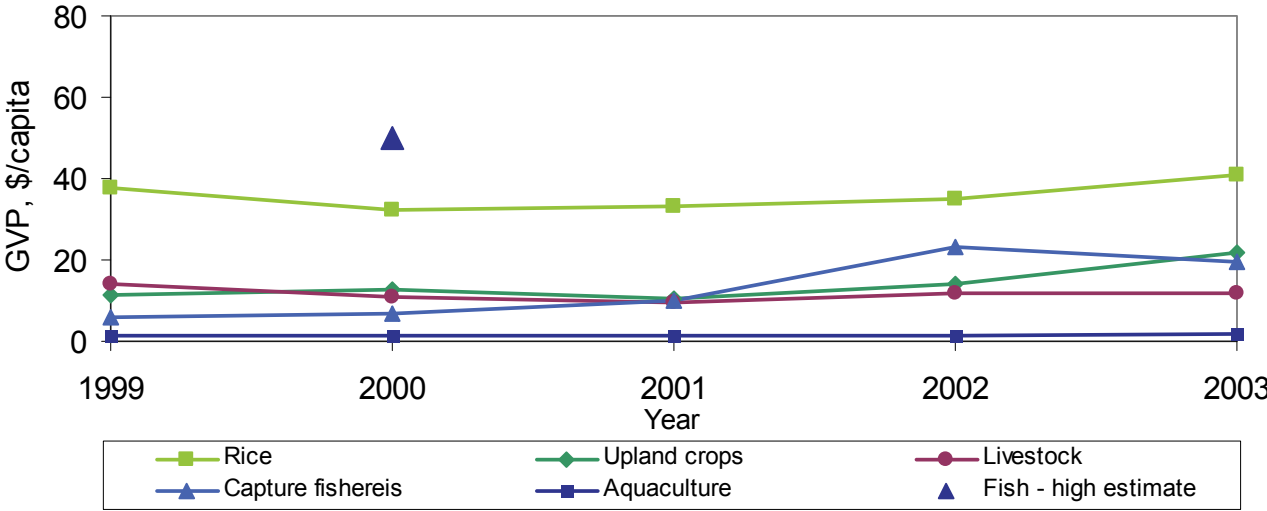


Figure 7: Comparison of GVP per capita of different production sectors of Cambodia

The official statistics show the GVP of aquaculture production of Cambodia has increased from \$9 million in 1993 to about \$25 million in 2004. Phillip (2002) estimated the value of inland aquaculture production for Cambodia at \$17.2 million from 14,100 tonne of production for 1998. This gives the average price as \$1.22/kg. Sverdrup-Jensen (2002) considered the average price of aquaculture as \$1.05/kg. We used the price reported by Phillip (2002) for all the provinces and for all years to estimate the gross value of aquaculture production.

3.4 Fish price, production and GVP in Viet Nam

Fish production in the Mekong areas of Viet Nam is mainly in the Mekong Delta, where both capture fisheries and aquaculture are important.

The price of caught and farmed aquatic products in Viet Nam is not given in official statistics, but may be estimated by the total output value by the total production. The average price so estimated is given in Table 10.

Table 10: Average fish prices in Viet Nam

Year	Price of caught aquatic product <i>million dong/tonne</i>	Price of farmed aquatic product <i>million dong/tonne</i>
1999	8.29	11.66
2000	8.37	13.36
2001	8.22	15.75
2002	8.04	15.51
2003	7.95	15.79
2004	7.93	15.84
2005	7.96	15.80

As with the other countries, the official statistics underestimate production and are biased towards aquaculture (Coates, 2002). Figure 8 shows the officially-recorded overall production in Viet Nam. Being located along the coastline, the Mekong Delta of Viet Nam also has marine fisheries, called “people’s fisheries”, which develop spontaneously (Research Institute for Marine Fisheries, 2006). Its annual contribution to the total GDP has been increasing from 1.7% in 1985 to 4% in 2004 (Research Institute for Marine Fisheries, 2006). The Mekong Delta is one of the major sources of marine fisheries in Viet Nam (Figure 8). In 1999 it was the most important part of the fishery, but by 2005 marine production had, according to official statistics, been superseded by that of the rapidly growing aquaculture sector. FAO (2008) gives a total (shrimp plus freshwater catfish) production of about 600,000 tonnes in the delta in 2004.

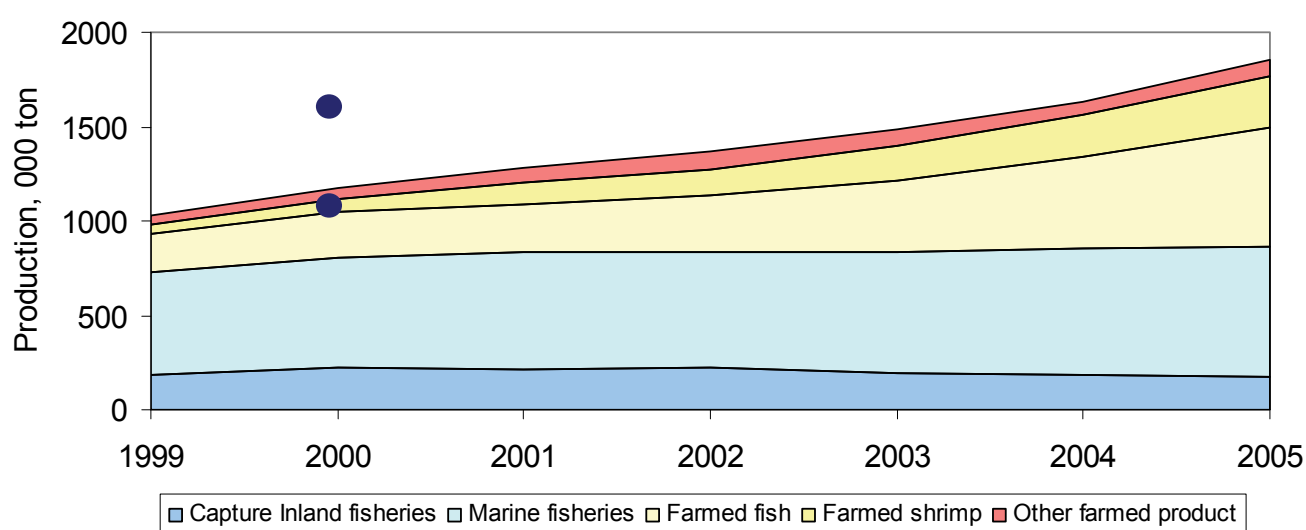


Figure 8: Production from the different fisheries sectors in Viet Nam. The lower dark blue point is the total production estimate, excluding marine fisheries, of Van Zalinge (2003), while the upper dark blue point is the estimate of Van Zalinge et al. (2003) added to the official marine production value

Other estimates of fishery productivity show a similar divergence with official statistics to that shown in the other countries, and include: Van Zalinge et al. (2000) - 190,000 tonnes from capture fisheries; Van Zalinge et al. (2003) - 845,000 tonnes in 2000 from capture fisheries with aquaculture production of 171,600 tonnes, and the total fish production of just over a million tonnes being equivalent to consumption of 60 kg/capita/year; Hortle (2007) – 850,000 tonnes.

Lam et al. (2002), based on a household survey, estimated consumption in Tra Vinh province at 51 kg/capita/year (fresh fish equivalent of 58 kg/capita/year), of which fresh fish (and other aquatic animals) was 42 kg/capita/year (inland fresh fish consumed was 31 kg/capita/year). The FAO health and nutrition survey (Petracchi, 1999b) reported fish consumption at about 13 kg/person/year: as in Cambodia, this estimate has been superseded by more recent figures in FAOSTAT (2007), which reports higher consumption estimates rising steadily from about 30 kg/person/year in the early 1990s to 55 kg/person/year in 2003-2005.

However, these figures are for the whole of Viet Nam and include all fish (Viet Nam has a substantial marine fishery), and so should be regarded as indicative only. The figure for 2000 of 45 kg/person/year is somewhat less than the Van Zalinge et al. (2003) figure of 60 kg/person/year, but nevertheless substantially above some other estimates.

The aquaculture production reported by Van Zalinge et al. (2003) of 171,600 tonnes is less than the 242,000 tonnes of farmed fish, and 372,000 total farmed aquatic produce, reported in the official statistics. This presumably arises because much aquaculture produce is raised for export, and thus does not show in Van Zalinge et al.'s (2003) consumption surveys.

Figure 9 compares the GVP of fisheries production from 1999 with the GVP of crop and livestock for the Mekong part of Viet Nam using both the lowest estimates from the national statistics and the highest estimate based on Van Zalinge et al. (2003). Crop and livestock production shows no trend, whereas there is an increase in the contribution of the fisheries sectors from 1999-2004.

This growth in the fisheries sector is predominantly due to the production in the Mekong Delta (figure 10), whereas the contribution of the central highlands is negligible at less than 1% of the total (figure 11). Since 2001, in the central highlands, there is an increase in the crop sector due to the rapid increase of income from non-rice crops (Mainuddin et al., 2008).

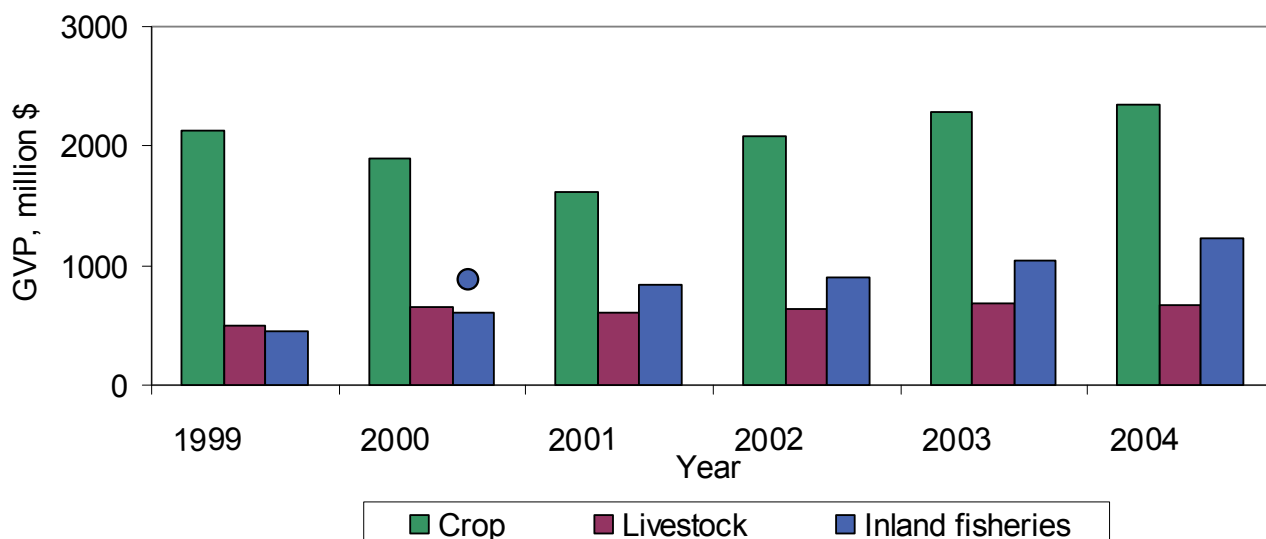


Figure 9: Contribution of the different sectors to the overall agricultural production of Viet Nam. The blue point shows the high estimate of Van Zalinge et al. (2003)

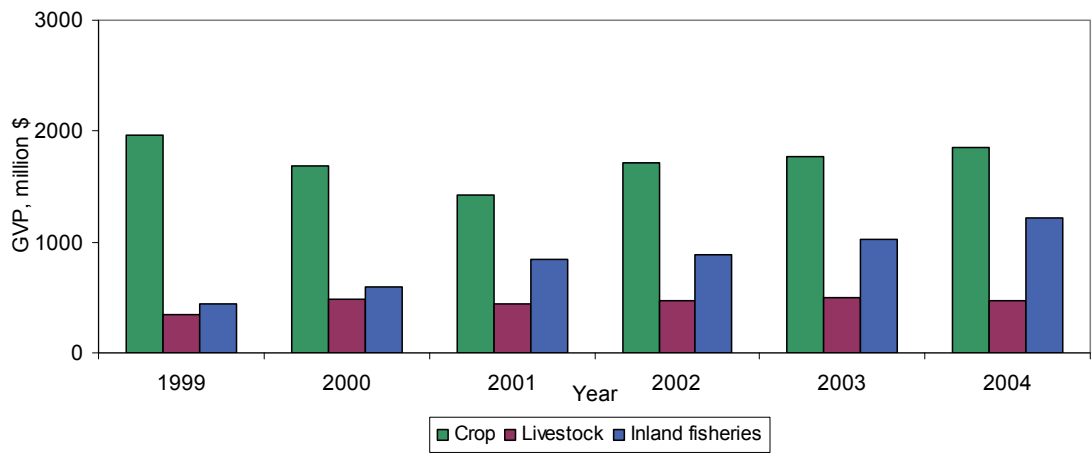


Figure 10: Contribution of the different sectors to the overall agricultural production of the Mekong Delta in Viet Nam

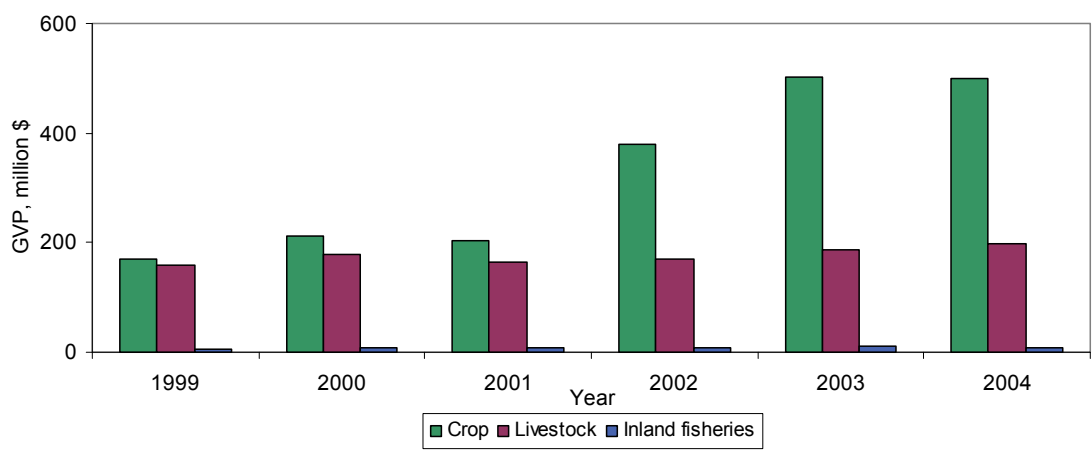


Figure 11: Contribution of the different sectors to the overall agricultural production of the central highlands of Viet Nam

Figures 12 to 14 show the comparison of per capita GVP of different sectors for Viet Nam total (delta plus central highlands), and the delta and the central highlands, respectively. The trend is similar to that of the figures showing the contribution of the different sectors. As with the Lao PDR and Cambodia, the low estimate of the official figures still places fisheries, especially aquaculture, as more important than many crops and more important than the livestock sector. The fishery figures are dominated by the production in the delta.

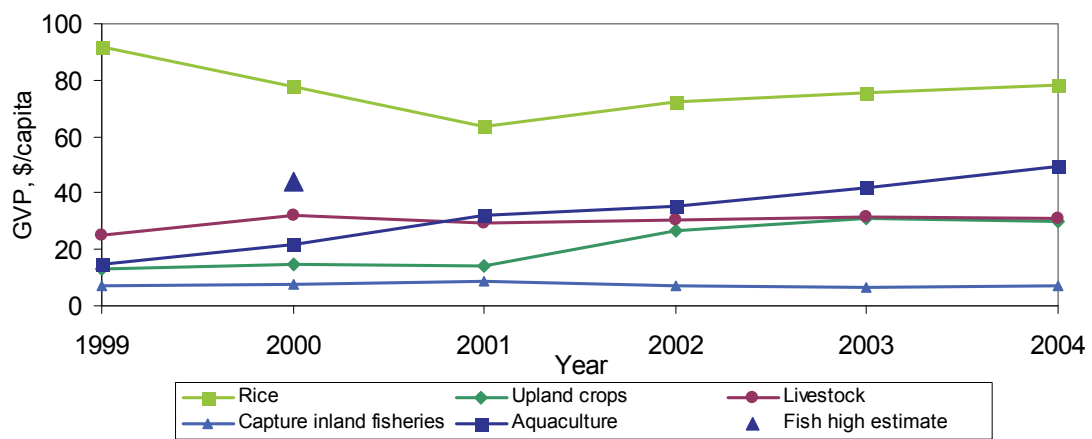


Figure 12: Comparison of GVP per capita of the different production sectors of Viet Nam

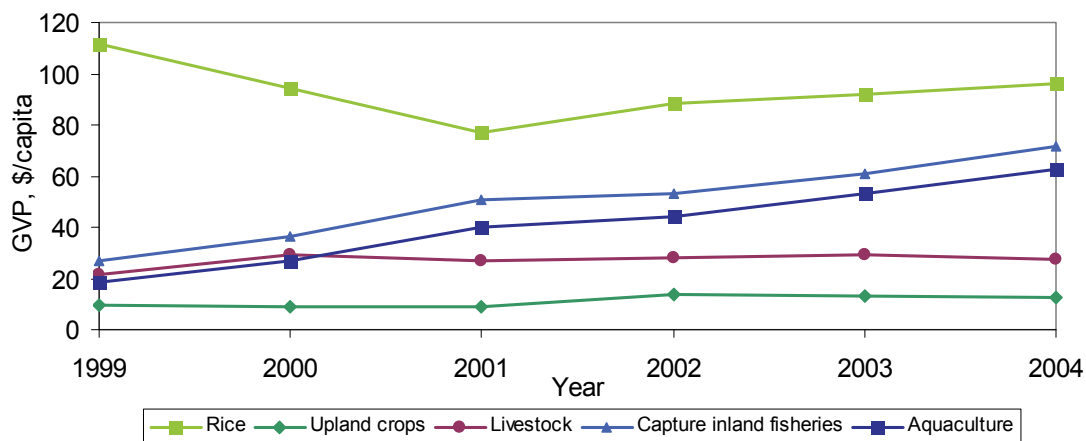


Figure 13: Comparison of GVP per capita of the different production sectors of the Mekong Delta of Viet Nam

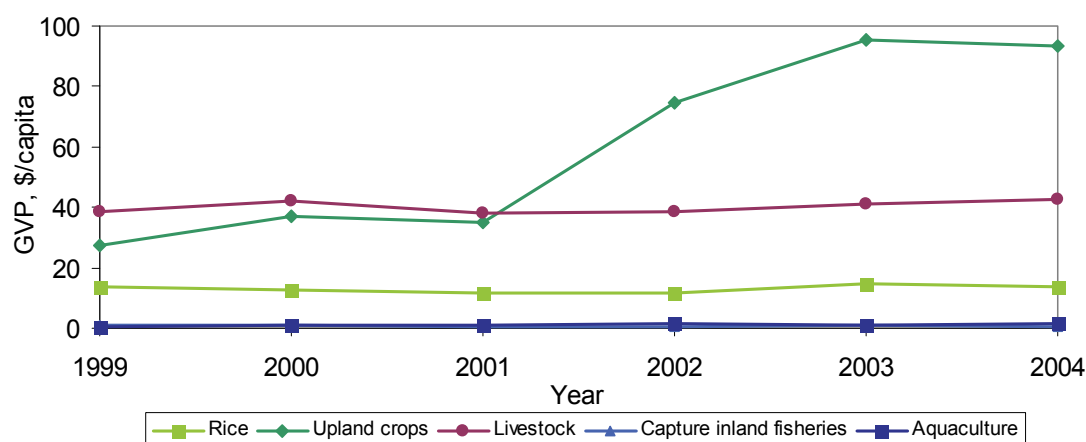


Figure 14: Comparison of GVP per capita of the different production sectors of the central highlands of Viet Nam

3.5 Varying estimates of overall production

The estimates of the production and value of fisheries vary considerably. Production estimates based on national statistics are known to miss much of the catch, and provide unreasonably low estimates. We believe that consumption-based figures provide much better indications of the overall production, but estimates nevertheless vary as much as fivefold from the FAO health and nutrition surveys (Petracchi, 1999a and 1999b) to the figures reported by Van Zalinge et al. (2003). The consumption-based figures have been revised upwards, with the earlier figures reported by Petracchi (1999a, 1999b) superseded by FAO (2007). The van Zalinge estimates are the highest estimates reported for the countries of the lower Mekong Basin, but are generally regarded as the best available (e.g. Baran et al., 2007). The more recent report by Hortle (2007) gives figures similar to, but a little lower than, those of Van Zalinge et al. (2003), but still higher than most other estimates. The Hortle figures may now be the best available estimates. The per capita consumption figures in Hortle (2007) are, however, somewhat lower than those given by Van Zalinge et al. (2003), at 37 (Cambodia), 29 (Lao PDR), 29 (Thailand) and 39 (Viet Nam) kg/capita/year (Hortle, 2007), compared to 65, 42, 53 and 60 respectively by Van Zalinge et al. (2003).

Table 11 shows that the difference between the official production estimates and the consumption estimates is greatest in northeast Thailand in absolute terms (about 200,000 compared to 1.2 million tonnes in 2000, a factor of six), but proportionally greatest in Cambodia (about 99,000 compared to 719,000 tonnes in 2000, a factor of about seven). The difference is proportionally less in Viet Nam (factor of about two in 2000), but the production estimate also includes exported aquaculture fish. The table also includes the production estimates for 2005 (Viet Nam) or 2002-4 (average,

Cambodia, Lao PDR, and Thailand), to show that in Cambodia and Viet Nam these estimates increased greatly over those years, and approach the consumption-based estimates. The increase in the reported production in Cambodia after 1998 results from the better surveys and the inclusion of smaller-scale fishing, although the increased estimates appear not to have flowed through for a few years. In Viet Nam, most of the increase is due to aquaculture much of which is exported and, again, this does not figure in the consumption-based estimate.

Other factors may confound these comparisons, including:

- the export and import of fish (especially from Cambodia to northeast Thailand);
- the consumption of marine fish especially in the Mekong Delta region of Viet Nam; and
- the differences between the central highlands and Mekong Delta regions of Viet Nam, with the Van Zalinge et al. (2003) high estimates appearing to be for the Mekong Delta region only. The production in the central highlands, while it may be seriously underestimated by official figures, is nevertheless likely to be small.

Table 11: Production and per capita consumption, lowest and highest estimates

Country	Year	Total production		Capture		Aquaculture		Consumption		Population <i>million</i>
		<i>000 tonnes</i>		<i>000 tonnes</i>		<i>000 tonnes</i>		<i>kg/person/yr</i>		
		Low	High	Low	High	Low	High	Low	High	
Cambodia	2000	99	719	86	682	14	14	9	65	11
	2002-4	304		283		21		23		13
Laos	2000	29	205	na	183	na	5	6	42	4.9
	2002-4	31		na		na		5		5.8
Thailand	2000	201	1188	na	932	na	68	9	53	22.5
	2002-4	199		na		na		8		23.5
Viet Nam ^a	2000	598	1022	225	845	242	172	35	60	17
	2005	1170		176		638		69		17
total / average	2000	928	3133					15	55	55.4
	2005	1704						27		59.3

^a The high estimate for Viet Nam appears to be for the Mekong Delta alone.

The low estimates are from official production statistics, and the high estimate is taken from Van Zalinge et al. (2003).

Table 11 also shows the per capita consumption. Most of the estimates based on reported production give values of around 5-10 kg/capita/year. The Cambodian consumption rises in the 2002-4 average to around 23 kg/capita/year. The Viet Nam consumption figure based on the reported production is much higher, but is biased by the exported aquaculture produce. In contrast to the production estimates, the high estimate from consumption data is 42-65 kg/capita/year. The upper figure for Cambodian consumption at 65 kg/capita/year is comparable to that of Japan.

FAO nutrition and health surveys (Petracchi 1999a, 1999b; Kaufmann, 2003) for Cambodia, Lao PDR, and Viet Nam reported consumption generally around 12 kg/person/year, whereas FAOSTAT (2007) revises these earlier estimates and gives the higher consumption figures shown in Figure 15 for Cambodia, Thailand, and Viet Nam. These figures are for the whole country and also include marine fish, but they show that the FAO estimates, like other estimates in the Mekong, have risen recently. They also give consumption figures approaching those of the Van Zalinge et al. (2003) estimate for Cambodia, and between that implied by the reported production and the consumption survey figures reported by Van Zalinge et al. (2003) for Thailand and Viet Nam.

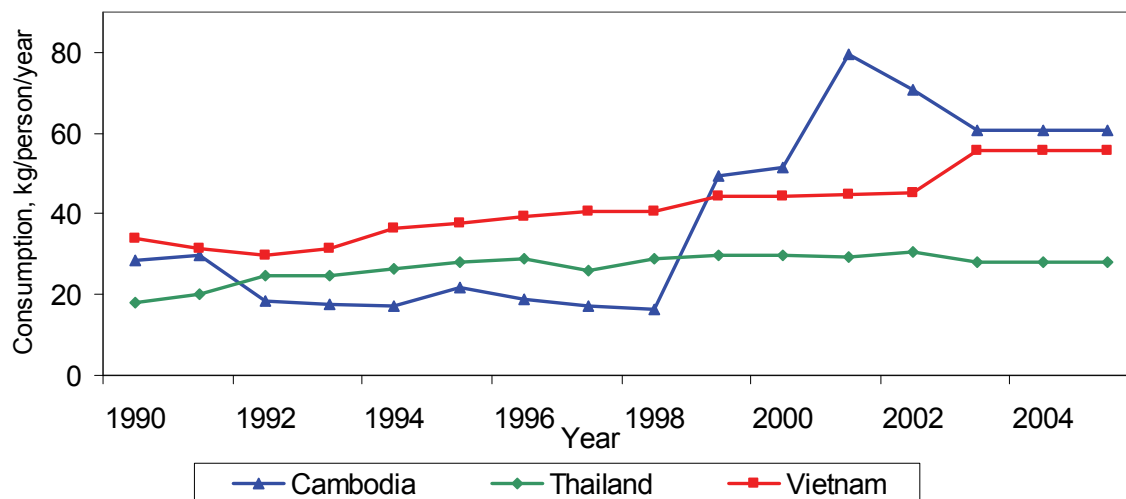


Figure 15: Consumption figures from FAOSTAT (2007)

The values reported in the high estimate of Van Zalinge et al. (2003) were supported by Hortle and Bush (2003) with the following arguments:

- Small scale production and consumption surveys show reasonable agreement (no reference or data are given).
- Yield estimates derived from the area of floodplain, while viewed as generally unreliable (Hortle and Bush, 2003), do lead to production estimates similar to the consumption estimates. Hortle and Bush quote a yield of 230 kg/ha/year and a floodplain area of 9.69 million ha, giving a yield of 2.23 million tonnes, which is similar to the total production estimate of 3.1 million tonnes. We admit that we do not fully understand this argument, since the bulk of the lower Mekong floodplain is in Cambodia and Viet Nam (the Tonle Sap alone expands by approximately six times during the seasonal flood), so this would imply that the production is mainly in Cambodia and Viet Nam only, whereas the argument is used to support large estimated production in all parts, and particularly in northeast Thailand. So, while not questioning the estimated consumption values, we find this a weak argument.
- Consumption in the four lower Mekong countries is similar to that in some developed countries where fish is a small part of the animal protein intake, and less than that in developed countries where fish are an important part of the diet (such as Japan). Again, we do not fully understand this argument, since: 1. There is a general correlation between all animal protein intake, including fish, and income and other development factors such as urbanization (e.g. Huang and Bouis, 1996; York and Gossard, 2004¹), which suggests that lower consumption of the Mekong countries is a reasonable expectation; 2. The suggestion that consumption is therefore comparable to Japan, which has a similar proportion of fish in the animal protein intake, is with a country that is free of many of the nutrition problems of the lower Mekong countries, again suggesting that a lower consumption is a reasonable expectation. This does not mean the estimates are wrong, but these comparisons require much care so that the conclusions might be different from those claimed.
- Expatriate nationals from the lower Mekong Basin living in Washington, USA, consumed quantities similar to those found in the consumption surveys in the Mekong. However, this does not take account of the correlation between animal protein consumption and income and other factors such as urban living. Again, while not questioning the estimated consumption values, we find this a weak argument.

Thus, we do not question the estimates of Van Zalinge et al. (2003), but we think the better arguments are in the survey work itself and in the more recent FAOSTAT estimates, not in the other evidence offered by Hortle and Bush (2003).

¹ Hortle (personal communication) disputes the correlations described by York and Gossard as being based on flawed surveys of fish consumption, and suggests that the correlations are an artifact of the surveys.

3.6 Regional and temporal trends in production and value

Notwithstanding the different estimates of production and consumption, the overall picture is of greater and increasing per capita production and consumption in Cambodia and Viet Nam of around 55 and 50 kg/capita/year respectively if we take the FAOSTAT (2007) estimates as compromise figures, bearing in mind the possible whole-country and marine fish bias. In Thailand and the Lao PDR, the amounts are somewhat lower and more static with time, perhaps around 30 kg if again we take the FAOSTAT (2007) estimates as compromise figures, bearing in mind again the possible whole-country and marine fish bias. The absolute figures change in the different estimates, but all estimates find this broad regional trend. In Cambodia and Viet Nam, consumption appears to have increased, whereas in Thailand it appears to have remained fairly static. Estimates of consumption over several years in the Lao PDR are not available.

Reported production estimates are not reliable but, to the extent that they help build the picture, they show that the overall production of caught fish is large in the Mekong Delta, Cambodia and Thailand, and smaller in the Lao PDR and the central highlands of Viet Nam, and are not increasing greatly with time (Figure 16). We emphasize again that the figure for Thailand is for the whole country. Aquaculture production is dominated by the Mekong delta region and is small elsewhere (Figure 17). Aquaculture production has grown dramatically in the delta in recent years (Mekong River Commission, 2007; also USDA, 2007, although the figures are for the whole of Viet Nam). Viet Nam anticipates continued rapid growth, and expected catfish production alone to exceed 1,000,000 tonnes by 2007 (Mekong River Commission, 2007). The total production (caught product plus aquaculture) is greatest in the Mekong Delta (Figure 18). The great growth in production since 2000 is generally missed by other authors including Baran et al. (2007), and only mentioned in passing by Hortle (2007).

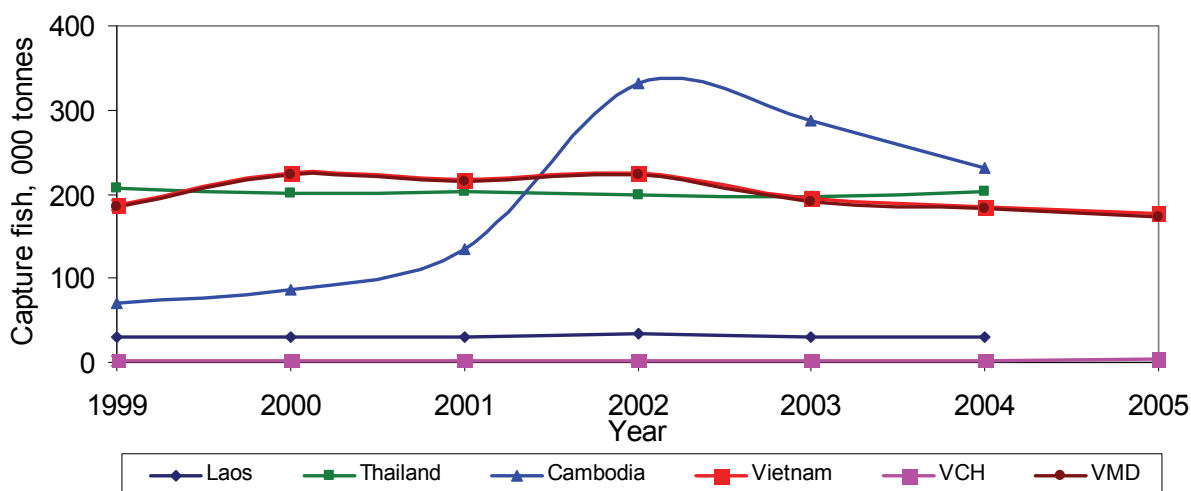


Figure 16: Capture fish production from official statistics

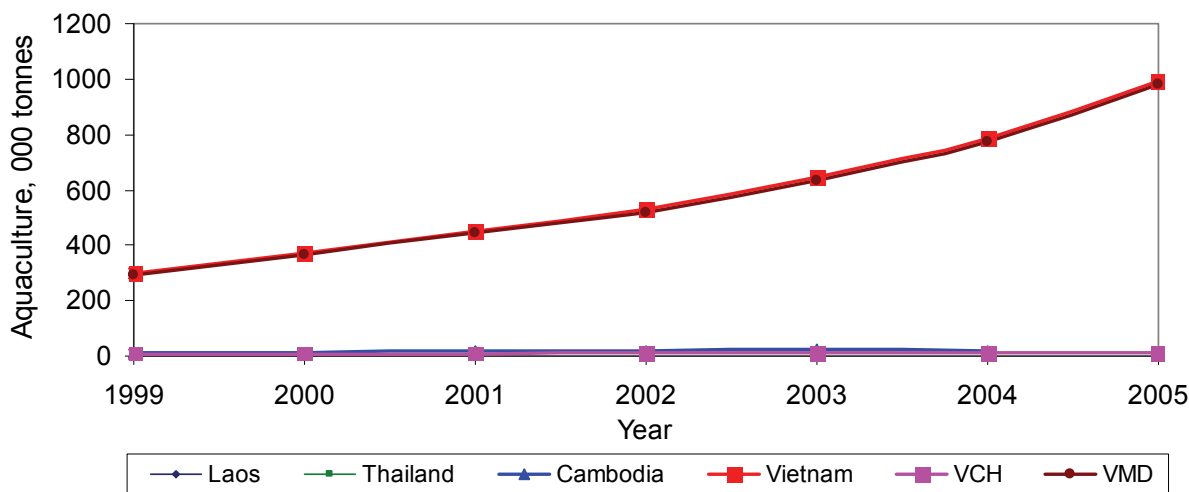


Figure 17: Aquaculture production from official statistics

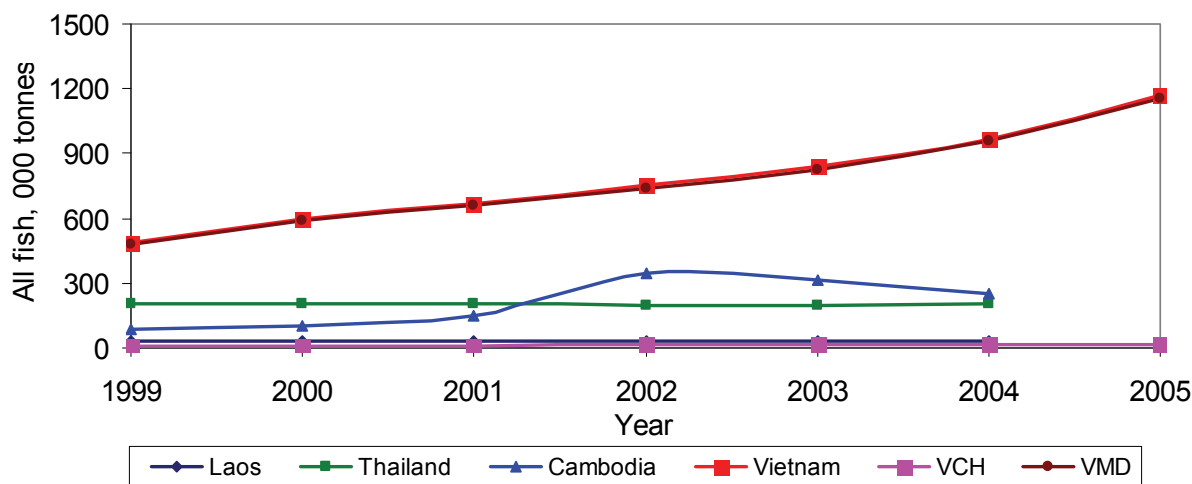


Figure 18: Total fish production from official statistics

The gross value of production calculated from the reported production estimates are also not reliable but, again to the extent that they help build the picture, they show that the overall value of fish is large and increasing in the Mekong Delta, mainly because of high-value (and largely exported) aquaculture production (Figure 19). Cambodia and Thailand have smaller production, increasing (probably mainly a reporting artefact) in Cambodia, and static in recent years in Thailand. Note again that the figure for Thailand is for the whole country. The value is smaller in the Lao PDR and the central highlands of Viet Nam, and is not increasing greatly with time.

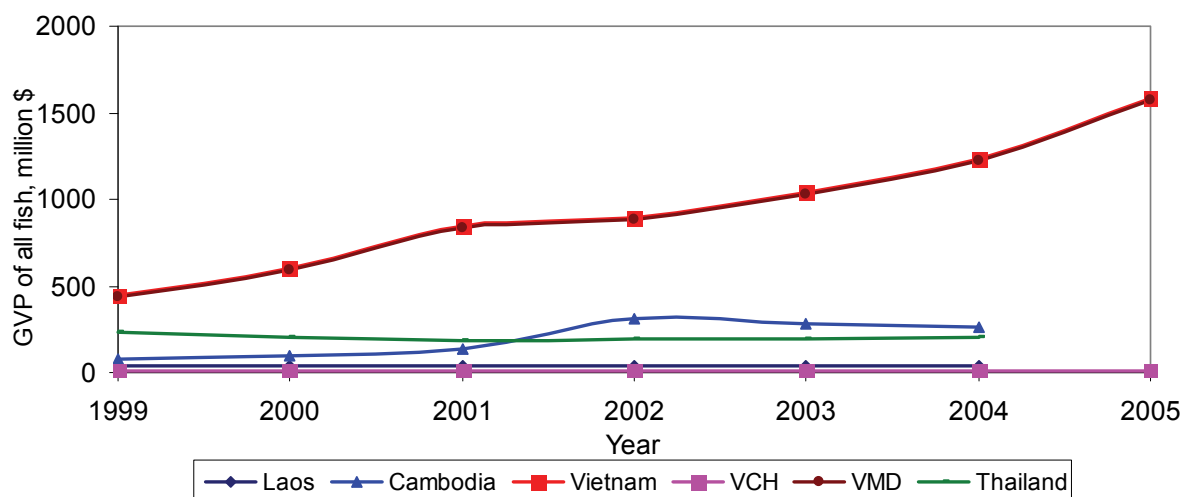


Figure 19: Value of total fish production from official statistics

Van Zalinge et al. (2003) gave the total value in 2000 as exceeding \$1.7 billion. According to the Mekong River Commission (2005), the total value of fish was about \$2,000 million in 2000, at about \$800 million in Thailand, \$750 million in Viet Nam, \$500 million in Cambodia and \$150 million in the Lao PDR. This puts the total value at about two to three times that shown in the figures above.

Figure 20 shows the gross value of fishery production as percentage of the gross value of rice production. Since 1999, the gross value of fishery production has increased significantly compared to the gross value of rice production. As a result, the contribution from the fishery sector to the total (crops, livestock, and fish) agricultural production has also increased (Figure 21). The value of fish as a proportion of the value of rice value or the total value of agriculture is greater in Cambodia and Viet Nam. Using the higher figures of Van Zalinge et al. (2003) and Mekong River Commission (2005), the value relative to rice, or total agriculture, would be significantly greater. The value of fish would be greater than that of rice in both Cambodia and Viet Nam in recent years.

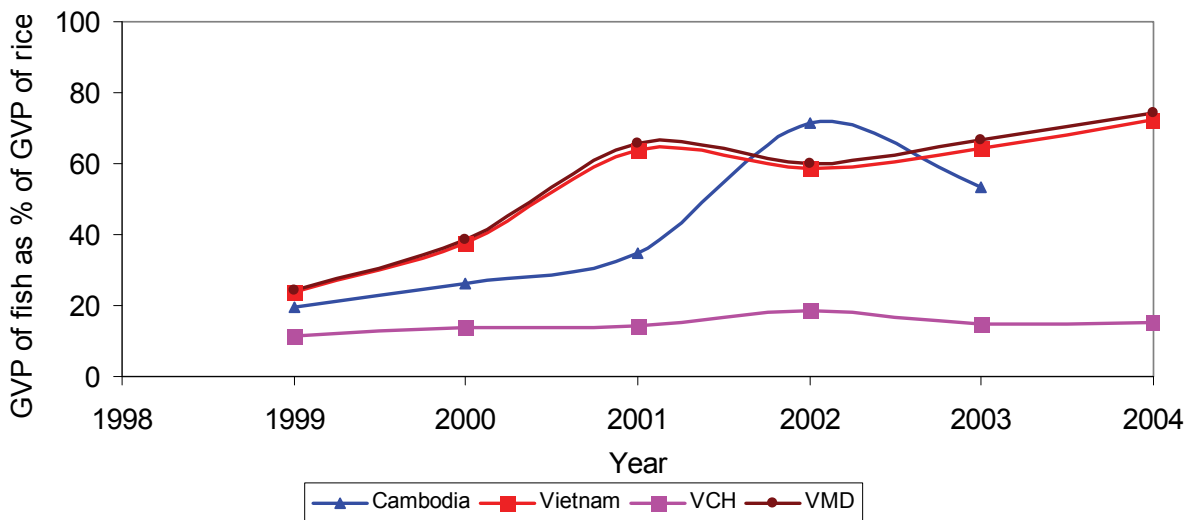


Figure 20: GVP of fisheries as percentage of GVP of rice

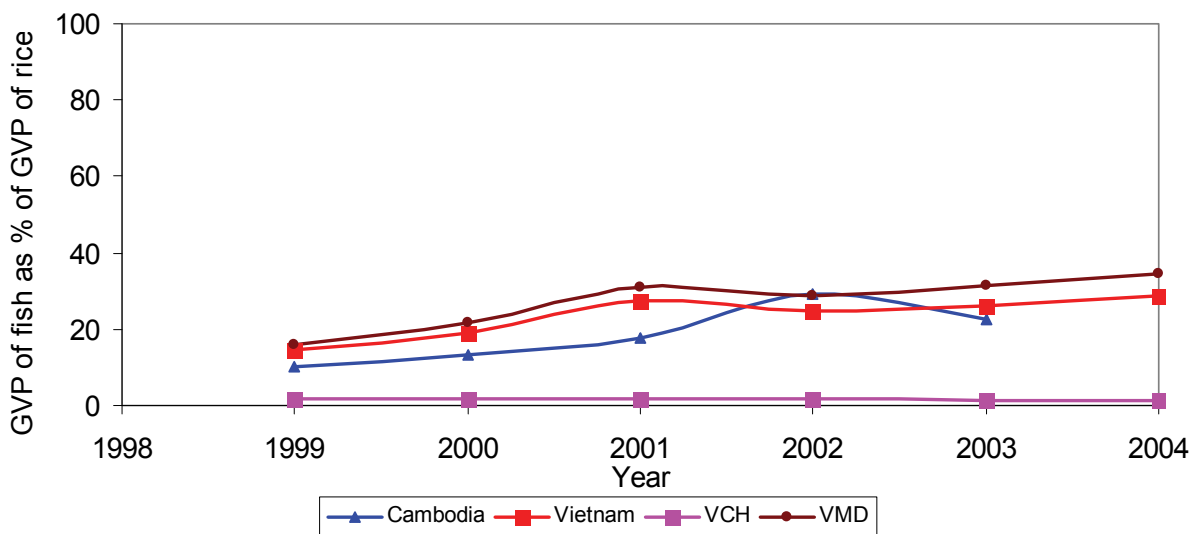


Figure 21: GVP of all fisheries as % of GVP of crops, livestock and fisheries

While the available data appear sufficient to establish broad trends, there is clearly much uncertainty. Fish as food and income are very important in the Mekong, as are the rivers and wetlands where the fish breed and grow. There is a clear need for more and better estimates of production (including production for export) and consumption



Source: Mohammed Mainuddin

Fish capture in the Mekong Delta

4. Threats and opportunities for Mekong fish production

The population of the lower Mekong Basin is likely to rise from the present 70 million to perhaps 80 million or more by 2020 and greater than 90 million by 2050 (based on medium variant projection, UN Population Division, 2006). Delgado et al. (2007) suggest that fish consumption in Southeast Asia to 2020 will grow at between 1.4 and 1.7% per annum, partly because of rising population and partly because of improving diets with increasing development (York and Gossard, 2004). Sokhem and Sunada (2006) suggest that an increase of between 0.4 and 1.6² million tonnes/year will be required by 2050, based on a production of 3.1 m tonnes in 2003. These increases are roughly proportional to the expected increase in population, and therefore appear not to anticipate increasing fish in the diet. A growth rate of 1.4% per annum, as suggested by Delgado et al. (2007), from the 3.1 m tonne base figure in 2003 would lead to an increase in demand of 0.8 and 2.9 million tonnes/year to 2020 and 2050, respectively, and a growth rate of 1.7% per annum would lead to increases of 1.0 and 3.7 million tonnes/year.

At the same time, there are concerns about several threats to the capture fisheries of the lower Mekong Basin (Sverdrup-Jensen, 2002; Mekong River Commission, 2003; Vanhan, 2004; Mollot et al. 2005; Baran et al. 2001a, Baran et al, 2007), viz:

- Removal of rapids, siltation, and changes to vegetation result in the destruction of spawning grounds and dry-season fish refuges.
- Dam construction and increased river diversions change the quantity and timing of flows for sensitive habitats and especially the annual flooding, which is associated with a large increase in fish populations. Dam development will alter the timing and magnitude of flows, and in particular will decrease flood peaks (Podger et al., 2004) and hence reduce the seasonal expansion of the Tonle Sap and flooding of seasonal wetlands elsewhere in the basin. This will in turn jeopardise fishery production, which is correlated with the magnitude of the flood (e.g. Baran et al., 2001b, 2007). Although the change in flows may not be large, the impact on fisheries would be considerable (Baran et al., 2007).
- Sediment trapping in completed hydropower dams in the upper Mekong has reduced sediment transport downstream leading to concerns that this will limit the supply of fresh nutrients for ecosystems in the lower basin, and hence affect fish production (Kummu and Varis, 2007). Water quality may also be affected by increased sediment load due to deforestation expanding the area of crops.
- Dams and weirs present physical barriers, which limits fish migration. Declines in fish production in the lower Mun River after the closing of the Pak Mun dam was largely due to the constraint on migration (Amornsakchai et al., 2000). The proposed Don Sahong dam appears likely to repeat this experience (Baran and Ratner, 2007).
- Over-fishing, of large species in particular but also of the whole assemblage (Allan et al., 2005). Baran et al. (2007) suggests that illegal fishing and over-fishing is a problem in the Tonle Sap and Mekong Delta regions.

In addition, there is concern about the ability of international institutions and agreements to deal with these issues, and the inadequacy of environmental impact assessments in respect of aquatic habitat and biodiversity (e.g. Sokhem and Sunada, 2006; Hirsch, 2005; Campbell and Parnrong, 2001).

Notwithstanding the threats, there has been considerable growth in aquaculture in the lower Mekong Basin, particularly in the delta in Viet Nam. It is the only growth in production that can reliably be established from all the estimates discussed in section 3. The growth was about 400,000 tonnes/year in aquaculture in the Mekong Delta over the five years from 2000. Aquaculture in the delta is thus currently increasing production at a rate sufficient

² Sokhem and Sunada give the increase to 2050 as 1.29 million tonnes, but in two places state that 4.7 million tonnes will be required, which is an increase of 1.6 million tonnes over the 3.1 million tonne base in 2003. The 1.29 million tonnes is obviously an error.

to cope with the anticipated future demand. It is reasonable to suppose that further growth is likely. Much of the aquaculture production was for export, however; continued growth in export will further increase the pressure on future production. Furthermore, the growth in aquaculture cannot be expected to increase indefinitely and does carry environmental costs. Growth of aquaculture depends on wild fish fry or trash fish as a feed and also on the introduction of exotic species (Vu and Bach, 2005; Baran et al., 2007), so the growth may be constrained and may also pose an additional threat to capture fisheries. Baran et al. (2007) argue that the emphasis should be on the protection of the current wild fish resources. Coates (1996) viewed opinions about the prospects for aquaculture growth as being over-optimistic, but having some justification, and also argued for the preservation of current resources.

Rice-fish farming systems offer prospects for improved production and livelihoods, but they must be managed with considerable care as integrated systems so that rice farming and pesticide use does not affect the fish production (Berg, 2002; Nguyen-Khoa et al., 2005; Frei and Becker, 2005). In addition, the reservoirs for irrigated rice production also yield extra fish (Sverdrup-Jensen, 2002), and the total fish from a reservoir and rice-fish paddy system may be greater than the loss of fish due to the creation of irrigation infrastructure (Nguyen-Khoa et al., 2005). Baran et al. (2007), on the other hand, caution that aquaculture production is likely to be less than the loss of production from capture fisheries. What is not clear from these studies is how much rice production is accompanied by fish production, although the implication is that current levels are low. Nor is the potential level of production quantified. How much current rice production could be accompanied by fish production? What would be the production of fish if all rice production were so managed?

Given these competing factors, what are the prospects for increasing fisheries productivity to meet the likely increased demand by 2020 and 2050? The available information appears inadequate to answer this question fully but we may note that:

- If over-fishing is beginning to change the size and composition of the catch, capture fisheries may not be able to meet the increased demand;
- In addition, there is no indication of growth in the production estimates of capture fishery, with the national statistics being unreliable and the consumption-based figures being just for one year, again indicating that capture fisheries may not be able to meet the increased demand;
- Nevertheless, since capture fisheries are the largest sector of fishery production, the prospects of meeting demand will be seriously jeopardized by any reduction in the current capture fishery resulting from dams and other developments and consequent changes to hydrology. It is therefore crucial that these developments do not impact the ecology of the river and its fisheries;
- The reservoir catch may offer scope for increased production, although presumably not at a scale sufficient to meet the demand;
- Rice-fish systems may also offer scope for increased production, although the basin-wide impact has not been quantified;
- Aquaculture has grown dramatically in recent years, at a rate far above that required to meet future demand (it is nearly doubling every year). It therefore appears in principle to be capable of meeting the demand. We are not aware of any study that quantifies the physical, social or other limits to aquaculture production, however. As mentioned by Baran et al. (2007) growth that relies on wild fish fry may be limited, but the implications of this are not quantified.

So, will fishery production meet the anticipated demand? As shown, the current estimates give no means to answer the question quantitatively, and so we can only speculate and offer our opinion. We offer four scenarios; no doubt more are possible. These scenarios are not mutually exclusive.

Decline of the capture fishery. As demand rises, there is unchecked over-fishing and illegal fishing of the capture fishery resource, combined with changed flow regimes resulting from upstream dam development and irrigation diversion. The fishery for a while yields extra production with change in the size of individuals and species in the

catch, but ultimately declines greatly. This is similar to the experience in Bangladesh (e.g. World Bank, 2006, Chapter 4), and for a similar mix of physical and institutional reasons.

Maintenance of the capture fishery. Many dams are built, but mostly well upstream on the main channel and in the tributaries, and the management of releases limits the impact on flows; the Don Sahong in the Lao PDR and other high impact dams are not built by negotiating transboundary agreements. In the main downstream fisheries, the institutions (especially community management and a system of enforced access and property rights) are put in place. Cambodia experimented with community access in 2000, though the system was incomplete and not very successful (Ratner, 2006).

Unchecked, export driven rise in aquaculture. The current growth in aquaculture in the Mekong Delta continues, and spreads to areas upstream. While the growth in production is sufficient to satisfy the growing demand, most of it goes for export. The benefits are thus mainly income, and confined to those directly and indirectly employed in the sector and those who own production and marketing facilities. The rural poor outside this sector benefit little, and indeed are disadvantaged by competing for fish at higher prices. In addition, there are largely unchecked adverse impacts on the environment, ranging from destruction of other habitats (including mangroves and wetlands), pollution, pressure on capture fisheries to provide feed, and disease epidemics in the farmed fish.

Regulated rise in aquaculture. The current growth in aquaculture is maintained, but the emphasis shifts to rice-fish and small pond systems (as in Bangladesh), with much of the increase being for local consumption. This scenario will only be realized with considerable local extension and education, backed by research into local management factors, species, and social uptake. This scenario, coupled with maintenance of the capture fisheries, is the only one that copes with the projected increase in future local demand.

Our main point in describing these scenarios is to emphasise that there are choices, and not all of them lead to outcomes that will maintain the current level of fish in the local diet.



Mekong Delta

Source: Mohammed Mainuddin

5. Conclusions

There are major uncertainties in estimates of fisheries production and value in the lower Mekong Basin. Catch surveys underestimate the production, although recent catch survey estimates in Cambodia report production since 2001 greatly larger than in earlier years probably as a result of taking the non-commercial catch into account.

Consumption surveys generally result in higher estimates of production, but nevertheless report a range of values. The highest estimates are from 42 kg/capita/year in the Lao PDR to 65 kg/capita/year in Cambodia. The data and methods supporting the higher estimates are not readily available for evaluation, however.

Fishery production is dominated by capture fisheries in Cambodia, where it is concentrated around the Tonle Sap and the Mekong River, and in the Lao PDR and Thailand. In Viet Nam, aquaculture dominates production, and is concentrated around the main rivers in the Delta and along the coastal strip.

The uncertain estimates of production make conclusions based on them tentative, but it appears that production from capture fisheries increased relatively little from about 1995 to 2005 in all the four lower Mekong countries.

A large reported increase in Cambodia in recent years appears to be a change in estimation methodology rather than a true increase in production. In aquaculture, there is a clear, large increase in production in the Mekong Delta region of Viet Nam since about 2000. Much of the increased production is probably for export.

The value of the fisheries is, like the production, somewhat uncertain. The greatest estimates of value, using the consumption based estimates of production, put the value of the 2000 catch at about \$3 billion. Other estimates (including those using other consumption figures) place the overall value somewhat lower. The value is probably not changing greatly with time, though again the range of estimates and poor data mean that this conclusion is tentative. Aquaculture in Viet Nam is rapidly increasing in value, to match the increase in production, and in 2005 was worth over \$1 billion. Aquaculture is also growing in Cambodia but is still in its infancy.

The contribution of the fisheries sector to overall agricultural (crop, livestock and fish) production is small in the Lao PDR and Thailand. The crop sector is the biggest contributor in all countries. The contribution from fisheries is smaller than that of livestock in the Lao PDR and Thailand and bigger than livestock in Cambodia and Viet Nam. While the fisheries sector in Viet Nam has grown in recent years, the crop and livestock sectors remain more or less static.

The demand for fish will inevitably rise in the future, partly as a result of increasing population in the region and partly as a result of increasing incomes. Over and above this, fish exports are also likely to rise.

The lower Mekong fisheries face threats to production from dams, changed water availability and quality, barriers to fish migration, and over-fishing. If the increased demand is to be met, these threats must be managed in such ways that the developments do not reduce the production of fish, especially of capture fish.

The increasing demand appears unlikely to be met through an increase in production of capture fisheries. The current rapid growth of aquaculture, if it can be maintained, appears capable of meeting the demand.

There are neither quantitative estimates of the limits to growth of aquaculture, however, nor how and whether it will pose risks for the capture fisheries by taking small fish fry as feed for aquaculture fish. Therefore, doubts remain whether the current growth of aquaculture can be maintained. Rice-fish farming may also contribute to increased production, but again the impact has yet not been quantified.



Source: MRC

Fish landing, Khong Island, Laos

References

- Ahmed, M., H. Navy, L. Vuthy, and M. Tiongco 1998. Socio-economic assessment of freshwater capture fisheries of Cambodia: Report on Household Surveys. Mekong River Commission, Phnom Penh, Cambodia. 186p.
- Allan, J.D., R. Abell, Z. Hogan, C. Revenga, B.W. Taylor, R.L. Wellcome, and K. Winemiller 2005. Overfishing of inland waters. *Bioscience* **55**, 1041-1051.
- Amornsakchai, S., P. Annez, S. Vonvisessomjai, S. Choowaew, P. Kunurat, J. Nippanon, R. Schouten, P. Sripapatprasite, C. Vaddhanaphutri, W. Wirojanagud, and E. Watana 2000. Pak Mun Dam, Mekong River Basin, Thailand. World Commission on Dams Case Study, final report. Secretariat of the World Commission on Dams, Cape Town. <http://www.dams.org/docs/kbase/studies/csthmain.pdf> (accessed July, 2008).
- Baran, E. and J. Cain 2001. Ecological and modelling approach to flood-fish relationships in the Mekong river basin. Contribution to the National Workshop on Ecological and Environmental Modelling (ECOMOD 2001), 3-4 September 2001, Universiti Sains Malaysia, Penang, Malaysia. 6 pp.
- Baran, E., T. Jantunen, and C.K. Chong 2007. Values of inland fisheries in the Mekong River Basin. WorldFish Center, Phnom Penh, Cambodia. 76p.
- Baran, E. and B. Ratner 2007. The Don Sahong dam and Mekong fisheries: a science brief from the WorldFish Centre. The WorldFish Centre, Penang.
- Baran, E., N. Van Zalinge, and P.B. Ngor 2001a. Floods, floodplains and fish production in the Mekong basin: present and past trends. Contribution to the Asian Wetlands Symposium 2001, 27-30 August 2001, Penang, Malaysia. 11p.
- Baran, E., N. Van Zalinge, Ngor Peng Bun, I.G. Baird, and D. Coates 2001b. Fish resource and hydrobiological modelling approaches in the Mekong Basin. ICLARM, Penang, Malaysia and the Mekong River Commission Secretariat, Phnom Penh, Cambodia. 60p.
- Barker, R., D. Dawe, and A. Inocencio 2003. Economics of Water Productivity in Managing Water for Agriculture. In: Water Productivity in Agriculture: Limits and Opportunities for Improvement, Kijne, J. W., Barker, R. and Molden, D. (eds), Comprehensive Assessment of Water Management in Agriculture Series, No 1. International Water Management Institute, Sri Lanka.
- Berg, H 2002. Rice monoculture and integrated rice-fish farming in the Mekong Delta, Vietnam—economic and ecological considerations. *Ecological Economics* **41**, 95-107.
- Bouakhamvongsa, K., S. Siravong, and K.G. Hortle 2005. Monitoring river fishers along the Mekong River in Lao PDR. In: Burnhill, T.J. and Warren, T.J. (Eds). Proceedings of the 7th Technical Symposium on Mekong Fisheries, MRC Conference Series, No 6, Mekong River Commission, Vientiane, Lao PDR.
- Bush, S.R 2004. Scales and sales: changing social and spatial fish trading networks in the Siiphandone fishery, Lao PDR. *Singapore Journal of Tropical Geography* **25**, 32-50.
- Campbell, I.C., and S. Parnrong 2001. Limnology in Thailand: present status and future needs. *Verhandlungen der Internationale Vereinigung für Theoretische und Angewandte Limnologie* **27**, 2135-2141.

- Chong, C. K., M. Ahmed, R.A. Valmonte-Santos, and H. Balasubramanian (undated). Review of Literature on Values of Inland Capture Fisheries and Dams Construction at the Lower Mekong and Ganga Basins. http://www.iwmi.cgiar.org/assessment/files_new/research_projects/Paper_Chong%20et%20al_ICLARM.pdf (accessed August, 2009)
- Coates, D 1996. Inland fisheries and food security. Catch and Culture: *Mekong Fisheries Network Newsletter* 2 (1).
- Coates, D 2002. Inland Capture Fishery Statistics of Southeast Asia: Current Status and Information Needs, FAO RAP publication 2002/11, 114 p.
- Cowx, I. G., O. Almeida, C. Bene, R. Brummett, S. Bush, W. Darwall, J. Pittock, and M. van Brakel 2003. Session 2 Review: Value of River Fisheries. In. Welcomme, R. L., and Petr, T. (eds.) Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries: Sustaining Livelihoods and Biodiversity in the New Millennium, 11th-14th February, 2003, Phnom Penh, Cambodia.
- Delgado, C.L., N. Wada, M.W. Rosegrant, S. Meijer, and M. Ahmed 2007. Fish to 2020: Supply and Demand in Changing Global Markets. International Food Policy Research Institute, Washington, DC, and WorldFish Center, Penang, Malaysia.
- Department of Fisheries 2001a. Trade, Marketing and Processing of Fisheries and Fisheries Product Review. Technical Report No. 6, MoF, Phnom Penh, Cambodia. <http://www.maff.gov.kh/pdf/TradeMarketingandProcessingReview.pdf> (accessed August, 2009)
- Department of Fisheries 2001b. Internal Fisheries Review. Technical Report No. 2, MoF, Phnom Penh, Cambodia. <http://www.maff.gov.kh/pdf/InlandFisheriesReview.pdf> (accessed August, 2009)
- Diep, L., S. Ly, and N.P.van Zalinge (Eds.), 1998. Catch statistics of the Cambodian Freshwater Fisheries. Mekong River Commission, 146p.
- Dyg, P.M. 2006. Understanding malnutrition and rural food consumption in Lao PDR. *Journal of Food Composition and Analysis* 19. 763–764.
- Frei, M., and K. Becker 2005. Integrated rice-fish culture: Coupled production saves resources. *Natural Resources Forum* 29, 135–143.
- FAO 2003. Nutrition Country Profile – LAOS. FAO, Rome.
- FAO 2008. National aquaculture sector overview, Vietnam. http://www.fao.org/fishery/countrysector/naso_vietnam, (accessed August, 2009)
- FAOSTAT, 2007. Rome, Italy: Fisheries and Aquaculture Department, Food and Agriculture Organization (FAO) of the United Nations. <http://faostat.fao.org/> (accessed August, 2009)
- Hirsch, P 2005. The politics of fisheries knowledge in the Mekong River Basin. Australian Mekong Resource Centre, University of Sydney.
- Hortle, K.G. and S.R. Bush 2003. Consumption of fish and other aquatic animals in the Lower Mekong Basin. MRC Technical Series, in preparation.

- Hortle, K.G., S. Lieng, and J. Valbo-Jorgensen 2004. An introduction to Cambodia's inland fisheries. Mekong Development Series No. 4. Mekong River Commission, Phnom Penh, Cambodia. 41 pages. ISSN 1680-4023.
- Hortle, K.G 2007. Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin. MRC Technical Paper No. 16, Mekong River Commission, Vientiane. 87P.
- Hortle K.G. and U. Suntornratana 2008. Socio-economics of the fisheries of the lower Songkhram River Basin, northeast Thailand. MRC Technical Paper No. 17. Mekong River Commission, Vientiane. 85p.
- Huang, J., and H. Bouis, 1996. Structural changes in the demand for food in Asia. International Food Policy Research Institute, 2020 Brief 41.
- Jensen, J 2000a. Save the Fish or lose the food security. MRCS in Mekong Fish Catch and Culture, Vol. 6 (1), p 1-2, September 2000, Phnom Penh, Cambodia.
- Jensen, J. 2000b. Food security and inland fisheries. In SEAFDEC Fish Regional Technical Consultation on Fisheries Management for the Conference on Food security – Fish for the People. November 2000, Penang, Malaysia.
- Kaufmann, S 2003. Nutrition Country Profile of Laos Nutrition Country Profiles – LAOS July, 2003 FAO, Rome, Italy.
- Khay, D. and K.G. Hortle 2003. Monitoring sales of fish and other aquatic animals at retail markets in “Phnom Penh, Cambodia. Proceedings of the 6th Technical Symposium on Mekong Fisheries, 26-28 Nov 2003, MRC Conference Series No. 5, MRC.
- Khumsri, M., N. Sriputt nibondh, and W. Thongpun 2005. Fisheries co-management in Lower Songkhram River Basin: problems and challenges. In: Burnhill, T.J. and Warren, T.J. (Eds). Proceedings of the 7th Technical Symposium on Mekong Fisheries, MRC Conference Series, No 6, Mekong River Commission, Vientiane, Lao PDR.
- Kummu, M. and O. Varis 2007. Sediment-related impacts due to upstream reservoir trapping, the Lower Mekong River. *Geomorphology* **85**, 275-293.
- Lam, P. T., P.M. Phuong, T. Visser, J.S. Sjorslev, and K.G. Hortle 2002. Inland fisheries activities and fish consumption in Tra Vinh province, Viet Nam. 5th Technical Symposium on Mekong Fisheries, 11–13 December 2002, Mekong River Commission.
- Mahasarakarm, O. P.N. 2007. An Introduction to the Mekong Fisheries of Thailand. Mekong Development Series No.5, Mekong River Commission, Vientiane, Lao PDR. 54p.
- Mainuddin, M., M. Kirby, and Y. Chen 2008. Spatial and Temporal Pattern of Land and Water Productivity in the Lower Mekong River Basin. Basin Approach. Basin Focal project Working Paper No. 5, CGIAR Challenge Program on Water and Food. http://www.waterandfood.org/fileadmin/CPWF_Documents/Documents/Basin_Focal_Projects/BFP_Publications/Spatial_Temporal_Pattern_Land_Water_Productivity_Mekong_BFPWP5_pgs1-21.pdf (accessed August, 2009).
- Mekong River Commission 2003. State of the Basin Report. Mekong River Commission, Phnom Penh, Cambodia.

- Mekong River Commission 2005. Fisheries Program Phase 2, 2006-2010. August 2005, Mekong River Commission, Vientiane, Lao PDR.
- Mekong River Commission (MRC) 2006. The MRC Basin Development Plan: Completion Report for Phase 1. Mekong River Commission Secretariat, Vientiane, Laos PDR, 104 pp.
- Mekong River Commission 2007. Catfish processing takes off in delta as global demand soars. *Catch and Culture*, p. 13, 2 September 2007. MRC, Vientiane, Lao PDR.
- Meusch, Eric, J. Yhoung-Aree, R. Friend, and S. Funge-Smith 2003. The role and nutritional value of aquatic resources in the livelihoods of rural people: A participatory assessment in Attapeu Province, Lao PDR. Food and Agriculture Organization RAP publication 2003/11. FAO Rome.
- Mollot, R., C. Phothitay, and S. Kosy 2005. Hydrology, habitat and livelihoods on the floodplains of southern Lao PDR. In. Burnhill T.J. and Hewitt M.M. (eds). Proceedings of the 6th Technical Symposium on Mekong Fisheries, 26th – 28th November 2003. MRC Conference Series No.5. Mekong River Commission, Vientiane. 194 pp.
- Nachaiphern, J., S. Nuengsit, P. Rukaewma, W. Taruwan, S. Nakkaew, and S. Sinsoontorn 2002. Fisheries Activities and Catch Assessments of three Reservoirs: Nam Oon in Sakon Nakhon Province, Kaeng Lawa in Khon Kaen Province and Huai Muk in Mukdahan Province, Thailand. 5th Technical Symposium on Mekong Fisheries, 11–13 December 2002. Mekong River Commission, Phnom Penh, Cambodia.
- Nakkaew, S., S. Nuengsit, J. Nachaiphern, W. Taruwan, P. Rukaewma, and S. Sinsoontorn 2001. Preliminary fisheries activities and catch in Huai Luang reservoir, Udon Thani province, Thailand. 4th Technical Symposium on Mekong Fisheries, Phnom Penh, 10-11 December 2001.
- Nam, S., 2000. Geographic analysis of poverty status and aquatic resources use- focusing especially on the livelihoods of the poor- in Cambodia. Consultancy report for DFID. Department of Fisheries, Phnom Penh.
- Naret, K., S. Viryak, and D. Griffiths 2000. Fish price monitoring in Kandal, Prey Veng and Takeo Provinces of Cambodia. Proceedings of the 3rd Technical Symposium on Mekong Fisheries, Phnom Penh, 8-9 December 2000.
- National Institute of Statistics 2005. Statistical Yearbook 2005. National Institute of Statistics, Ministry of Planning, Kingdom of Cambodia.
- National Statistics Centre NSC 2003. Statistical Yearbook 2002. Committee for Planning and Investment, National Statistics Centre, Vientiane, Laos.
- National Statistics Centre NSC 2004a. Statistical Yearbook 2003. Committee for Planning and Investment, National Statistics Centre, Vientiane, Laos.
- National Statistics Centre NSC 2004b. The Household of Lao PDR: Social and Economic Indicators. Lao Expenditure and Consumption Survey 2002/03, LECS 3. Committee for Planning and Investment, National Statistics Centre, Vientiane, Laos.
- National Statistics Centre NSC, 2005. Statistics 1975-2005. Committee for Planning and Investment, National Statistics Centre, Vientiane, Laos.

- Navy, H. and M. Bhattarai 2006. Economic Assessment of Small-Scale Inland Fisheries and Wetland Livelihoods in Cambodia, Paper prepared for presentation at International River Symposium, Brisbane, Australia, 4-7 September, 2006.
- Ngeth, L., S. Koun, O. Vibul, G. Cans, and N. Mattson 2005. Economic evaluation of small-scale aquaculture of indigenous fish in Cambodia. In: Burnhill, T.J. and Warren, T.J. (Eds). Proceedings of the 7th Technical Symposium on Mekong Fisheries, MRC Conference Series, No 6, Mekong River Commission, Vientiane, Lao PDR.
- Ngor, S., A.L. Deap, and K.G. Hortle 2005. The dai trey linh fishery on the Tonle Touch (Touch River), southeast Cambodia. In. Burnhill T.J. and Hewitt M.M. (eds). Proceedings of the 6th Technical Symposium on Mekong Fisheries, 26th – 28th November 2003. MRC Conference Series No.5. Mekong River Commission, Vientiane. 194 pp.
- Nguyen-Khoa, S., Smith, L., and Lorenzen, K., 2005. Impacts of Irrigation on Inland Fisheries: Appraisals in Laos and Sri Lanka. Comprehensive Assessment Research Report 7. Colombo, Sri Lanka: Comprehensive Assessment Secretariat.
- Pengbun, N., Sinath, A. and Hortle, K. G., 2005. The Dai Bongkong fishery for giant river prawns, *Macrobrachium rosenbergii*, in southeastern Cambodia. In: Burnhill, T.J. and Warren, T.J. (Eds). Proceedings of the 7th Technical Symposium on Mekong Fisheries, MRC Conference Series, No 6, Mekong River Commission, Vientiane, Lao PDR.
- Petracchi, C., 1999a. Nutrition Country Profile of Cambodia. Nutrition Country Profiles -CAMBODIA-24 February 1999, FAO, Rome. Available at: <ftp://ftp.fao.org/es/esn/nutrition/ncp/CMB.pdf>.
- Petracchi, C., 1999b. Nutrition Country Profile of Vietnam. 2 March 1999, FAO, Rome. Available at: <ftp://ftp.fao.org/es/esn/nutrition/ncp/vie.pdf>
- Phillips, M.J., 2002. Fresh water aquaculture in the Lower Mekong Basin. MRC Technical Paper No. 7, Mekong River Commission, Phnom Penh. 62 pp. ISSN: 1683-1489.
- Phimmachak, S. and Chanthavong, S., 2005. A survey of aquatic animal health problems affecting small-scale aquaculture production and fisheries in Lao PDR. In. Burnhill T.J. and Hewitt M.M. (eds). Proceedings of the 6th Technical Symposium on Mekong Fisheries, 26th – 28th November 2003. MRC Conference Series No.5. Mekong River Commission, Vientiane. 194 pp.
- Phonvisay, A., 2001. Fish Marketing Study in Vientiane, LARReC Technical Report No. 0003, LARReC, Vientiane.
- Phonvisay, A., 2003 The study of fish market channels in Luangprabang and Oudomxay Province, AMCF, Vientiane.
- Phonvisay, A., Bualaphanh, V., Sichanh, S., Singhanouvong, D., and Hortle, K. G., 2005. Monitoring of fish markets in Vientiane and Luang Prabang Province, Lao PDR, using logbooks. In: Burnhill, T.J. and Warren, T.J. (Eds). Proceedings of the 7th Technical Symposium on Mekong Fisheries, MRC Conference Series, No 6, Mekong River Commission, Vientiane, Lao PDR.
- Podger, G.M., Beecham, R.E., Blackmore, D., Stein, R. and Perry, C. 2004. Modelled Observations on Development Scenarios in the Lower Mekong Basin, Mekong Water Resources Assistance Strategy, World Bank, Nov. 2004, Vientiane.

- Prapertchop, P., 1989, Summary Report on Analysis of Freshwater Fish Consumption and Marine Product Marketing in North-East Thailand. Report No.9, Parts 11/111. Thailand-Canada North-East Fishery Project, DOF/CIDA, 8906/11415.
- Rab, M.A., H. Navy, M. Ahmed, K. Seng and K. Viner., 2006. Socioeconomics and Values of Resources in Great Lake-Tonle Sap and Mekong-Bassac area; Results from a sample survey in Kampong Chhnang, Siem Reap and Kandal Provinces, Cambodia. WorldFish Center Discussion Series No. 4. 98p.
- Rab, M.A., Hap, N., Ahmed, M., Keang, S.L., and Viner, K., 2005. Socioeconomics and Values of Resources in Great Lake, Tonle Sap and Mekong - Bassac Area: Results from a Sample Survey in Kampong Chhnang, Siem Reap and Kandal Provinces. WorldFish Center, Penang, Malaysia. (Available at www.ifredi.org).
- Ratner, B.D., 2006. Policy Review: Community Management by Decree? Lessons From Cambodia's Fisheries Reform. *Society and Natural Resources*, **19**:79–86.
- Research Institute of Marine Fisheries, 2006. Marine Resources and Fishing Situation in Viet Nam's waters: Current State of Resources and Fisheries Development Trends. Available at http://www.fistenet.gov.vn/details_e.asp?Object=2112463&news_ID=7263407. (Accessed on October 2007).
- Sokhem, P., and Sunada, K. 2006. Key Fisheries Issues in the Mekong Region Draft Paper for Mekong Region Waters Dialogues, Fisheries Session 230606 Available at: [http://www.sea-user.org/UserFiles/File/docs/Sokhem&Sunada_Fisheries_Session_draft_270606\(1\).pdf](http://www.sea-user.org/UserFiles/File/docs/Sokhem&Sunada_Fisheries_Session_draft_270606(1).pdf)
- Sjorslev J.G, 2001. Assessment of consumption of fish and aquatic animals in the Lower Mekong Basin. Draft report for the Mekong Development Series. 35 pp.
- Sjorslev J.G., Visser T., Suntornaratana U. , Apipoonyanon C. and SaeLim T. (2000) Combining sampling and census approaches for fisheries habitat assessment in Songkhram River Basin, NE Thailand. 3th Technical Symposium on Mekong Fisheries, Phnom Penh, 8-9 December 2000, Mekong River Commission.
- Sverdrup-Jensen, S, 2002. Fisheries in the Lower Mekong Basin: Status and Perspectives. MRC Technical Paper No. 6, Mekong River Commission, Phnom Penh. 103 pp.
- Tien, D. V., Chau, L. N., Chi, T. T., and Hortle, K. G., 2005. Trial monitoring of fishers in the Mekong Delta, Viet Nam. In: Burnhill, T.J. and Warren, T.J. (Eds). Proceedings of the 7th Technical Symposium on Mekong Fisheries, MRC Conference Series, No 6, Mekong River Commission, Vientiane, Lao PDR.
- UN Population Division, 2006. World Population Prospects: The 2006 Revision. <http://www.un.org/esa/population/publications/wpp2006/wpp2006.htm>
- USDA, 2007. Vietnam Fishery Products Shrimp Report 2007. USDA Foreign Agricultural Service. Available at: <http://www.thefishsite.com/articles/307/vietnam-fishery-products-shrimp-report-2007>
- Vanhan. H, 2004. Agriculture in the wetlands of Cambodia. In Magnus Torell, Albert M. Salamanca and Blake D. Ratner (eds.) 2004. Wetlands Management in Cambodia: Socioeconomic, Ecological, and Policy Perspectives. WorldFish Center Technical Report 64, pp. 17-21
- Van Zalinge, N, Nao, T. Touch, S. Tana, Deap, L., 2000. Where there is water, there is fish? Cambodian fisheries issues in a Mekong River Basin perspective. p. 37-48. In M. Ahmed and P. Hirsch (eds.) Common property in the Mekong: issues of sustainability and subsistence. *ICLARM Studies and Reviews* **26**, 67 pp.

- Van Zalinge, N. P., Nao T. & Sam, N., 2001. Status of the Cambodian inland capture fisheries sector with special reference to the Tonle Sap Great Lake. Inland Fisheries Research and Development Institute of Cambodia, Fisheries Technical Paper Series, Volume III. pp. 10-17.
- Van Zalinge, N. P., 2002. Update on the status of the Cambodian inland capture fisheries sector with special reference to the Tonle Sap Great Lake. Catch and Culture, Mekong Fisheries Network Newsletter, Vol. 8, No. 2, December 2002.
- Van Zalinge, N., P. Degan, C. Pongsri, S. Nuov, J.G. Jensen, V.H. Nguyen, X. Choulamany, 2003. The Mekong River System. In. Welcomme, R. L., and Petr, T. (eds.) Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries: Sustaining Livelihoods and Biodiversity in the New Millennium, 11th-14th February, 2003, Phnom Penh, Cambodia.
- Van Zalinge, N., Thuok, N., and Tana, T. S., 1998. Where there is water, there is fish? Fisheries issues in the Lower Mekong Basin from a Cambodian perspective. Contribution to the Mekong Panel at the Seventh Common Property Conference of the International Association for the Study of Common Property, Vancouver, Canada, 10 - 14 June 1998 Mekong River Commission. Available at <http://www.indiana.edu/~iascp/Final/zalingeo.pdf>
- Van Zalinge, N.P. and T.S. Touch, 1996. Cambodia National Environmental Action Plan. Fisheries management in the Tonle Sap. Contribution to the Workshop on the “Management of the Tonle Sap Ecosystem”. Siem Reap, 11 - 14 September 1996.
- Vu A.T. and Bach T.Q.M. (2005) Trash fish use as a food source for major cultured species in An Giang and Dong Thap provinces, Mekong Delta, Vietnam. In: Low Value and Trash Fish in the Asia-Pacific Region, Asia-Pacific Fishery Commission Regional Workshop, Hanoi, Vietnam, 7-9 June 2005, FAO Regional Office for Asia and the Pacific, Bangkok, 211–222.
- Welcomme, R.L., 1985. River fisheries. FAO fisheries technical paper No. 262. 330 pp.
- World Bank, 2006. Bangladesh Country Environmental Analysis. Bangladesh Development Series Paper no. 12. The World Bank Office, Dhaka.
- Yim Chea and McKenney, Bruce, 2003a. Great Lake fish exports: an analysis of the fee system. *Cambodian Development Review*, *Cambodian Development Resource Institute*, 7, 1-6.
- Yim Chea and McKenney, Bruce, 2003b. Fish Exports from the Great Lake to Thailand: An Analysis of Trade Constraints, Governance, and the Climate for Growth — Working Paper 27. *Cambodian Development Resource Institute*, Phnom Penh.
- Yim Chea and McKenney, Bruce, 2003c. Domestic Fish Trade: A Case Study of Fish Marketing from the Great Lake to Phnom Penh — Working Paper 29. *Cambodian Development Resource Institute*, Phnom Penh.
- York, R., and Gossard, M. H. 2004. Cross-national meat and fish consumption: exploring the effects of modernization and ecological context. *Ecological Economics* 48, 293– 302.

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The Challenge Program on Water and Food was launched in 2002 as a reform initiative of the CGIAR, the Consultative Group on International Agricultural Research. CPWF aims to increase the resilience of social and ecological systems through better water management for food production (crops, fisheries and livestock). CPWF does this through an innovative research and development approach that brings together a broad range of scientists, development specialists, policy makers and communities to address the challenges of food security, poverty and water scarcity. CPWF is currently working in six river basins globally: Andes, Ganges, Limpopo, Mekong, Nile and Volta.

About this R4D Paper

The Bac Lieu Province in the Mekong Delta is part of the Cà Mau Peninsula and is an important food- growing area in Viet Nam. It has a population of 830,000 with approximately 116,000 farming families living on small parcels of land producing a range of commodities for food security and the export market. These farmers and aquaculturalists (together called producers in this report) are highly dependent on accessing the right quality water, fresh or saline or both, at the right time to grow their crops or raise their shrimp, crabs or fish.

This evaluation was intended to identify what contribution the project had made to reducing poverty and food insecurity in the Mekong Delta as a result of an investment by the CPWF. The success of this project, however, can be attributed to its positive interaction with policy development, integrating good science with the tacit knowledge of producers, having the right players at the table at the right time and having built-in evaluative processes so partners could monitor progress.

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