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The Premium of Hilsa Sanctuary: A Socio-Economic and Ecological Evaluation from the Meghna Estuary, Bangladesh

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Abstract: Sanctuaries are widely regarded as a protected area where fishing has been placed under some restrictions by local, state, regional and national authorities for the conservation and management of fisheries resources. These sanctuaries have a broad array of positive and negative social, economic, cultural and political impacts on fishers. This study aims to analyze the socio-economic and ecological benefits and costs of hilsa sanctuaries to protect single most important hilsa species using Sustainable Livelihood Approach (SLA). Under the Protection and Conservation of Fish Act of 1950, six sites along the Padma, Meghna, Tetulia, and Andharmanik rivers have been designated as hilsa sanctuaries. Findings of the current study revealed that most fishers perceived production of hilsa and other species were increased as a direct consequences of sanctuaries establishment. However, a considerable proportion of hilsa fishermen was found to have low socioeconomic capital, as measured by monthly income, housing circumstances and asset ownership. During the restricted fishing season in the sanctuaries, these households are particularly vulnerable to food insecurity. The government's compensation scheme is a good example of payment of ecosystem services in an open water fishery; however, this scheme does not include all the affected fishers. It is found that hilsa sanctuaries lead to income loss of the poor fishers which is insufficiently compensated by government support program. To compensate income loss, fishers resort illegal fishing which undermine the success of sanctuary. If the sanctuaries are to function effectively, affecting fishers must be addressed by offering enough compensation schemes so that fishers are able to support their families. Moreover, some fishers believed that a co-management approach involving fishers and government is the possible best management option for operating sanctuaries in a sustainable way.

Keywords: marine protected area; *Tenualosa ilisha*; fishermen' perception; fish sanctuary; impact of sanctuary

1. Introduction

Fisheries contribute significantly to livelihoods, food safety, and wellbeing [1], supporting a total of 120 million people worldwide [2]. Nonetheless, despite their social and

economic benefits, fisheries resources are being degraded and overexploited at an alarming rate [2]. Overfishing, pollution, habitat degradation, and climate change are all harming these resources and undermining the benefits they provide to millions of impoverished people [3]. In this regard, many scientists and managers advocating the use of sanctuaries to help protect and restore fisheries while also conserving biodiversity [4–6]. Sanctuaries are areas that restrict or confine fishing activities in order to protect fish populations, particularly safeguarding spawning [6] to lessen continued fish mortality [7]. Sanctuaries have been found to be effective in protecting critical habitats and acting as safe havens for overexploited species supplying stock to neighboring areas, and acting as potential buffers against management errors [8,9]. A sanctuary is one such tool that is widely regarded as an effective conservation tool for fisheries resources all over the world [10,11].

Bangladesh is one of the foremost countries of the world in terms of total fish production, accounting more than 4.5 million metric tons in 2019–2020 [12]. Hilsa (*Tenualosa ilisha*) solely shared 12% of the total fish production and 1% of the Gross Domestic Product (GDP) of Bangladesh which has a total annual value of 1.3 billion USD [13]. Thus it affords a vital support to the economy through foreign exchange earnings [14]. Beside, Hilsa has great appeal for its biological, nutritional and commercial importance as well [15,16]. It is incredibly popular in Bangladesh, not only because of its monetary returns, but also for of its distinct flavors [16]. This species plays important role in Bengali culture being regarded as the national fish of Bangladesh. Not only are they a symbol of national, cultural and religious pride for Bangladesh, but up to 500,000 people directly depend upon the species for their livelihoods also [15].

Hilsa is a migratory fish belonging from herring family, migrates from the Bay of Bengal to the rivers and their tributaries and vice versa for breeding and nursing purposes [17]. It spawns all year, although the Bengali months of Ashwin-Kartik (September–October), depending on the full moon phase, are considered the main spawning season [16,17]. The Padma, Meghna, Jamuna, Rupsa, Shibsra, Bishkhali, and Pyra rivers support primary riparian ground for this flagship species throughout the year [18]. The Meghna River is one of the most critical and expansive rivers in Bangladesh shares the major part of riverine hilsa catch [19]. Unfavourably, the riverine hilsa catch has experienced a dramatic decline since 2003 due to the closure of migration routes by dams/barrages, degradation of habitats, indiscriminate harvesting of broods and juveniles, population increase, overfishing, pollution and climatic variability [13,15]. All of these factors have resulted in lower catches and less consistent income for fishers. Poverty, starvation, social tensions, stakeholder conflicts, and debt cycles have all risen as a result of this in more impoverished fishing communities [20,21].

Consequently, sanctuaries are established as a management intervention in the rivers of Meghna, Padma, Andarmanik and in inshore waters of Bangladesh since 2005 with a view to protecting habitat for reproduction, juvenile growth, saving natural environment [15,17]. Six sites along the Padma, Meghna, Tetulia, and Andharmanik rivers have been designated as Hilsa sanctuaries under the Protection and Conservation of Fish Act of 1950 (Table 1) [12]. Furthermore, the Department of Fisheries (DoF) enforces a countrywide ban on catching, carrying, and selling jatka (juvenile hilsa less than 25 cm in size) from November to June each year. Another restriction is that brood (mature and about to spawn) hilsa cannot be caught for 22 days during the peak breeding season in October [22,23]. These conservations resulted a mixed progress and outcomes. The establishment of hilsa sanctuaries has helped ecological conservation and halted the decline of hilsa stock which reflected in enhanced hilsa production in Bangladesh [15,21]. Nonetheless, sanctuaries have a wide range of positive and negative social, economic, cultural, and political effects on dependent fishermen [24,25]. The majority of negative socioeconomic consequences are income loss, seasonal unemployment, increased poverty, and decreased food security [15,26], which may eventually lead to unintended environmental consequences due to social noncompliance [21,26,27].

Table 1. The locations of five hilsa sanctuary areas and the ban period on fishing [12,16].

Serial No.	Description of Sanctuary	Ban Period
1	From Shantol of Chandpur district to Char Alexander of Laxmipur (100 km of lower Meghna estuary)	March to April
2	Madanpur/Char Ilisha to Char Pial in Bhola district (90 km area of Shahbajpur river, a tributary of the Meghna)	March to April
3	Beduria of Bhola district to Char Rustam of Patuakhali district (nearly 100 km area of Tetulia river)	March to April
4	Whole 40 km stretch of Andharmanik river in Kalapara upazila of Patuakhali district.	November to January
5	Lower Padma river at Shariatpur district (20 km stretch of the Padma river)	March to April
6	From Hizla to Mehendiganj at Barisal district (83 km-long stripe in Meghna River)	March to April

There have been studies on various aspects of Bangladesh's hilsa fisheries, such as the socio-ecological effectiveness of hilsa sanctuary [13], socioeconomic consequences [28–30], effectiveness of compensation scheme [15,23,31]. However, comprehensive study focusing impacts upon livelihood strategies and outcomes is still lacking. Hence, this study designed to investigate the socio-economic and ecological implications of hilsa fishery, and how livelihood strategies of fishers are being affected along Meghna river estuary using Sustainable Livelihood Approach (SLA). This study will provide a broad understanding of resources use pattern, implications of management upon livelihood strategies and outcome undermining the sustainability of hilsa fisheries, therefore aids policy makers to take factors into account when designing and implementing a management initiative.

2. Materials and Methods

The research was carried out in six communities located around the hilsa sanctuaries in Bangladesh's Barisal division. The communities were Char Ilisha & Beduria in Bhola district, Puratan Hizla & Laharhat in Barisal district and Kalapara & Mohipur in Patuakhali district (Figure 1). The main criteria for this selection were livelihood diversity, population, reliance on sanctuaries and vulnerability to climate change. These communities' livelihood were primarily based on fisheries, small-scale fishing, fish drying, fish trading, net mending, boat building and repairing. Data for this study were gathered from 115 randomly selected fishers. To collect empirical data, household survey was conducted and a number of qualitative tools such as interviews, focused group discussion and oral history were employed. This study identified livelihood strategies that fishers follow to maintain their livelihood and positive ways to enhance their capacity to improve their livelihood condition as well as governance and management. Data were collected from October 2020 to March 2021. Exploratory interviews were conducted in study areas to collect necessary information and the interviews lasted about an hour and covered a variety of socioeconomic topics such as monthly income, fishing time, gear types, mesh size of gears, catching rate, fishing constraints, the impact of sanctuaries on fishing and livelihood, livelihood assets, main risks and livelihood outcomes and their coping strategies.

A total of 5 focused group discussion sessions were held with each group consisting of 4–5 people (total = 23) and each session lasting approximately 2 h. The group of participants is guided by a moderator or group facilitator who introduces topics for discussion and help the group to participate in a lively and natural discussion amongst themselves.

To collect and verify the necessary information, cross check interviews were conducted with a community leader, local representatives, NGO workers, and a government employee. Where information was found to be contradictory, further assessment was done to explore the actual matter. A total of 12 key informants were interviewed to collect and verify necessary information. Then, the data was initially transferred in a Microsoft Excel spreadsheet

and coded through content analysis. Content analysis provides inclusive insights to better understand the circumstance [32]. Further, statistical analyses were performed in SPSS (Statistical Packages for Social Science) version 20 to analyze data pertaining to various components of the sustainable livelihood framework: livelihood strategy, outcome, and governance. SLA enhances understanding of poor people’s lives and illustrates the factors that limit or increase living opportunities. It can assist in the planning of governance to priorities activities that can sustain livelihood (Figure 2) [33].

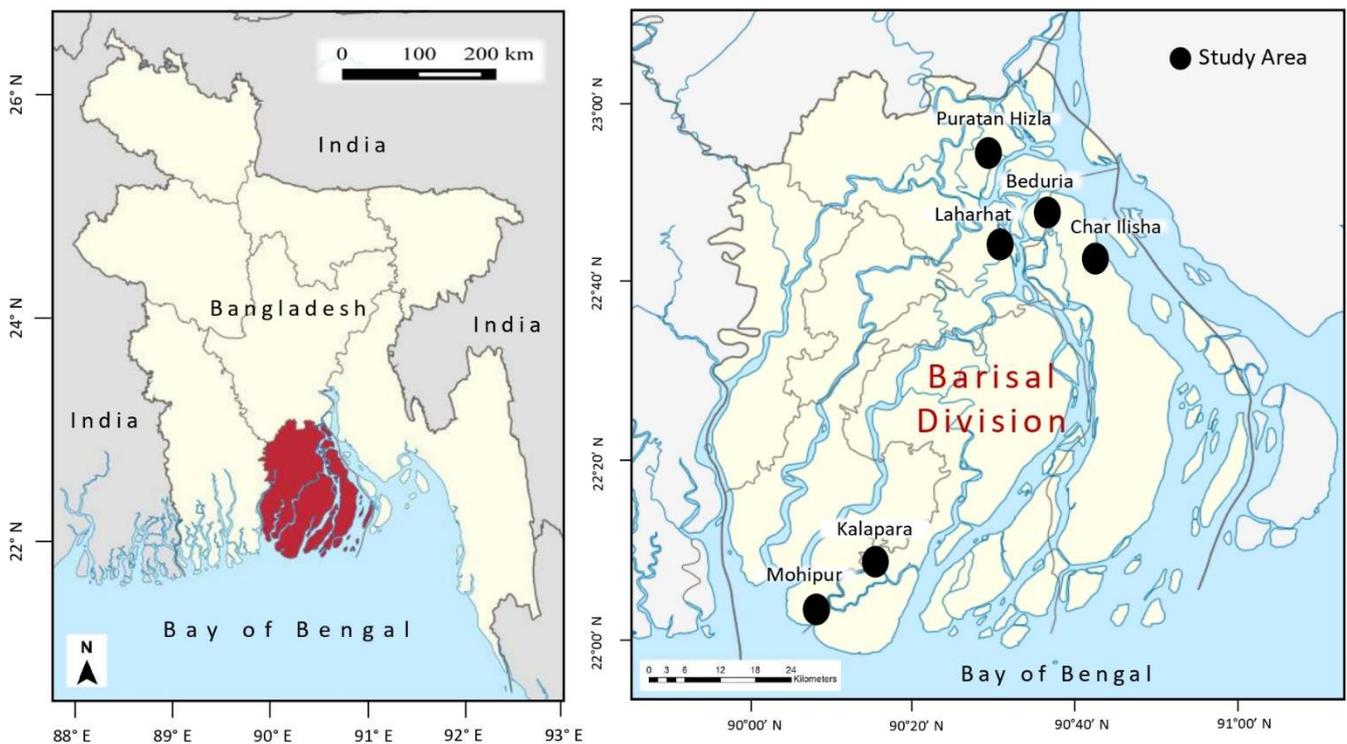


Figure 1. Map depicting data collection sites.

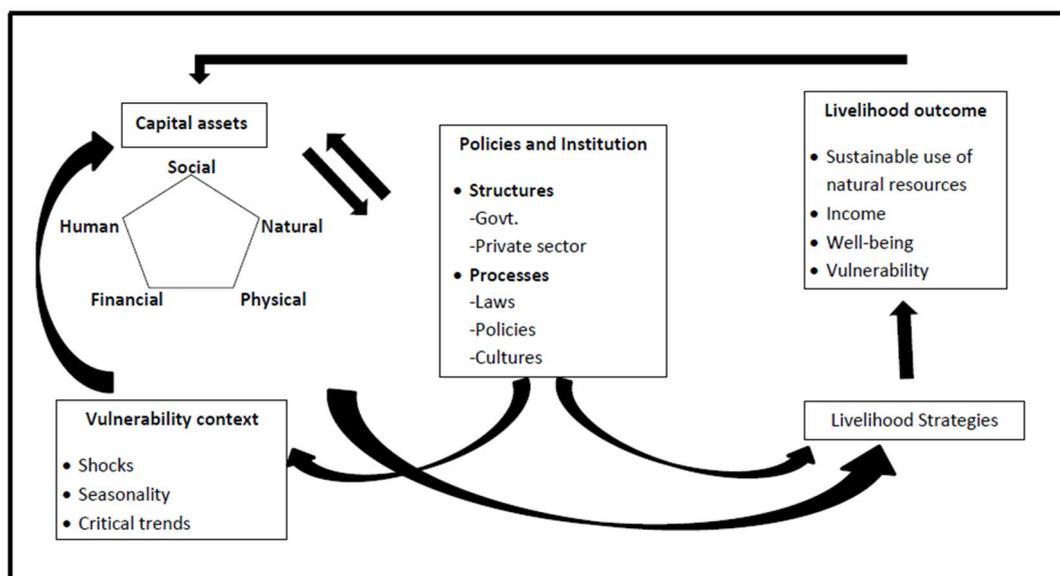


Figure 2. Sustainable Livelihood Framework (SLA) of sanctuaries on fishers’ of Meghna River Estuary (adopted from [33]).

3. Results

3.1. Demographic Features of Hilsa Fishers

Socio-economic profile of the respondent communities is illustrated in Table 2. Over a third (39%) of the surveyed fishermen had no access to education, while nearly half of them (46%) had access merely up to primary level. Each family had more than 5 family members on average. Most of the fishermen were living reliant entirely on fishing as it is the main occupation to over 90% fishermen. The mean fishing experience of respondent fishermen was 15 (± 7) years. Hilsa was the major constituent accounting for 93% of all catches. During the off-season, 37% fishermen had access to secondary occupation such as daily labor, rickshaw or van pulling. The respondents' annual income was estimated to be 1103.481 US Dollar Major gears used for hilsa fishing were gill net, for example, drift gill net, set gill net, monofilament gill net (current jal) etc. Subsidies from government received nearly 62% of respondents. Almost 86% of respondents had involvement in credit mechanism through the informal 'dadon' credit system (i.e., advance sales of catches) or micro-loans through non-governmental organizations (NGOs). More than half of the respondents (57%) had membership of social, professional and or cooperative society.

Table 2. Socio-economic profile of the respondent fishers.

Variables	Description	Mean (\pm SD)	Percentage (%)
Age	Age of respondent (year)	33 (± 5)	-
Education	Illiterate		39
	Primary school (class I to V)		46
	Secondary school (class VI to X)		15
Household composition	Number of members	6 (± 2)	-
Occupation	Main occupation is fishing	1 (± 3)	93
Experience	Number of years working in the fishing profession (year)	15 (± 7)	-
Income	Respondent's net yearly income	USD 1103.48 (± 120.83)	-
Secondary occupation	Respondent having secondary occupation	-	37
Target species	Main target is hilsa	-	93
Fishing craft	Length of fishing boat (feet)	27 (± 9)	-
	Non-motorized boat	-	79
	Engine powered boat	-	21
Government assistance	Respondent receives government assistance		62
Access to credit	Respondent able to access affordable credit	-	86
Organization membership	Respondent belongs to a social organization/group	-	57

3.2. Community Perceptions on Consequence of Sanctuary Establishment

Participants were asked whether they thought the sanctuary had a positive or negative impact on the community in terms of socio-ecological benefit. The majority of interviewees (80%, Figure 3) thought the sanctuary had a positive impact, while the remaining 20% thought it had a negative impact. The respondent was then asked in depth about the effects of sanctuary, focusing on a series of statements, and the response was recorded using a Likert scale ranging from strongly disagree to strongly agree (Figure 4). The respondent who stated that a sanctuary helps increase the catch of fish in the surrounding area received a score of 55 for agreed. Respondent strongly agreed (scored 40) with this statement that the sanctuary helps other fish increase along the sanctuary. However, the number of people who opined on the statement was not insignificant ('disagree' score; 25). Another fisherman confirms this: "Many species take shelter and breed here because of the sanctuary. These new fish stocks then spread to the surrounding water, increasing both the quantity and diversity of our catch."

Because fishing is prohibited in the sanctuary, fish are able to mature, and we are catching large fish". The fishermen also discovered that sanctuary confinement may be able to produce a more efficient catch in the future. Those who 'agreed' with the statement received a score of 40. An old experienced fisherman expressed his support for this by saying, "The government did a good job by declaring the sanctuary. Despite the fact that we are poor and are unable to fish due to the declaration of a sanctuary in a specific area, the effects are extremely beneficial. It will conserve fish, provide more fish, and ensure a healthy fish stock for future generations. For the time being, this appears to be a loss (due to not being able to fish in the sanctuary), but in comparison to long-term profit, this loss is insignificant".

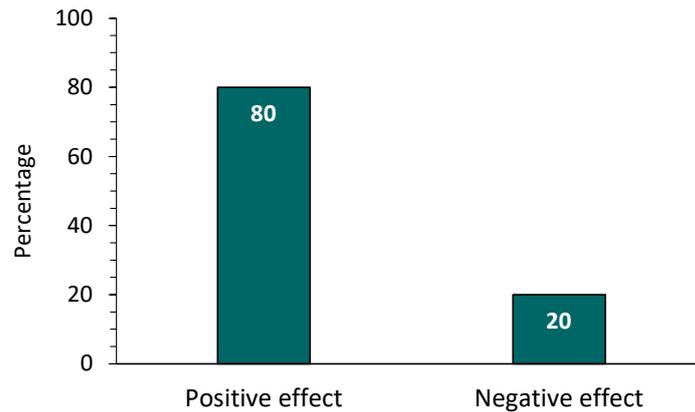


Figure 3. Community perception on hilsa sanctuary. Binary data of community responses on either positive (1) or negative (0) effect were converted to percentages.

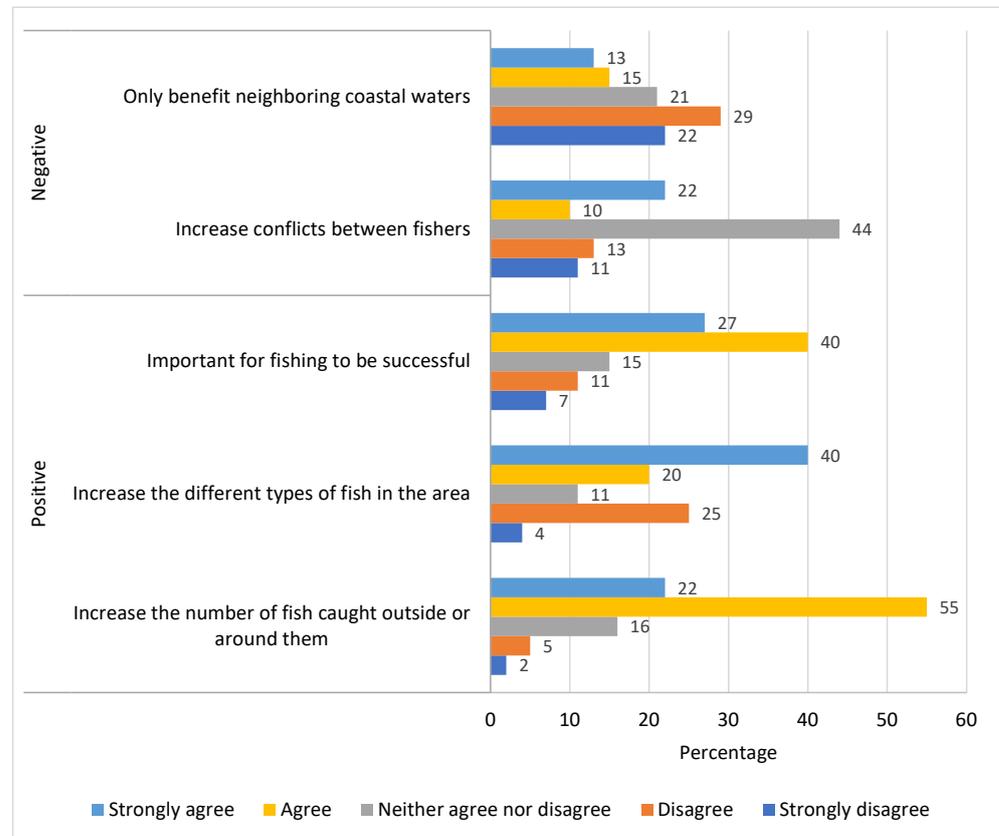


Figure 4. Community responses on different types of positive and negative effect of sanctuary. Responses are scaled from 1 (strongly disagree) to 5 (strongly agree).

On the other hand, responses to the negative performance of the Hilsa sanctuary revealed that fishermen strongly agreed that the sanctuary generates conflicts, with received scores of 22 while received score 44 for irresolute response. Similarly, the response regarding the sanctuary primarily benefiting only the neighboring coastal community received a score of 22 for strongly disagreed and 29 for disagreed respectively (Figure 4). It became clearer after a fisherman responded in favor of the negative effect, saying, *“For declaring sanctuary, we can’t fish here, so we’re now relying on other professions. Having a sanctuary in our neighborhood made us suffer. Our neighbors are turning out to be beneficial to our sanctuary. Fish from the sanctuary migrate to their area, where they can be caught. Furthermore, this type of practice exacerbates social conflict in our community”*.

3.3. Socio-Economic Implications of Sanctuaries Establishment

3.3.1. Impacts on Livelihood Capitals

The implementation of sanctuary regulation is seen as having a negative impact on assets, either directly or indirectly. In the surveyed communities, the sanctuaries were discovered to influence livelihood assets in two ways. First, the policies, institutions, and processes of the sanctuaries had a direct impact on asset access. Second, the outcomes of livelihood decisions can either facilitate or impede future asset access. Increased hilsa production, for example, as a result of the ban period, may result in additional earnings in the long run. An overview of how the sanctuaries influenced the livelihood resources available in (Table 3). According to community respondents, policies failed to take into account the needs for local capacity building. Two-third of the respondents pointed to an increase in the abundance of other species, hence natural capitals such as land, water, fish, and biodiversity resources have benefited from increased fish diversity. According to a focus group discussion, concerns about the hilsa sanctuary area grew, implying that vulnerability was increasing as a result of smaller catches and lower income. The social attachment of communities has been harmed due to rising conflicts among stakeholders. Local fishermen became enraged with direct consequence of the fishing ban and became involved in conflicts. The fishing ban had a negative impact on fishermen’s knowledge, skills, norms, behavior, and other human capitals as a result of food scarcity, lower income, and consequent poverty. One key informant from Laharhat of Barisal grieved as *“The Hilsa sanctuary has many positive outcomes, but government support is insufficient and ineffectively timely to compensate our income, which is discrimination against us. When the government prohibits fishing in the hilsa sanctuaries, we become completely unemployed, with no other way to support our families. The administration imposed a ban on fishing without providing an alternative source of income. Fishers must continue fishing in order to survive, which has turned local fishermen into criminals”*. The availability of a complex credit system at the local community level of the sanctuary area has a positive impact, but an unfair and illegal management system leads to a negative perception of financial capital. Similarly, participants’ perceptions of physical assets towards hilsa sanctuaries were unsatisfactory.

3.3.2. Impacts of Hilsa Sanctuaries on Livelihood Strategies and Outcome

The hilsa fishers in that area relied solely on hilsa fishing. The amount of money they made from fishing was determined by their ability to catch fish. Fishing was done on a regular basis by small-scale fishermen, who sold their catch to local traders. Some of them went straight to the local market to sell their wares. Fishermen in these areas had a regular schedule including fishing, selling fish after they were caught, preparing nets for the next fishing trip, sleeping, and going fishing again. However, when fishing is prohibited in sanctuary areas for several months, this consistency is broken. They lost their jobs. To supplement their fishing income, some anglers work as a street hawker, day laborer or build boats and nets. In search of work, some of them migrate to another location. Many of them are unable to leave the area because they are subjugated by the *dadon* credit system. *Dadon* is the specific system of high interest loans, that is not merely high interest based but also involves advance sale of catch often at lower prices than usual. The impact on livelihood

strategies and outcomes was the most discussed and concerning effect of the creation of the sanctuaries across all of the sites. Observed or possible outcomes elicited a wide range of responses, depending on livelihood strategies (Table 4). The most common concern expressed by participants was the exclusion of fishermen and subsistence harvesters from the area. However, a number of participants in these areas were observed that there had been minimal impact on fishers (Figure 5).

Table 3. Perceived influence of sanctuaries on livelihood resources.

Capital Assets	Perceived Influences	
	Positive	Negative
Financial capital	<ul style="list-style-type: none"> • Have some compensation from government 	<ul style="list-style-type: none"> • Loss of income of the fishers in sanctuary area of Bhola and Patuakhali • Unable to send the children of the fishers to school • Complex credit system with high interests • Financial loss due to destruction of fishing gear
Human capital	<ul style="list-style-type: none"> • Access of outer organizations deals with social programs 	<ul style="list-style-type: none"> • Leads some fishermen towards morally corrupted; • No provision of training or capacity building; • No scope of alternative livelihood
Social capital	<ul style="list-style-type: none"> • Free access of NGO's into the communities 	<ul style="list-style-type: none"> • Conflict between fishermen and administration; • Creation of inter community conflict
Physical capital	<ul style="list-style-type: none"> • Creation of network with multidimensional organization 	<ul style="list-style-type: none"> • Does not support the developments of land roads and infrastructure; • Destroy illegal fishing gear
Natural capital	<ul style="list-style-type: none"> • Mixed impacts on aquatic resources of the hilsa sanctuary area; • Undermines access to the hilsa sanctuaries; • Positive impacts on hilsa fish as production and availability is increased; • Mixed impacts on biodiversity of the water body 	

Table 4. Perceived impact of sanctuaries on livelihood strategies and outcomes.

Livelihood Strategies	Perceived Outcomes
Fishing and harvesting (for income or subsistence)	Impact on increasing poverty Little impact on decreasing food security Much impact on decreasing well-being (e.g., traditions, culture, social, conflicts)
Aquaculture	None as no local involvement More vulnerable to risks
Management	Minimal increases in employment Minimal increases in wealth Decreased well-being (e.g., dignity)

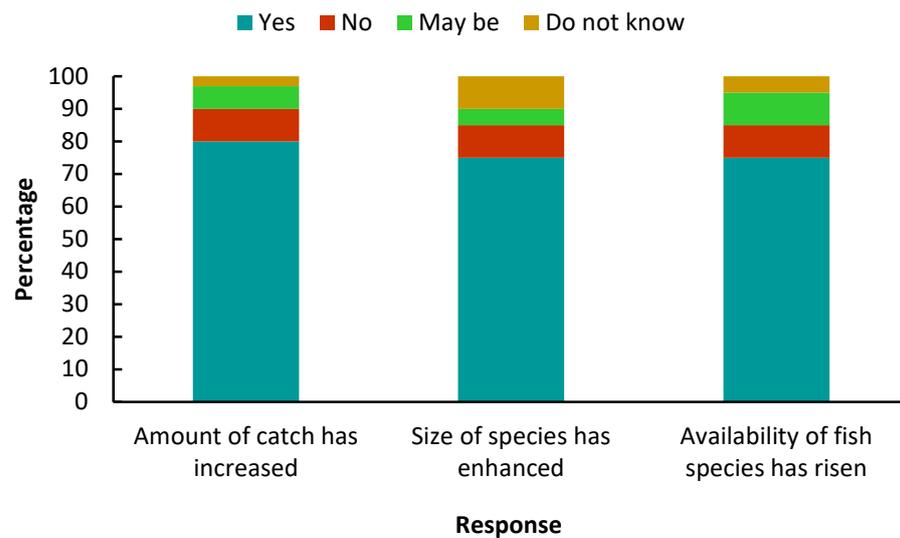


Figure 5. Fishers' perception regarding the impacts of sanctuaries on hilsa fishery of Bangladesh.

The perceived livelihood outcomes of the potential loss of access to fish and harvest for livelihoods and subsistence ranged from (a) no impact on incomes or households if the rules were not enforced to (b) concerns that losing access to fish and harvest would result in increased poverty, decreased well-being, increased conflict, and declining food security. Due to a lack of land, agricultural activities were limited. Other secondary occupations had a similar scope. Due to the negative attitude of local administration, they were denied aquaculture practices in bodies of water and plantation in open lands. Because most of the fishermen had no other way to make a living, they turned to illegal fishing. One fisher from Mohipur of Patuakhali district said, "Hilsa sanctuaries are a good initiative but government support is not sufficient to compensate our income which is injustice to us". Another potential alternative to these extractive livelihood strategies that could originate from the creation of the sanctuary were related to management. There were several ways that locals could be employed in management: as rangers, as managers, as contractors and as maintenance staff. Yet participants felt that only a minimal amount of additional employment in management would result from the sanctuaries and they were concerned both about the amount of pay and the potentially demeaning nature of the job. Overall it was perceived that there was limited hiring of locals into management positions and as one participant of Kalapara (Patuakhali) stated, "I am indecisive that this would happen". Moreover, participants discoursed that if this trends going on the poor small-scale fishers' would be excluded from the area and the purpose of protected area would be hampered. Additionally, they become worried about the existing management procedure. Because during closed periods they cannot go to that area for fishing, at the same time, allotted relief from government was not properly managed. Consequently, their livelihood and incomes suffered much. A commonly stated opinion in Focus Group Discussion was, "When government banned fishing we become unemployed and our family turned to helpless". During the ban periods of the sanctuaries, a number of alternative coping mechanisms were discovered, which the fishers became involved with. Day labor was the second most common alternative source of income during the ban periods. Some rely on loans from various government organizations and non-governmental organizations, while others continue to catch *jatka* and hilsa illegally. A few households engaged in alternative income generating activities, such as catching fish outside of the sanctuaries or working as rickshaw/van pullers.

3.4. Perceived Ecological Outcomes

Most fishers agreed that production of hilsa increased in their fishing zone and catch statistics also indicates that hilsa production has increased over the years (Figure 6; [12]).

In support of their claim, one fisher from Puraton Hizla, Barisal said—“If hilsa can breed safely, it will certainly increase your catch on your net”. A fisher from Beduria, Bhola explained the benefits of sanctuaries as—“Hilsa catch is very unpredictable, sometime for months fishers don’t get sufficient catch so they might perceive no change in hilsa production. If there were no sanctuaries, hilsa might be extinct in the next decade”. Moreover, many hilsa fishers of Meghna River basin thought that, this hilsa sanctuary supports increasing of other fish species as well as hilsa and resulted increased fish production.

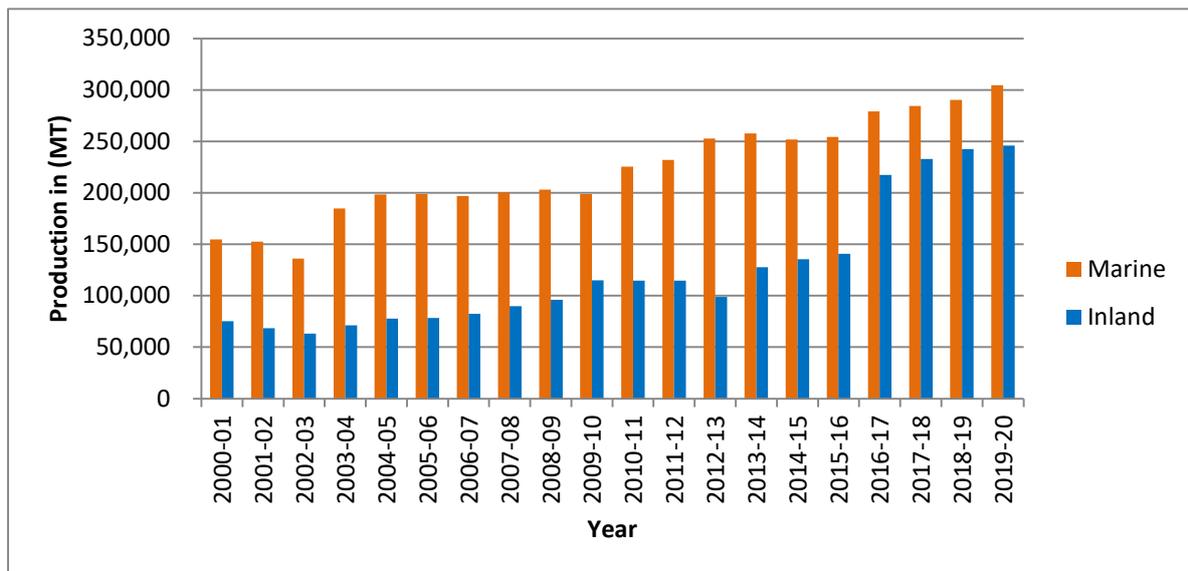


Figure 6. Production trend of hilsa in last two decade from 2000 to 2020 (Source: [12]).

4. Discussion

The findings show that the sanctuary promotes the growth of hilsa and other fish populations in and around the sanctuary. Studies have found a similar positive effect of sanctuary on increasing fish catch [15,21,34,35]. However, it has the potential to provide fish with a more favorable spawning ground where they can breed safely and pass their critical period without becoming entangled in fishing gears [15].

Despite being found to be beneficial from an ecological standpoint, the sanctuary has a negative impact on the socioeconomic status of fishers. Small-scale hilsa fishers have lower education, lower incomes, and limited access to basic facilities, according to their socioeconomic status. The vast majority of fishers are landless, impoverished, and rely solely on fishing for a living. They are among the most marginalized members of society, subjected to extreme stratification, discrimination, social exclusion, and economic dominance [36]. Fishers have a lower social status due to their low financial assets, limited skills, and limited living options [37]. Because of their limited occupational skills, they are unable to easily transition to other occupations. As a result, during fishing ban periods, they struggle to find alternative income-generating activities and suffer greatly [19]. Furthermore, the establishment of sanctuaries has resulted in negative socioeconomic consequences such as income loss, seasonal unemployment, increased poverty, and decreased food security [26], which exacerbates their suffering. Because the majority of fishers rely solely on fishing for a living, it is difficult for them to comply with spatial closure regulations because it eliminates their only source of income, which has a negative impact on their livelihood [16].

Given that the government of Bangladesh has taken the initiative to conserve hilsa by supporting fishers’ livelihoods [35]. During the fishing ban, hilsa fisher households were given 40 kg of rice per month (an increase from the previous allowance) since 2013. Both the hilsa fishery regulatory framework and the compensation scheme were found to have deficiencies that were likely to reduce public support and, as a result, compliance with legislation [3]. Furthermore, the AIGAs program aims to improve the livelihoods

of households in hilsa sanctuaries affected by ban season. The program provides hilsa fishermen with need-based training, refresher courses, and microcredit to enable them to conduct effective AIGAs [23]. Unlike grain distribution, the AIGAs program was only available to a small number of fisher households. AIGAs (costing about BDT 300 per household) were distributed to only 4388 households in 59 upazilas during the fiscal year 2009–2010. Some families received rickshaws, goats, cows (for fattening), or sewing machines, as well as money for small businesses, net making, poultry, plant nurseries, kitchen gardening, and cage culture [38]. The trainees were given a daily meal and a stipend of USD 6.932 to attend the training [23].

However, regulatory compliance and a lack of enforcement capacity are significant barriers to effective hilsa fishery management [3]. Low levels of regulatory compliance [39] and limited capacity for carrying out enforcement operations [40] are common features of command-and-control fisheries management. Conservation rules are frequently broken in protected areas. Poverty, insufficient compliance incentives, political interference, mismanagement and corruption, and the government's limited capacity frequently make it difficult for law enforcement to support conservation efforts [34]. Decentralization of fisheries governance and management could be an effective strategy for addressing compliance and resource issues in Bangladesh [3]. Delegating responsibilities to communities is critical to conservation success [41–43]. It has the potential to improve the existing hilsa sanctuary management system by allowing resident fishers to easily monitor and patrol these areas [44]. The participation of fishermen is expected to reduce the government's enforcement costs. Furthermore, if fishers are responsible for managing sanctuaries, they are less likely to violate conservation regulations [15]. It is suggested that all stakeholders be involved in monitoring and policing activities, as well as a compensation scheme, if necessary [23]. The period of fishing ban in sanctuary areas is not properly enforced [26], which is a major cause of noncompliance. To enforce regulations, the Department of Fisheries needs more efficient institutional arrangements and appropriate logistical support [8,15]. Overcoming financial challenges necessitates increased and consistent funding that is free of economic and political shocks. In this regard, it is suggested that a hilsa conservation trust fund (CTF) be established to provide long-term funding for the compensation scheme, ensure equitable benefit sharing, extend the ban period and protection zones, support critical ecological research, and aid in the development of long-term alternative livelihood strategies [3].

5. Conclusions

The establishment of hilsa sanctuaries is largely regarded as a highly effective approach for halting the collapse of the hilsa fisheries in rivers, estuaries and inshore waters of Bangladesh. Though there is a lack of sufficient scientific data to assess the usefulness of sanctuaries, some data derived from surveys based on fishermen's perceptions. Majority of respondents felt that sanctuaries are good, but only a few respondents had some kind of involvement in the development of sanctuaries. Some fishermen expressed dissatisfaction with hilsa sanctuaries since their revenues were limited during the prohibition period and the government provided few alternate sources of income. During two ban periods, fishermen face food and economic uncertainty which has a severe impact on their well-being. The government has implemented a management plan that includes the declaration of six sanctuaries along the Padma-Meghna Rivers and their tributaries, temporary fishing bans on juvenile and brood hilsa, and prohibitions on the use of destructive fishing gears such as *current jal* (monofilament gillnet), *behundi jal* (set bag net), and similar gears. The government has also issued a '*jelecard*' (Fishers ID Card) to the majority of the affected fishermen as reimbursement for the ecosystem services program, as well as rice and cash for alternative occupations. All of these measures contributed to ecological restoration, as evidenced by increased fisheries production and the reintroduction of the hilsa species into aquatic habitat, where it had been declining for the previous three decades.

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