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Economic Benefits from the Bay of Bengal Ecosystem Services

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Abstract: ***The Bay of Bengal provides many ecosystem services that contribute to human well-being, such as nutrient cycling, fish stocks, water quality, biodiversity, raw materials, and climate regulation. Valuation of the benefits provided by ecosystem services can aid in designing more efficient policies for the protection and in reaching the environmental objectives for the Bay. The most commonly valued services for marine ecosystems are the cultural services, followed by provisioning services, and then regulating and supporting services respectively. Based on landings, herring-like fishes, Indo-pacific mackerels and Hilsa dominated reported landings data, while tuna and shrimp dominated in terms of landed value.***

Keywords: Bay of Bengal, Marine ecosystems, Ecosystem services, Economic benefits

1. Introduction

The concepts of ecosystem services and „natural capital" have recently been developed to make explicit this connection between human welfare and ecological sustainability for policy, development and conservation initiatives [1]. Coastal and Marine ecosystem plays a vital role in supporting economic prosperity and social welfare in developing countries. They sustain the livelihoods of millions of poor households; provide multiple ecosystem services that are essential for life, yield vast amounts of food, and play a critical role in driving weather and climate [2]. With the participatory approach it is fostered the integration of different values attributed by stakeholders to a specific ecosystem service and how it is affected by a given decision. Bangladesh has vast coastal and marine resources along its south edge. Due to the geographical position and climatic condition, the coastal area of the country is known as one of the highly productive areas of the world. The biological and ecological values of the Bay of Bengal have been pointed out by many authors. The coastal and marine fisheries have been playing considerable roles not only in the social and economic development of the country but also in the regional ecological balance [3]. Economic analyses of ecosystem services require a clear understanding of the linkages between final values, benefits and ecosystem services over temporal and spatial scale. This will allow the decision makers to integrate the ecosystem services into mainstream decision-making processes [4]. Over recent years, much progress has been made towards getting a better understanding of the role of the natural environment in contributing to our economic performance as a country and as individuals. The main objective of this paper is to understand benefits of Bay of Bengal ecosystem services for human well-being, taking into account possible future developments.

2. Literature Survey

Economic valuation seeks to quantify the ways in which ecosystem services provide benefits to human populations, and express these values in monetary units that can be compared with other sources of value to society. Valuation techniques essentially seek to estimate Willingness to pay through different ways developed for different types of data [5]. Currently there are 42 countries in the world with reports of commercial seaweed activity. About 90% seaweed production comes from cultured based practices. Some 221 species of seaweed are utilized commercially. Of these, about 145 species are used for food and 110 species for phyco-colloid production. Large scale seaweed mariculture is carried out only in Asia, where there is a high demand for sea weed products and burgeoning populations to crate market growth. East and South East Asian countries contribute almost 99% cultured production, with half of the production supplied by China. Most output is used domestically for food but there is a growing international trade [6].

Valuation techniques essentially seek to estimate Willingness to pay through different ways developed for different types of data. Approximately 400 million people live in the Bay of Bengal catchment area, many of whom live in poverty. Many of these people depend wholly or in part upon fishing for their livelihood, and marine resources contribute significantly to income, livelihood, food security and employment [7]. Approximately two million fishermen are directly involved in coastal capture fisheries, the majority of whom are in Bangladesh, India, the Maldives and Sri Lanka [8]. Important fisheries include inshore small pelagics, demersal fish species, shrimp fisheries and offshore tuna, and species of particular significance include Indian mackerel (Rastrelliger kanagurta), hilsa (Tenualosailisha) and various shark species. Marine fish yield has increased four-fold over the last thirty years, and as of 2003, stood at approximately 4 million tons [9]. In 2011, Kenter and others developed a participatory and deliberative approach of choice experiment aimed to define the value attributed to ecosystem services in Solomon Islands. They showed how a participatory process could be helpful to find solutions and how important it is to the valuation of a complex good in developed and developing economies [10]. Through more pluralistic approaches, it is arguably possible

to achieve fair procedures with legitimacy. The deliberative processes could help to formulate values [11].

The Bay of Bengal and its coastal areas are one of the most poorly studied areas of the world although it possesses high potential for further stock improvement. The coastal and marine fisheries of the Bay of Bengal are briefly reviewed in this paper to provide a salient feature of the available information and resource base and to identify future research and management needs.

3. Material and Method

The paper combined market-based valuation of economic activities and value transfer methods for non-marketed impacts. The data used here mainly collected from secondary sources. The collected data were synthesized and the useful data were extracted for study.

4. Result and Discussion

Economical Benefits from the Bay of Bengal-

Bangladesh

Landings from the waters of Bangladesh were estimated to be 9.5 million ton over the 1950-2006 time period (424,000 ton year^{-1} since 2000), and consisted almost entirely of „miscellaneous marine fishes" until the mid-1980s. As of the mid-1980s, landings were reported for several species and species groups. The main species reported were Hilsa shad (*Tenualosa ilisha*), which represented 40% of the total landings between 1984 and 2006 (over 160,000 ton year^{-1} since 2000). Crustaceans represented 8% of the total landings during this same period (1984-2006), with 36,500 ton year^{-1} since 2000. Overall, reported landings from the waters of Bangladesh increased steadily until the early 1980s, after which they increased rapidly throughout the rest of the time period to peak at just under 480,000 ton year^{-1} in 2006. The main contributor to this was „miscellaneous marine fishes" (over 100 million ton year^{-1} since 2000), followed by Hilsa shad (47 million USD/year since 2000) and crustaceans (38 million USD/year since 2000) [12]. Landings by commercial group were dominated by „other fishes and invertebrates", followed by herring-like and crustaceans.

India (Mainland)

Total catches in the EEZ waters of India within the Bay of Bengal (i.e., the East Coast of India) were estimated to be 32.3 million tons over the period 1950-2006, and 1.2 million ton year^{-1} from 2000 on. Multifarious marine fishes made up the largest portion of total landings, followed by Indian oil sardine (*Sardinella longiceps*), drums or croakers (*Sciaenidae*) and penaeid shrimps, each representing roughly 7-8% of total landings. Total landed value of catches in India"s waters within the Bay of Bengal was estimated at 32.8 billion USD over the period 1950-2006, and over 1 billion USD year^{-1} from 2000 on. The value by commercial group was highest for crustaceans, whose landed value was 18 billion USD over the period 1950-2006, and over 470 million USD year^{-1} from 2000 on. „Other fishes and invertebrates" contributed the second highest landed values, estimated at 277 million USD year^{-1} from 2000 on, while catches of perch-likes were estimated at 128 million USD year^{-1} from 2000 on [13] that showed a smart catch than others.

Andaman and Nicobar Islands (India)

Landings for the Andaman and Nicobar Islands EEZ waters totaled 2.0 million tons over the 1950-2006 time periods. Reported landings were very low from 1950 to the mid 1970s, after which they increased substantially (see catch by country below) to a peak of just under 128,000 ton year^{-1} in 1998, followed by a rapid decline to around 56,000 ton year^{-1} in the most recent time period. The total landed value within the EEZ of the Andaman and Nicobar Islands was estimated at 2.3 billion USD over the entire time period, with a peak landed value of nearly 129 million USD year^{-1} in 1998, before landed value declined to around 83 million USD year^{-1} by the mid 2000s (Harper et al. 2011, 14-34). By commercial grouping, perch-like fishes represented the largest individual component, followed by tuna and billfishes, crustaceans and herring-like fishes.

Indonesia

Total landings from the BOBLME portion of the Indonesian EEZ were estimated to be 9.6 million tonnes for the 1950-2006 period, and 426,000 ton year^{-1} from 2000 on. The total value of landings for the 1950-2006 time period was estimated at 6.2 billion USD, and 239 million USD year^{-1} from 2000. The landed value was dominated by shrimp, with banana prawns, estimated at 65 million USD year^{-1} since 2000 being the single highest taxon, followed by *Metapenaeus spp.* and giant tiger prawns (*Penaeus monodon*), with 24 and 16 million USD year^{-1} from 2000 on, respectively. Landings by commercial groups were largest for perch-likes, which represented 41% of total landings. „Other fishes and invertebrates", crustaceans and herring-likes also represented significant portions of the total landings (15%, 13% and 11%, respectively (Harper et al. 2011, 14-34) in this Large Marine Ecosystem.

Malaysia

Landings from the EEZ waters of Malaysia within the Bay of Bengal were estimated to be approximately 13.3 million tons over the period 1950-2006, and 393,000 ton year^{-1} from 2000 on. The catch was dominated taxonomically by Indo-pacific mackerels (*Rastrelliger spp.*) accounting for 19% of total landings. Landings of Indo-pacific mackerels where highest from the mid-1980s onward. The total value of landings from Malaysian waters over the 1950-2006 time period was estimated at 17.50 billion USD, and about 476 million USD year^{-1} from 2000 on. Of note is that the potential target shift from „shrimp and prawns" to sergestid shrimp in the early 1980s is clearly reflected in landed values, with sergestid shrimp accounting for 22.6 million USD year^{-1} from 2000 on [14] which accounted a bit difference to other countries.

Maldives

Reported landings from the EEZ waters of the Maldives over the period 1950-2006 were estimated at 3.4 million tonnes, and 163,000 ton·year^{-1} from 2000 on. Skipjack tuna (*Katsuwonus pelamis*) represented the greatest portion of total landings (6%), with approximately 12,000 ton year^{-1} being landed during the 1950s and 1960s, and nearly

140,000 ton year^{-1} being reported by 2006. Landings of yellow fin tuna (*Thunnus albacares*) were also substantial, representing 13% of the total catch over the 1950-2006 time periods. The total landed value was estimated at 12.4 billion USD for the period 1950-2006 and 550 million USD year^{-1} from 2000 on. Landed value was dominated by skipjack tuna, with over 425 million USD year^{-1} from 2000 on, accounting for 74% of total landed value. Yellow fin tuna was valued at 76 million USD year^{-1} (14%) and frigate tunas at 16 million USD year^{-1} (5%) since 2000, while the remaining species contributed much less to the overall landed value [15]. Remarkably „sharks and rays" were the third most important taxonomic group in terms of landings for this region.

Myanmar

Reported landings from the EEZ waters of Myanmar for the period 1950-2006 were estimated to be 30.8 million tones, and 1.4 million ton year^{-1} from 2000 on. Landings were dominated by the „mixed group" of taxa (93%), being predominately „miscellaneous marine fishes" (91%). The remaining 6% of landings consisted mainly of „natantian decapods" (i.e., mainly shrimps and prawns) accounting for 351,000 ton (1.1%), Indo-Pacific mackerels (312,000 ton, 1.0%), Sardinella spp. (284,000 t, 0.9%), Indian scad (208,000 t, 0.7%), anchovies (205,000 ton, 0.6%) and big eye (198,000 ton, 0.6%). The total landed value from Myanmar"s waters was estimated at 21 billion USD for 1950-2006 period, and 990 million USD year^{-1}from 2000 on [16] that initiated the economic upscale of the country.

Sri Lanka

Landings from the waters of Sri Lanka by all fishing countries, as presented in the Sea around us Project catch database based on the global allocation process totaled 2.7 million tons for the period 1950-2006. The main species caught were herring-like fishes (Clupeiformes), silky shark (*Carcharhinus falciformis*) and „mackerels, tunas and bonitos" (Scombridae). The total value of landings over the period 1950-2006 was estimated to be 5.2 billion USD, and 52 million USD year^{-1} from 2000 on [17] but increased afterwards with significant catch amount and catch value.

Thailand

Landings from the EEZ waters of Thailand within the Bay of Bengal were estimated at 1.4 million tons over the 1950-2006 time period, and 82,500 ton year^{-1} from 2000 on . The total value of landings from the Bay of Bengal portion of Thailand"s EEZ was estimated at 1.2 billion USD for the 1950-2006 time period, and 67.5 million USD year^{-1} from 2000 on. The landed value by commercial groups was highest for crustaceans and „other fishes and invertebrates", estimated at 22.6 and 22.9 million USD·year^{-1} from 2000 on [18] in this region.

High Seas

Landings from the high seas within the Bay of Bengal Large Marine Ecosystem totaled 5.8 million tons (307,000 ton year^{-1} since 2000, Skipjack tuna, Long tail tuna (*Thunnus tonggol*) and Kawakawa dominated tax on-specific landings, each representing 5% of total high seas landings (16,000 ton year^{-1}, 14,600 ton year^{-1} and 16,000 ton year^{-1} respectively since 2000). Total landings by commercial group were dominated by „other fishes and invertebrates", that representing 65% of landings (211,000 ton year^{-1} since 2000), and „tuna and billfishes", representing 25% of total landings (70,900 ton year^{-1} since 2000. By landed value, „tuna and billfishes" were estimated about 134 million USD year^{-1} since 2000, while „other fishes and invertebrates" were estimated at 126 million USD year^{-1} since 2000 on [19] for high seas and related waters of high seas.

Export quantity and Export value (Table 1) for 1976-2008 time period of different countries surrounding the Bay of Bengal have distinct features among themselves. Thailand is the country that exported 29,053,711 tons, where as Bangladesh exported only 1,086,387 tons in that time period. Total quantity of export of all the countries is estimated 60,850,697 tons and exported value is 175,815,833 USD. Maldives is a country of which main GDP depends on fish catch; export a smart quantity of 1,122,582 tons. On the contrary, Exported value for Thailand is 89,068,597 USD, Bangladesh earned 7,524,415 USD and India 27,312,772 USD.

Table 1: Total exports (quantity and value) by country bordering the Bay of Bengal, summed for the 1976-2008 time period.

SL	*Country*	*Export Quantity (tons)*	*Export Value (USD)*
01	Bangladesh	1,086,387	7,524,415
02	India	8,534,436	27,312,772
03	Indonesia	12,774,144	35,541,179
04	Malaysia	5,396,666	9,043,943
05	Maldives	1,122,582	1,347,664
06	Myanmar	2,617,972	4,084,100
07	Sri Lanka	264,799	1,893,163
08	Thailand	29,053,711	89,068,597
	Total	60,850,697	175,815,833

Graphical presentation shows that Thailand is the country who exported (Figure 1) more than other countries in this region and Sri Lanka is the lowest exporter within that time period. According to earnings, reasonably Thailand is the highest earner of USD (Figure 2) and Maldives is the lowest.

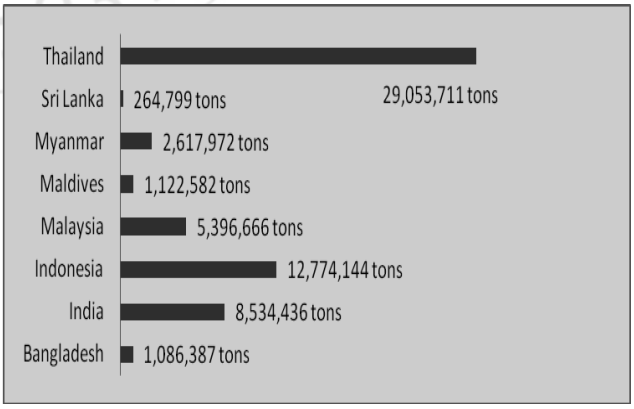

Figure 1: Total export quantity (tons) by bordering countries of the Bay of Bengal (1976-2008 time period).

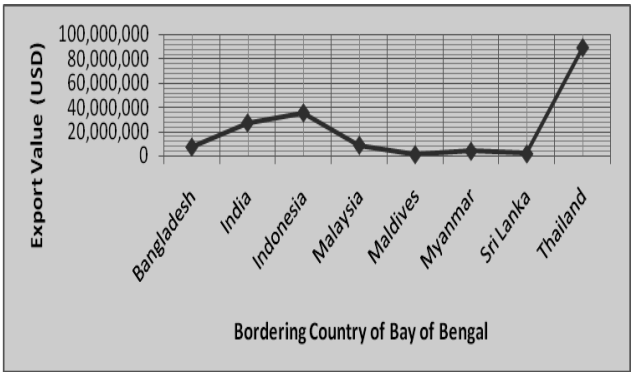

Figure 2: Total export value (USD) by bordering countries of the Bay of Bengal (1976-2008 time period).

5. Conclusion

Valuation is one part of the challenge, but there are many other factors at play. As with so many environmental issues, many authors point to the fragmentation of government responsibilities and the cross-sectoral nature of these issues as a key challenge going forward. Greater appreciation of coastal resources also can result in positive changes in governmental regulations [20]. The fish catch in the Bay of Bengal was 1.9 million tons in 1981 and 2.4 million tons in 1987. However, there are signs that harvest levels may not be sustainable, especially with regard to tuna fishing. Aquaculture operates intensively along the coast, with over 200,000 fish farmers currently involved, and the industry is expected to expand [21]. For the purposes of valuation, further work is needed on identifying and describing Bay of Bengal ecosystem services and their interactions, evaluating how policy changes affect these ecosystem services and assessing the effect of changes in ecosystem services to human welfare. The countries surrounding the Bay of Bengal face many more challenges than simply the management of their marine resources. Socio-economic constraints pose as major challenges in many of these countries, particularly Bangladesh, where poverty and weak governance are prevalent and have resulted in fisheries management considerations being secondary to meeting basic needs. While each of the Bay of Bengal countries faces its own unique set of socio-economic and political challenges, their dependence on coastal resources is universal.

6. Future Scope

The Bay of Bengal has been increasingly important for local development as well as for a global perspective. But proper attention is needed in every aspect of exploitation, handling and processing, export and marketing as well as in biological and institutional management strategies. The sustainable use of fisheries resources is therefore critical to maintaining and improving the livelihoods and food security of the Bay of Bengal‟s coastal population.

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