CHAPTER 4

Review of River Fisheries Valuation in Tropical Asia

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ABSTRACT

This study attempts to estimate the economic value of riverine fisheries in tropical Asia and quantify the economic impacts of any changes to the environment that affects rivers and hence fisheries. The value of riverine fisheries has been considered in the following two ways: firstly, through a compilation and summary of the results of existing studies on this topic; secondly, by estimating the direct use value of riverine and floodplain fishing by country using quantities and freshwater fish prices derived from various sources. Furthermore, a review of the characteristics of the fisheries is presented. These fisheries have been shown to be valuable (i.e., economically or socially important) in at least two specific ways: as a generator of commercially marketable output, and as a source of income and employment in relatively impoverished communities.

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1. INTRODUCTION

The aim of this report is to provide a review of the best available information on the direct value of tropical river fisheries in Asia as well as a valuation of environmental impacts, which affect rivers and hence fisheries.

In tropical Asia, a large part of the population is heavily dependent upon fishing within inland waters for their livelihoods. Catches in inland waters are profoundly affected by monsoons and have been observed to vary directly with water flow. In the dry season, predictable periods of drought occur resulting in lower catches, this is followed by increased water discharge during the wet season when the floodplains are inundated resulting in higher catches. One example is given in the study by Baran et al. (2001) who modeled the flow-catch relationship for the Dai (commercial fishery in Cambodia) in the Tonle Sap lake/ floodplain system of the Mekong. The study identified a positive correlation between the water level and the annual Dai catches. However, it is not only natural water flow that affects catches. Increasing competition for water resources and high population growth in riparian countries of major river basins, such as the Mekong, Ganges and Irrawaddy systems have elevated pressures on the distribution of water flow and depleted fisheries stocks as a result. Furthermore, there is competition for the usage of the river flow not only between countries but also for different activities, such as captures fisheries, aquaculture, agriculture (irrigation), tourism, forestry, and electricity generation.

Estimating the value of these fisheries is essential if the livelihoods of the communities dependent on them are to be protected. If the true value of the resource is not established, the resulting costs or benefits of any alteration to its present state cannot be quantified. As such, governments and international agencies that develop policies regarding the use, preservation, or degradation of natural resources will be unequipped to fully appreciate the impact on communities dependent upon fisheries.

For the purpose of this review, the geographical areas of tropical Asia will be defined as those watersheds that fall below or adjacent to the latitude denoted by the Tropic of Cancer (23° 30'). Figure 1 illustrates the watersheds considered. This assessment includes the following countries: Bangladesh, Cambodia, India, Indonesia, the Lao PDR, Malaysia, Myanmar, the Philippines, Sri Lanka, Thailand and Vietnam. China was omitted from this report because the majority of the country falls within the temperate region. Bhutan and Singapore were also excluded due to their low inland fisheries production and lack of available data.

The paper is broken down into seven sections. Following the abstract is Section 1: introduction. Section 2 then provides a description of the methodology used in this review. Section 3 briefly describes inland fisheries and riverine production in tropical Asia. Section 4 examines several economic valuation studies undertaken in tropical Asia. Section 5 highlights changes to the resource. Section 6 and 7 present the discussion and conclusion. Following the references are four useful appendices with statistical data.

2. CONCEPTUAL AND MEASUREMENT ISSUES

2.1 Economic Value

In this section, recent developments of methodology in natural resource evaluation are described. As shall be seen, the absence of market prices for most environmental assets (especially those with *public goods* characteristics) makes it particularly difficult to measure economic value in straightforward monetary terms.

The OECD (Winpenny 1995) explains the concept of economic value thus:

"To the economist, scarcity is what imparts value to a good or service. Something that is abundantly available to all who wish to consume it has no economic value, however much it may be desirable on moral, aesthetic, or other grounds. A beautiful sunset, or clean air, has no economic value so long as it is freely available to all. The moment it ceases to be freely available, it has potential economic value."

Economic value with regard to the environment is typically measured by attempting to elicit preferences for or against an improvement (or a reduction) in its current state. This often results in the generation of a monetary value. A commonly applied method is that of *willingness to pay* (WTP) where people indicate the value they are prepared to give up in order to see, for example, a specified level of improvement in or the preservation of a particular aspect of the environment. It is also possible to consider economic values as social values, as the concept of value is anthropocentric, i.e., the derived value of the resource under consideration is nothing more than that attached by the individuals themselves, the value actually residing within them rather than the objects of their assessment (Bene et al. 2002).

2.2 Economic Valuation of the Natural Environment

It is a controversial issue to place monetary value on something as intangible as the environment. Some of the points for and against this practice are worth consideration.

2.2.1 Reasons for the Economic Valuation of Natural Resources

The significance of overlooking the economic valuation of natural resources must not be underestimated. If the value of what we have in our midst is not known, informed decisions as to its use or management cannot be accurately or justifiably made. It gives certain tangibility to a resource's worth to society and, as such, any decisions regarding its

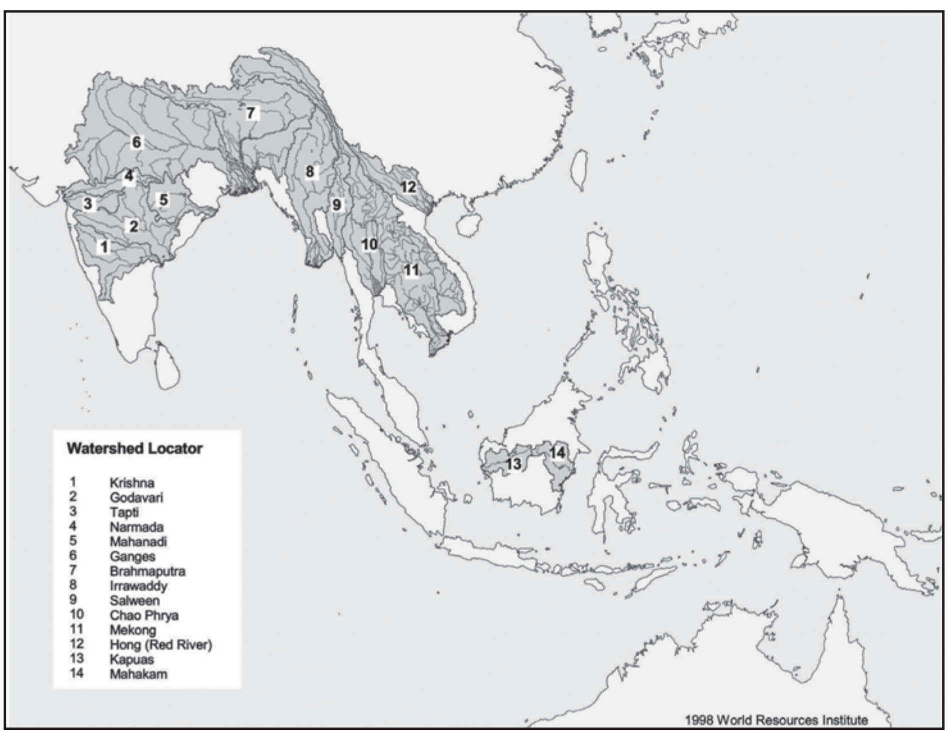


Figure 1: The major river basins in tropical Asia

preservation, use or degradation can be more easily made. If the initial value of a resource cannot be determined, the resulting costs or benefits of any alteration to its present state cannot be quantified.

Winpenny (1991) explains the importance of assigning economic value to environmental assets as follows:

- It allows measurement of the rate at which environmental resources are being consumed.

- Where environmental impacts can be quantified in monetary terms (i.e., valued) they will carry more weight with decision-makers, who can then set these data alongside other quantitative information. In such circumstances, better decisions will be made.

- By assigning a tangible, comparable, value to a resource, it reduces the number of occasions where decisions have to be made, based solely on the decision-maker's judgment.

- It can provide the basis for appropriate management or policy development, assuming the derived economic value is correct.

The use of expressions such as "*invaluable*" to describe anything must be considered dubious in nature. As Whitmarsh (1993) points out, the claim that a particular site or resource is "*priceless*", in the sense that we cannot possibly attach a monetary value to it, is simply not acceptable if it implies that it must be preserved at all costs. It is a fact that in a world of finite resources, nothing is of infinite value. However, accepting this still raises problems regarding the way a "*value*" is derived and is the matter of some debate.

2.2.2 Reasons against the Economic Valuation of Natural Resources

Although there have been substantial improvements in the techniques used to value the environment over the last two decades, a number of criticisms can be leveled against both the principle and the practice of valuation. First, it has been argued that placing a monetary value on things as intangible as the importance of species diversity or the value of life ultimately degrades the debate. Second, the potential for manipulation is present. An accusation often raised against *Cost Benefit Analysis* (CBA) is that if the requirements of objectivity are not met, the valuation process can simply end up being used to justify the desired outcome (Bowers 1990). Third, the accurate derivation of economic value requires precise economic, scientific and technical data. All of these can be notoriously scarce or costly and time consuming to obtain in developing countries.

Last of all, and with particular relevance in the present context, valuation techniques derived in the developed world are not always directly applicable to the developing world. For a start, there are likely to be important differences in respect to both social attitudes towards the environment and the functioning of ecological systems. Barbier (1993) discusses this issue from the social perspective, raising the point that the use and non-use values of areas such as wetlands tend to differ significantly between tropical and temperate areas. As a general rule, tropical wetlands occur in the developing world, whereas temperate ones exist more in the developed. The direct result of this is that many tropical wetlands are directly exploited, through *informa*l, non-market economic activity to support human livelihoods, e.g., fishing, hunting, and fire wood collection. Formal economic activity, such as tourism or recreational use, is often absent or relatively insignificant. In contrast, temperate wetlands will, with the occasional exception of commercial fisheries or forestry, be exploited more for recreation or tourism, the significance of direct exploitation being much reduced. As a result rigorous valuation and inclusion of informal, non-market, economic activity is essential if an accurate value of tropical wetlands is to be derived. Failure to do this is cited as a significant factor in policy decisions that result in the overexploitation or excessive degradation of tropical wetlands.

From the pros and cons of economic evaluation, it can be concluded that capturing the full monetary value of natural resources is a difficult task. One view is that:

> **"economic appraisal should attempt to monetize only what can be monetized, making it clear what environmental impacts have been excluded from the arithmetic and providing as much quantitative detail (even in non-monetary units) about these effects as possible." (Whitmarsh 1999)**

2.3 Total Economic Value (TEV)

The value of a resource can be defined as its total economic value. The concept of TEV is based on the recognition that natural resources are multifaceted and their absolute value is derived from the sum of both their *use* and *non-use* values. As demonstrated in Figure 2, TEV is divided into *use* and *non-use* values. Use values can be further divided into: *direct use value*, *indirect use value* and *option value.* These terms are defined below.

Direct use value is the most obvious benefit derived where individuals exploit the resource for commercial, livelihood or recreational purposes.

Indirect use value refers to a scenario where society does not profit directly or immediately from the exploitation of the resource. An example can be seen in the case where inundated forests provide habitat for the juveniles of fish stocks located elsewhere (indirect value), implying that changes to the forest (e.g., through logging) would destroy the breeding/nursery grounds and reduce catches in the future (direct value).

Option value refers to a situation where individuals are prepared to maintain a resource for possible use at a later date.

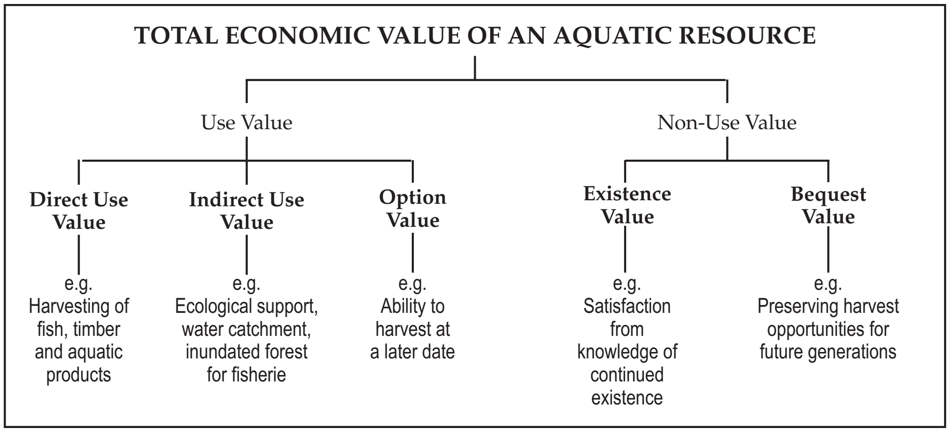
Non-use values are broken down into: *existence value* and *bequest value*.

Existence value exists where individuals are prepared to preserve something simply for the satisfaction of knowing that its existence is assured.

Bequest value exists where individuals derive value by maintaining something (e.g., a productive fishery) for the use of future generations.

The informational requirements and methodologies applied in order to derive the above values become more demanding as one moves from left to right across the bottom of Figure 2 (Laplante 2005). Direct use values are relatively straightforward to obtain; where a market exists for the derived good (e.g., fish) or service (e.g., recreation), a price is often available. As soon as one moves to the right of the direct use value box, quantification in monetary terms becomes more problematic and controversial. As such, a number of differing valuation methodologies have arisen in an attempt to tackle the issue.

Figure 2: Total economic value and its constituent parts



2.4 Applications of Resource Valuation

Economic efficiency analysis (EEA) is concerned with deriving the optimal allocation of resources in order to maximize social welfare. Two of the methods applied to measure this are: *Cost-effectiveness analysis*, where it is presumed that the least costly option is the most favorable (underpinned by the assumption that any gain in efficiency is desirable); and *Cost-benefit analysis* (CBA), where the option producing the highest benefits in relation to costs is favored.

With respect to fisheries, which are based on renewable resources and which have the potential to generate an indefinite benefit stream, it is often the quantification of *changes* to the value of output with which society is primarily concerned. It is, therefore, useful to be able to make *ex ante* assessments of interventions that may impinge on values, such as policy measures (e.g., effort controls) or public projects (e.g., stock enhancement). The potential change in benefit is commonly quantified through the application of CBA. Comparing the economic values of the current situation (the base case) with those of the one proposed gives decision-makers an indication of the economically optimal choice. However, it has been suggested that it is perhaps more appropriate to compare what the situation (and therefore the value) is expected to become under the new scenario relative to what the situation would be expected to become without the change. This is due to the fact that in many instances the two are not the same (Laplante 2005).

The value of a resource may also be assessed through the application of an *ex-post* CBA (Wattage and Soussan 2003). This type of assessment is useful when comparing the economic value of a resource over time and can be employed in instances where environmental degradation is suspected. Natural resource damage assessment is an application of this type and can be used to determine the social cost of incidents, such as an oil spill, or interventions, such as the construction of a dam.

2.5 Methods of Economic Evaluation

2.5.1. Stated Preference Methods – estimation of people's preferences based on direct questioning

(i) Contingent Valuation Methodology (CVM)

This is a direct technique where the value for a non-market good, such as clean air or water, can be estimated. CVM relies on the simulation of a market for the specified good, e.g., clean water, where individuals are then asked, through survey, what they would be willing to pay for the good or what they would be willing to accept in compensation if this good were to become unavailable or to be lost. An advantage of this technique is that it can be used to estimate both use and non-use benefits. It can also be used to directly elicit payments (open-ended forms) or to obtain yes/no answers to a predetermined WTP value (closed-ended).

(ii) Discrete Choice Modeling (Conjoint Analysis (CA))

This is another direct technique. Data collection occurs via survey and is used to represent individual judgments of multi-attribute stimuli. Individuals' preferences are estimated by determining the relative importance of attributes for goods, services, objectives and/or alternatives. The technique is based on the assumption that any good or service can be described by its attributes and that the extent to which an individual values a good or service depends on the levels of these attributes.

The four primary uses of discrete choice modelling, as indicated by Ryan and Farrar (2000), are to:

- Show how people are willing to trade between characteristics; this is useful when deciding on the optimal way to undertake a project with limited resources.

- Produce overall benefit scores for alternative ways of providing a good or service; this allows the ranking of goods or services against one another when setting priorities.

- Estimate the relative importance of different characteristics of a good objective; this allows the policymaker to observe the individual impact of each characteristic on the overall benefit.

- Estimate whether an attribute is considered important.

2.5.2. Revealed Preference Methods – estimation of people's preferences based on observed market behavior

(i) Travel Cost Method (TCM)

This indirect method is essentially based on an extension of the theory of consumer demand and considers the value of time. It originated from the desire to value areas used for public recreation, with a central assumption that the time (opportunity cost) and monetary costs individuals are prepared to incur in order to visit a specific location can be used to derive the unpriced value of a location. The required data are commonly gathered by surveying site visitors.

(ii) Hedonic Pricing Method

This is another indirect method; it assumes that the price of a commodity and its characteristics are related. Where one of these characteristics relates to the condition of the environment, e.g., water quality, the relationship between price and the characteristic can be used to derive a monetary value for clean water. This technique has often been applied in the housing market. Price differences that reflect the value of local environmental attributes are used to estimate the values (positive or negative) associated with changes in environmental quality (e.g., water/air quality) or amenities (e.g., aesthetic views). This methodology relies on the availability of data pertaining to house prices, quality of the environmental factor under scrutiny, and a set of attributes that influence property prices.

(iii) Production Function Analysis

This methodology is predicated on the idea that there is a physical relationship between the output of an economic activity (e.g., fishing) and the various factor inputs (human, man-made and natural) that are used in its production. Changes in any of the inputs will, therefore, be expected to have an affect on the level of output, the precise relationship between input and output being determined *inter alia* by the technological and biological characteristics of the system. The production function approach to economic valuation has a very wide potential application to fisheries. If outputs can be measured in monetary terms (using market or shadow prices) then it becomes possible to indirectly estimate a monetary value for the natural inputs (i.e., fish population and/or critical habitat) that generate it. Several studies into habitat-fishery linkages have adopted this analytical framework; those of particular note are by Hodgson and Dixon (1988) on coral reefs in the Philippines and Barbier and Strand (1998) on mangroves and shrimp fisheries in Mexico. Despite its potential, the production function approach has a number of limitations. First, it requires data on the prices of the outputs, which largely restricts its application to situations where a marketed commodity is being considered. For this reason, it is unable to account for the non-use value of fisheries resources, which *ipso facto* is unpriced. Second, it requires a relatively robust understanding of the physical (i.e., causal) relationships between input and output. Without such information, it is clearly not possible to make predictions about how the value of a fishery will alter as a result of environmental impacts brought about by policy intervention (e.g., vessel licensing) or anthropogenic disturbance (e.g., pollution).

(iv) Sustainable Livelihood Analysis (SLA)

Livelihood analysis is an attempt to go further than conventional economic analysis, such as CBA, where consideration is only given to whether there will be a net gain to society as a whole, neglecting the issue of how this gain is apportioned within society. The principal of *potential compensation*, where there is a net gain to society if the winners can afford to compensate the losers and still be better off, is an acknowledgement of this issue. However, the fact that this compensation rarely makes the transition from *potential* to *actual* is where the problem lies.

In the developing world, the question of who gains and, often more importantly, who loses is something that should be given careful consideration, especially when the losers are often the poorest members of society. Participatory methodologies are a holistic, people-centered approach, developed to help understand and analyse the livelihoods of the poor. The main aim of these techniques is usually to empower people. As DFID (2000) describes “participatory methods are not a fixed set of methods but rather a way of thinking, behaving and acting”. Some of the techniques used in these studies are: semi-structured interviews, focus group discussion, preference ranking, mapping, and modeling. Outputs such as identification of the social hierarchy can then be followed up allowing the path of any potential benefit flows to be mapped.

DFID (2000) lists the six core objectives of SLA; they are as follows:

- Improved access to high-quality education, information, technologies and training and better nutrition and health;
- A more supportive and cohesive social environment;
- More secure access to, and better management of, natural resources;
- Better access to basic and facilitating infrastructure;
- More secure access to financial resources; and

- A policy and institutional environment that supports multiple livelihood strategies and promotes equitable access to competitive markets for all.

The framework of SLA is illustrated in Figure 3; it can be divided into five core components moving from left to right: (1) the vulnerability context under which the communities being considered operate; (2) the livelihood assets of these communities; (3) the policies, institutions and processes that affect their lives and their access to livelihoods assets; (4) the livelihood strategies adopted by the communities; and (5) the outcomes they achieve or aspire to. The framework's main components emphasize their influences on livelihoods.

In focusing on these five components, the livelihoods approach aims to influence policy in a way that improves the well being of the communities under consideration. It addresses issues relating to reduced vulnerability and resource exploitation patterns in the pursuit of increased well-being. These values are difficult to assess but highly important when attempting to ensure basics such as food security.

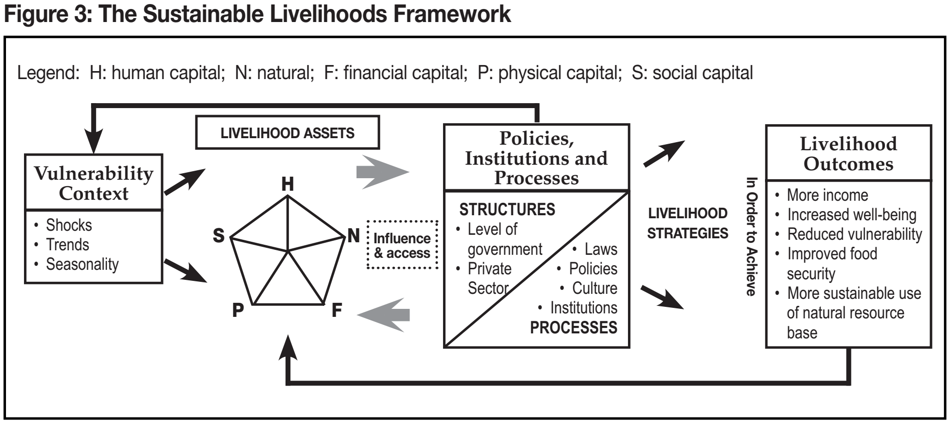
SLA is a highly useful set of techniques when valuing inland fisheries in developing countries as the resource is usually under threat from a multitude of factors and the areas have hardly or never been evaluated before. SLA allows researchers to quickly understand the area, the threats to the fishery, and conflicts among different stakeholders. SLA can be very useful in providing an initial evaluation of the resource before other data collection techniques (e.g., socioeconomic surveys) are used. As such, the use of SLA is limited as a technique of valuing inland fisheries.

2.6 Data and Sources of Information

As can be seen in section 2.5 there are, therefore, a range of methods that can potentially be applied to value fisheries. The choice of method will depend in the first instance on the question being addressed (e.g., economic efficiency in resource use, livelihoods of fishing communities, etc.). However, a serious practical constraint on the choice of valuation technique is the availability of data. As shall be revealed shortly, the reason why the vast majority of empirical studies on Asian river fisheries have focused on the direct use benefits of fishing is mainly due to the methodological challenge of obtaining reliable numerical estimates on the indirect and non-use benefits of aquatic resources.

In this report, information has been collated from an extensive search of the peer reviewed, internationally recognized, literature

Figure 3: The Sustainable Livelihoods Framework



and major databases. Owing to nature of the subject, there was also significant reliance on the so-called "gray literature", such as reports produced by the OECD, DFID and the FAO. To put these studies in context, some basic factual data are presented in Section 3 on the absolute and relative importance of Asian fisheries. In Section 4, examples are provided of empirical investigations that attempt to value riverine and other connected inland capture fisheries. The studies have been chosen based on their economic methodology and ability to generate an overall value for the fishery under review. In particular, studies were selected so as to provide some comparison of values created by fisheries with those of other activities exploiting rivers. The ability to compare different activities in this way is especially useful since it provides a more complete picture of the issues affecting the livelihoods of people within the area.

3. INLAND FISHERIES PRODUCTION

FAO figures for inland capture fisheries, aquaculture and total fisheries production for tropical Asia in the year 2002 are presented, by country, in Table 1. The percentage contribution of inland capture fisheries to total production for each of the countries evaluated is also shown.

The values in Table 1 indicate that Bangladesh is the country with the highest level of inland capture fisheries production. Floodplains followed by rivers and estuaries are the most productive fishing resources in Bangladesh (Liaquat and Zahirul 1997). Nevertheless, catches have declined over the years due to a major loss of habitats. This has been caused by: large-scale water abstraction for irrigation, construction of embankments for flood controls, siltation and soil erosion due to deforestation in the catchments. Excessive fishing pressure and destructive fishing practices have also contributed to declining catches (FAO 1994). When considering the contribution of inland capture fisheries to total production, Cambodia has the highest ratio (excluding Bhutan which only has inland fisheries production). Nevertheless, if we examine Cambodian production, no marine fisheries are reported in the FAO statistics.

Table 1: Inland capture fisheries, aquaculture and total production in tropical Asia in the year 2002

Country	Inland capture fisheries (t)	Aquaculture (t)		Total production (t)	Marine production	% inland to total production
		Freshwater	Brackishwater			
Bangladesh	688 435	696 997	32 026	1 890 459	473 001	36.4
Bhutan	300	0	0	300	0	100
Cambodia	411 150	14 133	0	425 283	0	96.9
India	425 283	2 076 734	0	6 061 366	3 559 349	7.0
Indonesia	316 030	429 166	313 531	5 679 391	4 620 664	5.6
Lao PDR	33 440	59 716	0	93 156	0	35.9
Malaysia	3 572	44 370	310	1 463 625	1 415 373	0.2
Myanmar	304 529	114 716	0	1 433 908	1 014 663	21.2
Philippines	131 111	147 362	216 686	3 371 874	2 876 715	3.9
Singapore	1 058	616	0	7 796	6 122	13.6
Sri Lanka	28 130	3 670	0	306 896	275 096	9.2
Thailand	205 500	327 795	98	3 566 106	3 032 713	5.8
Vietnam	149 200	390 000	28 000	2 042 500	1 475 300	7.3

Source: FAO FISHSTAT (2005)

Cambodian marine production is very small in comparison to inland fisheries production, but it does exist. The Cambodian government reported 36,000 tonnes of marine production in the year 2000 and 245,600 tonnes inland capture fisheries production for the same year (Planning and Accounting Office 2001). Nevertheless, the inland capture figure provided by the Cambodian government is very low compared to FAO's values and other expert values for this fishery. For example, Van Zalinge and Thuok (1999) estimated Cambodian inland capture fisheries to be in the range of 279,000 – 441,000 tonnes per year. The substantial discrepancies between sources for Cambodia is by no means an isolated case. This issue is highlighted in Appendix 1, which presents a compilation of the most recent estimates for riverine and floodplain fisheries production by country. This section provides some insight into the productivity of rivers and their floodplains within tropical Asia. However, this table also demonstrates the wide range in catch estimates derived from separate studies, demonstrating the need for more rigorous statistical evaluation of the resource.

4. ECONOMIC VALUATION CASE STUDIES

4.1 The Mekong River System

The Mekong River, now a dominant hydrological feature of Southeast Asia, originates in China and flows through Myanmar, Laos, Thailand, Cambodia and Vietnam. When compared with other river systems of the world, the Mekong ranks 8th in terms of discharge (15,000 m^3/second). It is the 12th longest river in the world (4,800 km) and has the 21st largest catchment area (795,000 km^2).

To the authors' knowledge, no non-market valuation studies have yet been conducted to value the environmental attributes of the Mekong River Basin. Rapid agricultural and economic development in the basin is resulting in increasing competition among the riparian countries for Mekong waters and means the need for such studies is increasing. Furthermore, there is competition for use of the river flow not only among countries but also within different activities, such as capture fisheries, aquaculture, agriculture (irrigation), tourism, forestry and electricity generation. Several models have been proposed in the literature in an effort to understand the interactions of different groups and different areas along the Mekong. The study by Ringle and Cai (2003) is especially noteworthy as it estimates the economic value of different activities along the entire Mekong River system. The results are reported below. Following this, we present the economic valuation of wetlands in the Mekong Delta.

4.1.1 Water Use in the Mekong River Basin (Ringle and Cai 2003)

The authors analyze alternative water-use strategies and their implications on riparian countries. The Mekong Basin is divided into seven sites: one in China, one in Laos, two in Thailand, one in Cambodia, and two in Vietnam. The baseline year is 1995. The data have been collected from several national and international databases. The model contains three components:

- Hydrological components, including the water balance in reservoirs, river reaches and crop fields.
- Economic components, including the calculation of economic benefits from water use by sector (irrigated agriculture, domestic-industrial areas, wetlands, fisheries and hydropower).

- Institutional rules and economic incentives that impact upon the economic and hydrologic components.

Water supply is estimated through the hydrological water balance in the river system. Water demand is estimated endogenously through water use by sector. Afterwards, water supply and demand are balanced based on the objectives of maximizing economic benefits to water use. The benefits from water use are presented in Table 2.

As shown in Table 2, Cambodia is the only country obtaining its highest economic return from fisheries. The rest of the countries in the Mekong obtain their highest economic returns from irrigation. This result agrees with the findings of Seckler et al., (1999), who argue that irrigated agriculture is the largest user of the world's fresh water. The direct use values of the fishery in the Mekong River Basin have been estimated by Ringle and Cai (2003) and Sverdrup-Jensen (2002). Both of these studies have obtained similar results and they are presented in Table 3.

Ringle and Cai (2003) do not specify how they estimated the price and cost for riverine fisheries production. Sverdrup and Jensen (2002) indicate prices from capture fisheries as the average first-hand sale price and for aquaculture as the average farm gate price. For the reservoir fisheries, a conservative value of US$ 680/t is used, because although the fish are produced by both aquaculture

Table 2: Baseline scenario, profits from water use in the year 1995

Country/Region	Irrigation	Domestic/ Industrial water use	Hydropower	Capture Fisheries	Wetlands	Total
			(million US$)			
China (Yunnan)	20	11	.	0.05	.	31
Laos	38	6	33	19	5	101
Vietnam	513	81	.	188	44	825
Vietnam (Central Highland)	29	6	.	.	.	35
Vietnam/ Mekong Delta	484	75	.	188	44	790
Thailand	320	65	10	151	4	551
North Thailand	52	5	.	10	.	68
North-East Thailand	268	60	10	141	4	483
Cambodia	26	7	.	188	80	301
Total Basin	917	170	43	546	134	1 809

Source: Ringle and Cai 2003

Table 3: Fisheries production of the Mekong River Basin

Authors	Production	Quantity (tonnes)	Price (US$/ tonne)	Value (US$ millions)	Estimated cost (US$/tonne)	Profit (US$ millions)
Ringle & Cai (2003)	Riverine capture	1 162 400	750	871.8	280	546.3
Sverdrup-Jensen (2002)	Riverine capture	1 533 000	680	1 042	.	
	Aquaculture	260 000	1 050	273	.	.
	Reservoirs	240 000	680	163	.	.
	Total	2 033 000	.	1 478		

and capture fisheries, the relative proportions cannot be estimated.

The results obtained by Ringle and Cai (2003) are presented in Section 5. The authors performed sensitivity analysis in order to evaluate the variation in economic value for the different activities.

4.1.2 Economic Valuation of Mangroves in the Mekong Delta (Trong Nhuan et al. 2003)

This study concentrates on analyzing the available data from previous research, and aims to provide the economic value (EV) of the main wetlands in Vietnam. Two of the provinces analyzed are Tra Vinh and Ben Tre (on the Tien River estuary). The Mekong River empties into the ocean in these two provinces. The EV estimated for the mangroves in both provinces is presented in Table 4 and Table 5. The overall picture from the emerging economic data is that wetlands are economically important to the country. The difficulties of estimating the value of all the ecosystem effects of mangroves are recognized in this study, which focuses on the valuation of the direct use benefits of products. Also overlooked are various sources of *non-visible* value, such as the benefits to the poor derived from the collection of (freely available) natural products. Both these limitations mean that the value of mangroves in the Mekong Delta is probably much higher than actually estimated.

Table 4: Ben Tre Province (on Tien River Estuary)

Direct use value	Low value (US$)	High value (US$)
Timber	9.52	10.34
Fuel wood	5.65	6.01
Coal	Not available	Not available
Aquaculture	1 401.96	1 469.28
Organized fishing	1 078.43	1 189.54
Unorganized capture fisheries (brackish/fresh)	316.99	409.80
Tourism	10.46	14.38
Indirect Use Value		
Stabilizing micro-climate, improving air quality, water quality, protecting the site from water surge, etc.	Not available	Not available
Economic Value/ha	2 823	3 099

Source: Adapted from Trong Nhuan et al. 2003

Table 5: Tra Vinh Province

Direct value	Low value (US$)	High value (US$)
Timber	9.93	10.49
Fuel wood	4.90	5.39
Aquaculture	1 211.76	1 339.87
Unorganized capture fisheries (brackish/fresh)	947.71	1 078.43
Tourism	166.01	186.27
Indirect value		
Stabilizing micro-climate, improving air quality, water quality, protecting the site from water surge, etc.	Not available	Not available
Economic Value/ha	2 340	2 620

Source: Adapted from Trong Nhuan et al. 2003

Table 6: Distribution of catch (t) and level of effort (gear hr x 10^6) in the base model for riverine fisheries of Bangladesh by river group

	Meghna	Padma-Ganges	Jamuna-Brahmaputra	Other Rivers	Total
Total actual catch	73 533	5 238	3 879	104 437	189 087
Total estimated catch	63 942	5 870	6 323	97 028	173 163
Estimated direct catch	56 950	4 630	5 021	73 256	139 857
Estimated bycatch	6 992	1 240	1 302	23 772	33 306
Total actual effort[a]	221 320	26 555	16 062	166 367	430 304
Total estimated effort[b]	93 793	7 637	6 684	88 940	197 054

[a] Approximate levels based on sample survey by the author, and survey of fishing units by DOF (unpublished data)

[b] Actual average annual catch from 1983-84 to 1989-90 (DOF unpublished data)

Source: Ahmed (1996)

4.2 Bangladesh

4.2.1 Net Economic Benefits from Riverine Fisheries in Bangladesh (Ahmed 1992, 1996)

In these two studies, the author determines the total benefits obtainable from various riverine fisheries in Bangladesh (Ganges, Jamuna-Brahmaputra, Meghna and others) under an optimal management regime. Both studies use a non-linear programing model. The use of a mathematical optimization approach enables incorporation into the model of non-linear catch-effort and cost functions, as well as price-responsive demand functions. This model allowed the author to estimate the performance-response of the fishery under different simulated changes in cost of harvest and changes in aggregate demand for fish. The data used in the analysis were the actual average annual catch from 1983-84 to 1989-90. Activity sets and constraints of the model were grouped into three blocks: harvesting, post-harvest handling (processing, transporting, storing, and marketing), and selling (retail demand). These blocks represented biological, technological, and market characteristics and interdependencies across species, space (region), time period of fishing (season), and the environment (different fishing grounds and/or rivers). The results presented in Tables 6 and 7 are for the whole fishery. Table 6 presents the actual and estimated catches and effort for the different river groups. A summary of the results of the base model for all the riverine fisheries of Bangladesh is given in Table 7.

As presented above, the optimal level of harvest is 173,163 tonnes. Of the total harvest, a significant portion comes as bycatch. In relation to fishing effort, the current actual annual level of effort is roughly 430,304 million gear (square meters) hour, which is about 118 per cent higher than the estimated level of effort. In relation to individual rivers, the size of current effort is higher by 136 per cent in the Meghna River, 247 per cent in the Padma-

Table 7: Summary of results of the base model for riverine fisheries of Bangladesh

Benefit-cost (Bangladesh Taka x 10^6)	
Net benefit	1 383
Gross benefit	5 634
Producer surplus	1 289
Consumer surplus	94
Total revenue	5 540
Total cost	4 251
- Harvest cost	2 435
- Post-harvest cost	1 816
Total Effort (gear hour x 10^6)	197 054
Catch per Unit of Effort (kg)	879

Source: Ahmed (1996)

Ganges River, 140 per cent in the Jamuna-Brahmaputra River and 87 per cent for other rivers. This shows that the principal rivers, especially the Padma-Ganges River, have a relatively higher level of excess capacity as compared to (other) small rivers.

The author believes that the reason for the high level of fishing effort in the Padma River is due to a 70 per cent reduction in annual fishery harvest in the Padma River from 1983-84 to 1989-90. The decline in fish catches was due to severe environmental degradation, such as loss of water flows and siltation due to the effect of the dam constructed in the Indian territory. There was no commensurate reduction in fishing effort.

The results of the base model are presented in Table 7. The total net benefit yielded by the various riverine fisheries is 1,383 million Bangladesh Taka (US$ 43 million) of which 1,289 million Bangladesh Taka (96%) constitutes the producer surplus and the remaining 94 million Bangladesh Taka constitutes the consumer surplus (4%). Because all costs are considered to be in terms of opportunity costs, the value for producer surplus can be treated as the total factor surplus.

The total cost of harvest and post-harvest activities is 4,251 million Bangladesh Taka, which is 77 per cent of the gross revenue. Of the total cost, 57 per cent represents the cost of fishing or effort (2,435 million Bangladesh Taka). The remaining 43 per cent (1,816 million Bangladesh Taka) represents the market margin or the cost of post-harvest handling, processing, and transporting of fish and fish products, equivalent to 33 per cent of the aggregate gross revenue.

The changes to the baseline model due to changes in fishing effort and demand will be presented in Section 5.

4.2.2 Stocking Seasonal Floodplains in Bangladesh for Capture Fisheries (Ali and Islam 1997)

The contribution of inland open waters to the country's fish production has declined to about 50 per cent at present. This is due to the natural reproduction of fish being disturbed by Overfishing and other causes. Under a project named the Third Fisheries Project (TFP) carp fingerlings were directly stocked into mainly seasonal floodplains in western Bangladesh. Stockings took place in six growing seasons over a period of six years (1991-96).

Stocking of carp fingerlings in floodplains is done by the Department of Fisheries in order to:

- Increase fish production by making use of underutilized resources
- Enhance the income for fishers
- Create employment opportunity

The economic analysis was done for eight floodplains out of the 26 floodplains that have actually been stocked. The author used the statistical data in catches and costs collected to estimate the average net benefits of stocking beels (deep floodplains) over the six years of stocking and thereafter. The results are presented in Table 8.

The analysis shows losses up to the third year, after which floodplain stocking generates net economic benefit. From 1997 onward, the study estimates net benefits to be 52,848,000 Tk every year.

The author also carried out a socio-economic survey on the local fishers fishing within the studied floodplains.The impact of flood-plain

Table 8: Economic analysis of selected beels floodplain stocking (actual to 1996; constant after)

Parameter	1991	1992	1993	1994	1995	1996	1997
Stocking area (ha)	3 700	13 200	14 700	22 200	22 200	22 200	22 200
Stocking quantity (kg)	73 049	253 874	249 094	428 606	265 658	325 539	358 591
Stocking density (kg/ha)	20	19	17	19	19	15	16
Stocking price (Tk/kg)	66	88	119	99	89	84	87
Catch (kg)	0	694 716	511 271	2 180 637	4 372 701	3 338 782	3 707 679
Catch/ha (kg)		53	35	98	308	150	167
Mean catch price (Tk/kg)		26	30	34	34	32	35
Costs (Tk'000)							
Stocking cost	4 855	22 419	29 559	42 284	23 624	27 313	31 148
Fishers' labor costs	634	5 696	8 645	10 991	9 922	11 591	11 591
Fishers' equipment costs	912	8 731	13 458	18 167	14 688	20 026	20 026
DOF admin costs	2 065	9 165	13 987	17 735	7 998	10 195	10 195
NGO supervision	0	392	276	260	3 690	7 124	7 124
Other supervision	0	0	0	17	111	111	111
Total financial costs	8 666	46 403	65 927	89 466	59 936	76 360	80 195
Total econ. costs	7 366	39 442	56 036	76 046	50 947	64 906	68 166
Benefits (Tk'000)							
Incremental catch	0	18 086	15 576	73 659	150 338	107 970	128 931
Total financial benefit	0	18 086	15 576	73 659	150 338	107 970	128 931
Total econ. benefit	0	15 373	13 239	62 610	127 787	91 775	109 591
Net benefits (Tk'000)	(7 366)	(24 069)	(13 436)	76 840	26 868	41 426	52 848
Net econ. benefits		42 020					
NPV @ 12%		29.70%					

Source: Ali and Islam 1997

stocking on local fishers is summarized in Table 9.

The socioeconomic evaluation indicates a better status of local fishers resulting from the fingerling-stocking program.

4.3 India

Social and Economic Aspects of Fisheries Enhancement in Kerala Reservoirs, India (Peters and Feustel 1997)

Reservoir culture-based capture fisheries are relatively new in Kerala, India. Overfishing and pollution have deeply affected the lives of many people. From 1992, the Indo-German Reservoir Fisheries Development Project (IGFP) has stocked several reservoirs. In 1996, ten reservoirs were managed under a culture based fishery and harvested by members of fisheries cooperatives and independent fishers. The aims of the project are as follows:

- Involve fishers in developing appropriate reservoir management strategies
- Provide fishery related income from the reservoir to the fishers
- Involve the community in planning and decision making
- Provide cooperative action planning and technical training to the target group

The authors undertook a socioeconomic

Table 9: Impact of floodplain stocking on local fishers

	Name of Floodplain		
Indicator	**CHANDA**	**BSKB**	**HALTI**
	Land assets		
Before (1991-92)	60 688	72 644	121 893
After (1993-94)	63 020	83 458	128 751
% Increase	4	14	5
	Livestock assets		
Before (1991-92)	4 678	5 086	4 441
After (1993-94)	6 138	5 136	4 991
% Increase	31	100	12
Fishing income			
Before (1991-92)	1 126	2 822	2 763
After (1993-94)	7 324	5 810	6 843
% Increase	550	105	147
	Per capita daily fish consumption (g)		
Before (1991-92)	20.30	5.62	8.71
After (1993-94)	48.79	18.11	24.76
% Increase	140	222	180
	Housing assets		
Before (1991-92)	11 570	10 361	10 877
After (1993-94)	12 487	11 579	11 176
% Increase	7	11	2

Source: Ali and Islam 1997

survey of five different reservoirs and used the recorded catches from the cooperative to estimate the returns from stocking the reservoirs. It is believed that recorded catches were greatly underestimated because the cooperative fishers preferred to channel their catches to the market instead of selling them through the cooperative counter. This occurred because fishers get a higher price for their catches in the market and also do not have to pay a share to the cooperative and the royalty to the government. The returns from stocking the Malampuzha reservoir presented below show the decline in reported catches to the co-operative despite the increase in stocking (Table 10). Also presented are the differences in prices obtained from the co-operative and the average prices in the markets near the reservoir of Malampuzha (Table 11). Finally, the authors compared the income of a co-

Table 10: Quantity and price of fingerlings and harvest in Malampuzha reservoir

Year	Stocking (individuals)	Harvest (kg)
1991-92	1 445 625	4 821
1992-93	3 446 370	4 306
1993-94	2 243 610	6 118
1994-95	3 185 746	1 518
1995-96	2 538 102	933
Average price of fingerlings	0.30 Rs/individual	
Average price for yield	25 Rs/kg	

Source: Peters and Feustel 1997

Table 11: Comparison of fish prices in the market near the Malampuzha reservoir and cooperative society prices

Co-operative Society Prices (in Rs)		Average Market Prices (in Rs)		
Species	Co-op	Market I	Market II	Market III
Stocked carps	25	35	35	30
Other indigenous spp.	15	30	30	25

Source: Peters and Feustel 1997

Table 12: Calculation of cooperative fisher's income from a 5-kg average catch per day and average incomes per day in other professions

Catch (kg)	Fish Sales Price (Rs)	Total Value (Rs)	Coop 25% Share	Govt. Share (Royalty) 25%	Daily Income (Rs)
5	20	100	25	25	50
Other Professions:		Agriculture Labor (Seasonal Men)			70-100
		Agriculture Labor (Seasonal Women)			45-70
		Firewood Collection (Women)			60
		Toddy Tapping (Men)			100
		Wood Cutting			125
		Minor Forest Produce Collection			50-60

Source: Peters and Feustel 1997

operative fisher from a 5 kg average catch per day with average incomes per day in other professions (Table 12). As can be observed, the income of a fisher whose catch is less than 5 kg per day is far below the amount that can be earned from daily wages in most other sectors.

4.4 Indonesia

Management Options for the Inland Fisheries Resource in South Sumatra, Indonesia: Bioeconomic Model (Koeshendrajana and Cacho 2001)

Fishing is an important occupation for a large number of rural people living in the floodplains of the Musi River and its major tributaries in South Sumatra, Indonesia. In this study, an evaluation of the status of the existing fish stock was undertaken, and an analytical model for identifying efficient levels of exploitation of the fishery was developed. The fishery is divided into two different types: the riverine and swamp fisheries. The swamp fishery refers to the total of lake and swamp fishery data. Primary data are used to describe the current costs of fishing effort. Secondary data (catch data from 1979-94), combined with results of analysis of primary data, are then used to derive a supply function of the fishery. Primary data was obtained through a cross-sectional survey in 1994 undertaken by the authors. Information was obtained about costs and landing prices in rivers and swamps. The total costs of fishing effort (TC) for the standard fishing unit in South Sumatra were Rp 2,974 and Rp 2,631 in river and swamp fisheries, respectively. The average actual prices of freshwater fish at the producer level were 1,215 Rp/kg (riverine) and 1,125 Rp/kg (swamp). The difference in prices between resources may indicate that the quality of harvested fish from the river is better than from the swamp. The authors chose two different models for identifying efficient levels of exploitation of the fishery: the Gordon-Fox model and the Gordon-Schaefer model. The various critical points for both models and the average actual capture during the period of study for both fisheries are presented in the Table 13.

Table 13: Calculated effort, catch, costs, revenues and profits of the inland fishery in South Sumatra, Indonesia based on the empirical model

Model/Resource	Harvest condition					
	MSY	MEY	MScY	BE	BESc	Actual (mean)
			Schaefer/River			
Effort (1 000 trips)	6 711	4 696	5 374	10 748	9 392	7 217
Catch (tonnes)	27 350	24 884	26 264	17 458	22 986	22 833
Cost (M Rp)	19 957	13 964	15 979	21 459	27 928	21 459
Revenue (M Rp)	33 231	30 234	31 911	21 459	27 928	27 743
Profit (or resource rent) (M Rp)	13 274	16 270	15 931	0	0	6 283
			Schaefer/Swamp			
Effort (1 000 trips)	4 407	4 281	4 329	7 246	6 285	5 415
Catch (tonnes)	17 960	17 945	17 955	10 508	14 701	14 830
Cost (M Rp)	11 597	11 265	11 391	11 822	16 538	14 249
Revenue (M Rp)	20 205	20 189	20 199	11 822	16 538	16 684
Profit (or resource rent) (M Rp)	8 608	8 924	8 808	0	0	2 435
			Fox/River			
Effort (1 000 trips)	6 472	3 763	4 468	12 053	9 400	7 217
Catch (tonnes)	24 900	22 002	23 427	19 578	23 005	22 833
Cost (M Rp)	19 246	11 190	13 285	23 788	27 951	21 459
Revenue (M Rp)	30 253	26 733	28 464	23 788	27 951	27 743
Profit (or resource rent) (M Rp)	11 007	15 543	15 180	0	0	6 283
			Fox/Swamp			
Effort (1 000 trips)	4 120	2 450	2 951	8 140	6 170	5 415
Catch (tonnes)	15 851	14 137	15 078	11 805	14 433	14 830
Cost (M Rp)	10 843	6 447	7 765	13 280	16 237	14 249
Revenue (M Rp)	17 832	15 904	16 963	13 280	13 237	16 684
Profit (or resource rent) (M Rp)	6 990	9 457	9 197	0	0	2 435

MSY=Max. Sustainable Yield; MEY=Max. Economic Yield; MScY=Max. Social Yield; BE=Bionomic Equilibrium; BESc= Bionomic Social Equilibrium;

Source: Koeshendrajana and Cacho 2001

Results indicate that, from both biological and economic perspectives, the inland capture fishery in South Sumatra has been over-fished during the period of the study because the actual effort is beyond both MEY and MSY levels. Even though MEY produces the highest resource rent, the required reduction in fishing effort implies that some fishers may be forced out of fishing, a result that would be socially unacceptable if applied to the small-scale fisheries in Indonesia. Therefore, the authors suggest that policy actions in the small-scale fishery should be directed to maximizing social yield (MScY) instead. Under social optimization (MScY), the fishing effort would also have to decrease relative to the actual simulation, but not by as much as with MEY. The optimal solutions derived from the Schaefer and Fox models are similar. However, the fishing effort in the Schaefer model is higher than in the Fox model. In the riverine fishery, the Schaefer model yield values of E_{MScY} (5.37 million trips) that are 20 per cent higher than in the Fox model. In the swamp fishery, the Schaefer model yields values of E_{MScY} (4.33 million trips) that are 46 per cent higher than in the Fox model. If a more conservative (i.e., lower) level of effort is desired on biological grounds, then the Fox model results would presumably be favored.

4.5 Malaysia

Fisheries Evaluation of the Chenderoh Reservoir Using the Rapid Rural Appraisal (RRA) Technique (Livelihood Analysis) and Fishers Survey (Ali and Lee 1995)

A study considering the artisanal fishery of Chenderoh Reservoir, Perak River, Malaysia was conducted using a fishers and middlemen survey and RRA evaluation. The RRA provided the socioeconomic background of the fishing community. Furthermore, the RRA indicated the number of landing sites, active fishers and middlemen, and it provided information on the numbers, types of fishing gear, and the sizes and mesh sizes of gill-nets used. The survey was conducted fortnightly from April 1988 to May 1989 at Kg. Pelagut, the main landing site of the reservoir, but the other three landing sites were determined through the RRA and it was estimated they were small and insignificant. Three types of data were obtained from the fishers, the number of active fishers per day, the amount landed, and the sizes and body weight of fish caught. The middlemen indicated the number of active fishers, the types of gear used, and the total daily landings. From this information, the authors estimated monthly and annual catches as well as catch per hectare of the reservoir's surface area. Furthermore, gear uniformity and single operator/ownership among fishers allowed catch per unit of effort (CPUE) to be calculated based on the fisher's day as a unit of effort. Table 14 gives a summary of the monthly catch statistics of capture fisheries for the 1988-89 season.

The study identified four commercial landing sites around the lake, each controlled and operated by permanent middlemen. The

Table 14: Monthly catch statistics of fisheries during the 1988-89 season at Kg. Pelagut (Malaysia)

Catch Parameters	April	May	June	July	Aug	Sept	Oct
Total monthly catch (kg)	2 542.1	1 791.4	8 97.2	841.7	3 328.6	803.4	704.5
CPUE (kg/fisher-day)	6.5	7.3	8.4	2.7	9.5	3.3	2.8
Total daily catch (kg)	84.7	7.9	29.9	27.2	107.4	26.8	22.7
Total daily income (M$)	236.2	200.2	53.0	90.0	285.0	71.2	41.8
Total monthly income (M$)	7084.8	6 006.2	1 591.0	2 699.6	8 548.9	2 135.9	1 253.5
Daily income/fisher (M$)	18.0	22.9	10.6	9.1	28.1	7.7	4.9
	Nov	**Dec**	**Jan**	**Feb**	**March**	**April**	**May**
Total monthly catch (kg)	5 472.2	1 928.6	1 109.7	3 376.3	1 760.3	2 815.9	3 279.1
CPUE (kg/fisher-day)	12.8	7.1	3.0	10.4	8.6	7.2	6.5
Total daily catch (kg)	182.4	62.2	35.8	120.6	56.8	93.9	105.8
Total daily income (M$)	405.1	185.7	85.8	330.7	152.0	238.6	254.7
Total monthly income (M$)	1 2152.2	5 570.8	2 575.0	9 922.2	4 561.1	7 156.6	7 639.7
Daily income/fisher (M$)	32.0	24.3	9.3	32.4	21.3	19.5	15.9
Total annual catch (kg) landed by the fishing community 25 713 kg							
Total annual income (M$) obtained by the fishing community $63 179.74 (US$ 1 = M$ 2.60)							

Source: Ali and Lee, 1995

total annual catch and income generated by the fishery was 25,713 kg and M$ 63,179.74, respectively.

4.6 Sri Lanka

4.6.1 Valuing Water in a Multiple-use System (Renwick 2001)

The inland capture fisheries of Sri Lanka are almost entirely restricted to its perennial reservoirs. It is reported that there is a lack of any riverine fishery worth mentioning and that the main share of inland production originates from the reservoirs (Sugunan 1997). This situation is reflected in the available literature. However, one noteworthy study is by Renwick (2001), who examines the economic contribution of multiple uses (agriculture, a consumptive use, and reservoir fisheries, a non-consumptive use) within the Kirindi Oya Irrigation and Settlement Project (KOISP) in southeastern Sri Lanka. The economic value of water in irrigated paddy and fisheries are estimated for the KOISP as a whole and on a per-cubic-meter basis.

Initial failure of the KOISP project to deliver an expected two crops a year on all the 9,600 hectares of land has led to alternative management strategies being considered. The derived values are used to examine the economic implications of alternative water management practices. It was assumed that improvements in allocative efficiency may be achieved if decision makers account for fishery requirements in management decisions. Agriculture plays a substantial role in the local economy of the Kirindi Oya area, accounting for about 55 per cent of the household income in the KOISP. Paddy cultivation is the largest single source of agricultural income, averaging 30 per cent for the area. However, approximately half the households surveyed relied on fishing as the sole source of household income. Surveys were conducted on 12 per cent (20 boats) of the estimated 157 fisher boats operating in three reservoirs. Detailed information was obtained on: monthly catch, amount of catch sold and consumed at home, prices received in wholesale and retail markets, type of boat and nets, and specific costs. The economic contribution of inland fisheries in the KOISP area was calculated by using the estimated economic returns to fishery operators and the value of water in fisheries. Data were collected for three of the five waterbodies in the area where commercial inland fisheries exist, namely, Lunugamwehera Reservoir, Wirawila Tank, and Yoda Wewa. In combination, these account for about 81 per cent (4,100 ha) of the total reservoir surface area in the project.

See Table 15 for information on catch, value of production, costs of production and economic returns for the three waterbodies surveyed. The value of production was estimated based on the actual monthly catch per unit of effort (CPUE) data, number of trips per month, home consumption, amount sold by each fisher to wholesale and retail markets, and actual prices received. Average annual costs were estimated to be 23 per cent of the total value of production in each reservoir. Economic returns were also estimated in order to provide a measure of the economic value of water in the reservoir fisheries. This calculation included the value of both marketed fish and those consumed at home, as well as the costs of non-cash inputs such as labor and depreciation of fixed assets. The economic return per boat was estimated to be roughly US$ 2,789 and the average economic return per fisher (usually two per vessel) to be approximately US$ 1,395.

Annual returns for all five commercially important fisheries were estimated based on actual monthly returns to fishers for the surveyed reservoirs. The total annual economic returns to the five reservoirs from inland fishing were calculated to be about US$ 544,000-566,000 per year. The value of water use in fisheries is roughly estimated at 18 per cent of that required for irrigated paddy production.

The use value of water in reservoirs was estimated based on the reservoir storage levels (Table 15). The per-unit value of water use in fisheries was determined to average 25 per cent (0.0033 US$/m^3) of that for water delivered to irrigate paddy fields (0.0133 US$/m^3). Nevertheless it must be considered that as a large proportion of the water that supports fisheries ultimately ends up irrigating crops giving it extra value.

Fisheries are not currently recognized in management and water allocation plans for the KOISP region. This reflects the fact that the development of inland fisheries is a secondary use of most reservoirs. This study demonstrates the economic value of the fisheries and indicates that integrated water management plans, considering irrigation and non-irrigation uses, would be preferable.

A number of assumptions were made in the estimation of the value of water in paddy production and a full list can be found in Appendix B of the original report. One assumption perhaps worthy of note is that yield figures used to estimate the value of water in paddy production were assumed to be upwardly biased and, as such, were reduced by a factor of 25 per cent.

4.6.2 Assessment of the Economic Value of Muthurajawela Wetlands (Emerton and Kekulandala 2003)

This report was based primarily on published literature and involved a limited collection of original field data. The authors concede that few data exist on the economic value of the Muthurajawela wetlands and this study is a first attempt at estimating the economic value of these resources. The assessment of fisheries was limited to its direct use economic value by calculating the market prices of output. Data were insufficient to assess the value of fish breeding and nursery for downstream fisheries. About 13-14 per cent of the 1,200 local households are involved in fishing activities in the marsh area (including both freshwater and brackish-water parts). Fishing in the marsh is primarily for household consumption. The marshland also

Table 15: Catch, value of production, costs and economic returns for the three waterbodies surveyed (1999)

	Lunugamwehera	Wirawila	Yoda Wewa	Total
Catch per unit of effort (CPUE) (kg)	50.0	20.6	33.8	34.8
Annual yield (tonnes)	1 354.5	225.3	421.8	2 001.6
-------------------- Rupees --------------------				
Per boat				
Value of production	370 164	207 900	293 220	290 424
Costs of production	124 116	62 148	99 240	95 148
Economic returns	246 048	145 752	193 980	16 632 132
Per reservoir				
Value of production	32 204 268	6 237 000	11 728 800	50 170 068
Costs of production	10 798 092	1 864 440	3 969 600	16 632 132
Economic returns				
Total by reservoir	21 406 176	4 372 560	7 759 200	33 537 936
	$ 305 803	$ 62 265	$ 110 845	$ 479 113
Per m^3 of water delivered (storage level)	0.16	0.46	2.38	0.23

Source: Taken from Renwick (2001)

maintains and supports downstream fisheries production in the coastal Negombo lagoon by trapping sediment, purifying wastewater, supplying freshwater and providing habitat and fish breeding areas. The value of the Negombo lagoon fishery was assumed to be Rs 200 million (US$ 222,222) in 2002.

Economic value:

Direct use
The marsh fishery was calculated to have a value of Rs 3,000/month.

The total economic value for the surrounding households was estimated to be Rs 6.26 million/yr (US$ 69,556), based on 175 households being involved in fishing.

Indirect use
This value is unknown. The authors suggest a conservative estimate of at least Rs 20 million (if removal of the ecological services provided by the marshlands had only a 10 per cent impact on the fishery downstream).

The primary beneficiaries of the marshland fishery were deemed to be the 675 people living next to the marsh. Downstream, 11,600 people depend on the fisheries in Negombo.

5. THE IMPACT OF CHANGING RIVER FISHERY MANAGEMENT AND WATER MANAGEMENT

In this section, the impact of change on tropical river and inland fisheries in Asia is examined from two perspectives: changes relating to fishery management factors (institutions and economic conditions) and changes relating to water management in river basins. Six case studies are presented.

5.1 The Mekong River System

5.1.1 Changes in Fisheries Production and Prices before and after a Change in Fisheries Legislation (Norman-Lopez 2004)

This study assessed the effect of the reform of fishing lots in the year 2000 on the commercial fisheries and family-scale fisheries in the province of Takeo, Cambodia. The area is situated at the Bassac River (Lower Mekong). The legislation released large areas formerly controlled by commercial fishers for family

Table 16: Economic value of Muthurajawela

	Value (US$/yr)	Value (US$/ha/yr)	Value as % of total
Flood attenuation	5 394 556	1 758	66.80
Industrial wastewater treatment	1 803 444	588	22.30
Agricultural production	336 556	110	4.20
Support to downstream fisheries	222 222	72	2.80
Firewood	88 444	29	1.10
Fishing	69 556	23	0.86
Leisure and recreation	58 667	19	0.73
Domestic sewage treatment	48 000	16	0.59
Freshwater supplies for local populations	42 000	14	0.52
Carbon sequestration	8 667	3	0.11
TOTAL	8 072 111	2 632	100

Source: adapted from IUCN 2003

fishing. The primary aim of the reform was to transfer responsibility of resource protection and management from the government to local resident communities.

The methodology uses a livelihood analysis in order to understand the way different stakeholders accessed the resource and how they were affected by the reform of fishing lots. The quantitative data for the analysis of the villagers' responses were collected through a household survey questionnaire and the quantitative data for the commercial fishers from key informant interviews with commercial fishers. In relation to family fisheries, 88 households were interviewed and the Wilcoxon test showed with a one per cent level of significance that capture fisheries (snails, whitefish, blackfish) and real prices of these products have changed significantly before (1998) and after (2003) the reform. A summary of the results may be seen in Table 17.

Key interviews with lot operators and subleasers in the area also showed a decline in fish catches over time. Nevertheless, real prices increased with the decline in catches so some of the operators increased their profits (Table 18).

5.1.2 Changes in Water Use Value Due to Variation in Water Flow, Wetland Value and Fisheries Exploitation Cost (Ringle and Cai 2003)

In Section 4, the hydrologic-economic model developed by Ringle and Cai (2003) was introduced in order to value water supply in the Mekong River system. In this section, the changes in water use value due to changes in water inflow, wetland value, and fisheries production cost are presented. Sensitivity analysis estimates the variation in water use value in comparison with the base model. The authors then estimate a reduction in water flow (by 50%, 60% and 80%), an increase in water flow (20%), a decline (US$ 16) and an increase (US$ 50) in wetland value, as well as a reduction (50%) and an increase in fishing costs (200%) for comparison with the base model. The results are given in Table 19.

From the sensitivity analysis, fisheries will be negatively affected by a decline in water flow and positively affected by an increase in water flow. A 20 per cent reduction in water flow is estimated to reduce fisheries profits by 18 per cent in comparison with the base model. On the other hand, a 20 per cent increase in water flow will increase fisheries profits by 33 per cent compared to the base model.

Interestingly, the output from the model suggests that a change in wetland value will have no direct impact on the values derived from any of the functional uses of the Mekong (irrigation, water extraction, hydropower or capture fisheries). This, of course, does not deny the indirect importance of wetlands in supporting fisheries by acting as a habitat for juveniles. Other results of the model are more clear-cut. For example, if fisheries production costs are reduced to half of baseline production costs, then profits from fish production increase to 133 per cent of baseline profits, and the overall basin profits to 110 per cent. Increased fish production profits cause a slight reduction in net irrigation

Table 17: Results of family capture fisheries based on 88 households surveyed

		Snails	Blackfish	Whitefish
Before reform (1998)	Quantity (kg)	2 645.35	210.60	278.10
	Real Price (Riel/kg)	188.75	2 085.63	353.40
After reform (2003)	Quantity (kg)	781.87	80.96	181.01
	Real Price (Riel/kg)	481.58	2 940.83	494.87

Source: Norman-Lopez 2004

Table 18: Cash flow for several commercial fishers

LOT OPERATORS	CATCH & PRICE	1998-99	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004
Lot operator #1	catch blackfish (kg)	35 000	35 000	33 300	26 000	17 200	13 600
	real price blackfish (R)	2 759.25	2 651.00	2 670.75	2 685.75	3 960.36	3 914.00
	catch whitefish (kg)	23 000	23 000	18 600	18 400	31 700	27 200
	real price whitefish (R)	772.59	742.28	747.81	752.01	1 250.64	1 236.00
Subleaser 1 lot#1	catch blackfish (kg)	5 250			3 480	2 940	2 450
	real price blackfish (R)	2 759.25			2 846.90	3 699.81	3 811.00
	catch whitefish (kg)	10 000			11 200	9 400	9 400
	real price whitefish (R)	596.00			580.12	896.29	885.80
Subleaser 2 lot#1	catch blackfish (kg)	NOT SUBLEASING					2 675
	real price blackfish (R)						6 180.00
	catch whitefish (kg)						1 300
	real price whitefish (R)						2 163.00
Subleaser from KREG	catch blackfish (kg)	NOT SUBLEASING				2 810	2 810
	real price blackfish (R)					13 896.00	13 733.33
	catch whitefish (kg)					3 100	3 100
	real price whitefish (R)					2 188.62	2 163.00
Lot operator #2	catch blackfish (kg)	9 300	NOT SUB-LEASING	LOT RELEASED TO COMMUNITY MANAGEMENT			
	real price blackfish (R)	1 655.55					
	catch whitefish (kg)	19 800					
	real price whitefish (R)	331.11					
Lot operator #3	catch blackfish (kg)	12 000	LOT RELEASED TO COMMUNITY MANAGEMENT				
	real price blackfish (R)	2 759.25					
	catch whitefish (kg)	17 000					
	real price whitefish (R)	772.59					
Lot operator #5	catch blackfish (kg)	77 400	77 400	77 400	73 700	58 200	45 000
	real price blackfish (R)	2 759.25	2 651.00	2 670.75	2 685.75	3 647.70	3 914.00
	catch whitefish (kg)	32 600	32 600	32 600	21 400	25 000	23 000
	real price whitefish (R)	772.59	742.28	747.81	752.01	1 250.64	1 236.00

Source: Norman-Lopez 2004

profits, and an improvement in hydropower profits to 102 per cent of the baseline values.

5.2 Bangladesh

Performance-response of the Inland Fishery under Different Simulated Changes in the Cost of Harvest and Changes in Aggregate Demand for Fish (Ahmed1992, 1996)

5.2.1 Changes in the Cost of Harvest

The model used in the analysis has been previously discussed in Section 4. In the analysis, the author studied the case where effort is fishery specific but flexible to operate in different fishing grounds. Table 20 shows the aggregate results in percentage terms under several alternative cost conditions from the base model.

Overall, a decline in costs by 25 and 50 per cent will increase fishing effort and catches. This result implies that potential catches of the fishery could be much higher than actual catches. If the fishery were exploited at its full potential, a decline in fishing costs could increase fishing effort, however catches would hardly change or even decline due to the excessive exploitation. On the other

Table 19: Sensitivity analysis: profits from water use (values and percentage)

Parameters	Levels/ values	Irrigation	Domestic/ industrial water use	Hydro-power	Capture fisheries	Wetlands	Total
		(million US$)					
	BASE MODEL	**917**	**170**	**43**	**546**	**134**	**1,809**
Inflow	50%	586.9 (64%)	161.5 (95%)	24.1 (56%)	174.7 (32%)	109.9 (82%)	1 049.2 (58%)
	60%	632.7 (69%)	168.3 (99%)	28.0 (65%)	245.7 (45%)	116.6 (87%)	1 193.9 (66%)
	80%	871.2 (95%)	168.3 (99%)	32.7 (76%)	447.7 (82%)	127.3 (95%)	1 646.2 (91%)
	120%	944.5 (103%)	170 (100%)	43.9 102%)	726.2 (133%)	128.6 (96%)	2 008.0 (111%)
Wetland value [a]	US$ 16	917 (100%)	170 (100%)	43 (100%)	546 (100%)	107.2 (80%)	1 790.9 (99%)
	US$ 50	917 (100%)	170 (100%)	43 (100%)	546 (100%)	335 (250%)	2 008.0 (111%)
Fisheries production cost [b]	50%	916.1 (99.9%)	170 (100%)	43.9 (102%)	726.2 (133%)	133.9 (99.9%)	1 989.9 (110%)
	200%	917 (100%)	170 (100%)	43 (100%)	218.4 (40%)	134 (100%)	1 483.4 (82%)

[a] Baseline value is US$ 20

[b] Baseline value is US$ 280

Source: Ringle and Cai 2003

Table 20: Behavior of the riverine fisheries of Bangladesh under alternative cost conditions (changes in the cost of harvesting from the base model)

Items	Condition of cost					
	50% decrease	**25% decrease**	**Base Model**	**25% increase**	**50% increase**	**100% increase**
Benefit-cost[a]						
Net benefit	2 808	2 258	1 383	929	642	330
Gross benefit	10 712	8 099	5 634	4 153	3 041	1 661
Producer surplus	2 163	1 653	1 289	873	616	321
Total revenue	10 066	7 494	5 540	4 097	3 016	1 652
Total cost	7 904	5 841	4 251	3 224	2 399	1,331
- harvest cost	3 186	2 918	2 435	1 929	1 456	819
- post-harvest cost	4 718	2 922	1 816	1 295	943	512
Catch-Effort						
Total catch (t)	305 650	230 060	173 160	130 230	96 580	54 130
- direct catch	245 870	184 260	139 860	104 670	77 360	44 300
- bycatch	59 770	45800	33 310	25560	19 220	9 830
Total effort[b]	483 363	303 101	197 054	131 493	84 671	38 787
CPUE (kg)[c]	632	759	879	990	1 141	1 396

[a] In million Bangladesh Taka (US$1 = BDT32)

[b] In gear hours x 10^6

[c] CPUE = catch per unit of effort

Source: Ahmed 1996

hand, a 25, 50 and 100 per cent increase in fishing costs would reduce fishing effort and catches.

The shadow price of effort would be lower for a cost increase and higher for a cost decrease at any given level of effort. This implies that an increase in harvest costs would shift the shadow price down and vice versa. The implication of such movements of shadow prices across different cost conditions are that each additional unit of effort would result in a larger contribution to the net benefit when applied to a cost situation that is lower than the one assumed in the base model and vice versa.

5.2.2 Changes in Aggregate Demand

Changes in population and real income will change aggregate demand. This in turn, will lead to changes in fishing effort and catches. Table 2 shows the changes in fishing effort and catches predicted to result from increases or decreases in demand of 10 and 20 per cent. As shown in Table 21, a decrease in the aggregate demand would reduce the level of effort and catches while an increase in the aggregate demand would increase the level of effort and catches when compared with the base model. The results again imply that the potential catches are higher than the actual catches. If the fishery were exploited at its full potential, fishers would increase fishing effort and catches would remain the same or even decline. The author also examined the shadow prices of effort under alternative demand conditions, and concluded that the optimal level of effort would be higher if aggregate demand increased, and vice versa.

5.3 Sri Lanka

5.3.1 Valuing Water in a Multiple-use System (Renwick 2001)

As indicated in Section 4, this study looked at the economic contributions of agriculture and reservoir fisheries within the Kirindi Oya irrigation and settlement project (KOISP)

Table 21: Behavior of different riverine fisheries of Bangladesh under alternative demand conditions (changes in the demand intercept from the base model)

	20% increase	10% increase	Base model	10% decrease	20% decrease
Benefit-cost[a]					
Net benefit	2 619	2 099	1 383	935	561
Gross benefit	8 978	7 459	5 634	4 082	2 827
Producer surplus	2 443	1 973	1 289	878	529
Total revenue	176	126	94	58	32
Total cost	6 359	5 360	4 251	3 147	2 267
- harvest cost	3 811	3 185	2 435	1 742	1 184
- post-harvest cost	2 548	2 175	1 816	1 405	1 083
Catch-Effort					
Total catch (t)	232 045	206 610	173 163	139 072	105 254
- direct catch	186 050	164 847	139 857	110 071	83 498
- bycatch	45 995	41 763	33 306	29 001	21 758
Total effort[b]	310 900	247 995	197 054	142 178	91 250
CPUE (kg)[c]	746	833	879	978	1 153

[a] In million Bangladesh Taka (US$1 = BDT32)

[b] In gear hours x 10^6

[c] CPUE = catch per unit of effort (Ratio of total catch to total effort)

Source: Ahmed 1996

Table 22: Economic value of water in irrigated paddy and reservoir fisheries under alternative water management schemes

	Water management scheme			
	Status quo	Scenario 1	Scenario 2	Scenario 3
Irrigation conservation per hectare reductions	0	0	5%	10%
		-------------------- 1 000s --------------------		
Paddy (16 730 Rs/ha)	251 352	264 878	278 816	294 303
	$ 3 591	$ 3 784	$ 3 983	$ 4 204
Fisheries (16.76 Rs/kg)	33 547	34 251	34 251	34 251
	$ 479	$ 489	$ 489	$ 489
Total	284 898	299 129	313 068	328 555
	$ 4 070	$ 4 273	$ 4 472	$ 4 694
Economic gain		14 231	28 169	43 656
		$ 203	$ 402	$ 624

Source: Taken from Renwick 2001

in southeastern Sri Lanka. Following this, the study went on to model the potential outcomes of three alternative water management schemes. In KOISP, the reservoirs provide storage for irrigation water and habitats for fish. Therefore, allocation and management decisions for the purposes of irrigation directly affect reservoir fisheries by changing water levels.

Based on the assumption that there is an optimal range of water volume stored within a reservoir in terms of fishery productivity, a simplified econometric model of fishing yield was specified and estimated to better identify the relationship between CPUE and reservoir levels. The average monthly CPUE by reservoir was regressed on a constant, the mean monthly storage levels for each reservoir and reservoir dummy variables for each reservoir to determine capture differences among them.

The model was deemed to perform well with an adjusted R2 of 0.62 indicating a good fit. A strong correlation was seen between declining water levels and CPUE for the observed range of levels in 1999. The estimated elasticity of CPUE with respect to water levels is -0.21 indicating that a 10 per cent decrease in storage is associated with a 2.1 per cent increase in CPUE. However, this elasticity is only valid over the range of storage levels observed in 1999 and for marginal changes in storage levels. The result is important, as a substantial negative change in the volume of water would ultimately have a negative impact on the fisheries.

After estimating the main model, three scenarios were investigated. Scenario 1, evaluates the economic gain of proportionally allocating an increasing amount of water for irrigation and a decreasing amount for fishers. The effect of more efficient management of this increased volume, for the purposes of irrigation, was then looked at (Scenarios 2 and 3).

Primarily, the model indicated that marginal reductions in the amount of water allocated to fisheries reservoirs actually generated individual economic gains for both the fishery and farming activities, resulting in overall economic gains for the area.

Scenario 1, which reduced reservoir levels by 14.47 MCM (million cubic meters) would lead to higher fishery yields and an economic gain of 42,000 kg of fish or approximately

US$ 10,000 per year over the status quo scenario. The optimal, estimated economic gain for paddy farming from this increased allocation of water was US$ 613,000 per year (under Scenario 3).

The model demonstrated that the status quo per-unit value of water was, on average, higher for paddy irrigation (0.0133 US$/m^3), and that, with more efficient management, the value might be further increased (0.0148 US$/m^3). The average per-unit value for fisheries is significant (0.0033 US$/m^3) and would be higher if the gains could be made to both simultaneously.

5.3.2 Adaptive, Participatory and Integrated Assessment (APIA) of the Impacts of Irrigation on Fisheries – Evaluation of the Approach in Sri Lanka (Nguyen-Khoa, Smith and Lorenzen 2005)

A later, ex-post APIA study of the Sri Lankan KOISP project assessed the economic impacts of its implementation on fisheries in the areas previously evaluated. Impacts were assessed through a series of workshops, field studies, interviews with key informants and the compilation of a knowledge base from primary and secondary data sources and technical assessments.

Five critical issues were identified for investigation:

- Reduced river flow and floodplain habitats
- Excessive drawdown of water levels for reservoir fisheries
- Impacts of drainage inflow to the lagoons
- Conflict of interest between fishers and farmers
- A lack of institutional coordination between irrigation and fisheries agencies

The first three were considered as impacts of the project and/or management, and the last two as contributing factors. These issues were used to define the scope of the projects.

As shown in Table 23, the KOISP project had a modest positive impact on preexisting fisheries in terms of aggregate production and value.

The reduction of river flow downstream was thought to have had little impact, in terms of fisheries, as neither subsistence nor commercial fisheries had ever developed in the floodplain. On the other hand, the

Table 23: KOISP fisheries balance in terms of production and value

	Before KOISP			After KOISP		
Water body	Catchment area (ha)	Production t/year	Value Rs 1,000	Catchment area (ha)	Production t/year	Value Rs 1,000
Floodplain	6 200	124	50	0	0	0
Lagoons	15 000	150	225	1 500	150	60
Lunuganwehera	0	0	0	3 200	1 344	538
Tanks	1 608	1 013	405	1 608	1 013	405
Small Tanks	300	189	76	200	126	50
River*	-117 800	35	14		0	0
Total*	9 608	1 511	14	6 508	2 633	1 053
Change				-3 100	1 122	284

* The river does not contribute to catchment area but it contributes to fisheries production and value.

Source: Taken from Nguyen-Kho et al. 2005 creation of a large reservoir upstream led to a substantial increase in aggregate fish production. This compensated for downstream losses. However, negative impacts of scheme operation and water management on the actual production of the preexisting reservoirs and lagoons were valued at Rs 225,000. Overall the combined effects of the KOISP project, overfishing and a recent drought were held responsible for degrading fish stocks and driving fishing towards being little more than a livelihood of last resort.

The authors conclude that if savings could be made in the water needs of farming and the minimum water levels needed to conserve fish stocks were better accounted for, gains could be made in the national fish output, employment, and improved nutrition for poor households.

5.3.3 Impact of Dams

According to Marmulla (2003), the construction of dams and weirs for irrigation, hydropower generation or flow management has a long tradition in many parts of the world; in the past 50 years, many thousands of dams of different sizes have been constructed. The construction of such barriers has a negative impact on natural fish populations and, together with other factors, greatly contributes to the reduction, disappearance and even extinction of some species. Marmulla (2003) highlights that LARS2 (The Second International Symposium on the Management of Large Rivers for Fisheries) identified dams and the disruption of ecological flows in rivers and floodplains as a major factor in the decline of inland fisheries. It should be noted that dams are a significant feature of developing countries, compared to developed ones, and their number is expected to increase at a much faster pace. This is because of demands for water (and electricity) from industry, agriculture and expanding populations of consumers.

In Asia, dam construction has had a major impact on many rivers and their fisheries. Dams remain a component of many national development plans to control flooding, regulate and store water for agriculture and electricity generation. For example, 160 dams are currently proposed for the Mekong River Basin alone.

While the impact of dams on river fisheries has been recognized, and assessed to some degree in terms of environmental, ecological and biological impacts, there have been relatively few valuation studies undertaken (or at least published in the literature). Some of the impacts and issues involved can be illustrated with reference to cases studies from the Lao PDR, Thailand and India/ Bangladesh.

In the case of the Nam Theun 2 Hydroelectric Project in the Lao PDR, the environmental assessment plan showed that the dam would destroy 45,000 hectares of land, supporting 4,500 people and natural habitats (Wegner 1997). The social and environmental costs were estimated at US$ 60-130 million, with half of this represented by the opportunity cost of the land. The mitigation budget for the project was set at US$ 60-75 million, with a sum of up to US$ 50 million for additional unforeseen costs. Wegner (1997) commented that, overall, the costs of the project had been underestimated and the benefits overestimated.

In Thailand, the World Bank (2000) highlighted to the World Commission on Dams (WCD) that the proposal for the Pak Mun Dam, similar to other such projects, did not include detailed baseline studies on fisheries. There were also additional problems in determining the appropriate level of compensation for the impact of the dam, as well as the application of the cost-benefit analysis with particular reference to the loss estimates. The issue of the impact on biodiversity was particularly difficult to assess, and it was as difficult to

Table 24: Economic evaluation of Asian riverine fisheries: a summary of the evidence

Country/Region	Author	Method	Key Results
Mekong river system (Lao PDR, Cambodia, Thailand, Vietnam)	Ringle and Cai (2003)	Production function and sensitivity analysis	Value of the fishery US$ 546.3 million. Negative correlation between water flow and fishery value
Mekong delta (Vietnam)	Mai et al. (2003)	Estimated economic value (EV) using secondary data	Range value of the fishery in Ben Tre Province (US$ 2 832 – 3 099) and Tra Vinh Province (US$ 2 340 – 2 620)
Bangladesh	Ahmed (1992, 1996)	Supply-demand model; cost-benefit and sensitivity analysis	Net benefit yielded by the various riverine fisheries (US$ 43 million)
	Ali and Islam (1997)	Cost-benefit analysis	Net benefit from stocking seasonal floodplains for capture fisheries (Tk 42 848 000)
India	Peters and Feustel (1997)	Socioeconomic survey	Failures of coop. system leading to undervaluation of fishery in official figures
Indonesia	Koeshendrajana and Cacho (2001)	Production function (bioeconomic analysis)	Estimation of various optimal management solutions for Musi River fishery
Malaysia	Ali and Lee (1995)	Livelihood analysis	Total annual income for fishing community in the Chenderoh Reservoir (US$ 63 180)
Sri Lanka	Renwick (2001)	Cost-benefit analysis; Regression analysis to est. CPUE and reservoir levels relationship; and scenario analysis	Estimated total annual economic returns for five reservoirs in KOISP project region (US$ 544 000 – 566 000)
	Emerton and Kekulandala (2003)	Estimated economic value (EV) using secondary data	Estimated direct use value for Muthurajawela wetland marsh fishery (US$ 69 556)
	Nguyen-Khoa et al. (2005)	Livelihood Analysis	Increase in aggregate economic value of fisheries after implementing the KOISP project (Rs 284 000)
Cambodia	Norman-Lopez (2004)	Livelihood analysis and socioeconomic survey	Overall decline in catches and increase in prices for commercial and subsistence fishers due to legislative reform

distinguish the impacts attributable to the dam as opposed to other impacts such as overfishing.

In India, there are two major dams on the tributaries of the Ganges at Hardwar and Farakka; both have produced major environmental changes and caused political problems between India and Bangladesh (Mukerjee 1998). The dams have negatively impacted on fish migration and production although the associated reservoirs have yielded good production. There are no valuation studies on the overall impact of the dams on the fisheries in the Ganges.

6. DISCUSSION

The aim of this study was to estimate the economic value of riverine fisheries in tropical Asia. It is widely accepted that this resource is significant in the maintenance of many people's livelihoods (Coates 2002); Van Zalinge et al. (2000). Nevertheless, examples of studies that have attempted to quantify this value are limited and often incomplete in nature (evaluation of direct use value but not indirect use value). This report examines the value of Asian riverine fisheries in the following two ways: firstly, through a compilation and summary of the results of existing studies on this topic; secondly, through estimating the direct use value of riverine and floodplain fishing by country using quantities and freshwater fish prices derived from various sources.

The review of several case studies not only provided fishery values in specific areas but also allowed us to put into perspective the values of riverine fisheries, compared to other riverine resource uses such as forestry, agriculture (irrigation), electricity generation, etc. A summary of the empirical studies that have been considered in this report is provided in Table 24. Presented in the table are the country/region where the study was undertaken, the author(s), main economic methodology used, and key fishery results. The main point to be highlighted is that all the studies under review estimated direct use values but none obtained indirect use values. Non-use attributes are just as important as use values. Nevertheless, estimating non-use values is usually so complicated in developing countries that only a few of these studies exist for tropical Asia. One such study is by Wattage (2002), who used the contingent valuation (CV) technique to measure the conservation value of water, fish and mangrove of a wetland in Sri Lanka. This report pointed out that the conservation value of coastal wetlands in Muthurajawela Marsh and Negombo Lagoon (MMNL) area is equally important in developing countries in addition to the formal direct values. This study was, however, not included in this review for the simple reason that it does not separate the value of the fishery from the entire value of the resource. Finally, some of the studies reviewed, such as Ahmed (1996), and Ringle and Cai (2003), not only provide the present value of the fishery but also include the change in value under different situations. This is absolutely necessary to understand the effect to the resource and society under different management regimes.

The estimation of a direct economic value by country provides a rough estimate of the importance of riverine and floodplain fisheries (Appendix 3). This value provides a first glimpse of the significance of these fisheries to the countries reviewed. The main problems encountered were accuracy and availability of data on quantity and price. It is generally accepted that quantities are often underreported and studies usually differ in data collection methods as well as accuracy. This problem is highlighted in Appendix 1. For those countries where several reports present fisheries production, high variations in values exist. This discrepancy can be seen, for example, in the case with the Lao PDR. In the year 2000, the capture production in the Mekong river system was reported at 27,000 tonnes; nevertheless, Van Zalinge et al. (2003) estimated from consumption values that the capture fisheries production in the Mekong for that year was 182,700 tonnes. In relation to prices, a large variation in the quoted figures is apparent (see Appendix 2). The main problem is due to unit values being derived from estimates based on different freshwater species in different areas of the country. A range of values for the riverine fisheries of each country reviewed is provided in Appendix 3. This not only provides an insight into how valuable the fishery is within the area but also emphasizes the problem of data availability.

A major outcome of this study is the realization that we still have some way to go before truly reliable estimates of the *total* economic value riverine fisheries provide to the countries and communities of tropical Asia are available. Only when more rigorous investigations are conducted that capture *all* the values derived from these resources, can we be confident enough to consider the figures as actual representations of the fisheries value to society.

7. CONCLUSION

Studies have demonstrated the social and economic importance of Asian riverine fisheries using various different indicators, and in the broadest sense, this makes them valuable. These fisheries have been shown to be valuable (i.e., important) in at least two specific ways: as a generator of commercially marketable output, and as a source of income and employment in relatively impoverished communities. We could also make the obvious point that these fisheries are important to consumers, and indeed make a necessary contribution to nutrition and food security.

These fisheries in their present state are *valuable* on a number of different definitions and measures, but it is necessary to know how that value will change under different circumstances. Some of the studies discussed in this report have addressed this issue, but there is a need for more research in this area. With a few exceptions, most of the valuation studies have undertaken *snapshot* reviews of fisheries in order to gauge their current actual value. What is important, however, is to be able to see how that value compares with the maximum value that could potentially be achieved under alternative fisheries management regimes. The fact that many Asian river fisheries are open-access and thus have a tendency to become overexploited suggests that economic surplus in the form of resource rent is being at least partially dissipated. Assessing the magnitude of this lost value and finding ways in which it can be reappropriated should, therefore, be a priority. While this will require economic research that can only be undertaken at a cost, policymakers will be rewarded with improved knowledge of how to manage these fisheries for the benefit of Asian communities.

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APPENDIX 1: CAPTURE RIVERINE (AND FLOODPLAIN) PRODUCTION

Country	Year	Production (t)	Author	Comments
Bangladesh	1989/90	89 006	Bangladesh Bureau of Statistics (1994)	Annual total catch in principal rivers (Padma-Ganges; Jamuna-Brahmaputra; Meghna River systems)
	1990/91	561 824	DOF (1998)	Annual catches of rivers and floodplains
	1991	124 000	De Graaf and Chinh (2002)	Annual total catch for ALL rivers
India	1994/95	28 500	Sugunan (1997)	Production in rivers and canals
Sri Lanka	1998	16 796.57	Nissanka et al. 2000; Fish-Stat FAO (2005) and De Silva (1988)	Total inland capture fisheries production in 1998 (FAO Fish-Stat) was 29 900 tonnes. Capture riverine production is the remainder once reservoir production has been accounted for. Reservoir production is estimated as the product of the average yield of 11 reservoirs in 1998 (118.59 kg/ha/yr. Nissanka et al. 2000) and the total surface area of major, medium and hydro-electric reservoirs (110 491 ha)
Cambodia	1995	400 000	Jensen (2000)	Production in the Mekong River system
	2000	289 000 – 431 000	Baran (2005)	Production from Mekong River, floodplains and Tonle Sap lake
	2000	682 150	Van Zalinge et al. (2003)	Production estimated from consumption values. Catch from Mekong River, floodplains and Tonle Sap lake. Reservoir catch 22 750 t, aquaculture 14 100 t. Total production in Mekong River system 719 000 t
Lao PDR	2000	27 000	Van Zalinge et al. (2000)	Production in Mekong River
	2000	182 700	Van Zalinge et al. (2003)	Production estimated from consumption values. Catch from Mekong River and floodplains. Reservoir catch 16 700 t, aquaculture 5 400 t. Total production in the Mekong River system 204 800 t
	2002	17 790	ASEAN Database of Inland waters	Production in Mekong River and 14 tributaries (70 kg/ha/yr)
Thailand	2000	303 000	Van Zalinge et al. (2000)	Production in Mekong River and floodplains
	2000	875 000	Van Zalinge et al. (2003)	Production estimated from consumption values. Catch from Mekong River and floodplains in northeast of Thailand
	2001	200 000 – 500 000	Coates (2002)	Est. national production from rivers, floodplains, canals, lakes, marshes (reservoir production and aquaculture not included); Reservoirs provide the largest capture production.

Vietnam	1976	60 000 – 75 000	De Graaf and Chinh (2002)	Annual total catches for ALL rivers
	1980's	29 500	UNEP (1998)	Annual total catches for ALL rivers (20 000 t Mekong River; 6 000 t Red River; 3 000 t Central rivers; 500 t High land rivers)
	1998	136 000	Coates (2002)	Annual production in rivers and floodplain
	2000	190 000	Van Zalinge et al. (2000)	Annual production in rivers and floodplain
	2000	50 000 – 200 000	ASEAN Database of Inland eaters (2005)	Inland fish production in Mekong Delta (Mekong River, floodplains, canals)
	2000	844 850	Van Zalinge et al. (2003)	Production estimated from consumption values. Catch from Mekong River and floodplains
Mekong (Cambodia, Lao PDR, Thailand, Vietnam)	1995	1 162 400	Ringle and Cai (2003)	Production in the Mekong River system
	1995	> 1 200 000	Jensen (2000)	Production in the Mekong River system
	2000	809 000 – 951 000	Baran (2005)	Production in the Mekong River and floodplains
	2000	1 533 000	Sverdrup-Jensen (2002)	Production in the Mekong River and floodplains. Price US$ 0.68/kg This generates a value for the Mekong River system of US$ 1 042 000
	2000	2 642 000	Van Zalinge et al. (2003)	Production estimated from consumption values. Catch from Mekong River and floodplains
	2004	2 500 000	Baran (2005)	Production in the Mekong River and floodplains
Myanmar (Burma)	2000-01	253 373	FAO (2003)	Production in rivers, lakes, floodplain, reservoirs and lagoons
	2000-01	600 000 – 900 000	Coates (2002)	Estimated indicative figure for actual catches (rivers, lakes, swamps, floodplains and reservoirs)
	2000	360 000	ASEAN Database of Inland waters	Production in rivers, lakes, floodplains, reservoirs and lagoons
	2002	530 000	ASEAN Database of Inland waters	Production in rivers, lakes, floodplains, reservoirs and lagoons
Indonesia	1999	800 000 – 900 000	Coates (2002)	Estimated indicative figure for actual catches (rivers, lakes, swamps, floodplains and reservoirs)
	2000	297 300	BPS Statistics Indonesia (2000)	Production in rivers, lakes, swamps, floodplains and reservoirs
	2000	191 805	Coates (2002)	Estimated river and swamp production for the main islands (Kalimantan, Java, Sumatra, Maluku and Irian Jaya, Bali and Nusa Tenggara). The only large island not included in the estimate is Sulawesi due to lack of data. The author indicates catches are probably 2-3 times higher than the official figure.

Philippines	2002	131 644	Bureau of Fisheries and Aquatic Resources (2004)	Production includes lakes, reservoirs, rivers, and marshes
Malaysia	1999	10 008	Coates (2002)	Estimated indicative figure for actual catches (rivers, lakes, swamps, floodplains and reservoirs)
	2001	3 368.51	ASEAN Database of Inland waters	Production includes lakes, reservoirs, rivers, floodplains and marshes

APPENDIX 2: CAPTURE RIVERINE (AND FLOODPLAIN) PRICES

Country	Year	Prices (US$/kg)	Author	Comments
Bangladesh	1995	0.812	Ahmed (1996)	32.555 Bangladesh Taka/kg. Average exchange rate (1995): 40.100 Bangladesh Taka/US$. The price is derived from freshwater capture fisheries of several species caught in main rivers in Bangladesh (Jamuna-Brahmaputra, Meghna, Padma-Ganges and other rivers).
	1997	0.815	Ali and Islam (1997)	35 Bangladesh Taka/kg. Average exchange rate (1997): 42.930 Bangladesh Taka/US$. The price is derived from average freshwater capture fisheries of species caught in beels (deep floodplains) (stocked and non-stocked species)
	2002	1.098	Dey et al. (2004)	The price has been derived by dividing value and quantity from a range of capture and culture species.
India	1991-96	0.796	Peters and Feustel (1997)	25 Indian rupee/kg. Average exchange rate (1995): 31.410 Indian rupee/US$. The price is derived from freshwater capture fisheries of major carp species stocked in reservoirs (*Catla catla, Labeo rohita, Cirrhinus mrigala, Labeo fimbriatus, Cyorubys carpio*).
	2000	0.717	Dey et al. (2004)	The price has been derived by dividing value and quantity from a range of capture and culture species.
Sri Lanka	1999	0.239	Renwick (2001)	Average price, 16.76 Rs/kg. of freshwater capture fisheries from Lunugamwehera reservoir, Wirawila Tank, and Yoda Wewa reservoir. Approximate exchange rate: 70 Rs/US$
	2002	1.364	Dey et al. (2004)	The price has been derived by dividing value and quantity from a range of capture and culture species.
Cambodia	1995	0.750	Jensen (2000)	The author averaged production in the Mekong River system to be 0.75 US$/kg. [Jensen estimated production in Cambodia as 400 000. So estimated value of production is 300 US$ million.]
	1998	0.510	Nam and Thuok (1999)	Average price of Mekong River fisheries. [The authors estimated production to be 284 000 t. So estimated value of production is 145 US$ million.]
	2003-4	0.577	Norman-Lopez (2004)	Average price: 2 317.66 Riel/kg. Estimate obtained from freshwater capture fisheries in Bassac River, Takeo Province. Average value from commercial and local fishers for blackfish and whitefish species. Blackfish [4 454.75 Riel/kg (commercial fishers); 2 940.83 Riel/kg (local fishers)] Whitefish [1 380.2 Riel/kg (commercial fishers) 494.87 Riel/kg (local fishers)]. Only one commercial fisher removed from estimation due to variability in estimate from other fishers. Exchange rate (2003-4): 4 016.25 Riel/US$

Lao PDR	2002	0.55	Singhanouvong and Phouthavong (2002)	Average price: 5 562.5 kip/kg. Estimate obtained from small and large catfish and scaled fish. Exchange rate (2002): 10 056.3 kip/US$
Thailand	2000	1.30	Dey et al. (2004)	The price has been derived by dividing value and quantity from a range of capture and culture species.
Vietnam	2000	1.33	Dey et al. (2004)	The price has been derived by dividing value and quantity from a range of capture and culture species.
	2000	0.36	Mai et al. (2003)	Price obtained from inland fisheries in Mekong River estuary (Ben Tre Province). Exchange rate (2000): 14,020 VND/US$
Mekong (Cambodia, Lao PDR, Thailand, Vietnam)	1995	0.75	Ringle and Cai (2003); Jensen (2000)	Prices from freshwater capture fisheries. Value at retail market price. [Jensen (2000) estimated production to be > 1.2 million tonnes. So production estimated 900 – 1 000 US$ million]
	2000	0.68	Sverdrup-Jensen (2002)	Prices from freshwater capture fisheries. Average first-hand sale price
Myanmar (Burma)	1999	0.15	Coates (2002)	Price derived by dividing value of lease fishery (commercial fishery) (621.89 million Kyat) by estimated landings (70 000 tonnes). Exchange rate (1999): 6.286 Kyat/US$
	1999	1.41	Coates (2002)	Price derived by dividing value of tender *open* fishery (83.519 million Kyat) by estimated landings (90 000 tonnes). Exchange rate (1999): 6.286 Kyat/US$
	2003	1.6	FAO (2003)	Price derived by dividing value (US$ 16) by quantity (10 kg) of fish sold at market. Fish sold were mainly snakehead, relatively high value.
Indonesia	1994	0.56	Koeshendrajana and Cacho (2001)	Price obtained from Musi River. Average actual price of riverine freshwater fish at the producer level was 1 215 Rp/kg. Average exchange rate (1994): 2 160 Rp/US$
	2000	0.51	Dey et al. (2004)	The price has been derived by dividing value and quantity from a range of capture and culture species
Philippines	2000	0.80	Dey et al. (2004)	The price has been derived by dividing value and quantity from a range of capture and culture species.
	2002	0.03	ASEAN Database of Inland waters (2005)	Freshwater capture production from lakes, rivers, reservoirs and marshes. Exchange rate:1 PHP/US$
Malaysia	1988-89	2.46	Ali and Lee (1995)	Capture fisheries production in Chenderoh Reservoir, Perak River, Malaysia. Exchange rate from authors: 2.6 M$/US$
	2000	1.83	Dey et al. (2003)	The price has been derived by dividing value and quantity from a range of capture and culture species

APPENDIX 3: CAPTURE RIVERINE (AND FLOODPLAIN) VALUES

Country	Quantity (tonnes)	Price (US$/tonne)	Value (US$ '000)	Comments
Bangladesh	561 824 [1]	1 098 [a]	616 883	Value derived from river and floodplains
	124 000 [2]	1 098 [a]	136 152	Value derived from catches for all rivers
India	28 500 [3]	796 [b]	22 686	Production in rivers and canals
Sri Lanka	16 797 [4]	8 015 [c]	13 462	Approx. river production value
Cambodia	289 000 [5]-682 150 [6]	544 [d]	157 216 – 371 090	Est. production from the Mekong river floodplains and Tonle Sap lake
	400 000 [7]	750 [e]	300 000	Est. from Jensen (2000)
	284 000 [8]	510 [f]	145 000	Est. from Nam and Thuok (1999)
Lao PDR	17 790 [9] – 27 000 [10]	553 [g]	9 838 – 14 931	Reported production in Mekong river and tributaries
	182 700 [6]	553 [g]	101 033	Est. from Mekong river and floodplains
Thailand	200 000 [11] – 500 000 [11]	1 297 [a]	259 400 – 648 500	Est. national production from rivers, floodplains, canals, lakes, marshes Excludes reservoirs
Vietnam	136 000 [11] – 844 850 [6]	842 [h]	114 512 – 711 364	Est. production from rivers and floodplains
Mekong (Cambodia, Lao PDR, Thailand, Vietnam)	809 000 [5] – 2 642 000 [6]	680 [i]	550 120 – 179 656 0	Est. production from Mekong river and floodplains
	> 1 200 000 [7]	750 [e]	900 000 – 1 000 000	Est. from Jensen (2000)
	1 533 000 [12]	680 [i]	1 042 440	Est. from Sverdrup-Jensen (2002)
Myanmar	253 373 [13] – 2 900 000 [11]	781 [j]	197 884 – 702 900	Est. production in rivers, lakes, floodplains, reservoirs and lagoons
Indonesia	297 300 [14] – 900 000 [11]	514 [a]	152 812 – 462 600	Est. production in rivers, lakes, swamps, floodplains and reservoirs
	191 805 [11]	514 [a]	98 588	Est. river and swamp production for the main islands (Kalimantan, Java, Sumatra, Maluku, Irian Jaya, Bali and Nusa Tenggara); the only island not included is Sulawesi due to lack of data
Philippines	131 644 [15]	415 [a]	54 632	Est. production in lakes, reservoirs, rivers and marshes
Malaysia	3 369 [9] – 10 008 [11]	1 833 [a]	6 175 – 18 345	Lowest value represents reported production in lakes, reservoirs, rivers, floodplains and marshes. Highest value represents est. production for same areas.

Origin of data used

Quantity (Appendix 1)	Price (Appendix 2)
[1] DOF (1998)	[a] Dey et al. (2004)
[2] De Graaf and Chinh (2002)	[b] Peters and Feustel (1997)
[3] Sugunan (1997)	[c] Average from Renwick (2001) and Dey et al. (2004)
[4] Nissanka et al. 2000; FAO Fish-Stat FAO (2005) and De Silva (1988)	[d] Average from Nam and Thuok (1999) and Norman-Lopez (2004)
[5] Baran (2005)	[e] Jensen (2000)
[6] Van Zalinge et al. (2003)	[f] Nam and Thuok (1999)
[7] Jensen (2000)	[g] Singhanouvong and Phouthavong (2002)
[8] Nam and Thuok (1999)	[h] Average from Dey et al. (2004) and Mai et al (2003)
[9] ASEAN (2005)	[i] Sverdrup-Jensen (2002)
[10] Van Zalinge et al. (2000)	[j] Average from Coates (2002)
[11] Coates (2002)	
[12] Sverdrup-Jensen (2002)	
[13] FAO (2003)	
[14] BPS Statistics Indonesia (2000)	
[15] Bureau of Fisheries and Aquatic Resources (2004)	

APPENDIX 4

BANGLADESH

General information♠

Surface area:	143 998 km^2
Population (1995):	118 000 000
GDP (1996/97):	US$ 14 000 million
Agricultural GDP (1996/97):	US$ 4 508 million
Capture fisheries as percentage of GDP[1]:	1.88%
Aquaculture as percentage of GDP[1]:	2.69%
Indicative exchange rate (1999) US$ 1 = Tk 48.5	

♠ FAO. World fisheries statistics (1999)
[1] Asia-Pacific Fishery Commission (2005)

Main rivers

Total area rivers and estuaries:	4 047 316 ha
Total length of 700 rivers:	22 155 km

The Padma-Ganges and its distribution system

Annual catch[3]:		6 489 tonnes (1996-97) (capture)
i)	Ganges, Padma:	305 km
	Surface area[2]:	69 481 ha
Annual catch[2]:		1 641 tonnes (1991-92)
		50.6 kg/ha (1991-92)
		0.34% contribution to production (1991-92)
ii)	Mathabhanga:	128 km
iii)	Ichhamati:	285 km
iv)	Bhairab:	559 km
v)	Kumar:	443 km
vi)	Kobadak:	280 km
vii)	Chitra:	188 km
viii)	Nabaganga:	210 km
ix)	Garai, Madhumati:	314 km
x)	Arial Khan:	266 km

The Meghna and Surma system

Surface area[2]:		73 999 ha
Annual catch[2]:		84 737 tonnes (1989-90)
		54 244 tonnes (1991-92)
		1 369.60 kg/ ha (1991-92)
		11.3% contribution to production (1991-92)
i)	Surma:	350 km
ii)	Kushiyara:	110 km

The Jamuna-Brahmaputra system

Surface area[2]:		73 666 ha
Annual catch:		2 280 tonnes (1989-90)
i)	Brahmaputra:	350 km
	Annual catch:	505 tonnes (1989-90)
		391 tonnes[2] (1991-92)
		0.081% contribution to production[2] (1991-92)
ii)	Jamuna:	531 km
Annual catch:		1 775 tonnes (1989-90)
		2 253 tonnes[2] (1991-92)
		30.58 kg/ ha[2] (1991-92)
		0.46% contribution to production[2] (1991-92)

Other rivers in Western region

i)	Nagar:	238 km
ii)	Tangan:	119 km
iii)	Purnabhaba:	133 km
iv)	Mahananda:	90 km
v)	Baral:	20 km
vi)	Karatoya Atrai, Hurasagar Gum, Gumani:	841 km
vii)	Dharla:	62 km

Rivers in Chittagong region

i)	Karnaphuli:	180 km
ii)	Sangu:	287 km
iii)	Matamuhari:	161 km

☙ Bangladesh Bureau of Statistics (1994)
2 FAO (1994) 2: Productivity and Exploitation of Inland Open Water Fisheries
3 Payne et al. (2003) A Review of the Ganges Basin: Its Fish and Fisheries

Inland fisheries ♣

Inland fisheries surface area[1]:	4 047 316 ha
Inland fishers[2]:	768 632 fishermen (1988-89)
Inland catches as percentage of total catches:	90% (1960s) 77.9 % (1995-96) total production 1 264 435 t total inland production 985 265 t

Year 1995-96	Inland open water (capture)[2]					Inland close water (culture)		
Inland water	River and estuaries	Sundarban	Depression (beels & haors)	Kaptai Lake	Flood Land	Ponds	Oxbow lake (baors)	Shrimp farms
Production (tonnes)	146 744	7 857	63 014	7 449	370 105	310 130	3 018	76 948

♣ Liaquat and Zahirul (1997) An Assessment of the Economic Benefits from Stocking Seasonal Floodplains in Bangladesh.
1 FAO (1994) Productivity, Exploitation and Fishing Technology of Inland Open-Water Fisheries, Bangladesh
2 Bangladesh Bureau of Statistics (1994)

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				Kg/year
Fish for direct human consumption	1 170	0.3	38	1 128	9.5
Fish for animal feed & other purposes	5	-	-	-	

Estimated employment (2002)

(i) Primary sector (including aquaculture):	
Full-time fishers:	570 000
Part-time:	1 196 000
(ii) Secondary sector:	NA
Gross value of fisheries output (1997): (at ex-vessel prices, estimate)	US$ 1 000 million (=3.12% of GDP)
Trade (1994-95)	
Value of fisheries imports (estimate):	US$ 590 000 (Average 1994-95)
Value of fisheries exports:	US$ 325.11 million (9.38% of total export)

Inland fisheries ♦

Development and the growing population in Bangladesh have had a strong impact on its inland fisheries. The development of flood control schemes and changes in patterns of land use have often led to siltation. This has caused a reduction in water flows and fish being cut off from vital access routes to feeding and reproduction grounds. Another factor contributing to the deterioration of the aquatic environment is the accumulation of industrial pollution resulting from the increased use of pesticides and fertilizers in agriculture. Furthermore, the growing population has increased fishing pressure. This is seriously affecting the abundance of some species such as valuable migratory carps and may also be impacting the availability of more resilient floodplain fish.

Increasing fishing pressure has led to greater competition for access to inland fisheries resources, frequently resulting in confrontation and violence. This illustrates the importance of the resource and the pressure to which it is subjected. Furthermore, leases to formally harvest the resource have increased in value following the rise in demand. The increased value of access arrangements has contributed to government revenue but at the same time encouraged leaseholders to further exhaust the resource. This situation has had greatest impact on those fishers that traditionally used to harvest the resource for subsistence.

The Government of Bangladesh is addressing these issues through a strategy that includes: (i) protecting aquatic resources; (ii) shifting priority to sustainable production rather than revenue generation; (iii) involving resource users in the management of the resource; (iv) rehabilitation of degraded habitats through a program of floodplain stocking and fish pass construction. Also, the introduction of gear-based licensing schemes has been seen to facilitate a more equitable distribution of benefits between users in some fisheries.

♦ FAO. World fisheries statistics (2005)

CAMBODIA

General Information ♠

Surface area:	181 040 km^2
Water area:	4 520 km^2
Population (2004):	Est. 13 363 421
Population growth (2004):	1.8%
GDP at purchaser's value (2003):	US$ 25.02 billion
Agricultural, fisheries and forestry percentage of GDP (2002):	8.6%
Fisheries GDP (2003):	US$ 442 million (12%)
Capture fisheries as % of GDP[1]:	10.03%
Aquaculture as % of GDP[1]:	0.89%

♠ FAO. World fisheries statistics (2005)
1 Asia-Pacific Fishery Commission (2005)

Main rivers

Mekong River (originates in China and passes through Myanmar, Laos, Thailand, Cambodia and Vietnam)

Total length:	4 225 km
Length (in Cambodia):	500 km
Total annual catch[1]:	279 000-441 000 tonnes (1999) (excludes aquaculture)

The Mekong River in Cambodia flows into 4 main branches:

- Great Lake
  - Surface area:
  - Dry season: 2 000-3 000 km^2
  - Wet season: 10 000-12 000 km^2
  - Annual catch[2]: 235 000 tonnes (1995-96)
- Tonle Sap River
- Lower Cambodian Mekong River
  - Length: 90 km
- Bassac River
  - Length: 100 km

1 Van Zalinge and Thuok (1999) Summary of Project Findings: Present Status of Cambodia's Freshwater Capture Fisheries and Management Implications
2 Sverdrup-Jensen (2002). Fisheries in the Lower Mekong Basin: Status and Perspectives

Inland fisheries ♣

Inland fisheries include rivers, lakes, ponds, floodplains, ricefields and swamps. The types of land and water resources in Cambodia are presented below.

Areas of various types of land and water resources that support Cambodia's freshwater capture fisheries [1]

Types of land and water resources in Cambodia	Areas (ha) 1992-93
Permanent water (river, lake, ponds, etc.)	411 100
Flooded forests	370 700
Flooded secondary forests	259 800
Flooded grassland	84 900
Receding and floating ricefields	29 300
Seasonally flooded crop fields	529 900
Swamp	1 400
Total	1 687 000

Inland catches as % of total catches: 89.6% (1999)

Inland fisheries production by different scale of fisheries

Rice-field production:	45 000-110 000 tonnes
Small-scale fisheries:	115 000-140 000 tonnes
Middle-scale fisheries:	85 000-100 000 tonnes
Large-scale fisheries:	34,000-91 000 tonnes
Total	279 000-441 000 tonnes

♣ Van Zalinge and Thuok (1999) Summary of Project Findings: Present Status of Cambodia's Freshwater Capture Fisheries and Management Implications

1 Ahmed et al. (1996) Sustaining the gift of the Mekong: the future of the freshwater capture fisheries of Cambodia

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				Kg/year
Fish for direct human consumption	412.7	1.6	31.6	382.7	28.4
Fish for animal feed & other purposes	-	-	-	-	

Estimated employment (2002)	
(i) Primary sector (including aquaculture):	812 500
(ii) Secondary sector:	> 2 000 000
Trade (2003)	
Value of fisheries imports:	US$ 5.4 million
Value of fisheries exports:	US$ 34.5 million

Inland fisheries ♦

Cambodia's inland fisheries are some of the richest in the Mekong, and the world. This is due to the Mekong's natural flood regime and its ecological diversity. The Cambodian section of the Mekong River flows into four main branches, the Great Lake, the Tonle Sap River, the Lower Cambodian Mekong River and the Bassac River. The direction of flow in the Tonle Sap River changes twice a year. In the rainy season, water flows back towards the Great Lake and vice versa during the dry season. This allows the annual inundation of large floodplains around the Great Lake and northeast and south of Phnom Penh, where important fish habitats such as flooded forests are found leading to rich fish productivity.

According to the fisheries Fiat Law from 1987; the inland capture fishery is divided into three categories: small-scale fisheries, medium-scale fisheries and large-scale fisheries or fishing lots.

Small-scale fisheries are open-access non-licensed with certain restrictions on gear size and use. These fishers are allowed to fish anywhere at anytime, except within fishing lots during open seasons and in protected areas. This scale of fisheries is intended for "subsistence" but this term is open to interpretation as to whether it refers only to fishing for food or fishing to derive a small income from the sale of the catch.

Some of the gears used in small-scale fisheries include, short gillnets, cast nets, scoop nets, shrimp scoop nets, hand-push nets, small bamboo traps, short hook lines, single hook lines, spears and harpoons. Rice-field fishing is also considered small-scale fishery.

The level of production within small-scale fisheries is usually underestimated as the national census only records the main occupations. Therefore secondary and tertiary occupations in fisheries are not revealed.

Middle-scale fisheries indicate the use of medium-size fishing gear under a system of licensing. Nevertheless, this system cannot be considered as a tool to manage the resources as there are no set limits to the number of licenses that are issued. Middle-scale gears are medium mobile and fixed fishing gears, such as giant cast nets, seine nets, surrounding nets, long gillnets, giant push nets, long lines, arrow-shaped traps, and short-barrage bamboo traps. The quality of the fish caught within this method is not as good as within fishing lots because the fish is normally killed or damaged during capture. As a result middle scale fishers tend to sell the fish to processors and markets within the immediate area.

Large scale fishers or fishing lots are licensed fisheries that operate for commercial purposes. Fishing lots are typically found in a geographically defined river location (*dai* lots) such as a stretch of river, a river beach or temporarily flooded land which may or may not include flooded forest areas. Fishing lots are operated under a strict two-year contract acquired via a public auction to the highest bidder. This is one of the government's main instruments for extracting a resource rent from fisheries. The auction grants private lot owners exclusive rights over a particular fishing ground or anchor position for large-scale fishing gear. Nevertheless, these lots are often sub-leased both as a means to recoup the money paid and also because they are too large to be fished effectively by one operator.

The areas covered by fishing lots are so large that villages are often located within or in close proximity to fishing lots. As a result the interaction between fishing lot operators and these villages has proved to be a source of conflict.

♦ FAO. World fisheries statistics (2005)

INDIA

General information ♠

Surface area:	3.3 million km^2
Population (1999):	approximately 1 000 million
Population growth (2004):	1.8%
GDP (1997-98):	US$ 319 733 million
Agricultural GDP (1997-98):	US$ 89 479 million
Currency: rupee. Indicative exchange rate (1999) US$ 1 = Rs 43.3	

♠ FAO. World fisheries statistics (2000)

Main rivers

The catch from rivers does not contribute significantly to the total inland fish production in terms of volume. On the other hand, reservoirs are considered the prime resource as regards capture fisheries and extensive aquaculture.

Total riverine fisheries production	
Number of fishers:	190 000
Riverine production:	150 kg/fisher/year

Flowing into the Bay of Bengal

Indus	
Total length:	1 114 km
Catchment area:	312 289 km^2
Ganges River (Starts in the Himalayas and passes through China, India, Nepal & Bangladesh)	
Total length:	2 525 km.
Length (India):	2 071 km
Number riverine fishers[1]:	7.8 fishers/km
Potential river production[2]:	198.3 kg/ha/year
Actual river production[2]:	30 kg/ha/year
River production (1993-94) [1]:	49.4 mt/year (from Patna Market Centre)
Ganges River basin (Catchments area):	India 80.1%, Nepal 19.3%, and Bangladesh 0.6%)
Surface area:	1 060 000 km^2
Main tributary:	Yamuna River (main tributary from the Ganges)
Tributaries:	Ramgange Gomati Ghagra Gandak Saptkosi Mahananda
Length:	1 300 km
River production:	128 – 174 tonnes/year (from Allahabad Market Centre)[1] (1979-80)
Brahmaputra River	
Total length:	2 580 km
Length (India):	885 km
River production:	No data available
Brahmaputra River Basin	
Surface area:	1 000 km^2
Mahanadi River	
Length:	857 km
Sabarmati River	
Length:	371 km
Catchment area:	21 674 km^2
Mahi River	
Length:	583 km

Catchment area:	34 842 km²
Godavari River	
Length:	1 465 km
Catchment area:	312 812 km²
Krishna River	
Length:	1 401 km
Catchment area:	258 948 km²
Pennar	
Length:	597 km
Catchment area:	55 213 km²
Cauvery	
Length:	800 km
Catchment area:	81 155 km²
Brahmani	
Length:	799 km
Catchment area:	39 033 km²
Mahanadi	
Length:	851 km
Catchment area:	141 589 km²

Flowing into the Arabian Sea

Narmada River	
Length:	1 312 km
Catchment area:	98 796 km²
Tapti River	
Length:	724 km
Catchment area:	65 145 km²

Sugunan (1997) India. In: Fisheries management of small water bodies in seven countries in Africa, Asian and Latin America

[1] Payne et al. (2003) A Review of the Ganges Basin: Its Fish and Fisheries

[2] Das (2002) Social and economic impacts of disease in inland open-water and culture-based fisheries in India

Inland fisheries*

Inland fisheries include rivers, floodplains, estuaries, mangroves, estuarine impoundments, lagoons, upland lakes, reservoirs and ponds.

Inland Fisheries resources of India

Resource	Size
Rivers and canals	173 287 km
Swamps and other wetlands	1 097 787 ha
Floodplain lakes	202 213 ha
Upland lakes	72 000 ha
Mangroves	356 500 ha
Estuaries	285 000 ha
Lagoons	190 500 ha
Reservoirs	3 153 366 ha
Freshwater ponds	2 254 000 ha
Brackishwater ponds	1 235 000 ha

Inland catches as percentage of total catches:

43.03% (1994-95)	52.10% (1998-1999)
total production: 4 950 000 t	total production: 6 158 000 t

Inland catches: description year 1994-95; total inland catches: 2 130 000 t

Capture fisheries	Production
Rivers & canals	28 500 t
Reservoirs	93 650 t
Other capture fisheries	507 850 t
Freshwater aquaculture	1 500 000 t

♣ Sugunan (1997). India. In: Fisheries management of small water bodies in seven countries in Africa, Asia and Latin America

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				Kg/year
Fish for direct human consumption	5 378	Nil	385	4 670	4.8
Fish for animal feed & other purposes	780	-	-	-	

Estimated employment (1997)	
(i) Primary sector:	
Full-time fishers:	2.40 million
Part-time:	1.45 million
Occasional:	2.11 million
TOTAL	**5.96 million**
(ii) Secondary sector:	NA
Gross value of fisheries output (1997-98) (at ex-vessel prices, estimate):	US$ 4 845 million (=1.47% GDP)
Trade (1998-99):	
Value of fisheries imports:	Nil
Value of fisheries exports:	US$ 1 107 million

Inland fisheries ♣

Over the ten-year period covering 1987-1997 inland fisheries production steadily increased by 45.4%. Inland production includes catches from rivers, upland lakes, peninsular tanks, reservoirs and oxbow lakes. The major states contributing are: West Bengal (33%), Andhra Pradesh (9.09%), Bihar (8.71%), Assam (6.92%) Uttar Pradesh (6.49%), Orissa (6.01%), Tamil Nadu (4.82%), Madhya Pradesh (4.07%), Karnataka (3.89%) and Maharashtra (3.4%).

♣ FAO. World fisheries statistics (2000)

INDONESIA

General information♠

Surface area:	1 900 000 km^2
Population (2003):	214 500 000
Population growth (1998-2003):	1.3 %
GDP (2003):	US$ 208.3 billion
Agricultural GDP (2003):	US$ 34.6 billion (16.6 %)
Capture fisheries as % of GDP[1]:	2.35 %
Aquaculture as a % of GDP[1]:	1.66 %

♠ World Bank (2003) Indonesia at a Glance
[1] Asia-Pacific Fishery Commission (2005)

Main rivers

Five main islands

Kalimantan Island (539 460 km^2)
Sungai Kapuas River (longest river in Indonesia)
Length: 1 400 km
Makakam River
Length: 920 km
Catchment area: 77 700 km^2
Barito River (largest river in Indonesia, 3 km wide and 10-30 m deep in places)
Tributaries
Martapura River
Length: 600 km
Kupas River

Sumatra (473 606 km^2)
Lempuing River (one of the most productive inland fisheries in Indonesia)[1]
Fishermen density: 3-4/km^2 (1997)
Fishing activity: 4 hours/day (1997)
Catch/fisherman: 2.2 – 3.3 tonnes/year (1997)
Catch/area: 72 – 118 kg/ha/yr (1997)
Siak River
Asahan River
Hari River
Musi River
Length: 2 000 km
Catchment area: 60 000 km^2
Annual catches[1]: 22 833 kg (average river catches 1979-94)
Indragiri River
Batanghari River
Kampar River

Sulawesi (189 216 km^2)
Jeneberang River
Length: 75 km
Surface area: 760 km^2
Walanae River (feeds Lake Tempe)

Irian Jaya (Papua) (421 981 km^2)
Mamberamo River system (largest river on the island)
Length: 1 300 km
Baliem River
Length: 400 km
Java (132 187 km^2)
Bengawan Solo River basin (largest river on the island)
Length: 600 km+
Surface area: 16 100 km^2
Brantas River (second largest river on the island)
Tributaries
Konto River
Widas River
Ngrowo River

Length:	320 km
Catchment area:	11 800 km^2
Wawar River	
Catchment area:	780 km^2
Flooded area (annual):	15 000 hectares
Tarum River	
Manuk River	
Serang River	
Catchment area:	281 km^2
Serayu River	

Main lakes

Kalimantan

Jempang	
Surface area:	10 875 ha
Melintang	
Surface area:	7 062.5 ha
Potential fish production:	55 kg/ha/yr
Semayang	
Surface area:	8 937 ha
Potential fish production:	54 kg/ha/yr
Luar	
Sentarum	
Siawan	

Sumatra

Toba (largest lake of Indonesia and largest lake in Southeast Asia)

Surface area:	1 145 km^2

Tempe (important for fisheries)
Maniinjau
Kerinci
Singkarak

Sulawesi

Towuti
Sidenreng
Poso
Tondano
Matan

Irian Jaya

Pania
Sentani

[1] Koeshendrajana and Cacho (2001) Management Options for the Inland Fisheries Resource in South Sumatra, Indonesia: I Bioeconomic Model

Inland fisheries*

Indonesia has a huge area of inland open water covering 55 million hectares; – natural lakes, man-made lakes, rivers and swamps.

In 1991, it was estimated that Kalimantan and Sumatra produced 50 per cent and 30 per cent of all the open, freshwater fish production in Indonesia, respectively. It was also estimated that at this time 43 per cent of Indonesian freshwater ponds were located in Western Java.

Inland catches as a % of total catch (2000)[1]:	5.8 %
Brackish/freshwater aquaculture as a % of total catch (2000)[1]:	14.54 %
Inland fisheries production (2000):	297 300 tonnes
Brackishwater pond cultured (2000):	360 800 tonnes
Freshwater pond cultured (2000):	185 200 tonnes
Cage cultured (2000):	97 300 tonnes
Paddy field cultured (2000):	100 800 tonnes

Inland fisheries potential and actual (1998) yield per island[2]:

Potential capture inland fisheries yield per island[1]

Island	Area (ha)	Potential yield (T)	Actual yield (T) (1998)[a]
Java	96 400 ha	30 000 – 35 000	?
Sumatra	4 053 850	300 000 – 330 000	86 365
Kalimantan	9 029 000	400 000 – 450 000	118 227
Sulawesi	492 200	50 000 – 55 000	34 438
Maluku & Irian Jaya	63 300	13 000 – 20 000	2 582
Bali & Nusa Tenggara	17 500	7 000 – 10 000	?

[a] The author estimated the actual catches were two to three times the official figure.

♣ BPS Statistics Indonesia (2000)
[1] Inland/aquaculture catch percentage generated using year 2000 figures from BPS Statistics Indonesia
[2] Coates (2002) Inland capture fishery statistics of South-East Asia:C current status and information needs

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				kg/yr
Fish for direct human consumption	4 066 630	19 169	715 498	3 370 301	16.3
Fish for animal feed & other purposes	329 100	197 935	95 029	432 006	

Estimate employment (1997)	
(i) Primary sector:	4 600 000
(ii) Secondary sector:	NA
Trade (1999)	
Value of fisheries imports:	US$ 49 million
Value of fisheries exports:	US$ 1 640 million

Inland fisheries and aquaculture ♦

In 1997 the open water fisheries are thought to have employed 154,302 vessels. The majority (approximately 93 per cent) were engineless with outboard engines being used on 85 per cent of the remaining vessels. Fish were primarily landed fresh with some being salted/dried, frozen or smoked. The fishery employed 508,626 primarily part-time (64 per cent) fishers, 35 per cent from Sumatra, 29 per cent from Kalimantan, 25 per cent from Java and 5 per cent from Sulawesi.

Multiple gears were exploited in the open water capture fisheries and included, in order of importance; set gillnets (21 per cent), traps (16 per cent), handlines (11 per cent), guiding barriers (10 per cent) and long lines (5 per cent). River fisheries were most important contributing slightly less than 62 per cent of open water landings. Swamps (21 per cent), lakes (12 per cent) and reservoirs (5 per cent) accounted for the remaining 38 per cent. Just under 95 per cent of the open water capture landings were finfish and originated from Kalimantan (55 per cent), Sumatra (19 per cent), Java (13 per cent) and Sulawesi (11 per cent).

Aquaculture was growing in 1997, at which point there was thought to be 2,052,725 fish farmers, primarily in Java (68 per cent). Freshwater pond aquaculture was the predominant form of culture (68 per cent) followed by paddy-field, brackishwater and then cage aquaculture. However, brackishwater aquaculture produced the highest volumes of fish generating 307,259 tonnes and occupying 306,740.9 ha of land. The majority of brackishwater finfish production was milkfish (73 per cent), Mozambique tilapia (12 per cent) and mullets (6 per cent). The main areas of brackishwater aquaculture were Java (36 per cent), Sulawesi (31 per cent), and Sumatra (26 per cent). Pond aquaculture occupied 60,647.8 ha and generated 171,768 tonnes of fish. It primarily produced common carp (31 per cent), catfish (14 per cent), Nile tilapia (10 per cent), Mozambique tilapia (10 per cent), Java carp (9 per cent) and more. This form of culture was most prevalent in Sumatra (48 per cent), then Java (37 per cent) and Sulawesi (9 per cent).

LAO PDR

General information ♠

Surface area:	236 725 km^2
Population (1995):	5 032 000
GDP at purchaser's price (1995):	US$ 1 500 million
Agricultural GDP (1995):	US$ 362
Fisheries GDP (1995):	US$ 900 million
Capture fisheries as % of GDP[1]:	1.43%
Aquaculture as % of GDP[1]:	5.78%

♠ FAO. World fisheries statistics (1999)
[1] Asia-Pacific Fishery Commission (2005)

Main rivers

Mekong River (originates in China and passes through Myanmar, Laos, Thailand, Cambodia and Vietnam.)

Total length:	4 220 km
Length (Laos):	886 km
Surface area:	202 000 km^2 (97% of total country area)
Annual catch:	182 700 tonnes (2000) (capture fisheries)

(The capture fisheries figure is five times the officially reported figure.)

16 700 tonnes (2000) (reservoir)
5 400 tonnes (2000) (aquaculture)

Sverdrup-Jensen (2002). Fisheries in the Lower Mekong Basin: Status and Perspectives

Inland fisheries

Inland catches as percentage of total catches: 100%

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				Kg/year
Fish for direct human consumption	40.0	3	0.01	42.99	8.54

Estimated employment (2002)	
(i) Primary sector (including aquaculture):	200 000
(ii) Secondary sector:	25 000
Gross value of fisheries output (ex-vessel prices):	US$ 48 million
Trade (2003)	
Value of fisheries imports:	US$ 4 million
Value of fisheries exports:	NA

Inland fisheries♦

Inland fisheries represent its entire fisheries production as Lao PDR is landlocked. The majority of landings come from the Mekong River and its tributaries (60%). Rice fields are another important source followed by catches from hydropower reservoirs; although productivity from the latter is usually low.

In the Mekong River and tributaries, the main fishing gears are beach seines and drifting gillnets. Other gears include long-lines and traps. Fishers commonly use flat-bottom boats similar to riverine canoes, although boats equipped with long-tail engines are becoming very popular. Most of the catches from the Mekong River and tributaries are thought to be landed in Thailand due to higher market prices.

Rice fields mostly provide a variety of small species with a short life span and rapid growth. Some of the species include crabs, shrimps, fish, snails, frogs, and insects. All these aquatic species are consumed entirely within Lao PDR. It is thought the fisheries statistics data could be under accounting for total household consumption of aquatic species as the data collection may be concentrating on fish.

♦ FAO. World fisheries statistics (2002)

MALAYSIA

General information♠

Surface area:	329 758 km^2
Population (2003):	24 800 000
Population growth (1998-2003):	2.2 %
GDP (2003):	US$ 103.7 billion
Agricultural GDP (2003):	US$ 10.0 billion (9.7 %)
Capture fisheries as % of GDP [1]:	1.13 %
Aquaculture as a % of GDP [1]:	0.37 %

♠ World Bank (2003): Malaysia at a Glance
1 Asia-Pacific Fishery Commission (2005)

Malaysia consists of the Malay Peninsular, West Malaysia, (154,680 km^2) and the northwestern part of Borneo Island, East Malaysia, (202,020 km^2)

Main rivers

East Malaysia

Rajang River		
	Length:	565 km
	Est. productivity:	100 kg/ha/yr
Kinabatangan River		
	Length:	565 km
	Catchment:	+17 000 km^2
Batak Lupar		
	Length:	228 km
Baram River		
	Length:	402 km
	Est. productivity:	142-169 kg/ha/yr
Limbang River		
	Length:	196 km
Sarawak		
	Length:	115 km

West Malaysia

Pahang River system		
	Length:	459 km
	Annual catch (2000-02 average)[2]:	131 tonnes
Kelantan River		
	Length:	400 km
Perak River		
	Length:	522 km
	Est. productivity:	11.64 kg/ha/yr
Gombak River		
	Length:	
	Est. productivity:	180 kg/ha/yr
Klang River		
	Length:	120 km
	Catchment:	1 200 km^2
Langat River		
	Length:	160 km
	Catchment:	1 240 km^2

Main lakes

West Malaysia

Lake Kenyir (largest reservoir in Malaysia and sustaining a small-scale commercial fishery)

Area:	360 km^2
Mean depth:	37 m
Annual catch[1]:	720 tonnes
Lake Temengor	
Area:	152 km^2
Est. annual catch[2]:	100 tonnes
Lake Bera (largest natural lake)	
Area:	61.5 km^2
Annual catch:	No data available
Bukit Merah	
Storage:	75 million m^3
Annual catch:	100 tonnes
Chenderoh (oldest reservoir in Malaysia)	
Annual catch (late 80s):	2.57 tonnes
Value of landings:	63 179 RM (US$ 24 300)

☙ Jackson & Marmulla (2001)

1 This figure has been synthesized and is based on a yield figure of 20 kg/ha/year derived by Yusoff et al. (1995)

2 Khoo et al. (2003)

Inland fisheries♣

Freshwater fish catch (2000):	22 636 tonnes
Freshwater aquaculture production (1997):	20 303 tonnes

♣ Earthtrends Water Resources and Freshwater Ecosystems (2003) Malaysia

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 (tonnes (live weight)				kg/yr
Fish for direct human consumption	1 252	343	94	1 003	45.9
Fish for animal feed & other purposes	210	47	58	221	-

♦ FAO. World fisheries statistics (2000)

Estimate employment (1997)	
(i) Primary sector (excluding FW fisheries sector):	79 000
(ii) Secondary sector:	NA
Trade (1999)	
Value of fisheries imports:	US$ 258.7 million
Value of fisheries exports:	US$ 181.2 million

Inland fisheries ♦

Cyprinids and silurids are the species dominating the inland capture fisheries within Malaysia's major rivers (Khoo et al. 1987). Nevertheless, Malaysia has no large river systems compared to other countries. Man-made lakes dominate the Malaysian lentic environment. The estimated surface area of these lakes is 1 000 km^2. Furthermore, there are several large reservoirs that have been developed for inland fisheries. In particular, the Perak and Terengganu dams located in Peninsular Malaysia have been successfully converted for recreational fisheries.

♦ FAO. World fisheries statistics (2003b)

1 Khoo et al. (1987)

MYANMAR (BURMA)

General information ♠

Surface area:	676 577 km^2
Population (2001-02):	47 114 million
GDP at purchaser´s price (1999-2000):	2 190 301 million kyat
Agricultural GDP:	29 151 million kyat
Aquaculture as % of GDP[1]:	0.17%

♠ FAO. World fisheries statistics (2001)
[1] Asia-Pacific Fishery commission (2005)

Main rivers

The Mekong River system and the Irrawaddy system have great similarities in terms of their fisheries. Therefore, the fisheries of Myanmar and Cambodia are usually compared. Even though the Mekong River runs along Myanmar, it only covers a very small area of the country.

Total aquatic resource area of the river systems[1]: 8.2 million ha

Irrawaddy system

Ayeyarwaddy River (or Irrawaddy River)	
Length:	2 150 km
Catchment:	424 000 km^2
Annual catch[2]:	No data available
Chindwin River (tributary of the Ayeyarwaddy River)	
Length:	844 km
Annual catch[2]:	No data available
Sittaung River	
Length:	563 km
Annual catch[2]:	No data available
Salween (Thanlwin) River	
Length:	2 400 km
Annual catch[2]:	No data available

** FAO (2003) Myanmar Aquaculture and Inland Fisheries
[1] Coates (2002) Inland capture fishery statistics of Southeast Asia: Current status and information needs
[2] No data available for specific permanent water bodies and seasonal floodplains

Inland fisheries♣

Inland fisheries production comes mainly from floodplains, the water surface of which covers six million hectares during 4-5 months of the year[1].

Inland catches as percentage of total catches: 25%
(Total fisheries production 1 300 648 tonnes (2000-01))

Degree of exploitation:	
Inland freshwater fishers[2]:	1 398 410 fishers
Inland capture fishery potential[3]:	600 000-900 000 tonnes
Inland capture fisheries (2000-01)[4]:	253 373 tonnes
Inland culture fisheries (2000-01)[4]:	109 188 tonnes
Inland prawn farming (2000-01)[4]:	6 603 tonnes

♣ FAO (2003) Myanmar Aquaculture and Inland Fisheries
[1] Moo (2002) Inland Fisheries of the Union of Myanmar
[2] Coates (2002) Inland capture fishery statistics of Southeast Asia: Current status and information needs
[3] Estimate based on revised valuation of the Mekong River system capture fishery potential
[4] Including lakes, rivers, floodplains, reservoirs and lagoons

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				Kg/year
Fish for direct human consumption	793.9	1	97.2	723.2	15.4
Fish for animal feed & other purposes	151.9	0.565	-	-	

Estimated employment (2002)	
(i) Primary sector (including aquaculture):	540 845 persons employed (full-time)
(ii) Secondary sector:	3 082 persons
Gross value of fisheries output (at ex-vessel prices 1999-2000):	106 763 million kyats
Trade (2003)	
Value of fisheries imports:	-
Value of fisheries exports:	US$ 158.56 million

♦ FAO. World fisheries statistics (2001) locally

Inland fisheries ♦

Permanent freshwater bodies include rivers and estuaries as well as two major lakes (the Inlay and Inndawgyi), which cover about 1.3 million hectares; and over one hundred major man-made reservoirs covering approximately 1.2 per cent of Myanmar's total annual water resources. There are three types of capture inland fishery: floodplain, leasable and open water.

The floodplain fishery is a seasonal fishery that takes place at the end of the monsoon when the waters recede from the Delta. During this time, fish either become trapped within water pockets of small lakes and ponds or they follow the receding floodwaters into rivers and their tributaries. To follow fish species following the decreasing waters, fishers use bamboo screens and fixed traps at suitable points. This type of fishing method is known as the Myanmar Inn and it is very profitable. As a result, it is considered to be the most important (inland) fishing method. In 2000-01, the production using this technique was 90,948.44 tonnes.

The leasable fishery is also seasonal. It is practiced in streams and various forms of water catchment areas. Fishing operators obtain temporary lease agreements to operate within these areas. In 2000-01, 3,481 leases were given out of the 3,721 designated leasable areas.

The open water fishery occurs in permanent freshwater bodies such as streams, rivers and lakes. The species caught are highly demanded fish including air-breathers, snakeheads, climbing perches, and feather backs. Private fishers and cooperatives require licenses to operate this fishery. Of the total inland catches within this fishery, 96 per cent are accounted by private fishers. The rest is accounted by the cooperative sector.

♦ FAO. World fisheries statistics (2000)

PHILIPPINES

General information♠

Surface area:	300 000 km^2
Total number of islands:	7 107 islands
Population (1998):	73 130 000
GDP (1998) current prices:	US$ 65 100 million
Agricultural GVA (1998) (current prices):	US$ 11 000 million
Based on an exchange rate of:	US$ 1 = peso 40.89 (1998)

♠ FAO. World fisheries statistics (2000)

Main rivers, lakes and swamps/marshes

Total number of islands: 7 107 islands
- Largest island: Luzon
- Surface area: 104 688 km^2

Main rivers

- Abra River basin (Northwestern Luzon)
  - Surface area: 5 125 ha
- Cagayan River basin (Northern Luzon)
  - Length: 190 km
  - Surface area: 25 649 ha
- Agno River basin (West Central Luzon)
  - Surface area: 13 800 ha
- Pampanga River basin (Central Luzon)
  - Surface area: 9 759 ha
- Pasig-Laguna River (Southern Luzon)
  - Length: 25 km
  - Surface area: 4 678 ha

Main lakes

- Laguna de Bay O
  - Surface area: 90 000 ha
  - Annual catch[1]: 20 400 tonnes (1979-80)
- Taal O
  - Surface area: 24 356.40 ha
  - Annual catch[1]: 11 800 tonnes (1984)

Main swamps/marshes

- Candaba Swamp, Bulacan and Pampanga provinces
  - Surface area: 32 000 ha
- Second largest island: Mindanao
  - Surface area: 94 630 km^2

Main rivers

- Mindanao River (Central Mindanao)
  - Length: 320 km
  - Surface area: 23 169 ha
- Agusan River (East Mindanao)
  - Length: 390 km
  - Surface area: 10 921 ha

Main Lakes

- Mainit O
  - Surface area: 17 430.20 ha
  - Annual catch[1]: 13 000 tonnes (1980-84)
- Lanao O
  - Surface area: 34 700 ha
  - Annual catch[1]: 10 000 tonnes (1984)

Main swamps/marshes

Agusan Marsh (in Agusan River basin)
Surface area: 90 000 ha
Liguasan Marsh (in Mindanao River basin)
Surface area: 220 000 ha

☙ Bureau of Fisheries and Aquatic Resources (2004). Current information on inland capture fisheries in the Philippines
1 De la Cruz (1997). Social, Economic and Cultural Aspects in Implementing Inland Fishery Enhancements in the Philippines

Inland fisheries♣

The Philippine inland resources consist of lakes, rivers, reservoirs, swamps, marshes, and small water impoundments. Lakes and reservoirs are the most important environments for inland fisheries with the total surface area of 219,000 hectares[1].

Inland catches as percentage of total catches[2]:
Year 1992: 8.75% (inland fisheries: 229 673 t; total: 2 625 607 t)
Year 2002: 3.95% (inland fisheries 131,644 t; total: 3 329 118 t)
(indicating decline in inland fisheries production over time)

Inland fishery resource area in the Philippines[1]

Environment	Surface area (ha)
Swamplands	246 063
Freshwater	106 328
Brackishwater	139 735
Existing fishponds	253 854
Freshwater	14 531
Brackishwater	239 323
Other inland resources	250 000
Lakes	200 000
Rivers	31 000
Reservoirs	19 000

♣ Bureau of Fisheries and Aquatic Resources (2004). Current information on inland capture fisheries in the Philippines
1 Coates (2002). Inland capture fishery statistics of Southeast Asia: Current status and information needs
2 Inland production includes lakes, rivers, reservoirs and marshes

Fisheries Data ♦

	Production [1]	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				Kg/year
Fish for direct human consumption	1 950.8	121.7	180.5	1 92.0	25.9
Fish for animal feed & other purposes	193.7	87.8[b]	43.2	238.3	-

Notes: 1 Excluding 642 319 t of seaweed (wet weight)
2 Including 42 989 t of fish meal (>> 85 978 t live weight)

Estimated employment (2002)	
(i) Primary sector (including aquaculture):	Approximately 1 million persons of which 57,000 were employed on large vessels, 259,000 in fish culture activities, and the remainder in municipal fisheries
(ii) Secondary sector:	Approximately 35,000 persons operating shore facilities and involved in fish drying and other post-harvest activities
Gross value of fisheries output: (at ex-vessel prices, 1998)	US$ 1.8 billion
Trade (1998)	
Value of fisheries imports:	US$ 83.3 million
Value of fisheries exports:	US$ 530 million

Inland fisheries ♦

Total inland water production has declined steadily over time, from 237,000 tonnes in 1990 to 146,471 tonnes in 1998. The decline is attributed to widespread overfishing; pollution and siltation from the discharge of urban and industrial effluents; as well as the use of the resource for activities conflicting with inland fisheries (e.g., the extensive development of fish pens).

♦ FAO. World fisheries statistics (2004)

SRI LANKA

General information ♠

Surface area:	65 610 km^2
Population (2004):	19 400 000
Population growth (1998-04):	1.3%
GDP (2004):	US$ 18.2 billion
Agricultural GDP (2004):	US$ 3.24 billion (17.8%)
Capture fisheries as % of GDP[1]:	1.428 %
Aquaculture as a % of GDP[1]:	0.468 %

♠ World Bank (2004). Sri Lanka at a Glance
[1] Asia-Pacific Commission (2005)

Main rivers

There are 103 distinct river basins covering over 4,500 km in length. The four main rivers all originate in the central hills and pass through the lower plains to the sea; they include the following:

Mahaweli		
	Length:	335 km
	Catchment area:	2 442 km^2
Kelani		
	Length:	145 km
	Catchment area:	2 292 km^2
Kalu		
	Length:	129 km
	Catchment area:	2 719 km^2
Walawe		
	Length:	138 km
	Catchment area:	2 471 km^2

Ministry of Irrigation and Water Management of Sri Lanka (2002)

Perennial reservoirs♣

The inland capture fishery of Sri Lanka is confined to its perennial reservoirs (1,550 km^2 in total)[1].

The culture fishery tends to be confined to the seasonal tanks (1,000 km^2) [1].

Main reservoirs:

Senanayake Samudra (largest reservoir)		
	Area:	76.8 km^2
	Catchment area:	983 km^2
Maduru Oya		
	Area:	63.9 km^2
	Catchment area:	433 km^2
Moragahakanda		
	Area:	40.5 km^2
	Catchment area:	782 km^2
Udawalawe Reservoir		
	Area:	34.2 km^2
Lunugamwehera		
	Area:	30.2 km^2
	Catchment area:	904 km^2
Randenigala		
	Area:	23.5 km^2
	Catchment area:	2 333 km^2

The overwhelming majority of the reservoirs in the country can be classified as small waterbodies[2].

Estimated surface area of inland lentic waterbodies in Sri Lanka including the recently constructed Manhaweli reservoirs[2]

Type	Number	Area (ha)
Major irrigation reservoirs (ancient)	73	70 850
Medium scale reservoirs (ancient)	160	17 004
Minor irrigation reservoirs (ancient)	10 000	39 271
Floodplain lakes	-	4 049
Upland hydroelectric reservoirs (recent)	7	8 097
Mahaweli reservoirs	5	22 000
Maduru Oya	-	6 280
Victoria	-	2 270
Kotmale	-	970
Randengala	-	2 750
Ulhiyia-Ratkinda	-	2 270
Total	10 245	175 811

♣ Individual reservoir details from De Silva (1988)
1 Ministry of Fisheries and Aquatic Resources (2005)
2 Sugunan (1997). Fisheries management of small water bodies in seven countries in Africa, Asia and Latin America

Inland fisheries♣

It is reported that while the floodplains are a productive ecosystem in Sri Lanka, there is no riverine fishery worth mentioning. The main share of inland production is from the reservoirs[1]. Most of the large reservoirs are constructed storages for hydroelectric power generation, and the medium ones are ancient (for capture fisheries). Small reservoirs and seasonal tanks are for culture fisheries.

Inland catches as a percentage of total catch (2003)[2]:	10.6 %
Freshwater aquaculture as a percentage of total catch[3] :	3 %
Inland fisheries production, including aquaculture (2003)[4]:	30 280 tonnes

♣ Individual reservoir details from De Silva (1988)
1 Sugunan (1997). Fisheries management of small water bodies in seven countries in Africa, Asia and Latin America
2 Inland catch percentage generated from 2003 figures obtained from the Ministry of Fisheries and Aquatic Resources
3 Freshwater aquaculture percentage from ICLARM The WorldFish Center (2002)
4 Catch figures from Ministry of Fisheries and Aquatic Resources (2005)

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				kg/yr
Fish for direct human consumption	286 370	67 284	13 680	339 974	17.4
Fish for animal feed & other purposes	-	N/A	-	-	-

♦ FAO. World fisheries statistics (2000)

Estimate employment (2004)	
(i) Primary sector:	250 000
(ii) Secondary sector:	100 000
Trade (2004)	
Value of fisheries imports:	US$ 59 million
Value of fisheries exports:	US$ 94 million

Inland fisheries and aquaculture ♦

Inland fisheries experienced steady growth, from 23,000 tonnes in 1995 to 30,280 tonnes in 2003 (including aquaculture). This growth is attributed to a development program that has stocked waterbodies with fingerlings; raised fish in ponds, cages and pens; and provided subsidies to fishers to purchase canoes and fishing gear. Furthermore, the Aquaculture Development Division of the Ministry of Fisheries and Aquatic Resources Development are providing support to rehabilitate two fish breeding stations at Dambulla and Udawalave. These institutions are also encouraging farmers, fishers and NGOs to increase fish feed production.

♦ FAO. World fisheries statistics (2004)

THAILAND

General information ♠

Surface area:	514 000 km^2
Population (2004):	62 400 000
Population growth (1998-2004):	0.7%
GDP (2004):	US$ 163.5 billion
Agricultural GDP (1996):	US$ 12 695.8 million
Capture fisheries as % of GDP[1]:	2.04%
Aquaculture as % of GDP[1]:	2.07%

♠ FAO. World fisheries statistics (2000)
1 Asia-Pacific Fishery Commission (2005)

Main rivers

Thailand has 47 major rivers
Estimated total riverine production[1]: 200 000 – 500 000 tonnes/year

Mekong River (originating in China and passing through Myanmar, Laos, Thailand, Cambodia and Vietnam)

Total length:	4 225 km
Length along the Thai-Laos border:	850 km (approx.)
Total annual catches[2]:	875 000 tonnes (2000) (capture fisheries)
	68 100 tonnes (2000) (aquaculture)
	187 500 tonnes (2000) (reservoirs)
Tributary	
Mun River	
Length:	673 km
Pak River	
Songkhram River (the only river without a main stream dam)	

Salween (Originating in the Tibetan plateau, it flows southward through China, down through the East of Myanmaralong the Thai-Myanmar border, before continuing through Myanmar and emptying into the Andaman Sea. It is the last free-flowing international river in Asia)

Total length:	2 800 km
Total length along the Thai- Myanmar border:	120 km
Total floodplain:	320 000 km^2
Floodplain within Thailand:	16 000 km^2 (5%)

Chao Phraya (Forming in Pak Nam Pho from four upstream tributaries, the river connects with three tributaries, Sakaekrung and Tachin from the southwest and Pasak from the northeastern Petchabun Range, before running off into the Gulf of Thailand.)

Length:	230 km
Floodplain:	21 521 km^2
	(overall Chao Phraya system: 160 000 km^2)
Tributaries	
Ping (major tributary)	
Length:	480 km
Catchment area:	35 535 km^2
Yom	
Catchment area:	19 516 km^2
Nan	
Length:	800 km
Catchment area:	32 854 km^2
Wang	
Floodplain:	11 084 km^2

Tapi River (longest river of southern Thailand)
Length: 230 km
Catchment: 5 460 km^2
Kwai Noi River
Mae Klong River
Kwae Yai River
Songrkham River
Production: 91 kg/ha
Pa Sak River
Length: 513 km
Catchment area: 18 000 km^2

Sources:
1 Coates (2002) Inland capture fishery statistics of Southeast Asia: Current status and information needs
2 Sverdrup-Jensen (2002). Fisheries in the Lower Mekong Basin: Status and Perspectives

Inland fisheries

The inland fishery in Thailand is primarily concerned with reservoir fisheries production. Therefore, the national figure provided for inland capture fisheries represents mainly reservoir fisheries production[1].

Inland fishery resources of Thailand

Inland fishery resources of Thailand[2]		
Resource	**Number**	**Area** (ha)
		(ha)
Rivers and canals	47	120 000
Natural lakes and swamps	8 000	300 000
Large reservoirs	21	292 590
Medium and small reservoirs	1 745	425 500
Village ponds	4 947	25 676
Brackishwater lakes	1	96 000
Other public waters	10 859	143 000
Total		1 285 420

Inland catches

Inland capture fisheries as a percentage of the total catch[3]:

48.2%(2000)[3]
Total production: 477 552 tonnes
Inland capture: 205 500 tonnes
Reservoir (estimate): 122 314 – 318 909 tonnes[1]

38.5% (2002)
Total production: 533 393 tonnes
Inland capture: 206 350 tonnes

1 Coates (2002). Inland capture fishery statistics of Southeast Asia: Current status and information needs
2 Sugunan (1997). Fisheries management of small water bodies in seven countries in Africa, Asian and Latin America
3 FAO – Fish-Stat Plus Database (2005)

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				kg/yr
Fish for direct human consumption	2 420	735	1 732	1 423	23.6
Fish for animal feed & other purposes	1 050	59	126	983	-

Estimate employment (1997)	
(i) Primary sector:	530 401
(ii) Secondary sector:	196 105
Trade (1999)	
Value of fisheries imports:	US$ 840.7 million
Value of fisheries exports:	US$ 4.1 billion

Inland fisheries ♦

Inland fisheries are harvested as an open access resource. Production has decreased slowly in the last few years due to habitat degradation and increased pollution from industrial wastes. Nevertheless, rehabilitation efforts and fish re-stocking programs are aiming to increase freshwater fish resources in public waters.

The most commonly used fishing gears are gill nets, long lines, hook–and-lines, scoop nets, cast nets and lift nets. Inland catches include local carp, catfish, gourami, shrimp and snakehead fish. The catch is used entirely for human consumption. Of which, 80 per cent is consumed fresh, 9 per cent is processed into salted and dried fish, and 5 per cent is fermented.

In the future Thailand plans to focus on intensifying fish stocks in public waters. In order to do this, the Department of Fisheries is releasing fish fry into these areas. For example, in 1999, 720 million fish fry were released countrywide. If three to ten per cent of these fry are estimated to survive to adulthood, then, the stocking of public waters should allow the number of food-fish available to increase between 2,160,000 and 7,200,000.

♦ FAO. World fisheries statistics (2000)

VIETNAM

General information ♠

Water area (inland):	329 560 km^2
Population (2004):	Est. 82 689 518
Population growth (2004):	1.3%
GDP at purchaser's value (2003):	US$ 203.7 billion
Agricultural percentage of GDP (2003):	21%
Fisheries GDP (2003):	4%
Capture fisheries as percentage of GDP[1]:	3.7%
Aquaculture as percentage of GDP[1]:	3.5%

♠ FAO. World fisheries statistics (2005)
[1] Asia-Pacific Fishery Commission (2005)

Main rivers

Total number of rivers			2 500 rivers
Red River system			
	Annual catches:		6 000 tonnes (1980's) (Capture fisheries)
	Thao		
		Length:	902 km
		Catchment area:	51 750 km^2
	Da		
		Length:	1 013 km
		Catchment area:	52 610 km^2
	Lo		
		Length:	469 km
		Catchment area:	38 970 km^2
	Hong		
		Length:	1 126 km
		Catchment area:	154 720 km^2
Red River delta			
		Surface area:	19 000 km^2
		Annual catches:	136 000 tonnes (Capture fisheries)
Thai Binh system			
	Cau		
		Length:	288 km
		Catchment area:	6 064 km^2
	Thuong		
		Length:	164 km
		Catchment area:	3 580 km^2
	Luc Nam		
		Length:	175 km
		Catchment area:	3 066 km^2
	Thai Binh		
		Length:	385 km
		Catchment area:	15 520 km^2
Kycung-BacGiang system			
	Bang Giang		
		Length:	108 km
		Catchment area:	4 565 km^2
	Kycung		
		Length:	243 km
		Catchment area:	6 663 km^2
Ma system			
	Ma		
		Length:	538 km
		Catchment area:	28 370 km^2
	Chu		
		Length:	325 km
		Catchment area:	7 552 km^2

Ca system			
	Ngan Sau		
		Length:	135 km
		Catchment area:	3 813 km^2
	Hieu		
		Length:	228 km
		Catchment area:	5 330 km^2
	Ca		
		Length:	531 km
		Catchment area:	27 224 km^2
Gianh			
		Length:	158 km
		Catchment area:	4 676 km^2
Quang Tri			
		Length:	156 km
		Catchment area:	2 500 km^2
Thu Bon			
		Length:	205 km
		Catchment area:	10 590 km^2
Ba system			
		Length:	13 814 km
		Catchment area:	13 814 km^2
DongNai-SaiGon system			
	Dong Nai		
		Length:	586 km
		Catchment area:	29 520 km^2
	La Nga		
		Length:	272 km
		Catchment area:	4 000 km^2
	Be		
		Length:	344 km
		Catchment area:	8 200 km^2
	Sai Gon		
		Length:	256 km
		Catchment area:	5 560 km^2
Mekong system			
	Bassac River		
		Total length:	420 km (Cambodia and Viet Nam)
		Length (Vietnam):	320 km
		Annual capture:	119 kg/ha/year[1]
	Cuu Long (Mekong River, originating in China and passing through Myanmar, Laos, Thailand, Cambodia and Vietnam)		
		Total length:	4 225 km
		Length (Vietnam):	350 km
		Catchment area:	795 000 km^2
		Annual capture:	>30 000 tonnes (63 kg/ha/year[1])
			20 000 tonnes (1980s)
Mekong delta			
	Surface area in Viet Nam:		39 500 km^2 (16 000 km^2 in Cambodia)
	Annual capture[3]:		190 000 tonnes (2000) for capture fisheries
	Total production[2]:		438 000 tonnes (2000)

* UNEP (1998). National Report of Vietnam
1 De Graaf and Chinh (2002). Floodplain fisheries in the southern provinces of Vietnam
2 Van Zalinge et al. (2000). Where there is water there is fish? Cambodian fisheries issues in a Mekong River Basin perspective
3 Baran (2005). Cambodia inland fisheries: facts, figures and context

Inland fisheries*

Inland catches as a percentage of total catches:	43.8%
Total catch (2003):	2 536 361 tonnes
Degree of exploitation (2003)	
Inland catches:	1 110 926.12 tonnes

Estimated amount of captured freshwater fish in different types of waterbodies and socioeconomic regions in Vietnam in the 1980s (tonnes)

	Aquaculture	Lakes Reservoirs	Rice fields	Rivers	Total
North	120 000	5 000	5 000	6 000	136 000
South	90 000	4 000	30 000	20 000	144 000
Center	5 000	3 000	900	3 000	11 900
High lands	5 000	1 000	100	500	6 600
Total	220 000	13 000	36 000	29 500	298 500

♣ UNEP (1998). National Report of Vietnam

Fisheries data ♦

	Production	Imports	Exports	Total supply	Per capita supply
	'000 tonnes (live weight)				kg/year
Fish for direct human consumption	1 434 (2002)	21	482	973	19.4 (2001)
Fish for animal feed & other purposes	990 (MOFI, 25% of total = 634)	54	8	1 036	

Estimated employment (2002)

(i) Primary sector (including aquaculture):	553 900
(ii) Secondary sector:	3.4 million
Gross value of fisheries output (2003):	US$ 1.7 billion
Trade (2003)	
Value of fisheries imports:	US$ 52.1 million
Value of fisheries exports:	US$ 2.24 billion (2.35 billion in 2004, estimated in January 2005)

Inland fisheries ♦

Fishing production means

In recent years, the number of fishing boats has increased considerably in Vietnam. The Vietnamese capture fishing industry had a total of 81,000 motorized fishing vessels with a total capacity of 4,038,000 hp (2003).

Inshore fisheries

The continuing construction of dams and reservoirs means the total size of its water bodies is still increasing. However, in 2005 natural lakes and rivers were thought to occupy approximately 4,200 km^2 with ponds and seasonal flood plains adding a further 6,000 km^2.

Freshwater capture fisheries, once of economic importance in certain regions, have been in decline. Overexploitation has resulted in diminished productivity and led to many fishers pursuing alternative activities and cooperatives ceasing to operate. Furthermore, management policies relating to flood control have led to once highly productive rivers such as the Red River Delta becoming significantly less so.

The inland fisheries that occur in rivers, lakes, dams and rice fields remain important to people living in rural areas. These fisheries are thought to have peaked in 2001 at 244,00 tonnes before falling to 209,000 tonnes in 2003. The figures include culture-based capture of species such as carp and tilapia but are still believed to underestimate true production (a common problem of fisheries statistics in the Mekong region). The Mekong itself is thought to support 48,000 Vietnamese fishers in 250 communities and produce 30,000 tonnes of fish each year.

♦ FAO. World fisheries statistics (2005)