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Livelihoods and Vulnerabilities of Small-Scale Fishers to the Impacts of Climate Variability and Change: Insights from the Coastal Areas of Bangladesh

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ABSTRACT

This study identifies the livelihood characteristics of small-scale fishers and how their livelihoods become affected through climate change-induced events, based on fieldwork in four fishing communities in lower Padma *hilsa* (*Tenualosa ilisha*) sanctuaries. To collect empirical data, several qualitative tools were employed, such as individual interviews, focus group discussions, oral history, and key informant interviews. A conceptual framework named Sustainable Livelihood Approaches (SLA) was used to analyze the data. The insights of the livelihood and climate vulnerability of small-scale fishers and fisheries management were addressed. The factors related to climate change included fluctuation of temperature and rainfall, frequent natural calamities, tidal inundation and outbreak of diseases. In addition, river pollution, alteration of migratory routes, poverty, malnutrition, debt cycle, social tension, stakeholder conflicts and lack of alternative earning flexibility made them more vulnerable. The current findings, derived from fishers' perceptions, are crucial for sanctuary's co-management, biodiversity conservation, planning and development of livelihoods of the small-scale fishers.

INTRODUCTION

Bangladesh is a Riverine country of South Asia. It is blessed with diverse fisheries resources with an area of 147570 Km^2 and a population of about 160 million (**Kuddus *et al.*, 2020; Sunny *et al.*, 2020a**). Bangladesh ranks the third in inland open water fisheries production and the fifth in world aquaculture production **(Sunny *et al*., 2021a)**. In terms of the tilapia,*Oreochromis niloticus*, production, Bangladesh ranks the 4th in the world and the 3rd in Asia **(DoF, 2018)**. Sixty per cent of the total Hilsa, *Tenualosa ilisha*, in the world are also produced from Bangladesh **(Sunny *et al*., 2021b)**. The national fish hilsa support 12 per cent of total fish production (394,951 MT) and contribute to 1 per cent of the Gross Domestic Product (GDP) of the country **(FRSS, 2017; Sunny *et al*., 2019a)**. About 3 million small-scale fishers depend on hilsa fishery for their livelihoods and wellbeing **(Islam *et al*., 2018a)**. Any ups and downs in hilsa catch adversely affect the livelihood sustainability of small-scale fishers, particularly in the coastal areas of Bangladesh **(Mohammed *et al*., 2016)**. Small-scale fisheries (SSFs) have been instrumental in meeting the basic needs of 12 million people in Bangladesh directly or indirectly **(Alok *et al*., 2018)**. They are recognised as one of the most climate-vulnerable professional groups and the poorest of the poor **(Milton, 2010; Rana *et al*., 2018)**. The annual per capita income (BDT 2,442) of the small-scale fishers is almost 70 per cent lower that of the country as a whole **(Rana *et al*., 2018)**. Dependency on a single profession, lack of alternative earning opportunities, inadequate income, debt cycle, and stakeholder's conflict mainly affect anthropogenic drivers making fishers' lives miserable **(Mohammed *et al*., 2013; Islam *et al*., 2016a)**. Frequent natural calamities, fluctuation of temperature and rainfall, tidal inundation, fishing ban period, and seasonality bring untold sufferings to the day to day life of the fishers. **(Rahman *et al*., 2015; Islam *et al*., 2016a; Rahman *et al*., 2017; Sunny *et al*., 2017)**.

The climate in Bangladesh has changed over the previous decades forming considerable adverse impacts on the coastal areas. The small-scale fishers are more vulnerable to the adverse impacts of climate change in such areas. Climate variability in Bangladesh include an increased number of extreme events, such as cyclones and floods, tidal inundation, irregular or excessive rainfall, temperature variation, drought, and sea-level rise that adversely affect coastal ecosystems. Remarkably, the climate vulnerability is a level of exposure to shocks, stress, poverty, risks and food security **(Pritchett *et al*., 2000)**. The aforementioned factors that affect drivers act as barriers to livelihood capitals and sustainability. Fishers' knowledge, skills, working ability, and good health are their human capital. Land, water, wild fry, fish, and all the fisheries products are natural capital. Financial capital includes fishers' incomes and savings. While, house, road, communication system, electricity, water supply, sanitary, existing health facilities, fishing gear, and boat are considered physical capital. Credit, cooperation, relationship, cultural norms, and knowledge sharing are recognised as social capital **(Sunny *et al*., 2020b)**.

Lower Padma hilsa sanctuary (5^{th} hilsa sanctuary) of Bangladesh is situated within a 20 km stretch of the Padma river at Naria to Bhederganj Upazila of Shariatpur district. Shariatpur is a desired place for the presence of both the mighty Padma and the Meghna River. The significant catches of the sanctuary are hilsa (Tenualosa ilisha), rita

(Rita rita), ayre (Sperata aor) bele (Glossogobius giuris), bata (Labeo bata), pangas (Pangasius pangasius) etc. Different types of fishing gears have been used in the sanctuaries, while some specific gears are used for specific species, and others are used for several species. **(Rana *et al*., 2018; Sunny *et al*., 2020c)**. People of this sanctuary rely mainly on hilsa fishing to support their livelihoods. Though this sanctuary is crucial for small-scale fishers, it is alarming because the lower Padma is one of the most disaster-prone areas of the country **(Hasan & Ahsan 2014; Khan *et al*., 2018)**. Thus, identifying the shocks and stresses attributed to climate change that make fishers vulnerable is crucial. Adequate information on livelihood sustainability is essential for decision-making, but the lack of required information of unprivileged small-scale fishers is the major obstacle to develop their livelihoods. Hence, the study was conducted to identify the livelihood sustainability of small-scale fishers by analyzing different livelihood assets and climate change-induced events that make them vulnerable by affecting the livelihoods strategies. Lower Padma sanctuary was selected due to the presence of densely vulnerable small-scale fishers and global consideration as a hotspot of climate variability and change **(Islam *et al*., 2018a)**. It is necessary to conduct a more in-depth study on the consequence of climate change on small-scale fishers because the vulnerability of fishing communities has been poorly studied. To fill this gap, this study aimed to work with one of the most highly vulnerable professional groups.

MATERIALS AND METHODS

Study sites and data collection

The study was conducted in the two fishing communities; namely, Uttor Char Bhaga and Dakkhin Char Bhaga of Char Bhaga union in Bhedarganj Upazila, and two fishing communities; namely, Uttor Banglabazar and Dakkhin Banglabazar of Haloishar union in Naria Upazila under Shariatpur district (Fig. 1). This study was based on both primary fieldwork and secondary data. From the four fishing communities, almost 120 fishers were randomly selected for interviews. The t questionnaire mainly focused on fishers' livelihood characteristics, level of dependency on fisheries, and exposure to climatic hazards. A mixed-methods approach was implemented in the current study, including the comprising quantitative method (semi-structured questionnaires) and the qualitative method, such as key informant interviews, focus group discussions and oral history interviews. The interviews took place at convenient sites for respondents, such as their houses, local markets etc., and the interview lasted for approximately half an hour.

Local government representatives (chairman and member), Upazila Fisheries Officers (UFO) and other associated stakeholders were selected for cross-check interview. Secondary data was collected from various scholarly articles and relevant literature and were comprehensively reviewed; the synthesized and relevant data were used in this study.

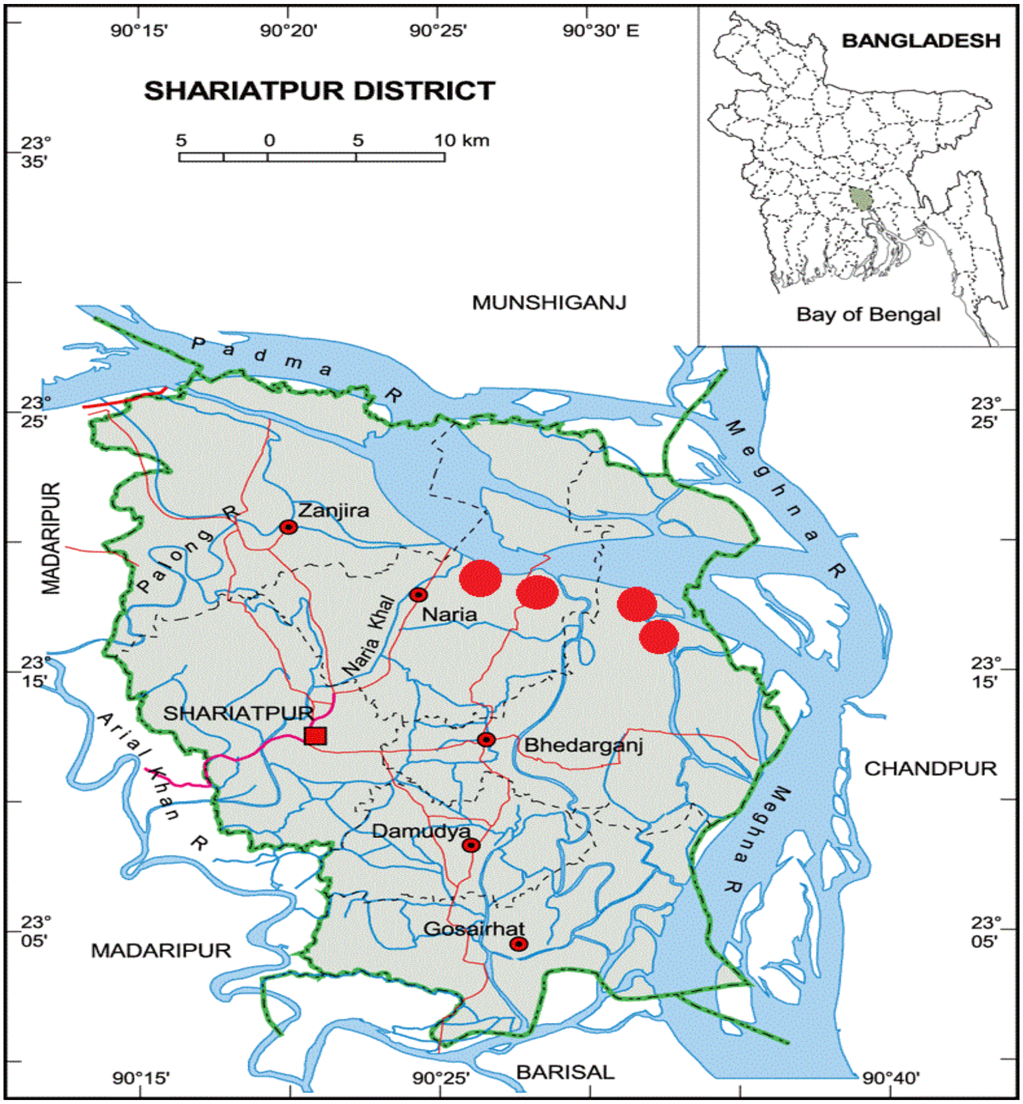

Fig. 1. Map of the Study area modified from **Sunny *et al*., 2020a**

Data processing, analysis and presentation

The Data were analyzed using MS Excel (Version 2016)and coded based on the predetermined themes. SLA (Sustainable Livelihoods Approach) framework **(DFID, 1999; Sunny *et al.,* 2020a)** was employed to shape the quantitative and qualitative data.

Sustainable livelihoods approach (SLA): A framework for analysing livelihoods of small-scale fishers

A livelihood is considered sustainable as long as it copes with and overcomes stresses and shocks and maintains or enhances its capabilities and assets for present and future generations without undermining its natural resource base **(Sunny *et al*., 2020a)**. A livelihood combines the critical factors that affect the strengths and weaknesses of an individual or family survival strategies **(Allison & Ellis, 2001)**. The small-scale fishers had various types of assets as defined by the DFID sustainable framework (Fig. 2), including human, natural, financial, social, and physical capitals **(Schreckenberg *et al*., 2010; Kabir *et al*., 2012)**. The sustainable livelihoods model can represent the risk that the poor could be very vulnerable, the assets and resources that might help them survive, and the policies and institutions that influence their livelihoods (DFID, 1999).

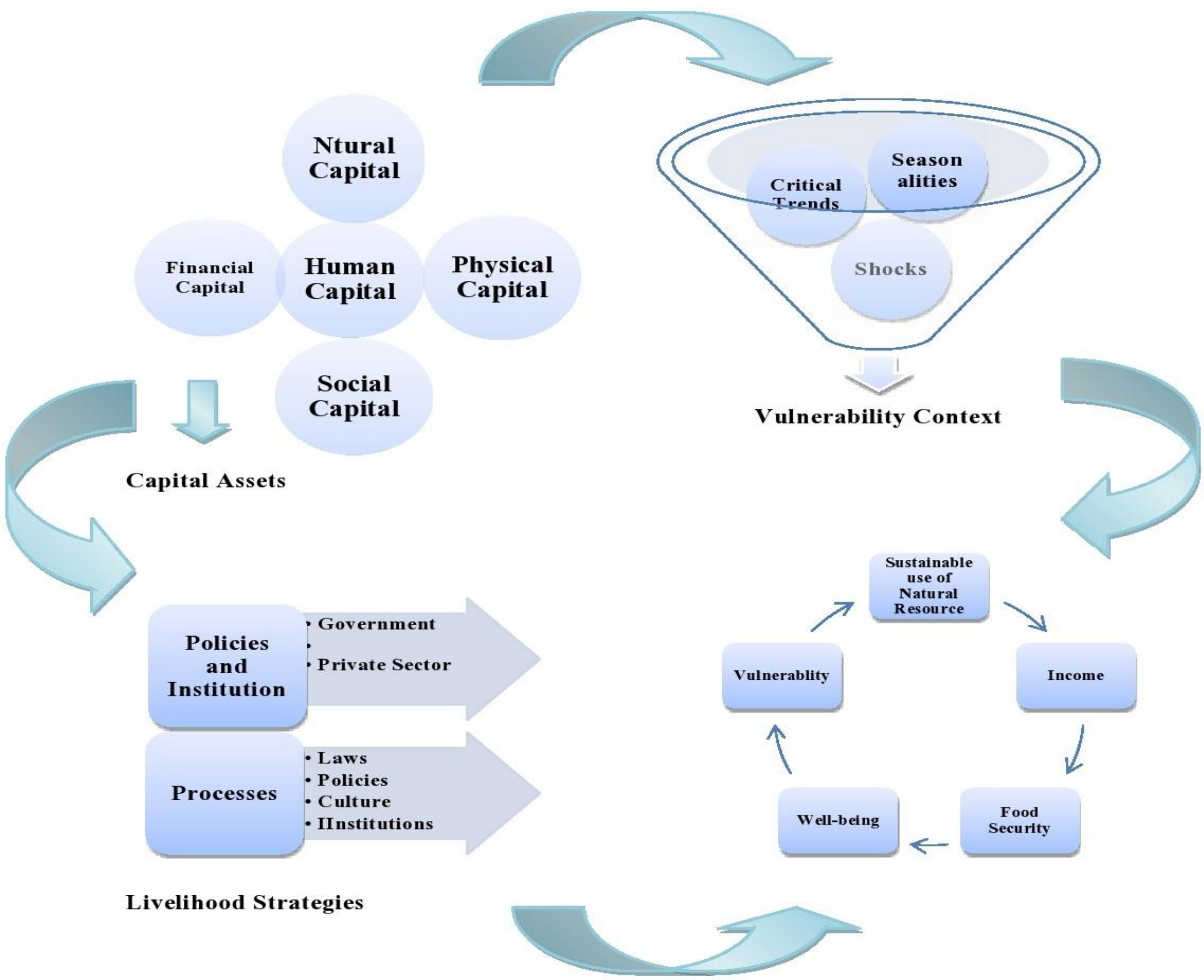

Fig. 2. The sustainable livelihoods framework **(Sunny *et al*., 2020a)**

RESULTS AND DISCUSSION

1. Social sketch of the small-scale fishers

Small-scale fishers of the country have no substitute profession and are also socially distinguished from other mainstream communities. In the Charvaga village, 3000 population existed in 370 households , and 204 of them were entirely engaged in fishing, while 166 were employed in fishing and small businesses. The majority (82%) had no fishing gear, and they worked as sold labourers to the Mahajan (local moneylender) leading a life below the absolute poverty line. The percentage of extreme poor (land size is 0 decimal), poor (land size is 5 decimal), and moderately poor were 26 per cent, 49 per cent, and 19 per cent, respectively (Table 1). In Naria Upazila, 120 nomads and 30 gipsy families were those who stayed there for an average of six to seven months in a particular year and were employed as day labourers. Generally, men fishers were engaged in fishing activities, but in gipsy and nomad communities, women were seen engaged in full-time fishing and identified themselves as self-dependent women. Nevertheless, in all the fishing communities, women possessed no decision making power and obviously, their male partner dominated them in all affairs. Since they live in a vulnerable situation, natural haphazard affects their earning options and working capacity, which consequently obstruct subsistence development. Subsistence identifies the resource, capability, commodities, and efficiency important for existence **(Sunny *et al*., 2020a)**. The DFID classified livelihood assets of the fishers through human, physical, natural, financial and social capitals that sketch out of the socially excluded small-scale marginalised fishing community **(Rahman *et al*., 2001; Sunny *et al*., 2019a)**.

Table 1. Social sketch of the small-scale fishers

Variable	Status	Mean (± SD)
Population	Total number	3000
Household	Total number	370
	Number of exclusive fishers	204 (2)
	Number of other	166 (3)
Gipsy	Number of households	30
Nomad	Number of households	120
	Temporary period (month)	6 (1.2)
Land size (decimal)	Extreme poor	0
	Poor	<5 (0.5)
	Moderately poor	>5(0.5)
Women's decision making power	Yes	2%
	No	98%
Natural calamities affect daily life	Yes	94%
	No	6%

2. Livelihood assets of the small-scale fishers

A professional group's livelihoods could be considered sustainable if it can cope with and recover from shocks and stress, maintain or enhance its capacities and assets for the current and next generation. The sustainable livelihoods approach (SLA) presents five types of assets upon which small-scale fishers' livelihood rely: human, natural, financial, social, and physical capitals. Human capital included age, family, marital status, fishing types and duration, education and literacy status, and religious and nutritional status.

Physical capital covered housing and infrastructure, health and sanitary status, fishing gears and utensils. Natural capital focuses on land properties, fish and other aquatic resources. While, financial capital comprises income and earnings.

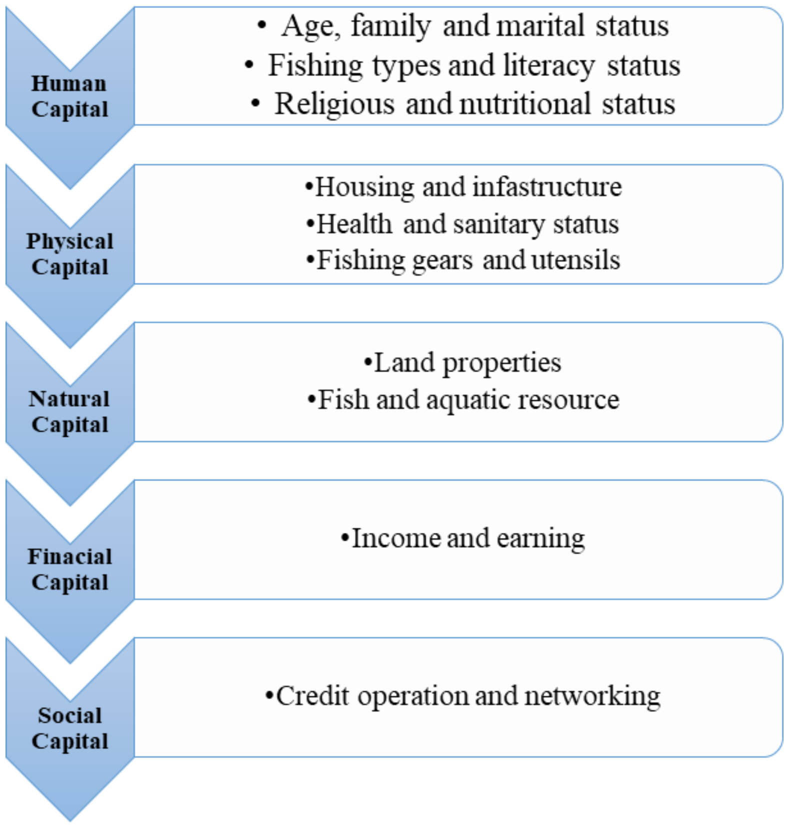

Fig.3. Livelihood Assets of the Small-Scale Fishers

2.1. Human capital

The study found that 100 per cent of the fishers were Muslims. The age structures of 40% of fishers of the study areas were 41-50 years of old. It was found that 22%, 18%, 11%, and 9% of fishers belonged to the age group of 21-30, 31-40, 51-60, and 61-70 years. Among the fishers, 50% were illiterate, whereas 30 %could sign only, 10% had primary education (class 1 to 5), and 10% had secondary education (class 6 to 10). The study found that 55% were married, while 40% were unmarried, and 5% were divorced. Poor socioeconomic status (55) and early fishing involvement (45) were mainly responsible for the low literacy rate in the fishing community. **Ali *et al*.** (2010) reported that in the fishing communities, 88 per cent of fishers were illiterate.

Family pattern varied from joint to nuclear. It was identified that 30 per cent of the fishers lived in a joint family, and 70 per cent lived in nuclear families. Based on their practice, fishers of the lower Padma sanctuary could be categorized into three groups;

namely, professional fishers (55.5%), seasonal fishers (35%) and subsistence fishers (55.5%). Professional fishers go fishing round the year for their livelihood. Seasonal fishers depend on fishing only at a particular time of the year. While, subsistence fishers catchfish for their home consumption mainly to meet family demands and sell the extra amounts to increase family income. In this context, **Rana *et al.* (2018)** identified 91 per cent professional fishers and 9 per cent seasonal fishers in the Meghna sanctuary. Professional and seasonal fishers went fishing day and night. Subsistence fishers harvested fish only during the day. The average fishing time for the professional fishers was 11 hours compared to 14 hours for seasonal fishers and 3.5 hours for subsistence fishers. The average fishing year of the small-scale fishers was found to be 16 years; with a minimum of 2.2 and a maximum of 17.3 years. The previous authors added that,the average fishing duration of the small-scale fishers of the Meghna sanctuary was 15 hours a day.

The nutritional status of the fishers was not up to the mark. A percentage of about 68.5 did not eat sufficiently, and nutrition reaches their meal thrice a day. Their primary diet lacked fish most of the times (25in a month). They sold their fish to earn more money, and in return, led to malnutrition and disease susceptibility. Similar health and the nutritional scenarios were found in the 4th (Bhola) and 6th (Barisal) hilsa sanctuary **(Islam *et al*., Minar *et al*., 2012; 2018b; Sunny *et al*., 2019a)**. Common diseases among the small-scale fishers were skin diseases (54), flu (68), headache (75), and fever (54).

2.2. Physical capital

Basically, the housing and infrastructure of the fishers are of two types, such as kutcha houses and semi pucca houses.The kutcha houses are made of bamboo spill and tin with mud floor, whereas the semi pucca patterns are made of wood and tin with cement floor. It was found that 88 per cent of the housing patterns were kutcha, and only 12% were semi pucca. The communication system of the areas was not properly developed. The fishers used various types of fishing gears determined in accordance to both the season and the availability of fishes. Moreover, they commonly used different types of nets, such as *pangaissha jal* (drift gill net), *moia jal* (seine net), *mushuri jal* (seine net), *gachi jal* (seine net), *boro chai* (fishing trap), *dar chai* (fishing trap) and *gura chai* (fishing trap), *gulti jal* (drift gill net), *current jal* (drift gill net) and ber *jal* (drift gill net) **(Zafar *et al.,* 2007). The current findings revealed that** the majority of the fishers (84.2%) drank tube-well water, 10% of fishers used their tube-well, 26% used government tube-well, and 59% used neighbours' tube-well. It was reported that 95.32% of non-migratory fishers used tube-wells as a source of drinking water, while only 9.24% of migratory fishers used nearby tube-well water whereas, the more significant proportions (89.77%) used river water for drinking and other purposes **(Khan *et al*., 2018)**.

Table 2. Fishing gears used by the fishers

Name of Gear	Types	Required man power	Specification	Status	Operating period
Current jal	Drift gill net	5-7	Mesh size (3 cm)	Illegal	Round the year
Gulti jal	Drift gill net	3-4	Mesh size (4.5 cm)	Legal	August, September, January, February, March
Pangaissha jal	Drift gill net	3-4	Mesh size (5 cm)	Legal	March, April, October, November, December
Ber jal	Seine net	8-10	Mesh size (.5 cm)	Illegal	Round the year
Moia jal	Seine net	8-10	Mesh size (.5 cm)	Illegal	Round the year
Gachi jal	Seine net	4-7	Mesh size (.4 cm)	Illegal	Round the year
Mushuri jal	Seine net	4-7	Mesh size (. 4cm)	Illegal	Round the year
Boro chai	Fishing trap	1-2	large in size (mouth 6 ft.), exclusively used for large fish; especially pangas	Illegal	March, April, October, November, December
Gura Chai	Fishing trap	1-2	Exclusively used for small fish with mouth of 1 ft.	Illegal	March, April, October, November, December
Dar chai	Fishing trap	1-2	Small in size, approximately 3 ft. in length	Illegal	March, April, October, November, December

The Sanitary status of these areas' fishers was entirely satisfactory and trying to use the sanitary toilet regularly as they were aware of the problems. It was found that 204 households had kutcha (earthen) toilets and 166 households respondents had semi-pucca (semi cemented) toilets, but 92% of fishers in northern Bangladesh used the unhealthy toilets reflecting their poor sanitary status **(Hasan &Ahsan, 2014)**. On the contrary, health and medical facilities were minimal, and in case of an emergency, they had to go to the far distant specialised hospital for treatment. Consequenty, to avoid this problem, they were accustomed to immediately take treatment and medicine from quacks, and 58%

of them took it allopathically, 21% washomoeopathic, and the other 21% was frequented totake herbals and other treatments. Another problem detected during this study was that electricity was highly fragile, and only 31% of people received available electricity. Most of them (69%) used solar power, and an earlier other study illustrated opposite findings of the electric facilities with maximum coverage **(Alok *et al*., 2018)**.

2.3. Natural capital

Fishing communities had a minor possession of land properties. They were terminal people, mostly landless and impoverished; they had <5 decimal land, and moderately poor fishers had >5 decimal land. The salinity range of the lower Padma sanctuary was near zero though it was considered a coastal climate-vulnerable area. Thus, the aquatic biodiversity of the sanctuary presented estuarine and freshwater aquatic species collectively. The study identified 72 fish species in the lower Padma sanctuary area (Table 3). In the lower Padma sanctuary, hilsa (*Tenualosa ilisha*) was identified as the main commercial fish. Among the recorded fishes, 34% were Cypriniformes followed by Siluriformes (25%), Perciformes (16%), Synbranchiformes (6%), Channiformes(5%), Clupeiformes (4%), and Osteoglossiformes, and Beloniformes (illustrated 3 per cent each) and tetraodontiformes, gasterosteiformes, cyprinodontiformes, pleuronectiformes and anguilliformes (represented 1 per cent each). The recorded fishes are shown in Fig. (4).

Table 3. List of available fish species

Sl. No.	Scientific identity of the taxon with author	Vernacular or local name	Common or English name
	Cypriniformes		
1.	*Salmostoma phulo*(Hamilton, 1822)	Fulchela	Flying barb
2.	*Esomus danrica* (Hamilton, 1822)	Darkina	Flying barb
3.	*Rasbora rasbora* (Hamilton, 1822)	Darkina	Flying barb
4.	*Chela labuca* (Hamilton, 1822)	Labuca	Hatchet fish
5.	*Aspidoparia morar* (Hamilton, 1822)	Morari	River stone carp
6.	*Megarasbora elanga* (Hamilton, 1822)	Along	Bengala barb
7.	*Barilius bendelisis* (Hamilton, 1807)	Joia	Hamilton's barila

8.	*Osteobrama cotio* (Hamilton, 1822)	Dhela	Cotio
9.	*Puntius sarana* (Hamilton, 1822)	Sar punti	Olive barb
10.	*Puntius chola* (Hamilton, 1822)	Chala punti	Chola barb
11.	*Puntius guganio* (Hamilton, 1822)	Mola punti	Glass-barb
12.	*Puntius conchonius* (Hamilton, 1822)	Kancha npunti	Rosy barb
13.	*Puntius ticto* (Hamilton, 1822)	Tit punti	Ticto barb
14.	*Puntius sophore* (Hamilton, 1822)	Jat punti	Pool barb
15.	*Puntius terio* (Hamilton, 1822)	Teri punti	One spot barb
16.	*Cirrhinus reba* (Hamilton, 1822)	Reba	Reba carp
17.	*Devario devario* (Hamilton, 1822)	Baspata	Bengal danio
18.	*Lepidocephalus guntea* (Hamilton, 1822)	Gutum	Guntea loach
19.	*Labeo rohita* (Hamilton, 1822)	Rui	Rohu
20.	*Catla catla* (Hamilton, 1822)	Catla	Catla
21.	*Cirrhinu scirrhosus* (Bloch, 1795)	Mrigal	Mrigal carp
22.	*Labeo calbasu* (Hamilton, 1822)	Kala Baush	Karnataka labeo
23.	*Labeo bata* (Hamilton, 1822)	Bata	Bata labeo
24.	*Amblypharyngodon mola* (Hamilton, 1822)	Mola	Molacarplet
25.	*Raiamas bola* (Hamilton, 1822)	Bhol	Trout barb, Indian trout
	Tetraodontifomes		
26.	*Tetraodon cutcutia* (Hamilton, 1822)	Potka	Ocellated pufferfish
	Anguilliformes		
27.	Pisodonophis boro (Hamilton, 1822)	Bamosh	Rice-paddy eel,

	Gasterosteiformes		
28.	*Microphis cuncalus* (Hamilton, 1822)	Kumirer khil	Crocodile-tooth pipefish,
	Siluriformes		
29.	*Eutropiichthys vacha* (Hamilton, 1822)	Bacha	Schilbi
30.	*Eutropiichthys murius* (Hamilton, 1822)	Muri bacha	Muriusvacha
31.	*Ompok Pabda* (Hamilton, 1822)	Modhu Pabda	Pabda catfish
32.	*Ompok Pabo* (Hamilton, 1822)	Pabda	Pabo catfish
33.	*Wallago attu* (Bloch & Schneider, 1801)	Boal	Freshwater shark
34.	*Silonia silondia* (Hamilton, 1822)	Shilong	Silond catfish
35.	*Pangasius pangasius* (Hamilton, 1822)	Pangus	Pangas catfish
36.	*Ailia coila* (Hamilton, 1822)	Kajuli	Gangetic catfish
37.	*Rita rita* (Hamilton, 1822)	Rita	Rita, Striped catfish
38.	*Sperata aor* (Hamilton, 1822)	Ayre	Long-whiskered catfish
39.	*Sperata seenghala* (Sykes, 1839)	Guizza ayre	Giant River catfish
40.	*Mystus vitatus* (Bloch, 1794)	Tengra	Stripped dwarf catfish
41.	*Mystus cavasius* (Hamilton, 1822)	Golsha Tengra	Gangetic mystus
42.	*Mystus bleekeri* (Day, 1877)	Golsha Tengra	Catfish
43.	*Mystus tengara* (Hamilton, 1822)	Bazari Tengra	Tengaramystus
44.	*Clupisoma garua* (Hamilton, 1822)	Garua	River catfish
45.	*Chaca chaca* (Hamilton, 1822)	Chaka	Squarehead catfish
46.	*Pseudeutropius atherinoides* (Bloch, 1794)	Batasi	Indian potasi
	Beloniformes		
47.	*Xenentodon cancila* (Hamilton, 1822)	Kakila	Freshwater garfish

48.	*Hyporhamphus limbatus* (Valenciennes, 1847)	Ekthota	Congaturi Halfbeak
	Channiformes		
49.	*Channa punctatus* (Bloch, 1793)	Taki	Spotted snakehead
50.	*Channa orientalis* (Bloch & Schneider, 1801)	Raga/Cheng	Walking snakehead
	Clupiformes		
51.	*Tenualosa ilisha* (Hamilton, 1822)	Ilish	Hilsa shad
52.	*Corica soborna* (Hamilton, 1822)	Kachki	The Ganges River Sprat
53.	*Setipinna phasa* (Hamilton, 1822)	Phasa	Gangetic hairfin anchovy
	Synbranchiformes		
54.	*Macrognathus aculeatus* (Bloch, 1786)	Tara baim	Lesser spiny eel
55.	*Mastacembelus armatus* (Lacepede, 1800)	Baim	Spiny eel
56.	*Mastacembelus pancalus* (Hamilton, 1822)	Guchi baim	Spiny eel
57.	Monopterus cuchia (Hamilton, 1822)	Kuchia	Gangetic mud eel
	Osteoglossiformes		
58.	*Notopterus notopterus* (Pallas, 1769)	Foli	Bronze featherback
59.	*Chitala chitala* (Hamilton, 1822)	Chital	Clown knifefish
	Perciformes		
60.	*Colisa fasciatu* (Bloch & Schneider, 1801)	Khalisha	Banded gourami
61.	*Colisa lalia* (Hamilton, 1822)	Lalkholisha	Dwarf gourami
62.	*Anabas testudineus* (Bloch, 1792)	Koi	Climbing perch
63.	*Chanda nama* (Hamilton, 1822)	Nama Chanda	Elongate Glass

			Perchlet
64.	*Parambassis lala* (Hamilton, 1822)	Lal Chanda	Highfin Glassy Perchlet
65.	*Parambassis ranga* (Hamilton, 1822)	Ranga chanda	Indian glassy fish
66.	*Chanda beculis* (Hamilton, 1822)	Chanda	Himalayan glassy perchlet
67.	*Glossogobius giuris* (Hamilton, 1822)	Bele	Freshwater goby
68.	*Rhinomugil corsula* (Hamilton, 1822)	Khorsula	Corsula mullet
69.	*Nandus nandus* (Hamilton, 1822)	Bheda	Mud perch
70.	*Brachygobius nunus* (Hamilton, 1822)	Nuna Baila	Bumblebee goby
	Cyprinodontiformes		
71.	*Aplocheilus panchax* (Hamilton, 1822)	Kanpona	Blue Panchax
	Pleuronectiformes		
72.	*Brachirus pan* (Hamilton, 1822)	Kathal pata	Pan sole

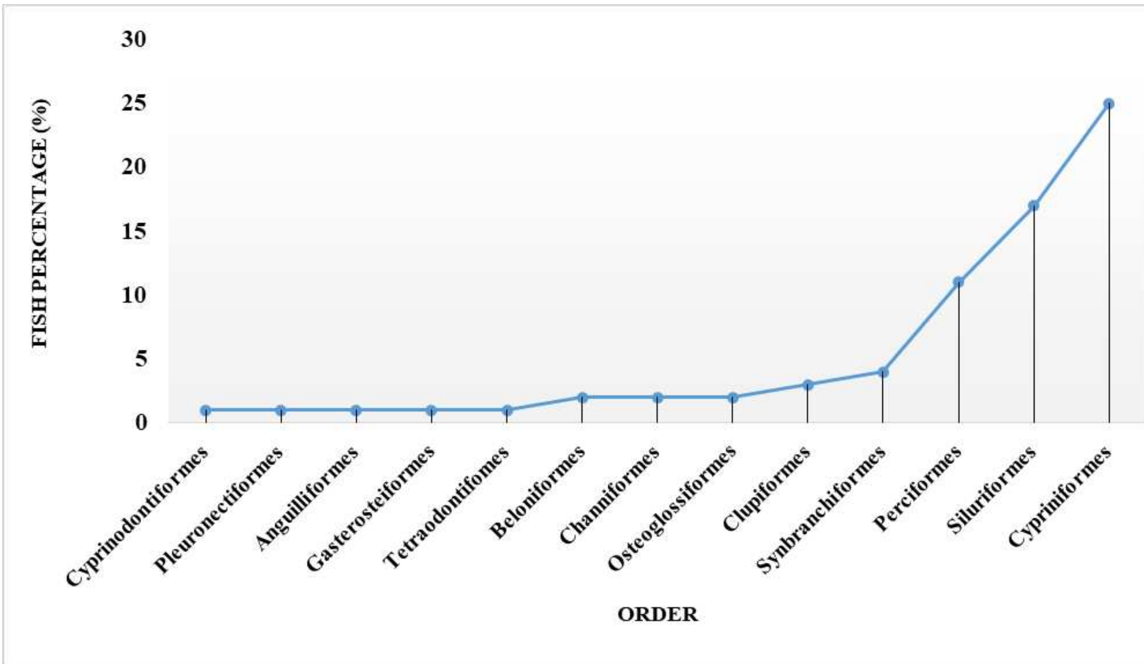

Fig. 4. Percentage of different orders of recorded fishes

2.4. Financial capital

Economically, the fishers' community was insolvent, and their socio-economic structure demonstrated the level of individual household income **(Islam *et al*., 2017)**. Although they lived in marginalised poverty and their income recognised them at relatively lower position in the Bangladeshi mainstream society, they monthly earned an average of 3000 to 7500 BDT. South and Southeast Asian fishers were marked out as the poorest of the poor **(Alok *et al*., 2018).** Besides, they had lack of professional mobility; the fishers had limited choice of work other than fishing and selling **(Sunny *et al*., 2019b)**. It was inspiring that they engaged in labour on agricultural land very recently, and fishers' women started rearing chickens and ducks on a limited range. Capital crisis and efficient skill were observed as the primary counteract for women (Table 4). Many contagious diseases disheartened them to engage in pet rearing. Thus, the study focused on the emergency of diversified alternative income generating activities (AIGAs) to develop the living standards of the fishers.

Table 4. Existing AIGAs for men and women of fishing households

Existing AIGA	Involvement	Inducing factors	Challenges
Fish farming and agricultural activities	Man	• Vast water resource and availability of unused land • Source of food and secondary income • Minimum investment • Less time consuming	• Minimum working scope • Lack of modern technology • Lack of communication with government department
Tailoring	Women	• Minimum investment • Maintain family and income equally • Regular income round the year	• Lack of capital to start or maintain the tailor house or machineries
Poultry rearing	Women	• Source of family income • Support egg and meat for family consumption • Increase earning and savings	• Contagious diseases • Lack of rearing place
Duck rearing	women	• Availability of natural feed due to having vast water resources • Require less monitoring • Source of earning and savings	• Contagious diseases

2.5. Social capital

The study constructed an idea that 93% of fishers were highly suffering from institutional or bank loans due to the lack of credit flexibility as they could not mortgage resource. They went to Mahajan (local moneylender) to take a loan with a high-interest rate, and even sometimes, they ought to sell their fishing gears, nets, and other instruments to feed their families and children. Another problem revealed that (48%) fishers were bound to work under the Mahajan at cheap labour rate as they provided easy accessible loan facilities, and some were forced to sell their caught fish at nominal value rates.

3.Trends of climate variability and associated vulnerabilities of small-scale fishers

Gradually, trend of temperature under changing climate had frequently become vicissitudes. Thus, it turned into excessive heat in summer and highly intolerable cold in winter, which ultimately created innumerable hardship by diminishing labour-power, the individual capacity of working hard, earning ability and spreading various health diseases. In return, fishers tended to catch more fishes by using current jal (monofilament gill net) in a possibly early time to avoid obsessive heating of the sun. On the contrary, they faced the coldest temperature during winter whilst catching fish and even quite often lost direction due to the foggy weather. As a result, the number of harvested fish decreased and trip expenses increased. Rainfall was usually so specific depending on the seasonal variety, but this trend was incredibly affected by climate change. Constantly, it was transferred creating many more problems. However, excessive rainfall in a particular year and significant shortage in the alternative year also became regular phenomena. This occasional rainfall was accountable for untimed flood and aridity, which impede the usual fishing stream. Accidentally, massive rainfall pattern directly hampered fishing activities and destroyed fishing gears which forced them to use prohibited current jal (monofilament gill net) that induced illegal fishing and hampered biodiversity conservation. Different types of natural phenomena occurred regularly in Bangladesh and the worst victims were the country's fishers. Several storms, irregular floods, cyclone, strong wind and wave, untimed drought, and frequent natural hazards were responsible for such natural catastrophe and made their (fishers) livelihood more vulnerable. Coastal fishers frequently faced tidal inundation where water clogged their households and created a movement problem. On the other hand, different water-borne diseases were broken out in the community and damaged their health system.

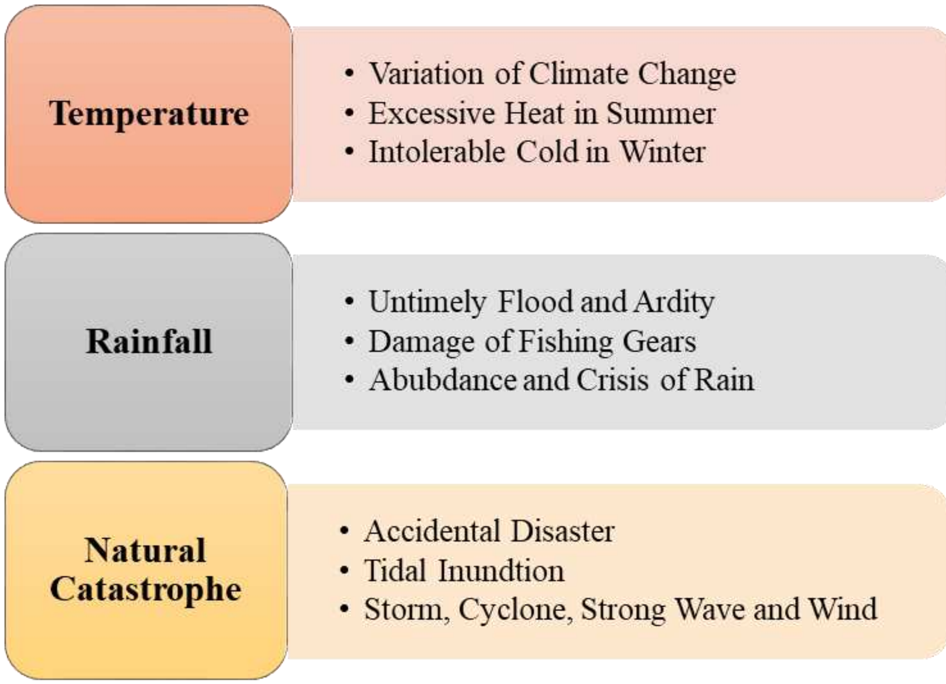

Fig.5. Climate variability and associated vulnerabilities of small-scale fishers

3.1. Impact on economic, social and physical circumstances

Generally, the fishing community has been living below the poverty line and leading an elegiac life. They hardly maintained proper subsistence owing to the lack of economic fate. Economically, this community was identified in a vulnerable situation due to the scarcity of loan facilities, credit and savings etc. Fishers were a socially marginalised community facing various stigmas in their lower position in society. On the other hand, these fragile fishing communities physically suffered most during the time of climatic hazards. Whenever natural disaster strikes out, their houses and infrastructures become greatly hampered. Excessive climatic ups and downs directly destroyed their non-productive assets such as household infrastructure **(Westlund *et al*., 2007)**. Thus, the hostile circumstance was liable for annihilating and deranging productive assets like fishing gear, net, boat etc. **(Jallow *et al*., 1999)**. These consequences affected roads and transportation systems; even sometimes, roads went underwater for dense rainfall that reduced the availability of daily necessities in the native market and raised commodity price **(Broad *et al*., 1999; Badjeck, 2008)**.

3.2. Impact on lives and reproductive assets

Small-scale fishers of this country were tremendously experiencing different vulnerabilities in their way of living. Fishing communities were living adjacent to rivers; thus, they became the first and foremost victims when the natural catastrophe occurred. Fishing was a risky profession, especially in natural hazardous times, because their lives were under threat due to sudden disasters and phenomena. Recent climate change has impacted fishing capitals regarding the fluctuation of temperature that resulted in the reduction of biodiversity and production **(O'Reilly *et al*., 2003; Vollmer *et al*., 2005).** Fisher communities have been facing some core vulnerabilities, such as ban period, insufficient support, debt load, diminishing of fish catches, cheap market facilities, dependency on a particular profession, inadequate incentive and damage of fishing gears **(Cheung *et al*., 2009; Brander, 2010;Drinkwater *et al*., 2010;)** that affected the livelihood sustainability of the fishers by decreasing their revenue.

CONCLUSION AND RECOMMENDATIONS

The small-scale fishers in Bangladesh were considered the most climate-vulnerable communities living along with the mainstream society with high discrimination, economic exclusion, social domination and enormous stratification. They depended entirely on a single profession and were still living below the marginalised poverty, and their earning pattern was positioned at a low level in the society. Their livelihood structure was not properly developed, so they were identified economically as a negligence class. Moreover, some socio-economic obstacles like credit insolvency, low income and lack of substitute earning flexibility made their life more vulnerable and pathetic. Hence, some immediate steps should be taken for a better livelihood status of fishers. The state should urgently assure sufficient aid, mainly financial assistance at the time of the ban period and other moments of crisis to maintain their livelihood. In addition, state and other related NGOs should arrange skill improvement programs and training facilities for the fishers. Additionally, policy developers and resource personnel have to ensure sustainable development and eco-management. Aquatic resource conservation necessities and climatic vulnerabilities of dependents need to be heavily addressed in a national and international platform.

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