Review of Literature on Values of Inland Capture Fisheries and Dams Construction at the Lower Mekong and Ganga Basins

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1 INTRODUCTION

Inland fisheries contribute to millions of people in terms of food security as well as a source of protein to the rural poor in Asia. In addition, it is also a source of livelihood to many of the rural poor. However, increasing competition on the use of water resources and high population growth in riparian countries of major river basins have elevated pressures on the distribution of these resources and reduction in fisheries production.

The purpose of this report is to provide information on the economic, social and cultural value of river fisheries in tropical Asia and to identify areas of focus for future research. An economic valuation literature review exercise is undertaken focusing on two major river systems: the Ganga and the Mekong. The review will provide information that can be used to ascertain the value of fisheries resources, through regional, country and local reports. The information is by no means complete, but gives an idea of the depth of knowledge in particular areas and the breadth of knowledge on the economic value of fisheries resources based on two major Asian river systems.

The major river systems in Asia that support fisheries resources contribute significant economic benefits to riparian communities and the national economy. The rivers are utilized to support and provide benefits to the inhabitants at the basins, including hydropower, transportation, freshwater and food in the form of fish and fish products, in addition to its cultural, religious and recreational values.

Valuation of ecological systems serves as an approach to support and guide development initiatives and policy decisions towards sustainable resources management. River systems support a variety of economic activities, which manifest themselves directly and indirectly throughout associated communities.

The paper is organized by region and country. It first explains the values documented for river fisheries in the relevant region, and highlights related values of individual countries within the river region. It is important to notethat there have been few economic valuation studies undertaken in this region *per se*. Hence, data such as catch and effort are also documented to estimate the value of these fisheries.

The structure of the paper is organized into seven sections, Section 1 as Introduction; Section 2 outlines the major rives covered; Section 3 summarises the values estimated on inland capture fisheries based on existing literature of the 2 basins; Section 4 identifies the impacts of dam construction on the 2 basins; Section 5 highlights methodological issues drawn from the literature; Section 6 identifies major gaps in the literature; and Section 7 provides conclusions and recommendations for future research.

2 MAJOR RIVER BASINS COVERED

This section covers literature review on inland fisheries valuation research in the Mekong River Basin and Ganga River Basin. These two river basins are the focus of the discussion due to its important role in supporting food security and high dependence of local communities at riparian countries for livelihood.

2.1 Mekong River Basin

With its headwaters on the Tibetan Plateau, the Mekong River Basin flows through part of China (Yunnan), Myanmar and Vietnam, nearly one-third of Thailand, and most of Lao PDR and Cambodia. The Mekong is the longest river in Southeast Asia. The Mekong River Basin covers nearly 795,000 km^2 and is home to more than 73 million people. On average, it discharges 475,000 million m^3 of water to South China Sea per year. The river is 4,800 km in length, with average annual rainfall of 2,000 mm at the basin and 1,250 mm for the whole area. The Lower Mekong Basin (LMB) covers four countries: Cambodia, Lao PDR, Thailand and Vietnam, and 77% of the total basin area with 55 million people. These four countries have signed the development agreement in 1995. The wet season occurs between May to October, results in an inundation as wide as 70,000 km^2 floodplains, with discharge as high as 30 times greater than that in the dry season in November to April at Pakse (Lao PDR) and 53 times at Kratie (Cambodia). (Ahmed & Hirsch, 2000; Van Zalinge et al., 2003)

Lorenzen et al. (2003) reported that fish species diversity in the Mekong basin is estimated at 1,200 species. Others reported that there are over 1,500 species of freshwater fish in the Mekong River Basin, referring it as one of the most productive and biologically diverse fisheries in the world.[1] Many studies have indicated that fish ecology of the Mekong River Basin is highly correlated to, and influenced by, the morphological and hydrological characteristics of the basin[2] (Ngor & Hem, 2000; Van Zalinge, 2003; Lorenzen, 2003).

The political division of the basin has given rise to varied perspectives on its social, economic, cultural and environmental significance. The disparity in political stability and regime has resulted in a different rate of economic development, thus, different level of dependence on the river resources for livelihoods, indicating the relative importance of the river resources to each country.

2.2 Ganga River Basin

The Ganga is 2,525 km long, run from the upper Himalayas to the Bay of Bengal (Sinhaet al., 1998). The basin is located 70-88°30' east longitude and 22°-31° north latitude. The total drainage area exceeds 1,060,000 km^2 and it is the fifth largest in the world (Welcomme, 1985). The maximum area of land that are flood prone throughout the basin vary considerably but are of the order of 295 km^2 in India and 77,000 – 93,000 km^2 in Bangladesh.[3]

The Ganga Basin is bound on the north by the Himalayas, on the west by the Aravallis and the ridge separating it from Indus basin, on the south by the Vindhyas and Chhotanagpur Plateau and on the east by the Brahmaputra ridge. It has a population of 450 million, with an average density of over 550 per km^2, in certain locality, this density is as high as over 900 per km^2 (Payne et al., 2003). There is considerable demand and competition for resources due to the high population, particularly on water. Most tributaries are controlled by irrigation barrages.Two major barrages are placed across the main channel, one each at Hardwar and Farakka. As the barrage at

[1] Opening speech by Samdech Hun Sen, Prime Minister of the Royal Government of Cambodia, at the Second Large River Systems Symposium, Phnom Penh, 11-14 February 2003.
[2] The correlation (R^2) computed between Dai catch and water level was as high as 0.89.
[3] This also includes flooded area due to the confluence of the Brahmaputra and Meghna in Bangladesh.

Farakka diverts water to Calcutta, it has been the source of disputes between India and Bangladesh as these structures modify the flow of the river and influence the fishery distribution. (Payne et al., 2003)

3 ECONOMIC VALUATION STUDIES CONDUCTED

3.1 Mekong River Basin

At the Lower Mekong Basin, water is used for many purposes. Its direct use value accounts for its contribution to food security in terms of fishery production, transportation, source of drinking water, and for other domestic uses. The other major use value of the river is generated from irrigation of rice fields. Besides, the river has high cultural, social and religious values to the inhabitants, which attract tourists to the basin. This is reflected among the Thai and Cambodians during the water festivals or Cambodian New Year and high number of visitors to these countries during the month of April.

The other values of inland fisheries realized but not valuaed are biodiversity and pharmaceutical values. However, pharmaceutical values may be reflected through market values indirectly according to population beliefs and culture. Van Zalinge (2003) reported that the number of fish species that found in the MB exceeds 2000. Although different types of values are reported on river fisheries in LMB, limited valuation studies have been conducted, and most of the values reported are direct extractive values of fisheries, which are market values.

Table 1 presents the estimated capture fisheries production in the Mekong Basin from different sources. Information on capture fisheries from Myanmar is not available, while information from China is estimated on the freshwater capture production from the Yunnan province[4]. The findings indicate that although Lao PDR has a long coverage by the Mekong River, it has a low capture fishery production compared to its neighbours especially Cambodia and Thailand. Table 1 highlights a major discrepancy of available statistics. The national capture production is lower than that from the annual catch data at Mekong (as in the case of Vietnam, Thailand and Cambodia). Although the statistics were reported by different sources, such discrepancies call for attention to the quality of the information available currently.

Table 1: Estimated capture fisheries production in the Mekong Basin, in tonnes[5]

Country	Annual Catch Range (in Mekong) [1]	Capture (for the country) (2000) [2]
Cambodia	289,000 – 431,000[a]	245,600
Lao PDR	27,000[b]	29,250
Thailand	303,000 [b]	209,404
Vietnam	190,000 [b]	161,000
Myanmar	N.A.	189,708
China	25,000 [c]	1,752,981

Source: [1] Ahmed & Hirsch 2000. [a] Ahmed et al. 1998; Deap et al. 1998. [b] MRC 1992; Jensen 1996. [c] On Yunnan only, estimated from Xie & Li, 2002.
[2] Fstat+ 2001, FAO Database

[4] The production was estimated from the bar chart in Xie & Li, 2002.
[5] This table is reproduced from Van Zalinge, et al. (2000)

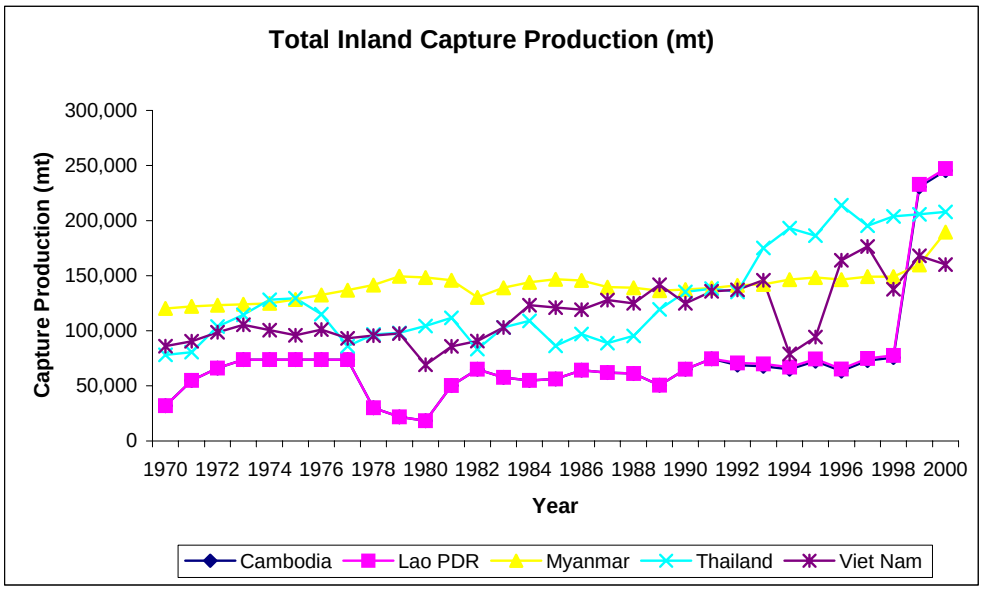
Based on the per capita consumption of all freshwater fish and other aquatic animal products excluding fish production fromaquaculture and reservoirs, a recent study by Van Zalinge (2003) reported that the total capture fisheries catch in the Lower Mekong Basin has increased to 2.6 million tons annually, with a value exceeding US$1.7 billion (as indicated in Table 2). The study also reported that Thailand has the highest capture fisheries catch estimated at 932,300 tons, followed by Vietnam (844,850 tons) and Cambodia (682,150 tons).

Table 2: Estimated annual consumption of freshwater fish products, including other aquatic animals in the Lower Mekong Basin by country and by source, 2000. [6]

Country	Population (Million)	Average per capita consumption (kg)	Total fish consumption[1] (tons)	Capture[2] fisheries catch (tons)	Reservoirs[3] fish catch (tons)
Cambodia	11.0	65.5	719,000	682,150	22,750
Lao PDR	4.9	42.2	204,800	182,700	16,700
Thailand	22.5	52.7	1,187,900	932,300[4]	187,500
Vietnam	17.0	60.2	1,021,700	844,850	5,250
Total LMB	55.3	56.6	3,133,400	2,642,000	232,200

Source: [1] Sjorslev 2001 recalculated by Hortle and Bush (2003)
[2] Total consumption minus Reservoir catch and Aquaculture production
[3] MRC Management of Reservoir Fisheries data
[4] Includes a large part of the probably more than 50,000 tons of freshwater fish products exported from Cambodia to Thailand (van Zalinge et al. 2001)

Figure 1: Total Inland Capture Production in the Lower Mekong Basin, 1970-2000.



Source: Fstat 2000, FAO

Figure 1 shows the production trend of total inland capture fisheries in the Lower Mekong Basin countries reported by FAO. The figure shows that production in the four countries have generally increased during the 20-year period from 32,000-120,000 tonnes in 1970 to 160,000-250,000 tonnes, except for some drastic decreases

[6] Expressed in whole fresh weight equivalents, as recalculated by Hortle and Bush 2003. This table is reproduced from van Zalinge et al. (2003)

in 1977-80 (Lao PDR), 1994-95 (Vietnam) and a drastic increase in 1999 (Cambodia). More details on the production will be discussed under the Country section that follows.

3.1.1 Cambodia: Values of Inland Capture Fisheries

In Cambodia, freshwater fisheries play a more important role than marine fisheries as it contributes to 90% of the total fish production (Sam et al. 2002). Inland fisheries contribute to 8.8 -10.3% of GDP, with an annual catch between 279,000 - 441,000 tonnes[7]. Ahmed et al. (2000) reported that Cambodia was ranked fourth in the world in its freshwater capture fisheries in 1996. The Department of Fisheries (DOF) of Cambodia reported that the total inland fish production (excluding rice field fisheries) for the whole country ranges from 234,000 to 331,000 tonnes in 2000. Van Zalinge et al. (2000) estimated the economic value of inland fisheries of Cambodia to be between $150 and $250 million annually, and up to a retail value of US$500 million. Thouk and Sina (1997) estimated the value of commercial fisheries to be at US$100-225 (estimated in 1995) while Degen et al. (2000) estimated that to be between US$150-200 million.

The main types of fisheries in Cambodia can be classified as 'large and medium scale', 'lot' and '*dai*' (bagnet) fisheries. Large and medium fishery generates some US$2 million (which accounts for approximately 70% of the total revenue generated) a year to the government revenue from fishing licenses. Fishing lots were auctioned by the Cambodian Government to the highest bidder for exclusive exploitation over a two-year period. As reported by Van Zalinge et al. (2000) there were 164 lots comprising of lake, riverine and river beach lots and covering an area of 852,900 ha. Other revenues generated (estimated to be less than US$1 million) were from middle-scale fishing, export commissions, export taxes, and fine from illegal fishing. There were 89 *dai* fishing lots and 15 fish sanctuaries. *Dai* lots are stationary trawls positioned in the river to capture fish migrating down stream. Table 3 below provides the freshwater fish production from 1992 – 2000. The statistics showed that the catch has fluctuated between 63,510 to 75,700 tonnes from 1992 to 1998. With the inclusion of catch by small-scale fishing, the statistics has drastically increased to 231,000 and 245,600 tonnes in 1999 and 2000 respectively.

There have been many debates on the differences in fisheries production reported by different sources (Van Zalinge, 2003; Coates, 2002) since those who pay taxes or license fees have a vested interest in under-reporting the catch, but research projects tend to maximise the importance of fisheries with the intention to increase funding for the research in this field.

In a valuation study on flooded forest, Hap, Thay & Hav (2001) reported that the average net income per household per year from small-scale fishing was US$78.6. The study also found that the gross return and net profit of the two large-scale fishing lots located in the study area[8] were US$132,379 and US$69,439 respectively.

[7] Data provided by the Department of Fisheries, including fish catch from rice fields.

[8] The study was conducted in the Ponhea Leu and Muk Kampul Districts in the Kandal Province, Cambodia.

Table 3: Freshwater Fish Production (1992-2000)*

Year	Department of Fisheries Data (tonnes)
1992	68.900
1993	67,900
1994	65,000
1995	72,500
1996	63,510
1997	73,000
1998	75,700
1999	231,000*
2000	245,600*

MRC – Management of Freshwater Capture Fisheries in Cambodia Project (1999)
Large-scale: Fishing lots 30,000 – 60,000 tonnes Bagnet lots 15,000 – 20,000 tonnes Middle-scale 85,000-100,000 tonnes Small-scale 115,000-140,000 tonnes Rice Field 50,000-100,000 tonnes **Total** 295,000-420,000 tonnes Source: Van Zalinge, et al.

** reproduced from Tana & Todd (2002)*

The on-going Wetlands Project conducted by the WorldFish Center provided a list of fisheries according to its values categorised as high, medium or low. Fish species listed as having high economic values in Takeo are snakehead, walking catfish, eels, sand goby and giant catfish. The findings also indicate that stakeholders participated in the PRA discussion considered these species have high production and the producers for these species include both rich lot owners and poor fish farmers. Medium-valued fish include barb and eels and were reported to have high production. Small fish (the low-valued fish) was reported to have very high production. More detailed valuation studies will be conducted to estimate the values of the production of these species in the wetlands. The findings from Siem Reap showed that the production of high-valued fish is medium while that for medium- and low-valued fish are high.

Conclusion

The review of the literature in Cambodia highlighted a significant divergence in the estimated value of inland capture fisheries by different sources such as FAO or other research institutions. The other serious discrepancy in the catch data (therefore the value of the inland capture fishery) is the inclusion of catch from small-scale fishers. This is considered an underestimate because there were more small-scale fishers' catch were not accounted for. More in-depth well-designed surveys need to be conducted to small-scale fishers to have a better estimate of the economic values of inland capture fisheries in the country.

3.1.2 Lao PDR: Values of Inland Capture Fisheries

Lao PDR covers about 202,000 km^2 of the total Mekong catchment, accounts for about 97% of the total area of the country. It contributes some 35% of the average annual flow of the Mekong. (Souvannaphanh et al. 2002)

The main economic sector in Lao PDR is agriculture, accounting for 52.6% of the national GDP. However, the overall importance of agriculture is declining with its average annual growth rate of 4.6% from 1989 to 1995, as compared to the average annual growth rate of 12.2% in the industry sector in the same period.[9] Lorenzen et al. (2000) reported that wild fish are highly priced for their taste than cultured species and participation in fishing is almost ever-present among rural households, with more than 80% households in Southern Lao PDR being involved (cited in Lorenzen, 2003).

9 Agriculture contributed to 60.6% of GDP in Lao PDR in 1989.

The seasonal fish production and consumption varies considerably, driven mostly by hydrological and ecological cycles. Peak catches occurred during the periods of up-migration of fish from perennial water-bodies to seasonal wetlands and during down-migration.

The Agricultural Census conducted in 1998/99 indicated that more than half the population of Lao PDR is engaged in capture fisheries in one way or another. It has also shown that there is a high correlation between fish catch and consumption at household level although the catch figures reported were consistently lower than the figures for consumption of fresh fish. This implies that household catch figures could have been under reported (cited in Lorenzen et al., 2003). Baird et al. (1998) reported from a survey at Kong District of Southern Lao PDR that the average catch for a family was about 355 kg of which 249 kg was consumed. The study also reported that fishery is the main source of animal protein as well as the largest source of cash income. Lorenzen et al. (2000) reported an indicative estimate of average household income, including fisheries, showed that in an average household, aquatic resource use (estimated value of US$90) accounts for about 20% of gross income (cited in Lorenzen et al., 2003).

The gross value of fisheries output is estimated at around US$48 million, contributing to GDP with approximately 4% from commercial fisheries and another 2% by subsistence fisheries (Lorenzen, 2003). However, Souvannaphanh et al. (2002) believed that fisheries account for about 8% of national GDP in Lao PDR. The LARReC Medium Term Plan 2000-2005 estimated that the value of total annual aquatic production to be in the range of US$ 66 million, exclusive aquatic plants.[10]

Current capture fisheries production is estimated at 30,035 tonnes (Phonvisay, 2002). Table 4 presents the fisheries catch based on the type of water resources or ecosystems. Capture fisheries contribute to 40.4% of fisheries production in the country. Out of this, 63% is from the Mekong River and its tributaries, 18% from irrigation and reservoir, and 10% each from reservoirs and swamps and wetlands.

Table 4: Inland Capture Production Based on Type of Water Resources

Type of water resources	Area in (ha)	Productivity (kg/ha/year)	Total production (tons/year)	% of total inland catch[a]
Mekong and tributaries	254 150	70	17 790	25
Reservoirs (stocked)	57 025	60	3 421	4
Irrigation and small reservoir (natural and stocked)	34 460	150	5 169	7.40
Swamps and wetlands	95 686	30[b]	2 870	4
Total:			**30 035**	**40.4**

Source: DLF, 2001

Note: a – Total inland catch includes aquaculture.

b - This appears to be a substantial underestimate and implies an average landholding of about 3 ha per household in the floodplains based on household catch data from Lorenzen 2000

[10] This is estimated based on the average market value of fish/ frog/ turtle (wet weight) at US$ 0.66 per kg.

FAO (1999) also reported that almost the entire aquatic resources production in Lao PDR is consumed in the country, with little or no fish exports, although a considerable amount of catch from the Mekong river may be landed in Thailand where market prices are higher (cited in Lorenzen et al., 2003).

Nguyen Khoa et al. (2003) reported in their recent study that the average household fishing effort was consistently about 5 hour/week, but household catches were lower in weir controls (0.77 kg/week) than in dam controls (2.07 kg/week). The authors indicated that the difference in catches was likely to reflect differences in the hydrology of weir and dam controls related to their different locations within watersheds.

Conclusion

Despite the high coverage of areas by the Mekong River, very limited information is available in Lao PDR reveals a large gap in information on the production as well as value of inland capture fisheries in the country. The high dependence on agriculture and fisheries for livelihood and food security calls for more in-depth studies to be conducted in the country for better and more effective planning for sustainable management of the resources and poverty eradication. As only a quarter of the fisheries output were generated from the Mekong, does it imply that the river resources have been 'designed' for other uses such as dams or reservoirs, or it calls for more development plans on river fisheries.

3.1.3 Thailand: Values of Inland Capture Fisheries

Inland fisheries play a significant role in Thailand in terms of providing food security and employment to fishing community and rural population. Inland fisheries contribute to approximately 6% to the total production of fisheries (about 200,000 tonnes) in Thailand. Inland fishing is conducted in both natural and man-made freshwater bodies in Thailand, which includes rivers and their tributaries, reservoirs, fishponds, etc. Pawaputanon (2003) reported that the total area for inland habitat covers 4.5 million hectares of rivers and wetlands and 400,000 hectares of large reservoirs. He also reported that there are 47 rivers and 21 large reservoirs contributed to freshwater fisheries production. The article also revealed that inland capture fisheries production reported by the Department of Statistics only reflects the production in reservoirs and large wetland water bodies, covering approximately up to 2.7 million hectares (comparing to approximate 4.9 million hectares of rivers, wetlands and large reservoirs).[11] Virapat et al. (1999) supported the view that statistics reported by DOF refer to reservoir almost exclusively, as noted:

> '… This confirms that the perception of inland capture fisheries in Thailand is one of reservoirs. Whilst reservoirs are obviously important, .. Thailand in fact does still have considerable river and swamp fisheries, plus some production from rice-fields. …' (cited in Coates 2002: p.78)

As reported by Coates (2002), an unpublished survey report of the Songkhram River Basin in N.E. Thailand, conducted by the Department of Fisheries, indicated that the

[11] Please refer to Appendix I for more details.

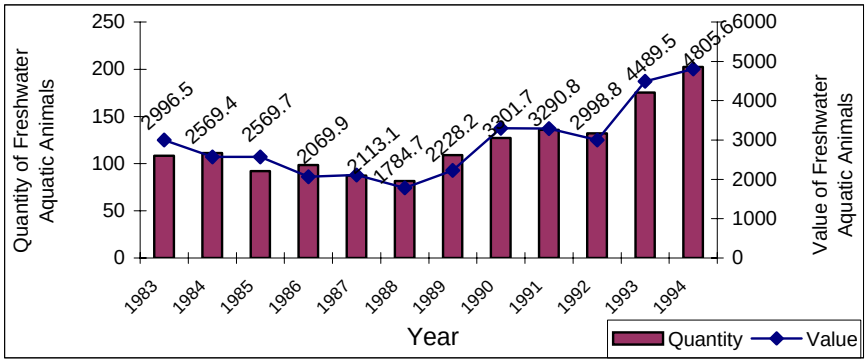
rivers, streams and canals accounted for 34.23% of the total catch taken from various habitats.[12] As commented by Coates (2002):

'It is widely held that dams have significantly reduced fisheries in major rivers in Thailand. This is probably true and has certainly been used as a major reason to devote most attention to reservoir fisheries and aquaculture.' (p.79)

Pawaputanon (2003) highlighted that the constraints of inland fisheries information collection in Thailand include the lack of basic up-to-date data, accuracy of data collected, lack of scientific data collection protocols to be used in the country, information is piece-meal and scattered in the country which make comparison and analysis difficult to be conducted, and difficulty in conducting surveys in large ecosystems due to research budget constraints.

Figure 2 provides the quantity and value of freshwater capture aquatic animals of Thailand from 1983 to 1994. As reflected in the figure, the inland capture production has declined from 1983 to 1988, and increased since to 1994.

Figure 2: Quantity and Value of Freshwater Capture Aquatic Animals in Thailand, 1983-1994.*



Source: Department of Fisheries, Thailand (cited in Prapertchob 1999)
Note: * in thousand tons and million bahts

Conclusion

The accuracy of the data and lack of up-to-date data is the major research gaps that need to be looked into immediately in order to provide more reliable information. Most ecosystems were not included in the past should be considered for future data collection in order to arrive at a better estimate on the production as well as the value of inland capture fisheries.

3.1.4 Vietnam: Values of Inland Capture Fisheries

Vietnam[13], with a total area of 331,689 km^2, has a population of 78.7 million at mid-2001 with an average annual growth (from 1995 to 2001) of 1.5%. Agriculture contributes 23.6% to the total national GDP (US$32.7 billions) in 2001. From 1994-1997, the fisheries sector contributes about 3% to the national GDP (Anh et al. 2003). However, Thai (2003) commented that fisheries sector has developed rapidly in

[12] Catch from the other habitats reported include swamps/ marsh (floodplain) (31.32%), rice-fields (22.18%), reservoirs (8.27%), lakes (8.27%) and aquaculture ponds (1.97%).
[13] Information in this section is extracted from the Anh et al., 2003.

Vietnam and has contributed to 7% of national GDP. Wild and cultured fish contribute to about 40% of the total animal protein intake of the population, availability estimated at 13.5 kg per person in 1995 and expected to reach 15.0 kg by 2000. Some researchers estimated the overall fish consumption in the Vietnamese parts of the LMB is 1,021,700 tons annually (Sjorslev 2001, Hortle and Bush, 2003). Although the fisheries sector has attained rapid growth in production from 890,590 tons in 1990 to 1,969,100 tons in 2000, capture fisheries has decreased in production since 1990 to 1996, and increased slightly from 1997 to 2000, while aquaculture production continues to increase, reaching at 727,140 tons in 2000.

Dollar et al. (1998) estimated that about 14% of families worked in the fisheries sector. The General Statistics Office (1999) of Vietnam reported that the number of fisher households was 60,677 in 1990 and increased to 87,645 in 1998 in the Mekong Delta. The number of fishers had also increased from 314,802 in 1990 to 448,564 in 1998. Anh et al. (2003) concluded that capture fisheries is an important livelihood strategy for rural people, both for the poor and the rich, in many parts of Vietnam for both full-time fishers and most households. Carl Bro (1996) concluded from a survey of three regions (the northern region, central region and the southern region) that the majority of surveyed households were involved in some form of fisheries or aquaculture activities. Nho & Guttman (1999) indicated from their study at Tay Ninh Province that most households are involved in some forms or activities of capture fisheries but the importance decreases from poor to rich households. The findings showed that 88% & 84% of 'very low income' and 'low income' households were involved in fishing respectively as compared to only 58% of 'medium income' and 44% of 'high income' households were involved in fishing.

Mekong Delta covers 369 million ha, accounts to about 12% of the whole country area. There were 145 taxa of fish and 14 taxa of prawns distributed in the freshwater areas of the Mekong Delta. They include 13 taxa of high value fish and 3 taxa of high value shrimp (Xuan et al. 1995; cited in Anh et al., 2003).

Conclusion

With increasing production from aquaculture in Vietnam, the role and production of inland capture fisheries is diminishing in the national economy as well as household income, albeit its contribution to food security, in particular to the rural poor. Due to the lack of the concern for inland fisheries, the record of statistical data is weak, thus future research should aims to improve the quality and availability of relevant information in this sector.

3.2 Ganga River Basin[14]

As the river flows through a range of altitude, most studies looked at the fisheries diversity according to categories defined by altitude level. It was reported in Shrestha (1978) that surveys in Nepal have shown no fish records beyond an altitude of 1650 m.amsl (cited in Payne et al., 2003). Singh et al. (1987) reported that fish zone probably ends at the uppermost point on the main stem of the Ganga River at Alaknanda, 460 –1600 m.amsl.

[14] Most of this section is extracted from Payne et al. (2003).

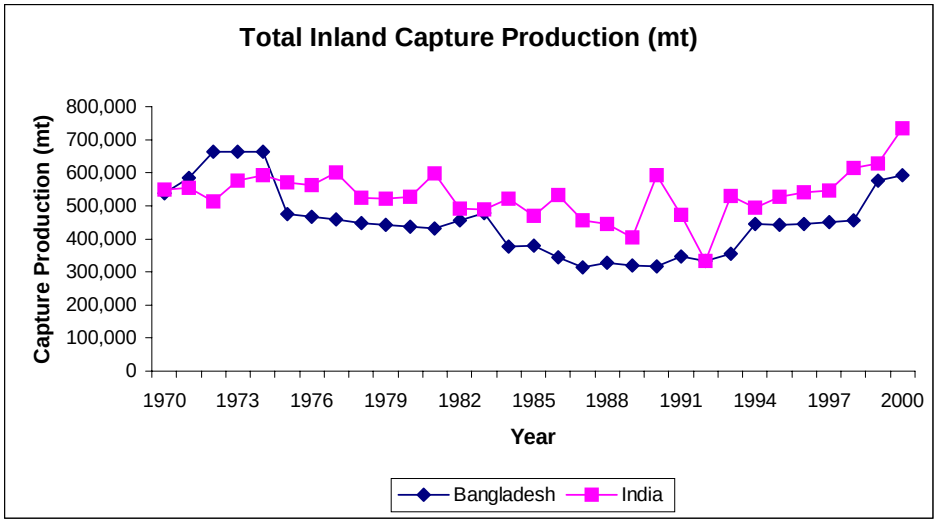
There are a total of 161 species in the freshwater sector of the Ganga Basin, with variation of species recorded for different parts of the river. Table 5 presents the number of species recorded at selected locations in the Ganga Basin.

Table 5: Number of Species Identified at Selected Locations at Ganga Basin

Location	No. of Species Recorded
Narayani[1]	108
Kosi[2]	103
Karnali[1]	74
Mahakali[1]	69
Alaknanda	41
Nepal[1]	130

Source:[1] Shrestha 1990, [2] Klun and Kamal 1980

Figure 3: Total Inland Capture Production, 1970-2000.



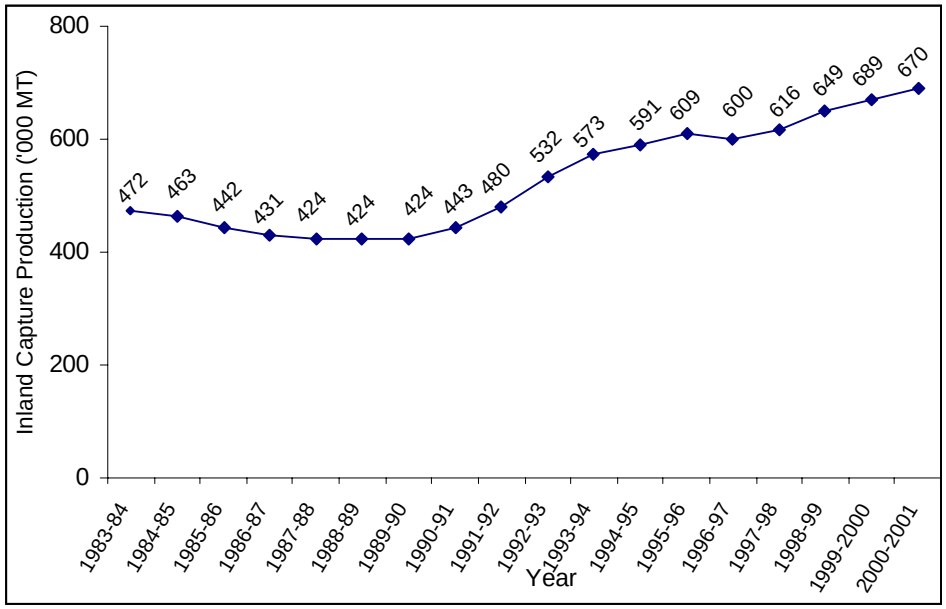
Source: Fstat, FAO. 2000

Figure 3 displays the total inland capture production in Bangladesh and India. The production fluctuates in the 30-year period in the two countries although the total production increased in the period. However, the production only increased slightly in Bangladesh, from 536,891 in 1970 to 591,300 tonnes in 2000, while the increase in India was more apparent, from 548,849 to 734,882 tonnes in the corresponding years. More details on the country capture at the Ganga basin are discussed in the country section.

3.2.1 Bangladesh: Values of Inland Capture Fisheries

Fisheries sector plays an important role in Bangladesh, contributing to 5.9% to the national GDP (BBS, 2000-2001) and 6% to the country export earning. Inland capture and enhanced fishery contribute 38.7% of the country fishery production (2000-2001). About 0.77 million full-time fishers depend on inland capture fishery for livelihood and about 70% of the population depend on subsistence fishing for their own consumption (DOF, 2002). Inland waters of Bangladesh are inhabitant by 260 native species and 13 exotic species of fish and 20 species of prawn. The marine waters are inhibited by 475 sp. of fish and 56 species of shrimp.

Figure 4: Inland Capture Fishery Production in Bangladesh, 1983-2001



Source: Department of Fisheries, Bangladesh

As revealed in Figure 4, the inland capture fishery production at Bangladesh has decreased in the 1983-90 period but increased in the 1991-2001 period. However, information on the distribution of inland capture data by river is not available for further analysis. Payne et al. (2003) reported that the Ganges (Padma) contributes around 4-5% to the catch in early 1990s. The report also revealed that the reduction in the catch from the Ganga

Among the species on the decline, a marked species is hilsa. In Bangladesh, the Ganga had shown a reduction in the catch of hilsa although Bangladesh has contributed 40-50% of the total catch of the species (cited in Payne et al. 2003). Peyne et al. (2003) also reported that the catch of major carp have also declined markedly in Bangladesh, and they cited that Tsai & Ali (1985) reported that the major carp portion of the catch on Seimanganj floodplain declined from 66.4% in 1967 to 13% by 1984. Habitat restoration focussed on clearing of silted channels connecting floodplains to the main river channel subsequently increased the proportion of migratory species caught, including major carp for 2% of the catch to 24% and increased the yield from 1860 kg/ha to 11,384 kg/ha per year (CNRS 1995; cited in Payne 2003).

Conclusion

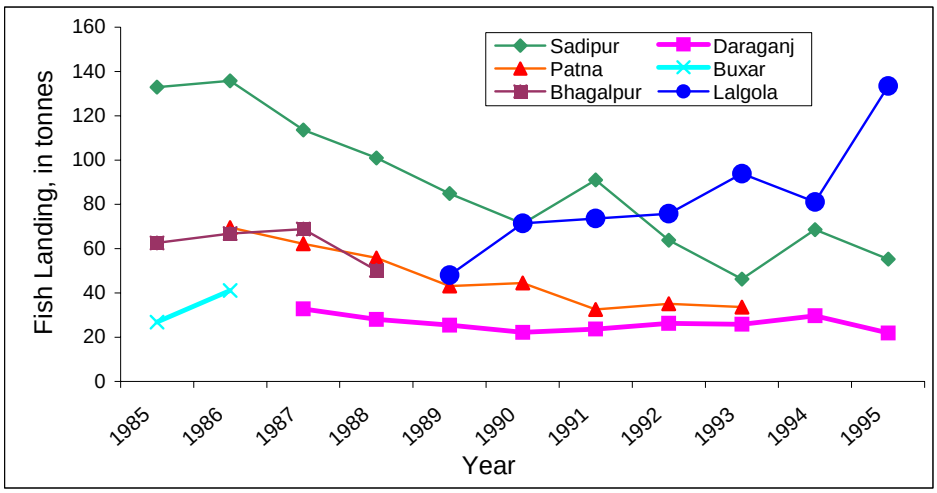
The review indicates that although the total production of inland capture fisheries may not change drastically, the production by different species may have changed drastically. The other attribute revealed in this exercise is the lack of information on values of inland capture fisheries. The presence of this information would let us better understand the dependence of the rural poor on fisheries for livelihood and food security.

3.2.2 India: Values of Inland Capture Fisheries

Various sources of information on inland capture fisheries production are available in India, however most of them are not comparable. Therefore information in this section are based on data that are comparable for a selected period. The other major observation on the literature of this information is that almost all production statistics were reported in terms of landings in tonnes, no production value were obtained in this review. This section only reports the change in production for selected stations along Ganga River Basin at India.

This section presents information on fish landings above and below the controversial Farakka barrage that diverts water flow on the Ganga to Calcutta instead of flowing to the Gulf of Bangal. Figures 5 and 6 present the charts for fish landings at selecting centers above and below Farakka respectively. It is reflected in the figures that considerable data gaps exist for stations above the barrage.

Figure 5: Fish Landings at different centers above Farakka, 1985-1995

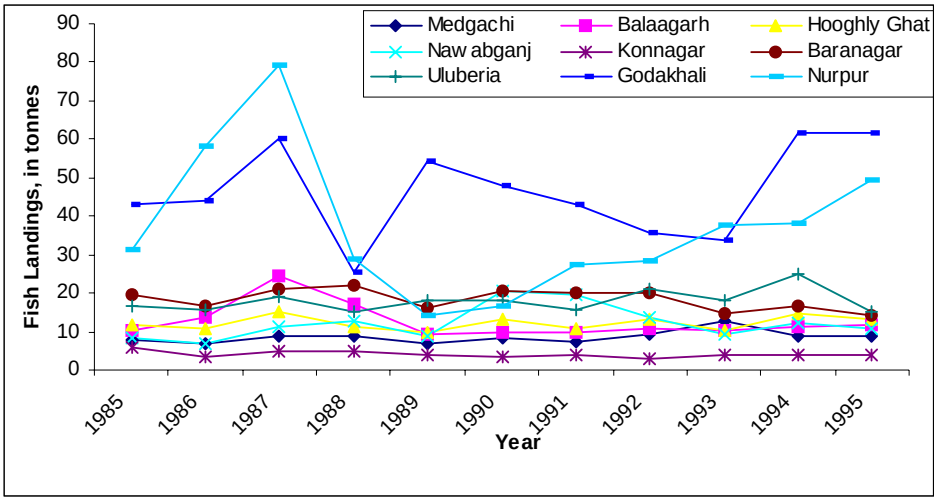


Source: Reproduced from Markandya & Murty (2000)

The fish landings in the stations above Farakka have declined in the 1985-1995 period, with landings at Patna and Sadiapur consistently declined in the period, which was attributed to over-fishing in early years, and reduced catch of cat fish at Patna (Markandya & Murty 2000). Increased landings were reported at Lalgota, in particular with sharp increase in 1995 from 81 to 134 tonnes, Markandya & Murty (2000) attribute this increase to higher catches of hilsa.

Fish landings at centers below Farakka showed increased catch in Nurpur and Godakhali in the 1985-1995 period. Landings at other centers fluctuated in the period.

Figure 6: Fish Landings at different centers below Farakka, 1985-1995



Source: Reproduced from Markandya & Murty (2000)

Table 6 (a, b & c) showed the decreasing trends of fish catch of different species at selected centers. Major carp and hilsa has declined consistently through the three periods at the three centers (Allahabad, Patna & Bhagalpur) while catfish landings have also declined consistently through the periods except for Bhagalpur (Table 6c).

Table 6a:

Allahabad								
Fish	*1958-59 to 1965-66*	*%*	*1973-74 to 1985-86*	*%*	*1989-90 to 1994-95*	*%*	*1996-97*	*%*
M. Carps	91.35	44.5	40.44	28.7	11.04	11.5	4.94	8.3
Catfish	46.66	22.7	30.82	21.9	21.5	22.5	14.28	24.1
Hilsa	19.94	9.7	0.87	0.6	0.92	1	2.47	4.2
Misc.	47.48	23.1	68.79	48.8	62.1	65	37.61	63.4
Total	**205.43**		**140.92**		**95.56**		**59.3**	

Table 6b:

Patna			
	1986-89	1990-93	1996-97
Total	57.73	37.7	18

Table 6c:

Bhagalpur						
Fish	*1958-59 to 1965-66*	*%*	*1973-74 to 1983-84*	*%*	*1996-97*	*%*
M. Carps	16.6	18.2	10.06	10.8	7.31	20.4
Catfish	19.43	21.4	25.21	27.1	14.91	41.7
Hilsa	4.08	4.5	0.87	0.9	0.38	1.1
Misc.	50.82	55.9	56.96	61.2	13.2	36.8
Total	**90.95**		**93.9**		**35.7**	

Source: Annual Reports, CIFRI, Barrackpore, West Bangal

Conclusion

Information available on inland capture fisheries in India is scattered and not comparable due to inconsistencies in catch data over different period although monitoring stations are defined. Comparatively, it is more difficult to identify the changes in production over a period. Such production trend is important for us to determine the change in the supply of the fisheries, in both its species and abundance. The review also shows the information on the value of catch is hardly available.

4. IMPACTS OF DAMS CONSTRUCTION

The impacts of dams on aquatic resources have been discussed in a few aspects in the literature. These include the impacts on water flow, biodiversity of fisheries, fish migration & spawning, fisheries production, etc. In this section, literature related to the impacts to fisheries biodiversity, fisheries migration and production will be discussed.

4.1 Mekong River Basin

Dam issues in the Mekong River Basin is driven by the need 'to produce more electric power in order to raise the national standards of living to a level comparable to that of nations, like the United States, that already have their dams in place'. It was reported that about 100 hydroelectric dams have been proposed by the Mekong Committee of the United Nations. [15] Dams on the Mekong tributaries and on the mainstream in China are producing 1600 megawatts of electricity. It is estimated that the total hydropower production capacity in the Lower Mekong Basin is 30,000 megawatts, more than enough to meet the expected demand in the coming decade (MRC, 2003).

The literature in general provides qualitative information such as type of losses incurred when a dam is constructed. Such qualitative losses include ruined local farmlands and required resettlement of local communities, impacts to downstream agricultural, and domestic activities, in particular rice production. Ecological impacts such as the flooding of a reservoir may result in irreversibly change of the ecosystem and water table downstream. In particular in places like Mekong Delta, where the lack of water flowing downstream may increase the likelihood that salinity levels increase downstream would kill wildlife and habitats dependent on semi-annual silt deposits and freshwater. The other major losses reported are the loss of animals and plant life that could be wiped out within a short time after the dam construction. Other more slow destruction and environmental degradation could range between 10-100 years.

Case Study: Nam Theun 2, Lao PDR[16]

Wegner (1997) provides an interesting comment on Nam Theun 2 (NT2) Hydroelectric Project Environmental Assessment and Management Plan (EAMP). The Nam Theun 2 hydroelectric project is located on the Nakai Plateau in Khmmouane Province in Central Lao PDR. When completed the Nam Theun Reservoir will store about 3,180 million m^3 of water, and cover approximately 450 km^2, or about 40% of the Nakai Plateau. The drainage area above the reservoir is about 4,013 km^2.

[15] TED Case Studies: Mekong River Dam.
[16] Information in this section is extracted from Wegner (1997).

The Economic Impact Assessment of the EAMP aimed to evaluate the social and environmental benefits and costs that would assess the trade-offs. The EAMP indicated that there would be approximately 45,000 ha (111,197 acres) lost which supported 4,500 people and natural habitats. The EAMP concluded that the social and environmental costs would range from US$60 to 130 million in 1996 dollars. Of this, nearly half (US$30 – 65 million) were attributed to the opportunity cost of the land. A mitigation budget of US$ 60 – 75 million was identified for resettlement, biodiversity, construction, health and downstream impacts. Additional unforeseen costs of US$10 – 20 million were identified with potential for another US$50 million.

In his review, Wegner commented that although contingent valuation methods were used to determine the values and other costs, no documentation was provided to assess the types of questions asked, statistical results of the assessment and the evaluation process. There were 11 species of fish in NT and 5 species in the Xe Bang Fai that were not found anywhere else. Their value was high in comparison to the exotic species that will replace them, he therefore commented that whether ecological integrity and endangered species protection has been included in the CVM? He also questioned on the calculation of resettlement costs, estimated cost on increased downstream flooding, impacts due to salt-water intrusion, etc. That is the Wegner commented that the costs were underestimated while the benefits were overestimated as certain losses such as biodiversity were considered as benefits.

Case Study: Pak Mun Dam, Thailand

Based on the case study of the Pak Mun Dam, Thailand, comments by the World Bank (1997) to World Commission on Dams (WCD) highlighted that the lack of detailed baseline studies on fisheries have caused serious unresolved problems, as such baseline information is important for compensation and estimation of losses in the costs-benefits analysis. Without knowing exactly what are the biodiversity of the fishery species before the dam construction also caused difficulty in costing the direct loss in fisheries due to the dam construction. The Bank also pointed out that the study conducted had not been able to differentiate the biodiversity loss due to the dam construction and the adverse impacts caused by other factors such as pollution, fishing mal-practices, population pressure, etc.

The Report indicates that there were 265 fish species at the Mun River before the dam construction and the number fell to 96 species in the upstream area after the dam construction.[17] Another study indicated that the number of species declined from 109 species in 1995 to 96 species in 1996 in the upstream areas. The reviewer attributed this to increased fishing pressure in the area that have continued rising between 1995 and 1997.[18]

4.2 Ganga River

There are two major dams on the Ganga, one at Hardwar that diverts much of the Himalayan snow melt into the Upper Ganges Canal, built by the British in 1854 to irrigate the surrounding land.

[17] The data from fish diversity studies in the Mekong and Mun rivers shows a radical decline between 1945 (265 species) and 1967 (141 species) surveys. This loss was largely attributed in the Report to an increase in pollution discharge, intensification and kinds of fishing done in the river, and probably also from upland deforestation and resultant soil erosion.

[18] Between 1992 and 1996, the number of households involved in fishing increased from 302 to 613.

The other is a hydroelectric barrage at Farakka, constructed in 1974, which has drastically reduced the natural flow of the Ganga water downstream in Padma. This barrage has caused serious disputes between India and Bangladesh. Mukerjee (1998) reported that the barrage has caused harm to both sides of the border, while Bangladesh associates it to flood damages due to high sedimentation in summer. Diversion of flow at this barrage has also increased the inland penetration of salinity in the low-flow season. Rashid & Kabir (1998) reported that at the Harding Bridge, the ratio of maximum and minimum discharge during pre-Farakka days and post-Farraka days are roughly 70% and 27% respectively, which was far greater than the ratio of 10% of maximum discharge required for maintaining a stable river regime.

Reservoirs in India's Punjab region have resulted in good fisheries but it has also negatively impacted migratory fishes (Gill 1984; Sandhu & Toor 1984. Cited in 'The influence of Dams on Fisheries', World Commission on Dams). Sugunan estimated fish yields for 291 small reservoirs at 49.9 kg/ha/year, while 100 medium reservoirs at 12.3 kg/ha/year, and 21 large reservoirs at 11.43 kg/ha/year. The overall national production rate for Indian Resarvoirs was 20.1 kg/ha/year, and small impoundments can yield on average 146 kg/ ha/year (cited in 'The Influence of Dams on Fisheries').

4.3 Conclusion

The review of this section indicates that the gaps in economic impact assessment include biodiversity loss that is difficult to be estimated, and tjhe loss in fisheries production due to block in pathways used in spawning, have not been accounted for. These gaps need to be addressed in order to enhance the costs-benefits analysis estimation that have reflected the losses of fisheries biodiversity and impacts to local community that depend on aquatic resources for livelihoods.

5. METHODOLOGICAL ISSUES

A few methodological issues have been identified from this review: (i) research methodology issue; (ii) documentation issue; and (iii) other issues.

Methodology Issue: This issue refers to methodology adopted for the estimation of inland capture fisheries production. In many cases, the methods are not well defined and different methods have been used even within the same country. Therefore, information gathered may not reflect the actual production statistics or not comparable (Coates 2002, Coates 2003, Pawaputanon 2003). Another example of this is the approach of taking estimation of production of selected ecosystems instead of all ecosystems. This has led to the lack of accuracy in data collected(Pawaputanon,2003).

The other concern on the methodology issues is data estimation. In most cases, national production statistics were estimated based on sample data collection. However, it was shown by some researchers that using the same method of estimation, the production statistics arrived at could be very different when studies were conducted by different groups of researchers. Such discrepancies are clearly reflected in the production statistics published by FAO, DOF and respective scientific research.

On the valuation of losses and damages due to dam construction, should it be estimated based on conventional valuation techniques (such as contingent valuation method, hedonic pricing, etc) or should it be estimated based on market value only.

Documentation Issue: This issue is commonly found in this review where many sources of information were not published formally such as publication in refereed journals. In many occasions, information reported are in the format that is only relevant to a selected period that the study were chosen, therefore, it is difficult to compare findings reported by different studies.

The Department of Fisheries in most countries only documented the production statistics in quantity, usually by weight of the fisheries products. Only limited countries documented the information on value.. Thus, comparison of time series data is only possible based on the production quantity, which is directly related to water flows. However, changes of the fisheries production and market forces were not reflected in the historical data sets since the values were not available. Only selected countries reported (estimated) value of inland capture fisheries.

In many cases, the methodology of data collection was not reported in detail. This has affected the quality and accuracy of the statistics reported.

Other Issues: Most of the values reported referred to the market value of fish (as food) and not on how losses of fisheries will impact the livelihood of local community who depend fully on the resources for food, income and employment. Other values of inland fisheries in biodiversity value, recreational, etc. were not considered when the statistics were compiled. The issue on valuation of fish for own consumption and subsistence remains unsolved, and how that should be considered in the values of inland capture fisheries.

The other valuation issue is how to account for the biodiversity loss in dam construction. In most cases, there is a lack of baseline information on fisheries biodiversity of these major river basins in the world. New species and abundance of fisheries are still being reported as scientists doing more work in these basins. Cumulative impact of dam construction on the aquatic resources and the inhabitants were not accounted for in most cases.

In most countries, environmental impact assessment (EIA) needs to be conducted for projects that will have great impacts on the resources, and local community, prior to the approval of a project. Participation of local community in the EIA and formulation of resettlement plan have been limited, in particular of those who depend on the natural resources for livelihood and food security.

6. MAJOR GAPS

The major gaps revealed in this literature review recommended for future research are highlighted below:

Lack of reliable information: Methodologies for data collection on inland capture fishery need to be reconsidered or streamlined to reflect resources in all ecosystems. Values of inland capture fisheries should be reported in addition to the production.

Data gaps exist in the actual values and abundance of various species in current literature. Policy makers should formulate policies based on more reliable information that includes stocks, abundance and biodiversity of fisheries, and its importance to local community in terms of livelihood and food security.

Information to be considered for EIA: On the EIA for dam construction, an important consideration deals withthe issue of what values to be considered in the cost-benefit analysis. Values such as existence values, option values are usually neglected although biodiversity loss (in terms of number of species available at post-project period) are reported. Various EIA reports reviewed noted that more species were identified recently in most of these major basins. This implies that it is difficult to estimate biodiversity loss, and most probably this loss has been underestimated in the past. It is a challenge to decide how to value biodiversity loss more efficiently and effectively in EIA for dam constructions, in particular for species that are not found in other parts of the world.

7. CONCLUSIONS AND RECOMMENDATIONS

The review of the current literature revealed some conclusions on the economic valuation of inland capture fisheries in general, river fisheries in particular, and the impacts of dam construction on river fisheries. This section is organized in two broad categories, conclusions and recommendations on (i) values of river fisheries, and (ii) impacts of dam construction on river fisheries.

7.1 Values of River Fisheries

Information is a powerful tool for the planning and management of inland fisheries resources, the review calls for the need of reliable information. Such information can be collected through different approaches, according to current mechanisms and resources available. Various tasks involved in collecting such relevant information can be integrated and while a single unit (such as Department of Fisheries or Department of Statistics) could be entrusted to process data collected. Pawaputanon (2003) proposed that the Thai Government should consider revising the Fisheries Act to obligate fishers to report fishing data to the government.

Based on his study on the inland capture fishery statistics of Southeast Asia, Coates (2003) concluded that most of these countries have to review current methodologies used in the data collection of inland capture fisheries production and explain the inadequacy of the current statistics. He asserted that the Governments need to improve present methodologies adopted and include estimates of production, degree of participation and the extent of dependency on inland capture fisheries. He recommends that governments should look for opportunities to incorporate inland capture fishery information requirements into surveys to be conducted by any agencies other than themselves.

Coates (2003) also concluded that the low quality of current statistics are not suitable to be used for monitoring trends. Researchers need to explore options for obtaining better information to enable tracking trends to be possible. He thinks that tracking trends in fish stocks is the priority, and such tracking can be done using low-cost and sustainable methods. Information for monitoring trends should include fishery biodiversity, environmental conditions relevant for inland capture fisheries, and

livelihoods related information in the statistics. Current statistics and information should be reviewed, revised or developed with other stakeholders such as relevant government departments (besides Department of Fisheries, this also includes Department of Statistics, Ministry of Agriculture, etc.), so that information that is highly relevant and needed for policy decision is generated.

While developing its database based on information supplied by the Department of Fisheries, Coates (2003) recommends that FAO should include qualifying notes and indications as the basis and meaning of the statistics reported in its annual statistical report. It is also important for the governments to share its information with other riparian countries and scientists or researchers so that information generated are well disseminated and utilized by all stakeholders.

7.2 Impacts of Dam Construction on River Fisheries

Dams alter river ecosystems and therefore call for the development of a new relationship between humankind and natural resources associated with these ecosystems. The review indicates that dams and their resulting reservoirs can have positive or negative impacts to humankind, depending on its size and how it is constructed.

Dams construction can cause trans-boundary issues, such as that caused by the barrage at Farakka between India and Bangladesh, if negotiations and discussions between governments were not held before the planning of such dams. Therefore it is recommended that governments of riparian countries should hold meetings regularly to plan for sustainable development of basins to further enhance collaborations between co-basin countries, in particular trans-boundary or regional issues should not be neglected.

Future research should also consider collaborations between private and public sector and donor agencies for dam construction, this will not only promote cost sharing but also can integrate the needs for irrigation schemes, or agricultural development in the process to minimize the negative impacts to farmers or other stakeholders.

Setting up of supra-national agencies such as MRC can be considered by other basins to investigate how it can benefit the government of riparian countries, and to promote sharing of information among the governments. Of course it is also important to look into the cost-effectiveness for such action (Biswas, et al 1998).

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