Building Resilience Towards Climate Change Vulnerability

A Case Study of Fishing Communities in Southern Bangladesh

Prabal Barua
Jahangirnagar University
Syed Hafizur Rahman
Jahangirnagar University
Maitri Barua
Chattogram Veterinary and Animal Science University

Fishers on the Sangu River on their Way to Fishing in the Southern Coast of Bangladesh. (Photo: Prabal Barua, 2020).

This chapter focuses on the river-based livelihood and economies of local commu-nities along the Sangu River basin in Bangladesh in response to climate change-induced problems. The fishers experienced climate change impacts through loss and damage of physical assets, reduced fisheries productivity, low fish catch and a decrease in fishing income. Socioeconomic impacts were felt through changes in capture, production, and income, as well as through possible greater risks of fishing gear and crafts being damaged or lost. Due to a low adaptive capacity, fishers tend to be poorer, more marginalized and at risk of losing their occupation as a direct impact of extreme, climate change-induced events. While the fishers adapt different strategies, these adapting mechanisms are coming under increasing strain with both the increase in climate change and an increase in the frequency and intensity of naturally occurring hazards. Consequently, climate change impacts are magnifying the existing inequities among fishers and other communities in the Banskhali sub-district of Chattogram district. The adaptive capacity of small-scale fishers can be strengthened through policies that enhance social and economic equity, reduce poverty, improve fisheries resources and coastal management, and increase community participation in strengthening the institutions.

Introduction

This chapter highlighted the impact of climate change-induced natural disasters on small-scale fishers dependent on the estuarine Sangu River. It also reported autonomous adaptation practices of the fishing communities towards formulating an integrated adaptation framework. The Sangu is a transboundary river, originating on the Indo-Burma border (North Arakan Hills of Myanmar, located at 21°13’N 92°37’), which flows northwards through the Chittagong Hill Tracts of Bangladesh, bending West at Bandarban until it breaks into the Bay of Bengal to the west of Dohazari, Chittagong. The River is 295 km long. In the recent years, due to excessive deforestation in the river basin, its ecosystem is facing a severe water crisis and degradation. Previously, the basin was covered by dense forest that collected and stored water, releasing it as waterfalls into the river. Nowedays, the denudation of forest covers in the catchment area causes the rain to hit the soil directly, leading to riverbank erosion and sedimentation. Sediment ends up filling up the river and leads to it drying up (Shaci, 2018). The major tributaries of the River are Chandkhali River and Dolu khal. The Sangu River is also significant as one of the major habitats of Indian major carps that migrate to the River Halda via Karnaphuli River for spawning during the breeding season. There are 127 fish species in the Sangu River: 109 finfish, 3 exotics and 18 shellfish species (Azadi & Alam, 2014).

The Sangu River is closely interlinked with the livelihood of local people. The people in the area depend on the river for irrigation, transportation, drinking water, sanitation, and for practicing religious, ethnic, and cultural rituals and traditions. About 1,390 fishers are engaged in fishing throughout the Sangu River in the Anwara-Banshkhali region. Too much reliance on the Sangu River is creating a conflict over resources and, in the long run, might diminish the potential of Sangu River to serve the communities due to overexploitation. This study is based on 75 semi-structured interviews with individual fishers, 8 focus group discussions with village elders and a household survey using a Rapid Rural Assessment. The study was undertaken over twelve months, between January and December of 2020. The findings were discussed and re-evaluated in a workshop focused on participatory scenario development in order to build a robust understanding of feasible adaptation measures and pathways, and their relevance for vulnerable fishers' groups.

Climate change impacts: as experienced by fishers

More than seventy percent (72%) of fishers perceived climate change impacts as effects caused by storm surges that resulted in loss of their physical assets such as fishing gears and crafts. The remaining number of fishers focused on low income, linked to low fish productivity (e.g., limited egg production), which is indirectly affected by climate change. The local fishers experienced an increase in the intensity and frequency of storm surges, which directly threaten fishers' livelihoods. They were not able to operate the fishing gear when the river is rough due to harsh weather and storm surge effects. In recent times, the fishers of the Sangu River of Banskhali and Anwara region, faced a category V cyclone named 'Amphan' that hit on May, 2020 and which displaced 50,000 people. This created an economic loss of approximately 5 crore BDT and led to a loss of 20,000 houses in Anwara-Banskhali region, many of whom belonged to fishers. These fishing communities of Sangu River were also greatly affected by cyclone 'Komen' on July 28, 2016 and cyclone 'Giri', on October 22, 2010, that had peripheral effect on Banskhali coast. As a result of the cyclone Amphan, the tidal surges were hitting seven to eight meters above the normal water level, and 78% of fishers of Banskhali had to move to safer shelters. Still, they were not able to put the fishing boats and gears in a safe place for protection. These cyclones caused severe damage to fishing boats and stationary fishing gear (Estuarine SetBag Net-ESBN) and injured 186 fishers. The estimated cost of such damage was BDT 20.5 million (Table 1).

Table 1. Estimates cost (BDT) of assets, damaged by the Cyclones Giri (2010), Komen (2015) and Amphan (2020) in the Sangu River.

Particulars	Cyclone *Giri* (2010)		Cyclone *Komen* (2016)		Cyclone *Amphan* (2016)	
	Unit	Loss (BDT)	Unit	Loss (BDT)	Unit	Loss (BDT)
Physical injury when fishers tried to protect their fishing gears and crafts	186	93,000	250	1,25,000	350	1,90,400
Rowboats						
75-100% damage	11	165,000.00	25	500,000.00	45	800,000
50-75% damage	17	170,000.00	15	180,000.00	12	190,000
25-50% damage	32	224,000.00	15	135,000.00	12	110,000
1-25% damage	46	161,000.00	30	150,000.00	20	140,000
Medium boats						
75-100% damage	23	575,000.00	20	600,000.00	30	800,000
50-75% damage	28	504,000.00	22	484,000.00	20	450,000
25-50% damage	39	390,000.00	30	360,000.00	28	370,000
1-25% damage	18	90,000.00	15	105,000.00	20	120,000
Engine boats						
75-100% damage	2	110,000.00	5	300,000.00	10	420,000
50-75% damage	2	70,000.00	2	80,000.00	4	90,000
25-50% damage	4	100,000.00	6	80,000.00	8	100,000
1-25% damage	6	60,000.00	2	30,000.00	3	50,000
Stationary gears ESBN						
75-100% damage	22	2,200,000.00	40	8,000,000.00	60	12,00,000
50-75% damage	40	2,000,000.00	45	270,000.00	60	420,000
25-50% damage	18	450,000.00	10	300,000.00	15	410,000
1-25% damage	35	420,000.00	20	300,000.00	22	400,000
Catch loss due to the damage of fishing gears and crafts	276 MT	11,932,000.00	520 MT	26,000,000.00	700 MT	50,000,000
Total (BDT)		**19,150,000.00**		**37,874,000.00**		**55,020,400**

Overall, the annual yield of the Sangu River declined to 162 MT from 658 MT over the last 15 years (2005 to 2020), which resulted in approximately 72% revenue loss. Though the catch price increased by 48% over this period, the monthly income from ESBN operation was not increased due to the reduction of yield and an 90% increase in operational cost. Consequently, the majority of the fishers could not earn enough to meet their family needs.

One of the FGD participants, Mr. Polin Das reported: *"We are compelled to lead a miserable life. With limited earnings, we are barely surviving. We try to first ensure meals and clothes for our family members, but we cannot bear our medical and educational expenses"*. Most of the fishers come from families with long fishing tradition. Mr. Polin Das has been fishing for over the 25 years but he was very disappointed with his profession. He added that the fishers here can only catch fish during the full moon or new moon but that they do not have any work during the rest of the time. *"But fishers cannot change their professions as they are not so educated and lack experience in other jobs,"* Mr das observed. A fisher leader Mr. Bashir said: *"Fish production is decreasing day by day. No fish is available in the Sangu River in abundance as before. Fishers were moving to the deep sea to catch fish."* At the same time, all participants echoed the opinion of Mr. Bashir. The fisher-leader blamed the changes in weather patterns for a decrease of fish in the Sangu River. He further observed that frequent strikes of cyclones in the coastal areas are posing a threat to the lives and livelihood of the fishers. Mr. Jafar Ahmed, a fishery entrepreneur. locally called *bahaddar*, incurred a loss of BDT 100,000 in this season, when his three fishing boats were damaged due to the strong surge, though he put his boats in a small narrow canal for shelter.

Mr. Kokon Kanti, an ESBN fisher, shared a horrible experience about the strong surge, which hit on October 22, 2010 and said: *"I saw a big surge that raged on my boat and broke it. Then I felt a complete darkness around me; somehow, I grabbed a plastic drum with my hand as a float; fortunately, it kept me alive and then other fishers rescued me"*. After the storm surge on October 22, 2010, most of the ESBN fishers struggled to reinstall their net in the Sangu River untill November, with the monthly yield dropping over the following months. Mr. Nazibul, another participants in the focus group discussion, reported: *"My fishing gear (ESBN) was almost damaged through strong water current during the storm surge, which required BDT 50,000 for necessary repairs - but I wasn't able to arrange such funds immediately. For these reasons, I had to borrow money from the local money lenders with high interest. It also took 20 days to repair my net, during which time I was unable to continue fishing and did not have any alternative means to recover financially"*. A fishing crew member, Mr. Jolil Mia said: *"I was* *unemployed when my employer lost his boat and fishing gear during the cyclone Amphan which hit on 13 May, 2020. It was quite difficult for me to maintain my family expenses as fishing was my only source of income. Then I had to borrow BDT 30,000 from a local NGOs with high interest, as a result of which I was bounded to pay BDT 800 per week. Then I had to work as a daily laborer in salt bed and in earth filling works where they paid BDT 180 per day, which led to me changing my profession".* Mr. Kolim, who worked in ice-factory said: *"My income is decreasing as I don't have sufficient work in loading and unloading ice for fishing boats".* Mrs. Chemon Ara, a mother of five sons and four daughters who works at a dry fish processing plant said: *"Now fish landings are interrupted and reduced due to the bad weather. I get only a small amount of trash fish after sorting dry fish, and it has been very difficult to sustain my livelihood, as I get only BDT 50-75 per day by selling the trash fish."*

Autonomous adaptation strategy

Barua et al. (2020) stated that exposure to floods and cyclones, sensitivity to disaster and a lack of adaptive capacity concerning physical, natural, and financial capital as well as a lack of diverse livelihood strategies are creating social and economic vulnerabilities for fishers of Bangladesh. Over the last ten years, 20% of household heads nearby Bakkhali estuarine river of Cox's Bazar coastal area have changed their profession, leading to a growth in dependency on non-fisheries livelihoods such as rickshaw pooling and small business, as observed in the fishing villages in this study. However, many of them are applying their traditional knowledge to cope with the changing climate stress and in conserving the biodiversity of the coast. In order to strengthen the adaptive capacity and to build resilience, government and the external agencies need to facilitate the existing traditional knowledge and systems with which the fishing communities have been historically responding to the environmental stresses.

The field research underlined that fishers along the Sangu River have been adapting to the impact of naturally occurring changes and other natural hazards for decades. They have experienced periods of scarcity in the past, and they are well accustomed to employing coping mechanisms. However, as climate change is increasing so is the frequency and intensity of naturally occurring hazards, and these coping mechanisms are coming under increasing strain, with the potential of this leading to conflicts in the future. Focus group participants from the study area provided examples of the types of autonomous adaptations that have been listed below (Table 2).

Table 2. Autonomous adaptations measures practiced by the fishers of the Sangu River.

Impacts	Adaptation strategy
Reduced fisheries productivity	• ESBN gear modification: Fishers reduced mesh size of the net to increase the catch rate.
	• Community-based mangrove plantation: All fishers believe there is a positive correlation between mangrove plantation and fisheries productivity.
	• Fisheries management: Fishers are in the process of adopting fisheries co-management with the help of some NGOs.
Damaged fishing gear and crafts; increased physical injuries during fishing due to bad weather	• Changes in gear operations: Using mobile gears (e.g., gill net, push net) instead of stationary gears like ESBN. For example, numerous ESBN fishers were operating push net as it requires low investment.
	• Changes in net-mending materials: Fishers preferred imported thick yarns rather than locally produced yarns for better longevity.
	• Craft modification: By increasing the size and draft of the fishing boat.
	• Anchoring in a sheltered place: Keeping the boat in narrow canals of the River to avoid the damages caused by the storm surge.
	• Life safeguards: Using plastic drums as a float for protection during fishing.
Increased variability of the yield and reduced income	• Changing fishing grounds: Fishers from the islands (Khankhanabad Superior Dip) moved to other fishing grounds located in the Bay near Kutubdia island.
	• Borrowing money: For the financial crisis caused by the low fish yield, they borrowed money from different sources, paying high interest.
	• Changing fishing occupation: Unemployed fishers had to change their profession, as they struggled to meet their family demand since their income had been reduced. But the options were very limited and they mostly worked as labor in the salt pens, grocery shops, or in earthwork.
	• Migration: Both temporary and permanent migration were observed when fishers moved to near urban areas and cities to search for jobs, most in rickshaw poling.

Compared with the previous socioeconomic data (Nabi et al., 2011; Adnan et al., 2019; Zzaman et al., 2020), the present study revealed a number of negative changes (Table 3). It showed that about 20% of the heads of the household changed their fishing profession, leading to an increase in the dependency on the non-fisheries livelihoods (e.g. rickshaw pooling, other business). In addition, the overall fishing efforts declined in the last 15 years. Mr. Monsur, a young fisher, delivered interesting information noting that: "*In recent years, there is a growing tendency to reduce the mesh size of the net to increase the catch rate*." The survey found that the mesh size of the cod ends was reduced to below 5 mm. Most fishers are indebted as they borrowed from neighbors, relatives, local rich people, and NGOs to cope with the crisis as access to bank credit was very limited. Under these circumstances, a significant number of fishers changed their profession since they couldn't support their family. Numerous ESBN fishers changed their fishing activities in wild shrimp fry collection, which had adverse effect on aquatic biodiversity. One of the participants, Mr. Porimal Das, who is a wild shrimp fry collector said, *"I was an ESBN fisher; when my nets were damaged in a devastating storm surge, I did not have money to repair it and there was no other options for earning except to engage with wild fry collection where I did not have to invest so much to buy the push net."* Moreover, the livelihood of fish workers involved in selling, repairing nets, fish processing and other supporting jobs was also affected as their works depended on the fishing activities in the river.

Table 3. Changes in the number of fishers, fishing gears and crafts over the last 15 years.

		Comparative changes (in number) over the last 15 years		
		2005	2015	2020
Fisher		2,500	1,538	1,010
Gears				
i	ESBN	157	145	130
ii	Beach Seine	15	10	7
iii	Gill Net	10	6	4
iv	Push Net	221	205	180
Crafts				
i	Non-mechanized smaller boat	113	105	95
ii	Non-mechanized medium boat	166	145	130
iii	Engine boat	25	20	15

Those who had lost their livelihoods in fishing had been forced to search for alternative work as laborers or to migrate temporarily or permanently in search of alternative employment. Temporary migration was a traditional mechanism for sustaining livelihoods during periods of environmental insecurity. It usually comprises of a short-term movement of one or two family members to a different location to secure employment. Temporary migrant fishers moved to urban areas to seek employment in the informal sector (such as rickshaw driving) or to rural areas to work on salt farms, grocery shops, and in earthworks. Mrs. Bilkis Banu, a wife of a fisher, stated: "*My husband was unemployed for the last few months as he lost his job in operating ESBN gears and had to migrate to Chittagong, where he now works as pooled rickshaw*." Moreover, the number of fishers migrating temporarily from the fishing villages that are vulnerable to natural hazards had significantly increased over the recent years, as localized coping strategies had become more difficult to sustain. Although the decision to migrate temporarily was determined by a number of push and pull factors, the frequency and intensity of naturally occurring hazards had increased the pressure on fishers to relocate both temporarily and on a more permanent basis.

In response to the severity and recurrent nature of storm surges and cyclones temporary migration of fishers often turned into a more permanent one. For example, in two fishing villages it was found that over 10% of families had made a deliberate and permanent move to Chittagong city. In contrast, an additional 20–30 % of people had not returned after a temporary migration. Although several factors may have contributed to this increase in permanent migration, climate change appears to have accelerated the process because of the reduction in opportunities in the affected fishing villages. However, certain factors prevent people from permanent migration, in particular the costs of relocating. It is estimated that about BDT 10,000-15,000 is required to migrate the short distance from Banskhali to Chittagong, and it would cost a lot more to relocate over longer distances. However, as the situation worsens, the number of permanent migrants was set to increase as more fishers save money to move away. Mr. Abul Monsur, a veteran fisher, stated: "*The majority of fishers living in areas affected by storm surge on this fishing village are 'potential migrants'. For now, they are trying to cope through finding temporary employment and shelter, but most are trying to save up the money needed to migrate*." From the overall discussion in the workshops, it was revealed that fishers in the investigated areas had a low adaptive capacity and were likely to be less resilient to recover from stressful climate change events and conditions. Moreover, the exposure and sensitivity indicated high vulnerability of the fishing community, where such low adaptive capacity showed less ability to manage and reduce this vulnerability. Nevertheless, many fishers want to stay in their homes and reverse the adverse situation through different strategies. For example, one veteran fishers, Mr. Jafar Ahmed, said: "*If we could create a green belt with the mangrove forest, it could reduce the intensity of wind power and reduce the storm surge effects*." He also said: "*We are trying to develop a safety green belt in our area through mangrove plantation with the support of local NGO*". Mr. Rahim Sheik, the most senior participant in a focus group discussion, added: "*This mangrove forest is favoring the fish, where fish come in the mangrove swamps to eat those leaves and fallen litter. During my fishing, I always found a high abundance of fish in adjacent areas of mangrove swamps rather than in other places*".

As agents for change

Fishers were not only the primary victim of climate change, but can also be effective change agents, managing both mitigation and adaptation. Fishers have extensive knowledge and expertise that can be applied in assessing community risk, selecting adaptation measures, and mobilizing communities to manage risk. In participatory workshops, all participants from different stakeholder group felt the necessity of an integrated approach to formulate the climate change adaptation strategies, which aim to address the full range of coastal climate change hazards to meet societal objectives. All the findings from this study were discussed in the final workshop to select the potential adaptation measures, during which fishers, fish traders, processors, net menders, boat makers, government officials, concerned NGOs and other fisheries resource user groups actively participated and provided their valued opinions. Finally, fisheries adaptation measures and strategies were developed with the assistance of all stakeholders. Local knowledge and perceptions influence people's decisions, both in deciding whether to act or not and what adaptive measures are taken over both short- and long-term. Therefore, local observations and perceptions were taken into account in effort to understand climate change, its impacts and how to adapt and mitigate it (Figure 1).

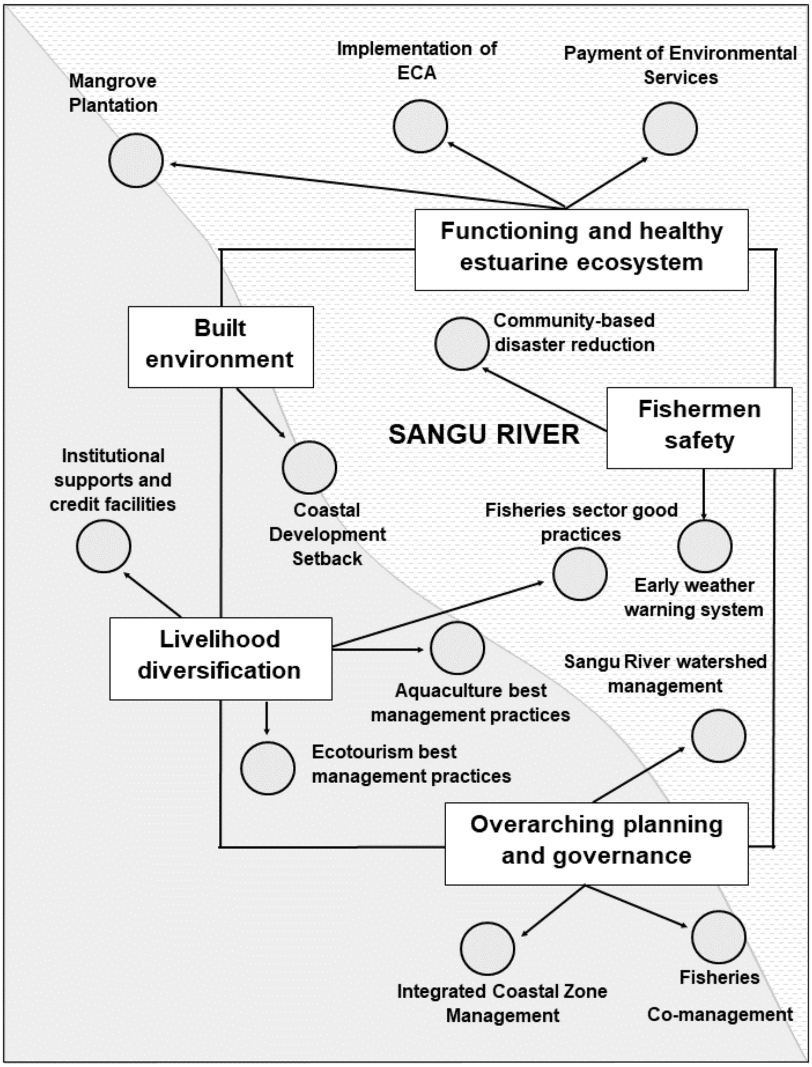

Figure 1. Climate change-adaptation goals and their relative measures as identified by the local resource user group in Banskhali-Anwara

Mangrove plantation along the bank of the Sangu River was identified as one of the potential climate change restoration, mitigation and adaptation measure, which provides feeding, breeding and nursery habitats for fisheries. It also provides ecosystems services for communities and their protection and livelihoods, and serves as a natural water filter and a buffer against coastal disturbances. To fulfill the environmental functioning and healthy ecosystem goals, financial instruments are needed under which beneficiaries of mangrove ecosystem services can compensate the suppliers to fund sustainable environmental management policies and actions. Coastal development setbacks protocol can be developed, with a set distance from a coastal feature within which all or specific types of development (e.g., navigational jetty, coastal aquaculture pond in the intertidal zone) need to be prohibited. Fishers pushed for a development of fisheries co-management for livelihood sustainability and a strengthening of their capacity to deal with long-term climate-related effects on habitats and ecosystems of the Sangu River. Fisheries management seeks equity for organizing and empowering vulnerable or less privileged groups of fishers to participate in management in a free and collaborative way. The participants identified diverse fisheries management-related options for the Sangu River, focusing on fishing, fishers, and productivity, which includes various management issues and their potential implementations at different management levels. Biological conservation should incorporate measures that will enhance the ecosystem and livelihood security. In addition, regulatory approaches, fishing gear or mesh size restriction, area allocation, fishing season prohibition, i.e., closure of fishing during the peak recruitment periods (July to September and February to April in selected areas) can be introduced for ESBN on the assumption that the juveniles would escape. Some of the immediate needs for the development of the fisheries management of the Sangu River include the development techniques for processing bycatch and non-traditional fishery items for the preparation of improved quality value-added products and the development of post-harvest technology to prevent deteriorative changes occurring in fish and shellfish during different stages of handling, transportation, processing. In addition, coastal aquaculture could be one of the potential alternative livelihood options. In this regard, largely selfenforced measures need to be taken to improve the efficiency and cost in the aquaculture sector to increase the benefits and promote development (Table 4 (page 16 & 17).

Moreover, cruising across the Sangu River was identified as another promising sector. Actions need to be taken that will enable the tourism sector to improve services and business while also minimizing the adverse effects on the environment and local communities. Besides, initiatives that enable capacity building for other alternate income generations should take place including livestock rearing, tailoring, handy crafts making for tourists, etc., through training and demonstration with necessary inputs and institutional supports. A mechanism for community-based disaster risk reduction and early weather warning systems should be developed in the area to ensure safety against natural disasters. Safety of the fishing people and their fishing accessories, as well as the disaster preparedness will reinforce equity. Moreover, to bundle a series of measures, an overarching integrated management approach or strategy involving planning and decision-making could be geared to improve economic opportunities and environmental conditions for the coastal people of Banskhali.

Many of these adaptation measures were not 'new' to those involved in autonomous adaptations. They included strategies and actions familiar to fishers for respond to episodes of natural hazards and shocks. There were also new approaches and tools being developed, such as nature-based approaches to coastal adaptation. Nature-based approaches include new tools for managing fisheries resources and strategies to conserve biodiversity in the face of shifting geographies. They focused on helping fishers and communities deal with climate change impacts by protecting mangroves, estuaries, and other systems on or near shorelines and the benefits they provided. These benefits included protection from storms, controlling erosion, and retaining and assimilating nutrients and sediments. In addition to these benefits, functional ecosystems were critical to maintaining biodiversity and to fishers and other resource users whose livelihoods rely on the conditions of natural systems. These approaches provide a departure for the next generation of adaptation guidelines. Using a single, stand-alone

Table 4. Adaptation measures and their management framework identified through the discussion with fishers and community residents in the study area.

Adaptation Measures	Management approaches	Relevance to Climate Change
Functioning and healthy estuarine ecosystems as a primary goal		
Mangrove plantation along the bank of the Sangu River	1. Zoning • Area allocation • Time-sharing 2. Mangrove afforestation programme through integrated and participatory approach	Acts as a buffer against extreme weather events, storm surge, and erosion; limits saltwater intrusion.
Payment for environmental services	1. Beneficiary group identification 2. Compensation scale determination for environmental insurance 3. Use the fund for environmental policies and actions.	Provides incentives to protect critical habitats that defend against damages from storm surges or other climate change effects.
The built environment is less exposed as a primary goal		
Coastal development setbacks	1. Code of conduct for coastal development 2. Zoning for developmental activities like navigational jetty, shrimp farms, and coastal embankments 3. Environmental Impact Assessment for developmental activities	Reduces the infrastructure and other resource losses and human safety risks of storm surge.
Diversified livelihoods as a primary goal		
Fisheries sector good practices	1. Zoning • Area allocation • Depth zone restriction • Carrying capacity 2. Gear specification 3. Craft modification 4. Limiting fishing days 5. Facilitating escape of bycatch and small-size fish and shellfishes 6. Licensing 7. Code of conduct	Contributes to the protection of rural livelihoods, food security and fisheries biodiversity against the impacts of extreme climate events, precipitation change, and other climate variables changes.
Aquaculture best management practices	1. Zoning • Area allocation • Depth zone restriction • Carrying capacity 2. Improving culture system 3. Preventive and curative measures of diseases 4. Quality fish and shrimp hatchery development for quality fry 5. On-farm feed production 6. Licensing 7. Code of conduct	Integration of climate change considerations helps safeguard against extreme climate events, precipitation, and other climate change variables.
Ecotourism best management practices	1. Code of conduct • Area allocation • Infrastructure development 2. Tourist facility development • Accommodation • Restaurant • Easy transportation • Recreation (site seeing, safety, and security) 3. Community participation	Integration of climate change concerns helps promote the sector's sustainability and safeguard against extreme climate events and other climate change variables.
Institutional supports and credit facilities	1. Enhancement • Education • Infrastructure • Service and trade business 2. Capacity building through training and demonstration • Livestock rearing (Poultry and Dairy) • Tailoring • Handicraft 3. Financial Input	Integration of climate change concerns helps promote the sector's sustainability and safeguard against extreme climate events and other climate change variables.

Table 4 - continued

Adaptation Measures	Management approaches	Relevance to Climate Change
Fishermen safety and safety enhanced as a primary goal		
Community-based disaster risk reduction	1. Structural measure • Cyclone shelters • Safe fish harbor 2. Sea safety • Use of safety gears during fishing • Surveillance and rescuing during a harsh environment 3. Community participation 4. Awareness campaign	By proactive planning and capacity building that addresses the specific needs of local communities increases their resilience and ability to respond to the effects of extreme climate events like storm surges.
Early weather warning system	1. Set up 2. Mass broadcasting when depression appears in the sea	Increase the resilience and ability to respond to the effects of extreme climate events like storm surges.
Overarching planning and governance as a primary goal		
Sangu River watershed management	1. Conservation of aquatic resources and forest resources 2. Sustainable exploitation and utilization of aquatic resources	Preserves estuaries, which act as a source of aquatic resources and also storm buffers.
Integrated coastal management	Integration among: 1. Different coastal resource user groups 2. Local communities, fishers, researchers, investors, traders, processors, Government of Bangladesh, NGOs 3. Sectors (fisheries, agriculture, environment, forestry, tourism, and land revenue) 4. Different levels of governments (national, district, local) 5. Disciplines (Natural sciences, social science, and engineering) 6. Integration of valuable resources (personal, fund, materials, and equipment) 7. Integration of responsibilities	Provides a comprehensive process that defines goals, priorities, and actions to address coastal and estuarine issues, including the effects of climate change.

measure was usually not the best approach. To respond effectively to a wide array of climate change impacts requires combining complementary measures. Selecting the best combination helps to look for measures that have interdependencies, contribute to good fisheries resources management, and bring additional benefits in terms of climate change adaptation. Most of the fishers along the Sangu River were not educated enough to have a basic understanding of the long-term management goals. Therefore, it doesn't appear that it will easy to implement even a well-formulated plan, which requires extension and awareness building at different levels. Supporting fishing communities and involving them in the management process depends on the existence of appropriate institutions relating to education, training, as well as demonstration and creation of alternative livelihood options. But the people of fishing villages were poorly organized above the level of households; they don't have a history of associations and institutions and, hence, have little cultural background in collective action. A major challenge of capacity building is to reverse the effects of centralized resource management that existed over many generations, which tends to suffocate fishing communities' ability for self-governance. Top-down resource management over a long time can result in the loss of civic institutions and local mechanisms for consensus building, rulemaking, enforcement, and monitoring.

Conclusion and Recommendations

This research gives an account of adaptation to environmental change in the context of the Sangu River fisheries. The study of Sangu River fisheries provided a wealth of information about how people live with environmental change, which is often presented in the extreme form. Climate change is not a purely physical or even solely an ecological phenomenon but has also social, cultural, and economic aspects. To understand these phenomena, local actors and their accounts of these changes and events are directly relevant. Only local people can explain how climate change is manifested locally and how it is evaluated, interpreted, and handled by the affected people. While local observations cannot substitute for scientific measurements and models, they are essential supplements that detail local phenomena and perceptions and insight into local concerns. Local observations can inform scientists by directing attention to the overlooked aspects and can aid in formulating new hypotheses and research questions.

Fishers along the Sangu River were affected differently by the impacts of climate change and climate vulnerability. Due to the low adaptive capacity, fishers tend to be poorer, more marginalized, and much more likely to be afflicted by natural hazards like storm surge. Fishers were vulnerable because of their social roles, inequalities in the access and control of other resources, lower education, and low participation rate in decision-making. Climate change magnified existing inequities among the fishers and other communities in Anwara-Banskhali region. Autonomous adaptations were not adequate to reduce the vulnerability, and all those who took part in participatory workshops called for participatory-based planned adaptations as a way to combat climate change impacts. Adaptive capacity can be strengthened through policies that enhance social and economic equity, reduce poverty, improve fisheries resources and coastal management, increase community participation, generate valuable and actionable information, and strengthen institutions.

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About the authors

Prabal Barua works as a Program Manager at YPSA (Young Power in Social Action) in Bangladesh. He is a marine biologist with a B.Sc and M.Sc in Marine Sciences from the University of Chittagong, Bangladesh, and an M Phil in Fisheries Technology from the University of Calcutta, India. He was awarded PhD in Environmental Science from Jahangirnagar University, Bangladesh, where his thesis focused on adaptation and resettlement of climate change-induced displaced people. He has 14 years of professional experience working in development sectors and is the author of 70 national and international publications covering climate change, natural resource management, coastal pollution environmental management issues.

Syed Hafizur Rahman is a Professor in the Department of Environmental Sciences, Jahangirnagar University, Bangladesh. He obtained his PhD Degree from School of Geography, Earth and Environmental Sciences, Birmingham

University, UK. He is a certified trainer in environmental sciences, climate change, disaster management and in pedagogy. He has training on teaching (ToT) Disaster Management and pedagogy. He has completed several projects on climate change and water integrity funded by local and international donor agencies. As a director of the Centre of Excellence in Teaching and Learning, Jahangirnagar University (CETL-JU), he has organized many training workshops on tertiary pedagogy for newly recruited faculty members of Jahangirnagar University since 2017. He has also published more than a hundred scientific articles in national and international journals.

Maitri Barua holds B.Sc (Hon's) degree in Fisheries and a Masters' degree in Fisheries Resource Management from Chattogram Veterinary and Animal Sciences University, Chattogram, Bangladesh. She has a keen interest in fisheries management, coastal pollution, aquatic resource management, COVID-19 and fishers aspects, and environmental conservation approach.