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Socio-Economic Conditions of Small-Scale Hilsa Fishers in the Meghna River Estuary of Chandpur, Bangladesh

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Abstract: Hilsa fish (*Tenualosa ilisha*) have become an essential factor behind the well-being of the fishing community, giving fishers their identity as a source of cultural heritage. A field survey was conducted to understand the socio-economic conditions of hilsa fishers at the Meghna river estuary of Chandpur District using well-structured questionnaire interviews (N = 250) with hilsa fishers. The survey revealed that fishers' livelihoods and living conditions were still below average due to low literacy levels, lack of professional skills, and low incomes. More than two-thirds of the fishers were entirely dependent on hilsa fishing, while more than one-third had between 11 and 20 years of fishing experience. More than two-thirds of the fishers did not have an alternative occupation during ban periods, and the incentives provided by the government were not adequately received by half of the fishers. Fishers were divided into three groups according to their dependence on hilsa fishing. Significant differences were found between these groups in terms of the age of fishers, annual income from fishing, and annual fishing activity days. Therefore, the government, Fisheries cooperatives, NGOs, and other relevant organizations must unite to support fishers for sustainable hilsa fishery management.

Keywords: small-scale fishery; livelihood; hilsa fishers; Meghna river estuary; socioeconomics

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1. Introduction

Small-scale fisheries are an essential and valuable element of global fisheries and play a crucial role in meeting the basic needs of millions of people worldwide in both developed and developing countries [1]. This sector offers many benefits, including economic growth, food, and nutrition security, employment, income for millions of people, and resilience to poverty, particularly for many low-income countries [2]. Recent estimates have shown that approximately 36 million (97%) of the world's fishers are in developing countries. In comparison, approximately 107 million (88%) of the world's fisheries and fish trade workers are employed in the small-scale fishing industry [3]. SSFs provide animal protein and livelihood to 11% of the total population but face risks due to multifactorial issues related to indiscriminate fishing, unregulated fishers and efforts, illegal fishing nets (fine-mesh monofilament nets), conflict over resources, and climatic variability. This, in turn, has led to fisheries-dependent livelihoods being vulnerable and ultimately unsustainable. Moreover, despite the vital role SSFs play in national and local economies [4], they are poorly planned and regulated, marginalized, and often neglected by all levels of government.

In Bangladesh, coastal resources, including rivers and small-scale marine fisheries, contribute significantly to the national economy and promote poor coastal fisheries communities [5]. Bangladesh is one of the world's leading fish-producing countries with a total production of 4.276 million metric tons in 2017–2018 [6], of which the hilsa (*Tenualosa ilisha*) catch makes up approximately 12% with a global average annual catch of about 0.72 million tons. Others know this country as the harbor of hilsa fish. In contrast, about 50% to 60% of hilsa comes from Bangladesh, 20% to 25% from Myanmar, 15% to 20% from India, and 5% to 10% from other countries, including Iraq, Kuwait, Malaysia, Thailand, and Pakistan [7,8]. This transboundary fish species shares a tremendous social, cultural, economic, and emotional bond with the people of the country and the other Bengali people living around the world through its high nutritive value and flavor.

Hilsa fish (the national fish/ GI indicator) is the largest single-species fishery in Bangladesh, contributing the highest to around 14% of the country's total fish production and 47% of total marine catch [9]. This fishing has become the "social and economic driving force" of the country [10], characterized by the usual conditions of joint ownership, using the resources available to fishers [11]. The total annual value of the hilsa fishery is USD 1.3 billion, accounting for more than 1% of Bangladesh's total GDP and directly or indirectly supporting the livelihoods of 4 million people of Bangladesh [8]. About 1 million fishers depend directly on hilsa fishing to maintain their livelihood. At the same time, another 3 million small-scale fishers are indirectly involved in hilsa fishing throughout the hilsa supply chain, including trade, transportation, marketing, and processing [12,13]. Moreover, this fish has become an essential factor behind the well-being of the fishing community, giving fishers their identity as a source of cultural heritage and symbolically contributing to many religious traditions. Therefore, fluctuations in hilsa catch negatively impact the livelihoods of hilsa-dependent communities and the country's national economy.

Hilsa is an anadromous clupeid native to the Bay of Bengal, the Indian Ocean, and the Arabian Sea. It is well distributed in the Ganga-Brahmaputra-Meghna drainage systems in India and Bangladesh [7]. In Bangladesh, the Padma, Meghna, Jamuna, Rupsa, Shibsa, Bishkhali, and Pyra rivers are the primary riparian hilsa fishing areas throughout the year [6]. The Meghna River is one of the most critical and expansive rivers in Bangladesh, and the maximum catch on the riverbank comes from this river. It covers 12 coastal regions of Bangladesh, where many people make a living from fishing [14]. A few decades ago, the distribution of hilsa was in almost all major rivers throughout the country. However, according to the latest research, the distribution of hilsa has reduced to 82 Upazilas in 16 counties [15].

Many small-scale fisheries are poorly managed today. New diagnostic approaches to contextualize fisheries and seek suitable entry points are needed to transform them into social-ecological sustainability and secure future livelihoods [16–18]. Small-scale hilsa fishers in Bangladesh are among the most vulnerable communities in society, living with extreme stratification, discrimination, social exclusion, and economic oppression [19]. These fishers occupy a lower position in Bangladeshi society due to their weak economic capacity, limited professional skills, and living options [12]. Most Hilsa fishers live below the poverty line and are often deprived of many basic amenities of life, especially in the off-season. Among small-scale fishers, hilsa fishers suffer more because of hilsa catching restrictions during the prohibition period.

Furthermore, much research has been done to assess the socio-economic or livelihood of the fishers in Bangladesh [11,20–24]. However, analysis of important issues such as living patterns, degree of dependence on fisheries, and related issues during the fishing ban has not been focused on adequately. Considering the above facts, this study aims to evaluate the socio-economic conditions and livelihood strategies of small-scale hilsa fishers at the Meghna river estuary of Chandpur, Bangladesh. Using the resource users' perspective, the study will contribute to more profound insights into the social-ecological aspects of small-scale hilsa fishers in the Meghna River. Furthermore, the study's findings will contribute to a knowledge base for new, practical, and fairer management approaches.

2. Materials and Method

2.1. Selection of the Study Areas

Using a comparative case study approach, the livelihoods of small-scale hilsa fishers in the Meghna river estuary were assessed (Figure 1). The study was carried out in two Upazilas of the Chandpur district, named Chandpur Sadar and Haimchar, and four villages were selected to represent different socio-religious patterns, Anandabazar, Charvanga, Charvoirovi, and Bishnupur (Tables 1 and 2).

Figure 1. Map of the study area (Banglapedia: The National Encyclopedia of Bangladesh (Online ed.). Dhaka, Bangladesh: Banglapedia Trust, Asiatic Society of Bangladesh. ISBN 984-32-0576-6.).

Table 1. Primary Data Collection Method, Survey Sites and Number of Individual Interviews (II), Focus Group Interviews (FGD), and Key Information Interviews (KI).

District	Upazila	Location	Study Sites	Sample Size (Number)		
				II	FGD	KII
Chandpur	Chandpur Sadar	23.21°39′ N; 90.63°61′ E	Anondobazar	80	3	5
			Charvanga	70	3	5
	Haimchar	23°4′ N; 90°38.3′ E	Charvoirovi	50	2	5
			Bishnupur	50	2	5
Total				250	10	20

The author also discussed with personnel of locally active NGOs (CNRS, ASA, BRAC, and SAJIDA), World Fish Center, DoF, local school teachers, fish traders, and community members to obtain an impartial impression about fishing villages.

Table 2. Surveyed fish landing centers in the Chandpur district.

District	Upazila	Landing Center	Location	No. of Fishers Aligned	Motorized Boat
	Chandpur Sadar	Boro station landing center	90°64′04″ E; 23°23′57″ N	7000	700
		Katakhali landing center	90°64′52″ E; 23°11′07″ N	3000	400
		Lalpur Machghat	90°65′73″ E; 23°29′89″ N	1920	200
		Anando Bazar Machghat	90°66′19″ E; 23°24′79″ N	1870	100
		Horina Machghat	90°64′26″ E; 23°14′08″ N	7320	500
	Chandpur Haimchar	Katakhali Machghat	90°64′53″ E; 23°10′69″ N	1560	200
		Telir More/Kalikhola Machghat	90°64′93″ E; 23°08′86″ N	1650	150
		HaimChar Machghat	90°65′25″ E; 23°07′02″ N	760	80
		Char Bhairobi Machghat	90°65′44″ E; 23°03′51″ N	1930	250
		Katakhal Machghat	90°66′00″ E; 23°01′73″ N	810	90

2.2. Data Collection Methods

Primary data were collected using qualitative methods, including interviews, focus group discussions (FGDs), and participatory observation from June 2018 to December 2018. Using a semi-structured questionnaire, in-depth interviews (N = 250) were conducted at two Upazilas, Chandpur Sadar, and Haimchar, to gather the necessary information. Interviews were held at fish landing sites, fishermen's houses, and local fish markets and shops, where fishermen spend their time in various activities such as loading and unloading fish, repairing nets and boats etc. Secondary data such as fisheries production data were from relevant published books, scholarly articles, and relevant literature through an online search.

2.2.1. Participant Observation

Information about the characteristics and fishing activities of hilsa fishers was collected through participant observation. Fieldwork in the selected fishing village began with an observation of the fishermen's lives and fishing methods. This observation appeared to be the most useful, practical, and understandable way of learning directly and confidently in a natural or social setting by immersing people's livelihood dynamics, motives, values, beliefs, interests, and local knowledge in the local cultural environment.

2.2.2. Semi-Structured Key Informant Interviews

Open-ended interviews with a semi-structured questionnaire were conducted with a duration of 30–45 min, with the key knowledgeable people in the communities, Fisheries Scientific Officers, and relevant NGO workers, to gather information on issues of coping strategies, livelihood diversities, fisheries resources, gear, indigenous knowledge, conflicts, changes in fishing regulations, local institutions, and other factors.

2.2.3. Focus Group Discussion (FGD)

In the study areas, 10 FGDs were conducted with 5–7 participants, each lasting up to 1 h (Table 3). FGD was effectively used to collect and validate production relations, livelihood changes, coping actions, diversity, rituals, social and economic institutions, and indigenous knowledge.

Table 3. Significant events of field research.

Techniques	Stakeholders	Remarks
Key informant interview	20	Each KI interviewed 2–3 times with a duration of 30–45 min
Focus group discussion	Ten events	With 5–7 participants with a duration of 45–60 min
Voyage with fishers for direct observation	3-day time voyages	Duration of each voyage ranging from 1–2 h.
Interviews with DoF, NGO, and BFRI personnel	10	Frequency ranging from 1–2 with each personnel.
Baseline survey	30 families	Socio-economic attributes.

2.3. Data Analysis

The collected information from the survey was accumulated, grouped, and interpreted according to the objective and parameters. The collected data were then organized, summarized, and followed by graphical analyzes during this study. Finally, all the quantitative data obtained from interviews were analyzed using SPPSS version 22.

3. Results

3.1. Socio-Economic Characteristics of the Fishers

People belonging to fishing communities in the coastal region of Bangladesh are economically vulnerable in terms of earnings and employment. Most hilsa fishers are so poor that they cannot renew their boats to fish in the aquatic environment. The survey was conducted on 250 hilsa fishers who were generally engaged in fishing, of which 240 (96%) were male (Table 4). In general, it was observed that women were engaged in domestic activities and were not allowed to go out for large-scale fishing due to social and security problems.

The results showed that 41% of the fishers were in the 26–30 age group, more than a third (38%) of the participants were in the 40–60 age range, and only a few (9%) of the fishers were in the age group of (>60 years). Fishers reported to prefer nuclear families (head of household, with spouse and children) rather than joint families (head of household, spouse and children, father, mother, brothers, and sisters) due to household expenses.

One of the most productive assets of the people living in the villages is to have agricultural land. The study revealed that 57% of the fishers had no land, 33% owned 5–10 decimals, and 10% had more than 10 decimals. The present study revealed that 79% of the fishers were entirely dependent on fisheries, 14% were partially dependent on fisheries, and only 7% were non-dependent fishers (Table 4). The fishing experience of the fishers was collected through in-depth interviews with fishers.

According to the survey, 35% of people have 11 to 20 years of experience, and few have more than 40 years of fishing experience. For most households (47%), monthly income was 5000 to 10,000 BDT (1 USD = 85.12 BDT), while 24% of fishers' income was less than 5000 BDT per month. On the contrary, 20% of fishers monthly income was 10,000–20,000 BDT, and only 9% of fishers reported monthly income of over 20,000 BDT.

Table 4. Summary of the socio-demographic characteristics of the hilsa fishers.

Characteristics	Categories	No. of the Respondents	Frequency (%)
Socio-demographic characteristics of the fishers			
Ages (Years)	>25	31	12
	26–40	103	41
	40–60	95	38
	>60	21	9
Sex	Male	240	96
	Female	10	4
Religion	Muslim	228	91
	Hindu	22	9
Family type	Nuclear	173	69
	Joint	77	31
Educational status	Illiterate	170	68
	Can only write the name	33	13
	Primary level	30	12
	Secondary level	17	7
Agricultural land ownership (decimal)	No land	143	57
	5–10	83	33
	>10	24	10
Fishers dependence group	Non-dependent fishers	16	7
	Partially dependent fishers	36	14
	Fully dependent fishers	198	79
Fishing experiences (years)	1 to 10	57	23
	11 to 20	87	35
	21 to 30	48	19
	31 to 40	45	18
	41 to 50	13	5
Monthly income (BDT) (1 USD = 85.12 BDT)	>5000	60	24
	5000–10,000	117	47
	10,000–20,000	50	20
	<20,000	23	9
Alternative occupation	Yes	63	25
	No	187	75
House structure	Tin & wood	133	53
	Straw roof and bamboo fence	60	24
	Built-in half bricks (*Semi pacca*)	45	18
	Built-in bricks (*Pacca*)	12	5
Basic facilities enjoyed by the fishers			
Electricity Facilities	Yes	235	94
	No	15	6
Drinking water facility	Own tube well	123	49
	Neighbor tube well	102	41
Sanitation facilities	River	25	10
	in Built bricks (*Pacca*)	40	16
	Built-in half bricks (*Semi pacca*)	75	30
	Built-in the sand (*Katcha*)	135	54
Treatment facilities	Village doctor	75	30
	Homeopathic	15	6
	Kabiraj	18	7
	Hospital	142	57
Credit access	NGO's	150	60
	Relatives & Neighbors	40	16
	Moneylenders (*Mahajan*)/Boat owners	50	20
	Banks	10	4
Get sufficient incentives during ban periods	Yes	100	40
	No	150	60

The pattern of the housing materials indicates the people's standard of living, their social status, and financial capacity. More than half (53%) of the fishers' houses were made of tin and wood, while the remaining fishers' houses were made with a straw roof and bamboo fences (24%), semi pacca (18%), and pacca (5%).

The sanitary conditions of the fishers were deplorable. Only 13% of fishers' families use sanitary toilets made of brick, while more than half of the fishers (54%) use toilets made of sand (*Katcha*). From the study sites, more than half of the fishers (57%) received health services from the hospital, whereas one-third of the fishers (30%) were dependent on unlicensed village doctors.

Credit access facilities for the small-scale hilsa fishers were minimal. Therefore, it has been perceived that most fishers rely on informal sources of financing to meet the expenses of their enterprises due to low incomes and limited personal savings. The survey found that 60% of the hilsa fishers borrowed money from NGOs, 20% from money lenders, 16% from relatives and neighbors, and only 4% from banks. In addition, it was found that 35% of the fishers received sufficient incentives from the government, while 65% reported that they did not receive sufficient incentives during the ban season.

3.2. Food and Nutrition

The major food items consumed by the hilsa fishers were fish, meat, dal, egg, and vegetables. It was found that the monthly intake of fish was higher (55%) than the other food items (Figure 2). Fishermen reported that they kept some fish for themselves as food while fishing and selling fish.

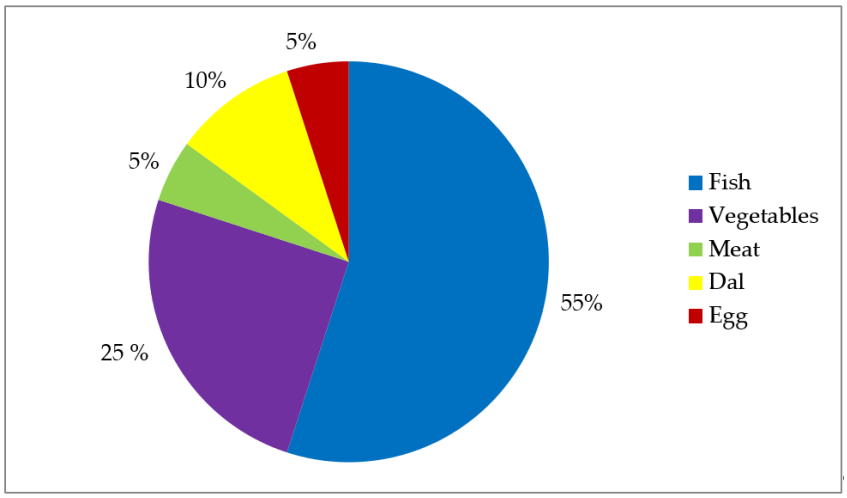

Figure 2. Food and nutrition intake.

During the fishing ban period, the poor fishers suffered from food shortages. A total 28% of fishers reported that to withstand this situation, they were compelled to reduce their meal frequency to two meals per day and consume less expensive food items (Table 5). They mainly depended on vegetables during the banning season, and their fish consumption was reduced to 0–1 days per week from 5–6 days per week (Table 5). Therefore, reducing meal frequency and fish consumption reflects low income levels and a lack of alternative livelihood opportunities during the ban season.

Table 5. Food consumption ratio of hilsa fishers.

Variables	Points	Non-Banning Season	Banning Season
Meal frequency/day	Three times/day	100%	72%
	Two times/day	0%	28%
Variation of food taken	Rice	Daily	Daily
	Fish	5–6 days/week	0–1 day/week
	Vegetables	4–5 days/week	6-days/week
	Meat/egg/milk	Once or twice every month	Rarely

3.3. Fishing Crafts, Engine Capacity, and License Availability

The main crafts operating on the Meghna River to catch hilsa fish were small mechanized and non-mechanized boats. The study revealed that 85% of fishers used mechanized boats and the rest (15%) used non-mechanized boats to catch hilsa fish (Table 6). In addition, mechanized boats went to extended areas for 3, 5, or 7 days (mostly gone in 3 days), depending on their storage and carrying capacity, while non-mechanized boats went to nearby areas.

It has been found that more than one third of the fishers (41%) in the study area used boats between 20–30 HP for hilsa fishing (Table 6). At the same time, fishermen reported that boats with 30–40 horsepower engines were used only for long-term fishing and only when there was a shortage of fishermen. Furthermore, fishers stated that they need a lower storage capacity boat for short trips (usually from 6 am to 5 pm or 6 pm). On the other hand, for long trips (usually 3 to 7 days), they need boats with higher storage capacity to catch hilsa fish. It is found that 30% of fishers have no license while the rest, 70%, have a license for hilsa fishing (Table 6). Although a license is crucial for hilsa fishing in both riverside areas in developed countries, there is no essential obligation for hilsa fishing in Bangladesh.

Table 6. Information about the boat used by the hilsa fishers.

Title	Types	Percentage (%)
Boat types	Mechanized	85
	Nonmechanized	15
Storage Facilities	Yes	81
	No	19
Engine Capacity (HP)	10–20	36
	20–30	41
	30–40	12
	>40	11
Carrying capacities (Metric Ton)	<0.5	28
	0.5–1.0	26
	1.0–1.5	18
	1.5–2.0	20
	>2.0	8
Having a License	Yes	70
	No	30

3.4. Fishing Gears Used for Hilsa Fishing

The nets used in hilsa fishing were of different sizes depending on the fishing boats used for catching fish. The use of fishing gear also varied from season to season, depending on the availability of fish. The nets used primarily for hilsa fishing in the study areas were the Current Jal (Gill net), Jagat Ber Jal, Ber Jal (Seine net), Chandi jal (Gill net), Gulti Jal (Seine net), Dora Jal (Gill net) (Table 7).

Table 7. A particular net operates in the study area.

Fishing Gears		Mesh Size (mm)	Location of Operation	Fishing Season	Species Caught	Remarks
Seine Net	Ber Jal	2–100	All types of the water body	All Season Nov.–June	All types of small fishes, but jatka with other fishes in Meghna river	This net is big (400–700) in the Meghna river
	Jagat Ber Jal	6–75	River and beel	April–Oct. to Janu.–May	All types of fish, Jatka mainly in Meghna river	
	Gulti Jal	75–125	Big rivers	March–Oct.	Mainly hilsa	
Drift Gill Net	Chandi Jal	90–115	Rivers	March–Oct.		
	Current Jal	55–85		All seasons		
	Dora Jal	75–90		Janu.–Oct.		
	Chandi Jal	90–115		March–Oct.		
	Current Jal	55–85		All seasons		

3.5. Total Hilsa Production of the Country vs. Hilsa Production of Chandpur

The given line chart represents the total fish production of the country versus total hilsa production versus hilsa production of Chandpur. Hilsa production in Chandpur was 14,583 metric tons in fiscal year 2008–09, followed by 21,264, 29,260, 26,920, and 29,180 Metric ton in fiscal years 2009–10, 2010–11, 2011–12, and 2012–13. Since then, hilsa production has declined dramatically until the fiscal year 2015–16. Numerous steps have since been taken to address the problem and as a result, hilsa production continues to grow with increasing demand from FY 2016–17 to FY 2019–20 (Figure 3).

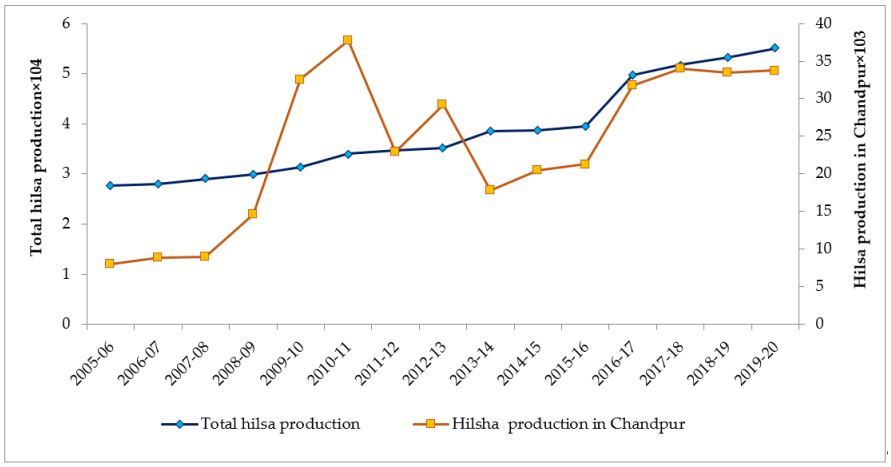

Figure 3. Total hilsa production vs. hilsa production of Chandpur.

3.6. Hilsa Production Trends

In 1999–00 the total production of hilsa was 2.19 lakh metric tons, and in the following years (2001–02) the production increased and reached up to 0.220 million MT. Afterwards, a significant fall in the production occurred in 2002–03 (0.199 million MT). Therefore, it was surprising that after the 2003–04 financial year, every hilsa production rose at a significant number, and at last, in 2016–17, it went to 0.4966 million MT (Figure 3). Hilsa fish production trends have gradually increased from year to year, as shown in Table 8. The highest production was achieved in 2019–20 with 532,795 tons, an increase index number of production of 1.92 compared to the base year (2005–06) (Table 8).

During the study, it turned out that hilsa production increased after increased management efforts (Figure 4). Production was comparatively lower from 2005–06 to 2006–07 as only sanctuary management was done. Later, production increased, and small incentives were imposed due to new management approaches such as ban periods. In 2009–10, the first year of a strict ban period, a full incentive package such as 30 kg m^{-1}h h^{-1} VGF

(US) was distributed for four months, and as needed, AIGA incentives were distributed to fishers in the production areas. This increased by 13% with increasing index number of production 1.13. After this incentive, hilsa fish production has gradually increased, and the production trend has become relatively high year by year. Therefore, hilsa fish production was 339,845, 346,512, 351,223, 385,140, 387,211, 394,951, 496,600, 496,417, 517,198 tons, 532,795 tons in 2010–11, 2011–12, 2012–13, 2013–14, 2014–15, 2015–16, 2016–17, 2017–18, 2018–19, 2019–20 respectively [9,25].

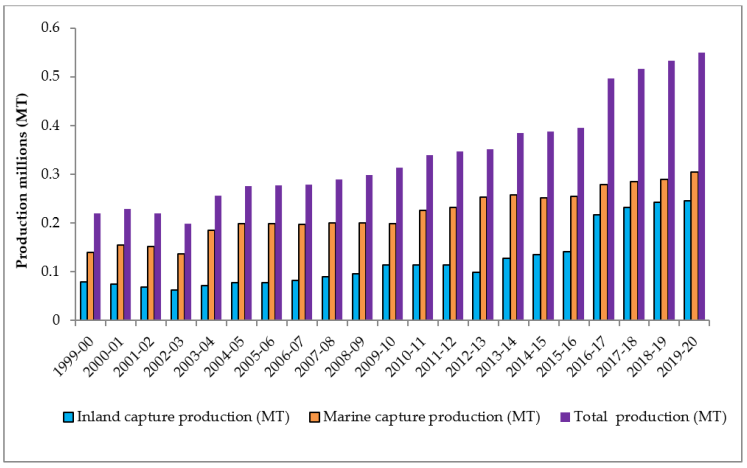

Figure 4. Increasing trend of hilsa production after hilsa management action plan introduced in 2003 [9].

Table 8. Production of hilsa with increased % in different years under different management activities [24] and this study.

Year	Hilsa Production		Management Strategies
	Total Catch (Tons)	Index No. of Production	
2005–06	277,123	Base Year	Sanctuary management
2006–07	279,189	1.01	Do
2007–08	290,000	1.05	Sanctuary management + small incentive (VGF 10 kg $m^{-1}h\ h^{-1}$)
2008–09	298,921	1.07	Sanctuary management + small incentive (VGF 10 $m^{-1}h\ h^{-1}$) + 10 days ban for brood hilsa catching in peak spawning season;
2009–10	313,342	1.13	Sanctuary management + 10 days ban for brood hilsa catching in peak spawning season + total incentive (VGF 30 kg $m^{-1}h\ h^{-1}$ + need-based AIGAs distribution)
2010–11	339,845	1.22	Do
2011–12	346,512	1.25	Sanctuary management + 11 days ban for brood hilsa catching in peak spawning season + total incentive (VGF 30 kg $m^{-1}h\ h^{-1}$ and need-based AIGAs distribution)
2012–13	351,223	1.26	Jatka conservation + sanctuary + 10 days hilsa fishing ban
2013–14	385,140	1.38	Jatka conservation + sanctuary + 11 days hilsa fishing ban
2014–15	387,211	1.39	Jatka conservation + sanctuary + 11 days hilsa fishing ban
2015–16	394,951	1.42	Jatka conservation + sanctuary + 15 days hilsa fishing ban
2016–17	496,600	1.79	Sanctuary management + 21 days ban for brood hilsa catching in peak spawning season + full incentive (VGF 40 kg $m^{-1}h\ h^{-1}$ and need-based AIGAs distribution)
2017–18	496,417	1.79	Sanctuary management + 21 days ban for brood hilsa catching in peak spawning season + full incentive (VGF 40 kg m
2018–19	517,198	1.86	Sanctuary management + 21 days ban for brood hilsa catching in peak spawning season + full incentive (VGF 40 kg m
2019–20	532,795	1.92	Sanctuary management + 21 days ban for brood hilsa catching in peak spawning season + full incentive (VGF 40 kg m

3.7. Perceived Drivers and Pressures in Hilsa Fishing

The main driving forces for less catching by fishers and the changes in the livelihood of the fishers are the use of illegal fishing practices, huge catch of jatka and brood hilsa, industrial pollution, heavy siltation that hinder the migration of hilsa, fishing ban season, use of destructive fishing gear, and violation of rules and regulation particularly in the prohibition period (Figure 5).

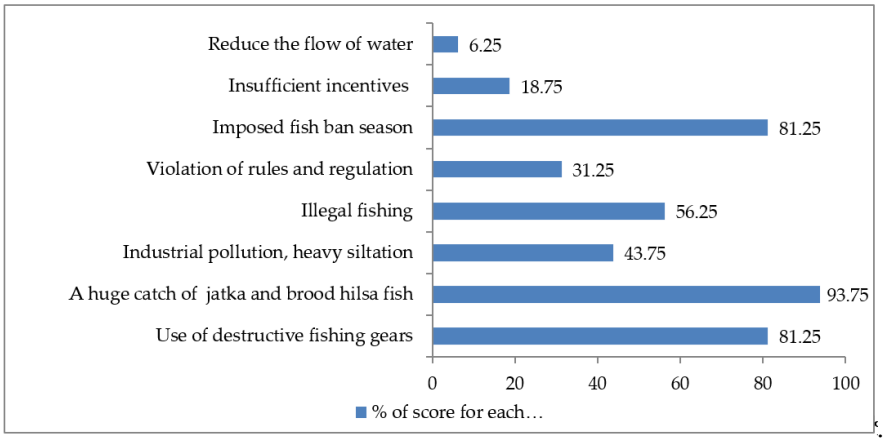

Figure 5. Perceived drivers and pressures in hilsa fishing.

3.8. Fishers Groups According to the Dependence on the Profession

The hilsa fishers (i.e., persons having a professional fishing license) were categorized into three groups with reference to their dependence on fisheries. The majority (72.4%) of the hilsa fishers interviewed belong to Group C (fully dependent fishers), minority (20%) were categorized in Group B (partially dependent fishers), and a further minority (7.6%) were categorized in Group A (non-dependent fishers) (Table 9).

Table 9 showed the number of hilsa fishers belonging to each dependent group by prefecture. Group A was more prominent in some prefectures of Ananda Bazaar (52), but was less numerous at about 8 and 4 in another group. This deviation is due to the presence of large-scale fishing-related activities. The most important part of the other three areas of study was Group A, not B and C.

Table 9. Number of hilsa fishers belonging to the three dependence groups in the prefectures of the study.

Prefecture	Group		
	A-(Non-Dependent Fishers)	**B-(Partially Dependent Fishers)**	**C-(Fully Dependent Fishers)**
Anandabazar	3	13	52
Char vanga	7	12	43
Char voirobi	5	17	38
Bishnupur	4	8	48

3.9. The Mean and Standard Deviation of the Dependence Group

People who are not dependent on fishing are classified in Group A, in this group, the minimum annual income of the fishers was less than 1 lakh (BDT), and the maximum is 180,000 (BDT) (1USD = 85.12BDT) (Table 10). Fishers used to fish from 150 to 235 days annually, with a minimum daily income of 250 (BDT) and a maximum of 800 (BDT) for fishers. Fishers said that a single fishing trip per day takes from half an hour to a maximum of four hours. On the other hand, the duration of the voyage per fishing trip lasts from a minimum of 2 to a maximum of 4 h, while the duration of fishing lasts from a minimum of 4 h to a maximum of 10 h (Table 10).

Fishers who are partially dependent on fishing are classified in Group B, where their minimum annual income was more than 1 lakh (BDT), and the maximum was 288,000 (BDT). Duration of a single fishing trip takes half an hour to maximum of four hours while the duration of voyage per fishing trip takes minimum 2 h to maximum 4 h, and the duration of fishing takes minimum 4 h to maximum 10 h in a day (Table 10).

Fishers wholly dependent on fishing are categorized in Group C, where their minimum annual income was more than 1 lakh (BDT), and the maximum was 234,000 (BDT). This group were reported to fish for at least 150 days to a maximum of 350 days, with a minimum daily income of 250 (BDT) to maximum of 650 (BDT). This group also said it would take half an hour to a maximum of 6 h to prepare for a fishing trip, where the duration of the fishing trip for each fisher would take 2–5 h (Table 10).

Table 10. Descriptive statistics of the mean and standard deviation of the dependence group.

Characteristics	Non-Dependent Fishers (Group-A)	Partially Dependent Fishers (Group-B)	Fully Dependent Fishers (Group-C)
Annual income from fisheries (BDT) (Mean ± SE)	119,025 ± 5610.58	136,500.00 ± 6626.24	133,345.45 ± 2022.69
Annual income from all sources (BDT) (Mean ± SE)	218,275 ± 3348.17	225,177.77 ± 7141.91	143,818.18 ± 2100.54
Annual days of activity (days) (Mean ± SE)	190.12 ± 5.29	268.33 ± 5.08	267.19 ± 2.38
Income per fishing day (BDT/Day) (Mean ± SE)	330.62 ± 15.58	379.1667 ± 18.40624	370.4040 ± 5.61
Duration of preparation per fishing trip (H) (Mean ± SE)	2.43 ± 0.25	2.9861 ± 0.16243	2.7955 ± 0.07778
Duration of voyage per fishing trip (H) (Mean ± SE)	2.93 ± 0.17	3.19 ± 0.11	3.26 ± 0.05
Duration of fishing per fishing trip (H) (Mean ± SE)	7.31 ± 0.36	7.47 ± 0.21	7.62 ± 0.07

Tables 11 and 12 show the average annual income and activity days per age class for the fisher dependence groups. There was no significant difference in the annual income from fisheries between the age groups, while there was a significant difference between the different dependence groups, as stated before. The income from fisheries follows the same aspect, although it has some important deviations.

Table 11. Mean and standard deviation of annual income (BDT) from fisheries per age class for the fisher dependence groups.

Dependence Group	Age Class			
Group	<40 Years	40 to 60 Years	>60 Years	Total
A		119,760 ± 23,029.81	108,000 ± 0.00	119,025 ± 22,442.32
B	129,600 ± 35,810.02	144,000 ± 45,128.38	162,000 ± 0.00	136,500 ± 39,757.47
C	132,523.48 ± 28,121.16	135,844.89 ± 29,629.69		133,345.45 ± 28,461.85

Table 12. Mean and standard deviation of annual days of fishing activity per age class for the fishers dependence groups.

Dependence Group	Age Class			
Group	<40 Years	40 to 60 Years	>60 Years	Total
A		191 ± 21.63	177 ± 0.00	190.12 ± 21.19
B	269.5 ± 35.94	266 ± 23.54	280 ± 0.00	136.500 ± 39.757.47
C	269.49 ± 35.03	260.20 ± 27.76		267.19 ± 33.55

3.10. The Relation between Fishers Dependence Group & Annual Income from Fisheries

The chi-square test shows that the annual income from fisheries in the three dependent groups is non-significant (*p*-value 0.360). Annual income from all fisheries is divided into 4 types. Less than or equal to 1 lakh, Category 1 represents income from 100,001 to 1.5 lakh, 2 represents the range between 150,001 to 2 lakh, 3 represents the range between 200,001 to 2.5 lakh. Most people who are not dependent on fishing were in the category 1(13) income range where the income was 100,001 to 1.5 lakhs per year, while the highest income range of non-dependent fishers was 150,001 to 2 lakhs per year. Partially dependent fishers and wholly dependent fishers also showed the same statistics with the maximum in Category 1. The result showed that the highest income of partially dependent fishers is 250,001 to 3 lakhs, while the highest income of wholly dependent fishers was 200,001 to 2.5 lakh (Table 13).

Table 13. Frequency distribution of annual income from fisheries for the 3 dependent groups of Fishers.

	Annual Income (Tk) from Fisheries					Total	*p*-Value
Type of Fishers	≤100,000	100,001 to 1.5 lakh	150,001 to 2 lakh	200,001 to 2.5 lakh	250,001 to 3 lakh		
Non-dependent Fishers	12.5%(2)	81.3%(13)	6.3(1)	0.0%(0)	0.0%(0)	100.0%(16)	0.360
Partially dependent Fishe rs	5.6%(2)	77.8%(28)	8.3%(3)	5.6%(2)	2.8%(1)	100.0%(36)	
Fully dependent Fishers	7.1%(14)	77.3%(153)	12.6%(25)	3.0%(6)	0.0%(0)	100.0%(198)	
Total	7.2%(18)	77.6%(194)	11.6%(29)	3.2%(8)	0.4%(1)	100.0%(250)	

3.11. The Kruskal Wallis Test

The Kruskal–Wallis test was used to evaluate differences among categories concerning the three dependent groups. The Kruskal–Wallis test illustrates that the age of hilsa fishers, annual income from all sources, and annual days of activity are significant. For example, the chi-square statistics for fisherman's age was 41.402, annual income from all sources was 102.535, and annual days of activity was 43.582 (Table 14). On the other hand, vessel length, vessel age, annual income from fisheries, income per fishing day, duration of preparation per fishing trip, duration of voyage per fishing trip, and duration of fishing per fishing trip are non-significant.

Table 14. Kruskal Wallis test statistics for hilsa fishers of the three dependent groups.

Characteristics	Chi-Square	Sig. Number
Age of Fisherman	41.402	0.000
Vessel length (miter)	0.243	0.886
Vessel age (Years)	2.717	0.257
Annual income from fisheries (Tk)	4.483	0.106
Annual income from all sources (Tk)	102.535	0.000
Annual days of activity (days)	43.582	0.000
The income per fishing day (BDT/Day)	4.483	0.106
Duration of preparation per fishing trip (H)	2.184	0.336
Duration of voyage per fishing trip (H)	3.018	0.221
Duration of fishing per fishing trip (H)	1.302	0.522

3.12. Analysis of Variance Test

The present results (Table 15) depict that vessel length, vessel age, annual income from fisheries, income per fishing day, duration of preparation per fishing trip, and duration of voyage per fishing trip were found insignificant, whereas age of fisherman, and annual days of activity were found significant.

Table 15. ANOVA test for determining the significance of different variables.

		Sum of Squares	Mean Square	F	Sig.
Age of Fisherman	Between Groups	7417.41	3708.70	37.985	0.000
	Within Groups	24,115.95	97.63		
	Total	31,533.37			
Vessel length (miter)	Between Groups	4.71	2.355	0.068	0.934
	Within Groups	8526.16	34.51		
	Total	8530.87			
Vessel age (Years)	Between Groups	309.64	154.82	1.136	0.323
	Within Groups	33,649.91	136.23		
	Total	33,959.55			
Annual income from fisheries (Tk)	Between Groups	3.59×10^9	1.79×10^9	1.991	0.139
	Within Groups	2.22×10^{11}	9.01×10^8		
	Total	2.26×10^{11}			
Annual days of activity (days)	Between Groups	89,402.13	44,701.068	42.286	0.000
	Within Groups	261,109.06	1057.122		
	Total	350,511.20			
Income per fishing day (Tk/Day)	Between Groups	27,669.973	13,834.987	1.991	0.139
	Within Groups	1,716,536.42	6949.540		
	Total	1,744,206.40			
Duration of preparation per fishing trip (H)	Between Groups	3.354	1.677	1.455	0.235
	Within Groups	284.646	1.152		
	Total	288			
Duration of voyage per fishing trip (H)	Between Groups	1.655	0.828	1.456	0.235
	Within Groups	140.406	0.568		
	Total	142.061			
Duration of fishing per fishing trip (H)	Between Groups	2.025	1.013	0.793	0.454
	Within Groups	315.376	1.277		
	Total	317.401			

4. Discussion

Small-scale fisheries are a sector that is heterogeneous at various levels (spatial, temporal, tool diversity), has different social and cultural importance, has its own characteristics, and is very difficult to define [26]. Small-scale fishers in Bangladesh are among the most vulnerable communities in society, living with extreme stratification, discrimination, social exclusion, and economic domination [19]. Their livelihoods and living conditions are still below average in the adjacent Padma and Meghna Rivers. The available data and the findings of this study show that some features of small-scale fisheries in Chandpur make them completely different from the average national status and present significant challenges to management. These are the number of small-scale fishers and boats and the various levels of fishing activities (Table 6). As a result, there is a high level of heterogeneity in the level of occupational dependence, as confirmed by current findings and previous studies [26].

The socio-economic status of small-scale hilsa fishers in this study shows that fishers have lower education levels, lower incomes, lower purchasing power, and limited basic facilities than the national average (Table 4). Most of the fishers were landless, poor, and dependent on fishing for their livelihoods (Table 4). For example, the study found that 31% of fishers lived in joint families, and only 69% lived with nuclear families. In contrast, the average number of members of a nuclear family was 4.17 per household, and the average size of the joint family was 6.22 per household. On the contrary, the average family members were below the national average of 5.6 persons per household in the single-family case. The findings of these studies are consistent with the study of [27], where the authors

stated that due to poverty and daily expenses, most community members prefer to have a nuclear family rather than a joint family.

Housing construction materials, availability of sanitary facilities, access to safe drinking water and food are considered units of measurement of peoples' standard of living and an indicator of a country's socio-economic status. It was observed that (53%) of housing structures were made of tin and wood, and the rest were katcha, semi pacca, and pacca. The health facilities of fishers in the study area were insufficient. Although there was one Upazila hospital in the study area, the health facilities used by the fishers were not satisfactory. Fishers often sought health advice from the unskilled, unprofessional village charlatan doctor and Kobiraj. This study was more or less related to [28], who stated that the health services of the Dhaleshwari River fishing community were received from 17.14% Kobiraj, 65.71% village charlatan doctors, 14.29% Upazila health complex, and 2.86% MBBS doctors.

Fishers having access to water sources were either dependent on tube well water, neighbors' tube wells, or sometimes on the river. The study area found that about 50% of the fishers used their tube-well water for drinking, and the latter half used their neighbors' water or sometimes river water for drinking purposes. Reference [24] reported that the great majority (58.25%) of lower Meghna river basin hilsa fishers used government tube-well and the remaining part used their own (15%) and neighbors' (26.75%) tube-wells to collect drinking water which is more or less similar to the present study.

Fishers occupy a lower position in society due to their weak economic capacity [13], limited skills, and options for living. Due to their limited occupational skills, they cannot easily convert to other occupations. Therefore, they find it difficult to obtain alternative income-generating activities during fishing ban periods and suffer a lot. In order to support the fishers and improve the socio-economic situation of the hilsa fishers, the Government of Bangladesh has implemented the food aid program during the fish ban period for fishing communities (covering 187,000 households). As part of the support program, the government distributed some VGF (Vulnerable Group Feeding) cards to poor fishers during the ban season. Through the VGF Card, fishers received 40 kg rice supplements per month for four months during the Jatka fishing restriction period (February-May) [23]. However, this allocation of Government and NGOs is minimal and only supports a small part. More than half of the fishers claimed that they did not receive the total allocation of the VGF card provided by the Government (Table 3). Instead, they get only 30–35 kg of rice per month. The findings are more or less similar to the study of [10,23], which stated that more than half of the fishers did not receive sufficient incentives from the government during the prohibition period due to nepotism and corruption. In addition, the government has also initiated some programs to support alternative income-generating activities such as supplying cash, rickshaw/van, and sewing machines to compensate for the loss of earnings resulting from the fishing ban periods [23].

Fishers were also well-known for the massive destruction of hilsa fish when using the current Jar to collect Jatka from the Meghna river estuary. The use of Gulti jaal, ber jaal also caused a massive loss of jatka and brood hilsa. Most fishers felt that the increase in mechanized boats over the last decade has led to the massive exploitation of the mouth of the Meghna River during the hilsa fishing season. The study of [29] has shown that sewage and industrial wastewater were the primary sources of pollution in the Hooghly River and that metal and pesticide contaminations could negatively impact the health of aquatic organisms. Heavy siltation by sedimentation is also a significant phenomenon in the Meghna river system, and many researchers supported this view.

The fish banning season has a tremendous impact on the livelihoods of small-scale hilsa fishers. As more than two-thirds (79%) of the fishers depend entirely on hilsa fishing, their incomes were about to cease during the prohibition season. They could hardly afford the necessary food and other expenses. Therefore, these fishers had to receive loans from moneylenders/*Mohajan*/boat owners or from microcredit organizations or neighbors, which led them to an endless debt cycle, leading them to practice illegal fishing methods to

have a stable livelihood and repay their loans. In general, boats, nets, and loans are offered by *aratders* on several terms.

After the introduction of incentive-based management, considering the impact on other management, the production of hilsa increased year by year, and the livelihood status of *Jatka* or hilsa fishers also improved. Similar opinions have been reported by researchers [14,30,31]. Also, hilsa production increased from 2.777 million tons (2005–06) to 3.51 million tons in 2012–13, rather than decreasing [32]. In addition, production has increased significantly in recent years due to the adoption of different management interventions for this fishery since 2005 [31]. To achieve sustainable production, it is imperative to preserve the jatka while saving the berried hilsa during the peak spawning period for the unabated release of a mature egg [14,32].

In recent years, the availability of hilsa in water bodies has decreased significantly due to anthropogenic pressures–the destruction of hilsa juveniles, habitat degradation, indiscriminate capture of hilsa juveniles, and poor enforcement of the net size regulation law [1]. Various law enforcement agencies impose seasonal fishing ban periods, including November-January and March-April. In addition, restrictions are imposed on juvenile hilsa fishing at the six hilsa fish sanctuaries in the Meghna River estuary between November and June. During the two ban periods, hilsa fishers suffered from food and income insecurity, insecure livelihoods, and low living standards that negatively impacted their well-being.

Where resources are scarce and livelihoods uncertain, some activities of fishermen are seen as a necessity rather than a choice [33]. In subsistence fishing, unemployment, poverty, inequality, and economic crises are common reasons for fishermen to not comply with fishing laws. The disadvantaged socio-economic situation of fishermen and the risks they faced in making a living, sometimes dictated the choice of illegal fishing activities that ultimately increases the risk of the serious collapse of fisheries. In [33–35], these studies also support this point. Therefore, addressing the threat of collapse should be a priority given the socio-economic dependence of fishing communities, which will have a major impact on the local economy.

Fishermen do not deny the role of authorities and government in compliance with laws and regulations for the long-term sustainability of local fisheries. They understand the problems imposed by socioeconomic expenditures, especially for the livelihoods and well-being of fishermen that arise during prohibition times and put the benefits of this strategy at risk [36]. Fishermen know that banning fish seasons or protecting breeding grounds will limit their activities and jeopardize their income from fishing, but they eventually cope by indiscriminate and illegal fishing practices, catching of brood and juvenile hilsa, use of destructive fishing gears etc. In this case, adequate assistance from the government, microcredit access can play a major role in supporting the fishermen themselves and also in reducing illegal fishing practices.

Complex problems require complex solutions. In this sense, measures such as the prohibition of hilsa hunting alone do not work. Instead, they should rely on other measures adapted to the specific fishing situation. However, conservation efforts will be successful if available income-generating activities in Bangladesh can be implemented [37]. Restricting the ecosystem for a certain period is not seen as a sustainable solution to conserve resources that limit the entry of new fishers and can have long-term negative impacts where significant numbers of people rely on natural resources [38]. Additional measures may be found away from fisheries management in relation to structural issues that require clear policy initiatives, such as corruption, poverty, and unemployment.

Consideration of the socio-economic needs of fishermen is essential, as they cannot forfeit their livelihoods and food security needs because they live on the subsistence level. This ethical and social impact highlights the need to understand the interrelationship between fishermen's socio-economic conditions and their ecological conservation needs. The Government needs to provide adequate assistance, particularly financial support, during the prohibition period and other inevitable crises to continue their profession. In addition, providing adequate assistance to hilsa fishers and identifying authentic, vulnerable hilsa

fishers may attract large numbers of non-fishers to participate in hilsa fishing [2]. The Government and affiliated NGOs should organize training programs and skills development seminars with knowledgeable personnel for the skill development of fishers. Policymakers and researchers should address sustainable co-management, aquatic ecosystem development, livelihoods, and vulnerability aspects. Moreover, without excluding the fishers from their responsibility for overexploitation, instead measures must be taken such as training and education of fishers, empowerment, and participation in decision making.

5. Conclusions

Hilsa, the national fish of Bangladesh, generates employment and income for millions of people in Bangladesh, India, and Myanmar. This study was focused on the livelihood of the hilsa fishers of Chandpur district, Bangladesh. Fishers mainly were poor and neglected in society and were exploited by wealthier classes, mohajan, and aratdar in different ways. Almost 100% of fishers used current jal of which 85% fishers used mechanized boat. Among all fishers 20 to 30 HP of the engine of the mechanized boat had the highest number (41%). The socio-economic condition of the hilsa fishers in the adjacent area was not satisfactory because they were deprived of many amenities. As fishers play an essential role in catching hilsa fish under severely stressful conditions, the government should take some essential steps by providing extra providence (VGF card, soft loan, fishing gears and nets, etc.) off-season to improve their socioeconomic conditions.

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