

Climate Change and Its Impacts: The Case of Coastal Fishing Communities of the Meghna River in South-Central Bangladesh

Md. Royhanur Islam, Thomas Cansse, Md. Sahidul Islam, Atiqur Rahman Sunny

Abstract—The geographical location of Bangladesh makes it one of the most vulnerable countries to climate change. Climate-induced phenomena mainly affect the south-central region of Bangladesh (Laxmipur district) where they have begun to occur more frequently. The aim of the study was to identify the hydro-climatic factors that lead to weather-related disasters in the coastal areas and analyse the consequences of these factors on coastal livelihoods, with possible adaptation options using participatory rural appraisal (PRA) tools. The present study showed several disasters such as land erosion, depressions and cyclones, coastal flooding, storm surge, and precipitation. The frequency of these disasters is of a noticeable rate. Surveys have also discovered that land erosion is ongoing. Tidal water is being introduced directly into the mainland, and as a result of the salt intrusion, production capacity is declining. The coastal belt is an important area for fishing activities, but due to changed fishing times and a lack of Alternative Income Generating Activities (AIGAs), people have been forced to search for alternative livelihood options by taking both short-term and long-term adaptation options. Therefore, in order to increase awareness and minimize the losses, vulnerable communities must be fully incorporated into disaster response strategies. The government as well as national and international donor organizations should come forward and resolve the present situation of these vulnerable groups since otherwise, they will have to endure endless and miserable suffering due to the effects of climate change ahead in their lives.

Keywords—Adaptation, community, fishery development, livelihood.

I. INTRODUCTION

BAKGLADESH is at the front line of experiencing the impact of climate change and is known as one of the most disaster-vulnerable countries in the world [24], [35]. The climate of Bangladesh has changed drastically over the last few decades and may continue to change even further, including at a faster pace which may result in considerable adverse impacts, especially on coastal areas [24]. Sometimes, the disasters are so deadly and devastating that they cost the lives of hundreds of thousands and cause enormous destruction and the loss of hard-earned properties and homes [24], [5]. From 1970 to 2004, a total of 500,000 deaths were

associated with tropical cyclones around the world, of which 60% occurred in coastal Bangladesh [18]. Its fisheries sector directly supports the livelihoods of about 7 million fishermen and contributes 4.43% to the GDP of Bangladesh and 2.73% to export earnings [10]. As a result, the fishing sector in Bangladesh is regarded as the most vulnerable to climate change in the entire world [6]. Importantly, small-scale fishing communities are the most vulnerable to the adverse impacts of climate change [13], [12], [18].

The impacts of climate change in Bangladesh can be observed in the form of temperature fluctuations, irregular or excessive rainfall, and an increased number of extreme events including floods, cyclones, droughts, tidal inundation, and salinity intrusion. Increasing temperatures, changed precipitation patterns, and sea-level rise affect the structure and productivity of coastal ecosystems [18], [9], [8], [11], [21]. In addition to the direct consequences of sea level rise (e.g., coastal flooding, salinity intrusion in agricultural areas and loss of habitable land), one predicted result of the enhanced greenhouse effect is an increase in sea surface temperatures at low latitudes, which may cause an increase in the incidence of tropical cyclones [29]. The intensity of tropical storms may also increase [30], accompanied by strong onshore winds and storm surge conditions [20]. Extreme weather events such as cyclones and floods may further intensify the impact of climate change by disrupting fishing operations and land-based infrastructure [36].

South-Central Bangladesh is one of the most disaster-prone areas in the world. This region is only on average 3–6 m above sea level, and surrounding water levels have increased more than before. Due to climate change, a rise in sea level would have the most severe effects in regions such as that. Identifying the adverse impact of climate change that makes the fishing community vulnerable could help with taking the necessary steps to ameliorate and minimize the adverse impact, which could be helped by the adoption of successful adaptation strategies [17]. But due to the high vulnerability of the fishing communities along with a rapidly changing climate and an excessive dependency on the fishing profession, any effective measures face a number of obstacles to control the adverse effects of climatic shifts [7], [22]. Any occurrence of sudden climate change is highly likely to alter the physical environment which could hamper the adaptation capacity of the community [27]. Hence, the study was conducted in order to identify the current climate change disasters that have occurred in South-Central Bangladesh with a thorough

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analysis of the consequences of climate change's impact on the livelihoods of fishing communities and their existing adaptation status. The South-Central part of Bangladesh was selected due to the fact it is home to most of the most dense and vulnerable fishing communities, and is globally considered a hotspot of climate change [18], [37], [25]. It is necessary to conduct more in-depth research on the impact of climate change on the fishing communities of South-Central Bangladesh, as the vulnerability of these communities is almost untouched, though a number of studies were conducted to assess the impact on the agricultural livelihood system [14], [28], [32]. Therefore, more studies are required on fishery-based systems, and in realizing this fact, this study aims to make up this gap by working on a highly vulnerable community in a highly vulnerable region of the world.

II. MATERIALS AND METHODS

The study was conducted in four fishing communities in Laxmipur district at Bangladesh named Char Kalkini (2248.234N, 09047.921E), Komolnagor; Char Ghasia (2258.824N 09041.442E), Raipur; (Modho Char Romoni Mohon 2252.027N & 09047.162 E), Sadar Laxmipur; Bangla Bazar (2239.042N 09054.345E), Char Alexander, Ramgoti. There is easy accessibility to the river Meghna in these communities that have a noticeable diversity in livelihood strategies, population density, degree of dependency on the river, and vulnerability to climate change.

The empirical part of this research was informed through both qualitative and quantitative data. For primary data collection, fieldwork was carried out over three periods split into 12 months from November 2015 to October 2016, using different data collection tools. There was a total of 250 respondents from different socio-economic and operational groups. As a method of carrying out a successful interview, the respondents were interviewed with semi-structured questionnaires designed for these purposes. The purpose of the survey was to gather information related to demography (e.g., basic information of community), depression and cyclones (duration, types of disaster, frequency/wind speed, storm surge height, and casualty), and mortality rate. Moreover, respondent response (Table IV: Statistical analysis of impact on consequences of disaster), transect analysis (e.g., resource, activities, problem, opportunities), seasonal activities (e.g. fishing, fish trading, net making, boat making, natural disasters, agriculture, erosion, and day labor), the percentage of the survey distribution adopting different strategies (e.g., selling livestock, lumber, furniture, crops, jewelry, boats/nets; money borrowing and lending, going without food, requiring help from government) also taken into consideration was the percentage distribution of resource utilization (e.g., boats/nets, money, dry fish stored, crop-agriculture, vegetables, jewelry, furniture) by fishermen during disasters at four fishing communities in Laxmipur. Descriptive statistics were derived in order to summarize the property of the dataset, and the analysis was conducted through the usage of SPSS version 16.0 (statistical package for social science) and MS Excel.

III. RESULTS

A. Climate Change Disasters in South-Central Bangladesh



Fig. 1 Location of the studied area

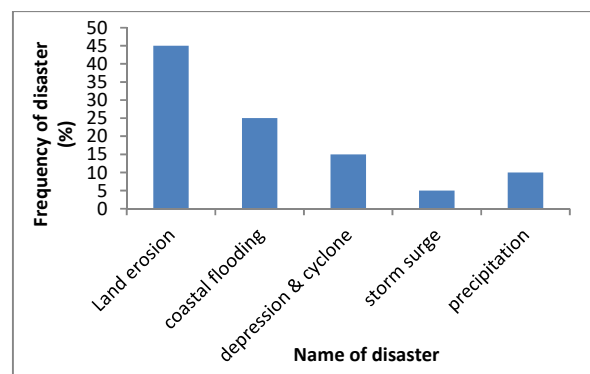


Fig. 2 Types of disasters occurring in South-Central Bangladesh

Because of climate change in South-Central Bangladesh, several phenomena have occurred there which include various disasters (Fig. 2) such as land erosion, cyclones and depressions, coastal flooding, storm surge, precipitation etc., which hamper the normal activities of this location. The effects of the disasters know no bounds, bringing great suffering with them. Among the disasters, the worst is now land erosion followed by coastal flooding, depressions & cyclones, storm surge, and precipitation. Currently, people are being displaced from there and being forced to migrate to other areas to search for sustainable livelihoods in this region.

The pace of erosion is so high because of strong tidal action and severe cyclonic effects.

The frequent occurrence of these natural disasters has now become a common phenomenon in this locality that causes loss of lives and properties due to the altered climatic pattern. The livelihoods of the people in these communities are at risk

due to the adverse impacts of these natural disasters. Besides, there are several cyclonic disasters occurring frequently. From field investigations, it was obvious that near the coast the frequency of cyclones is high, and several cyclones occur all year round. The major cyclonic disasters that have happened in South-Central Bangladesh are given in Table I.

TABLE I
MAJOR DEPRESSIONS AND CYCLONE THAT HAVE AFFECTED SOUTH-CENTRAL BANGLADESH (SOURCE: LOCAL GOVT., BBS, NGO)

Sl. No	Type of Disaster	Occurred Duration	Frequency/Wind Speed	Storm Surge Height	Casualties
1	1970 Bhola cyclone	7 November-13 November	222 km/h	10.6 m	Official death toll was 500,000
2	*Storm tropical cyclone	April 29, 1991	260 km/h=180 km/h	5-8 m	More than half of the people died
3	Tropical Cyclone	May 31- June 2, 1991	110 km/h	1.9m	14-15 died, <15 missing
4	Cyclonic Storm	April 29-May 3, 1994	210 km/h	2-3 m	20 died, 25 missing
5	Severe Cyclonic Storm	November (21-25) 1995	210 km/h	2.5-5 m	32 died, <100 missing with fishing boat
6	Severe Cyclonic Storm	May (16-19), 1997	225 km/h	3.05 m	injured 25, <105 missing with fishing boat
7	Severe Cyclonic Storm	September (25-27), 1997	150 km/h	1.83-3.05m	4 children washed away with storm water, missing boat 3-4
8	Severe Cyclonic Storm	May (16-20), 1998	150 km/h	1.83-2.44m	22 died of cholera, typhoid, <45 injured
9	Tropical Cyclonic Storm	November (19-22), 1998	90 km/h	1.22-2.44m	17, injured <30, missing without food <150
10	Cyclone Akash	May 12, 2007	115 km/h	2.99m	14 died, 50 missing
11	Cyclone Sidr	November 11, 2007	260 km/h	3m	<150 died, <2000 with boat missing
12	Cyclone Rasaki	2008	90 km/h	2.0-3.0 m	11 missing with boat
13	Cyclone Bijli	April 14, 2009	95 km/h	2.1-3 m	7 died, injured 84
14	Cyclone Aila	May 27, 2009	120 km/h	6.1 m	10 died, missing 13-15 fishing boats with <350
15	Cyclone Nargis	2009	115-125 km/h	4-6m	2 missing, 2 fishing boats
16	Eastern Indian Storm	2010	110-150 km/h	2.1-3.09 m	12, missing <20
17	Cyclone Roanu	2016	100 km/h	2.1-3.10	4 died

TABLE II
STATISTICAL ANALYSIS OF THE IMPACT FROM THE CONSEQUENCES OF DISASTERS

Respondent Response on	Opinion poll (%)					
	Very high	High	Medium	Low/Little	No	Unknown
Occurrence on climate change	-	35	28	25	12	-
Damage from climate change events	38	47	10	5	-	-
Number of cyclone warnings from meteorological department	5	70	18	-	7	-
Average number of cyclone signals per year	25	35	13	27	-	-
Perception about extremes of cyclones and depressions	62	25	8	5	-	-
Increase in amount of depressions, cyclones	25.42	20.33	12.20	3.5	-	-
Change in fishing times during extreme climate	-	5	30	53	12	-
Relation of water temperature with depressions and cyclones	-	31	12	8	12	37
Threats of food security during disasters	15.9	61.9	19.0	-	-	-
Migration of people from the native area	7.9	25.4	39.7	14.3	7.9	-
Support from the government	-	-	-	20.6	50.8	23.8

1. Analysis of the Impact from the Consequences of Disasters on the Livelihoods of the Fishermen

Vulnerability due to climate change is influenced by the status of the community and its geographical position. South-Central Bangladesh is more exposed to cyclones followed by surges (floods,) and jointly they adversely impact the livelihoods of these communities, including their strategies and outcomes. As an extreme case, one fisherman mentioned during an oral history interview “during Sidr, the water [surge] suddenly came and washed away my children and my house.” Fishermen mentioned in FGD that “We the fishers are more vulnerable to natural calamities as we become helpless in sudden calamities during fishing, we just remember God

and our families are the worst victims as they have to live in the coastal areas”. The respondents of the four fishing communities are the active participants for the assessment of the impact from the consequences of disasters (Table II). The experiences, field surveys with questionnaires, and the responses of community people are the basis of the assessment. Among the 250 respondents, several numbers are used to specific identification in their respective fields.

Table II provides information regarding the survey that was conducted for the impact assessment of natural disasters, livelihood conditions, migration patterns, and other fields related to the objectives of this research. Because of climate change, fishermen as well as their family experience a very high chance of risk. 73% of these communities have always

faced high risk during disasters; analysis indicates that the number of indebted families is increasing rapidly day by day due to disasters. More than 80% of the embankments and dikes of these areas have been damaged by recently occurring natural disasters. Nearly 38% of the people said that they experienced severe damages, where 47% mentioned a serious impact of damages for changing climate. The lives of the people and other habitants of the community may be endangered in the near future. For instance, during 1970 Bhola cyclone, during the 2007 Cyclone Sidr and 2009 Cyclone Aila, what did the people of these communities face, what was caused by the disaster, and what was the impact of it? It is noticeable that the climate is changing roughly – during the survey, it was observed that around 70% of the people reported the extreme change of cyclone warnings from the meteorological department. The number of warnings is increasing more than before and occurring more frequently. The fishermen have become more worried about the notifications of these warnings because previous experiences did not end well. Thus, the continuous notifications will remind them about the abrupt changes of climate in South-Central Bangladesh.

Most of the fishermen were not aware of depressions and cyclones before the Cyclone of 1991. After the path of destruction left in the wake of this Cyclone, more than 60% of people surveyed have highly believed in the dangers of the depressions and cyclones and are ready to take the necessary steps during disasters to minimize their losses. But, the fishermen are deprived of modern facilities, and most of the time they are unable to hear the news & fail to take proper shelter; mainly women, children, and the elderly are the main victims of these disasters. From the data analysis and survey, it was revealed that the occurrence of cyclones and depressions is a common phenomenon that takes place each year for more than three or four times and causes great suffering to the fishermen. The people's experiences are excellent when it comes to seeing the water condition to understand what's going on. More than 50% of fishermen said, there were little changes to the timing of fishing. The deep sea fisherman Rashid Majhi said *“fish can't be found at the same time like before, some small changes have happened, as for example Hilsa ilsha was found abundantly in the Bengali month of Ashwin –kartik, and is now found at the last of the ashwin –kartik, and the fishing ground is far from the previous ground.”* But, most of the offshore fisherman said that the time of fishing has been greatly changed. During the questionnaire survey, most fishermen did not fully understand the relationship of water temperature with depressions and cyclones; about 37% said it was god-gifted. But, nearly 30% of the people surveyed were aware of the increasing temperature as a consequence of melting sea ice (not known from where) which is responsible for increasing water levels and they also added that when water temperatures increased, the air pressure would decrease suddenly, and a tropical depression would occur.

About 85% of the people in this region are directly involved in fishing activities as a subsistence livelihood. During disasters more than 60% people experience serious starvation,

with the main victims being women and children. While the survey was being carried out, few people talked about receiving insufficient government assistance and inadequate help from private agencies, but their activities were not well off, as they provide loans at a high rate of interest, and if the loan is not paid the interest rate increases as equal intervals. In that case, the fishermen face a great deal of problems from their possibly insecure condition.

2. Adaptation Strategy for the Fishing Communities of South-Central Bangladesh

This region is notable for its extensive fishing activities in Bangladesh. Survey analysis showed that about 85% of the people are directly related to the fishing industry (Fig. 3 (a)) while Fig. 3 (b) indicates secondary occupations. The other 15% of people are engaged in activities given in Table III.

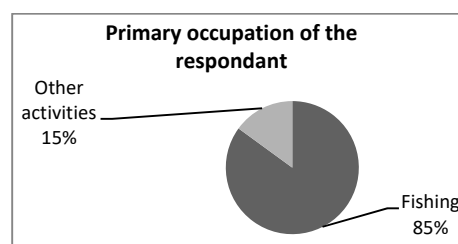


Fig. 3 (a) Primary occupational status

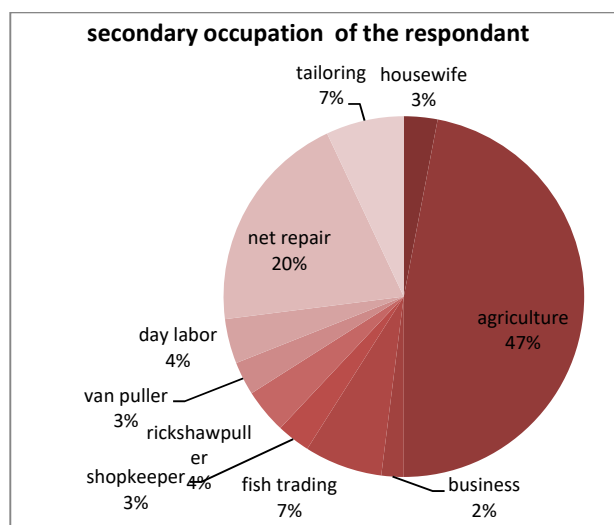


Fig. 3 (b) Secondary occupational status

In addition to fishing directly, the other 15% of people are involved in agriculture, the trading of fish, shop keeping, day labor, Arotder, Mohajon, Pikar, textiles, immigration, private/ govt. jobs, are disabled, or unemployed etc.

Aratdar/Dadondar: A locally rich & powerful person mainly responsible for lending or investing money to/in fishermen for fishing purposes with a certain rate of interest and acting as a commission agent, who is considered the go-to man at fish landing -based activities.

Mahajan: Owners of fishing boats and nets are responsible for recruiting majhis (leader of fishing boat), getting dadons

(money) from arotders and distributing this among the vagee (root level fishermen) through Majhee. Sometimes the Mohajon also acts as majhi in some cases.

Paikar (Fish Traders): The traders who operates the retail and whole sale of fish at local, sub-district and district levels commonly known as Paikar.

TABLE III
 PEOPLE INVOLVED IN OTHER ACTIVITIES THAN FISHING

Activities	Percentage (%) of involvement
Agriculture	2.10
Fish trade	1.95
Shop-keeper	0.9
Day labour	1.8
Arotder	1.5
Mohajon	1.65
Paikar	2.1
Textiles	1.2
Immigration	0.3
Job (Private/ Govt.)	0.4
Disabled	0.15
Unemployed	0.9

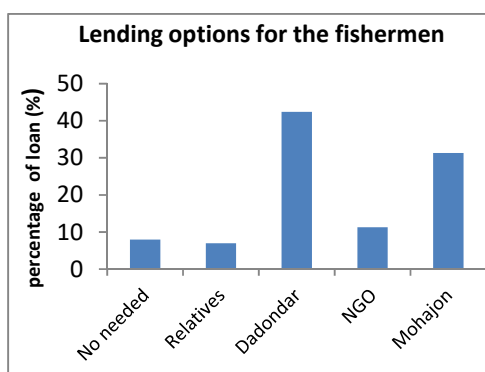


Fig. 4 (a) Loan options of the fishing community

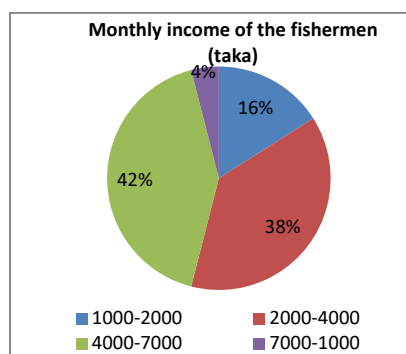


Fig. 4 (b) Monthly income of the fishermen

Most of the people are related with the fishing activities as laborers in the fishing industry (vagi). On average 10 to 12 fishermen worked on each fishing trawler where few part time fishermen are doing other jobs (Fig. 3 (b)). Fig. 4 (b) shows the monthly income of the fishermen. The poor fishermen are the main vulnerable to not being able to cope with the disasters, for their survival and to adapt to the concurrent crisis they take loans from various sources that is mentioned in Fig.

4 (a).

3. Constraints of Adaptation of Fishing Communities in South-Central Bangladesh

To adapt with the present climatic situation, fishermen face different obstacles that hinder the process of adaptation and increase the sufferings of the community. These constraints will be discussed in the following segments.

a. Climatic Constraints

Sudden environmental change may limit the adaptation options [27] as the frequent occurrence of natural disasters hinders the process of adaptation by damaging their residences and sanitation systems again and again. Fishermen mentioned that they did not build well-structured homes due to the possibility of frequent storms and cyclones that made them more vulnerable to extreme events by reducing a potential adaptation option of living safely. Again, fluctuations in temperature and rainfall also bring intolerable suffering to these communities. Extreme events are also responsible for the failure of communication systems in the communities that hinder the rescue activities immediately after a disaster.

b. Economic Constraints

Economic constraints of the fishing communities include low income, scarcity of savings and limited access to credit. Again, the frequent occurrence of natural disasters also makes their fishing profession very risky. Fishermen have very limited chances of receiving a loan from banks due to their ignorance of the complex banking system as they rarely have enough resources to mortgage at the bank. Different NGOs also provide loans to the fishermen with high interest, which due to the lack of education fishermen often go to moneylenders and pay high interest rates around 10% monthly.

c. Social Constraints

Social constraints include a lack of knowledge and reduced working skills and health status when it comes to pursuing their livelihood strategies. The income of the fishermen is very low. The only source of income of the fishermen is selling fish at the market and other places. There are very limited options for non-fishery related activities such as day labor activities in agricultural fields, painting, and small trade (shop keeper) work. Fishermen receive wages from 200 BDT to 350 BDT depending on their capability. Moreover, every year many people are becoming involved in other professions as a result of increasing continuous pressure on fishing due to climate change. The AIGAs are needed for the improvement of the living standard of the people in these communities. Income sources should be diversified and the engagement of women in income generating activities by maintaining the norms of their own society's religions can alter the situation.

d. Institutional Constraints

Lack of enforcement of fishing regulations and the misuse of these fishing regulations can badly affect the livelihoods of the fishermen. Existing corruption in the law enforcement

agencies, the police especially, hinder adaption strategies by reducing the savings of the fishermen. As well, the attacks of pirates also negatively further impact these situations. Due to weak law enforcement fishermen will often end up fishing with an unlicensed boat having no life preservers or a radio, increasing the risk during sudden disasters. Again, inaccurate warnings also cause the fishermen to be unaware of upcoming disasters. Additionally, delays and inaccuracy in weather forecasting also cause heavy losses of lives as a few hours are often not enough to return after stopping the fishing trip.

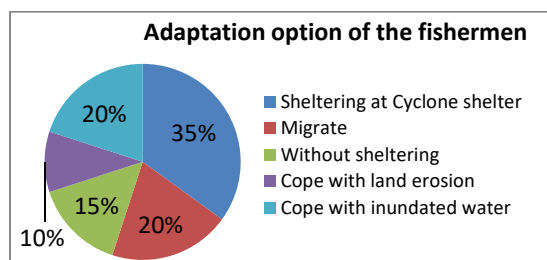


Fig. 5 Long term adaptation options of the fishing community

4. Adaptation Options to Cope with Changing Climate

Some indicators such as housing status, the number of fishing materials, natural capital, financial capital excluding income, social capital, and number of income-generating activities are significant ($p < 0.001$ – $p < 0.05$) in identifying adaptation options. The adaptation options of the fishermen can be classified in two ways, long-term adaptation and short-term adaptation. Long-term adaptation (Fig. 5) includes cyclone shelter during disaster, coping with water inundation, protection from land erosion by making embankments and dikes, sometimes without shelter; living in a boat/embankment, and finally migrating from the island for a

more secure life, while short term adaptation indicates the uses of resources during disaster. The people of these six unions adapt by using the resources found particularly in those areas. During disasters they cope by using their household resources (Table III).

TABLE IV
ADOPTING DIFFERENT STRATEGIES (IN PERCENTAGE) DURING DISASTER AT SOUTH-CENTER REGION

Strategies	C=1	C=2	C=3	C=4
Selling livestock	45.0	30.0	12.0	13.0
Selling lumber	5.0	40.0	55	5.0
Selling furniture	25.0	25.0	45.0	15.0
Selling crops	40.0	5.0	50.0	5.0
Selling jewellery	3.0	3.0	5.0	2.0
Selling boats, nets	15	12	40	25
Spent borrowed money	40.0	25.0	10.0	15.0
Without food	<10	<10	<3	<6
Help from government	50	55	55	60

* C= Community, C1= Modho Char Romoni Mohon, sadar Laxmipur, C2= Char Ghasia, Raipur, C3= Char Kalkini, Komolnagor, C4= Bangla Bazar, Char Alexander, Ramgoti.

TABLE V
PERCENTAGE OF DISTRIBUTION OF RESOURCE UTILIZATION BY FISHERMEN DURING DISASTER

Resources	Rich	Middle	Poor
Boat/Net	≤0	6.0	40.0
Land	6.0	4.0	3.0
Money	45.0	30.0	≤0.
Dry stored fish	35.0	20.0	5.0
Agricultural crops	35.0	30.0	12.0
Jewellery	0.0	0.0	5.0
Lumber	21.0	30.0	45.0
Furniture`	0.0	0.0	6.0

TABLE VI
COASTAL FISHING COMMUNITY DEVELOPMENT STRATEGY

Development priorities	Major Responsibility	Support Required
Fishery resource management	Law enforcement should take steps to stop fishermen from using illegal nets.	DoF, Navy, Coast guard, local administration
	Increase fishery production	
	Building awareness about fishery laws to fishermen & relevant stakeholders.	DoF, Fishermen, NGOs
	Formation of fishermen's association	
Livelihood Improvement	Catching of Hilsa and Jatka should be strictly banned.	DoF, NGO, Local administration
	Preparation of list of Fishermen.	
	Fisherman awareness through group meetings.	Responsible Hilsa group, NGO, DoF, Financial institution
	Relevant program should be organized based on special issues. Importance should have been given to Hilsa conservation.	
Community development	List of possible AIGA based on fishermen's demand & the local context of the community.	DoF, local administration, Formed Hilsa group
	Training arrangement for skill development	
	After training provide financial & technical support.	NGO, Local Administration, DoF
	Sort out true fishermen from govt. fishermen list.	
Land erosion	Subsidies should be given based on the number of fishermen per family.	Civil society, Chairman, UP Member, Water development board
	Improve govt. subsidies during ban period	
	Coastal flooding	Need to build embankments/dikes in suitable areas.

Fishermen were found to adapt to the adverse impacts of climate change by overfishing and the over exploitation of

other aquatic resources that put adverse impact not only on the biodiversity of this region but also the future of the next

generation as fishermen mainly depend on fishing and fish stocks for their livelihood. Fishermen were also found to adapt by selling their livestock assets, crops, furniture, jeweler, boats and nets. 50 to 65 % of fishermen mentioned that they received government assistance that helped to adapt to the immediate effects of natural disasters.

Boats, nets, and money were also identified as important indicators of adaptation (Table IV). The lack of boats, nets, and money may cause a fisherman to adopt more climate-sensitive strategies by taking higher risks. Owners of the boat and net force their crew to work harder at fishing during adverse climatic situations due to the hope of catching more fish, whereas crews (fishermen without boats and nets provide hired labor) had nothing to do with if they risk their lives when going fishing as they did not have any alternative option. A lack of livestock, jewelry and stored food can also limit a household's coping mechanism as a lack of resources and income increases livelihood vulnerability by reducing their adaptive capacity.

A community development plan for the selected Hilsa fishermen community has been developed to overcome the existing problem by including relevant stakeholders for achieving sustainable development in these vulnerable fishing communities.

IV. DISCUSSION

Fishing is a very risky activity for the people of this region as several cyclonic disasters shown in Table II occurred during the last few decades that exclusively hamper the livelihood of fishermen [23]. Climatic shocks have killed thousands of people in coastal Bangladesh; many of them are fishermen or their household members [18]. The impacts include not only fishing communities but also other dependent communities [8], [11], [6], [36]. Again, land erosion makes the current living areas unsuitable for the fishermen and may result in their displacement or may push them into a more vulnerable situation [4]. Sensitivity of these livelihoods to climate change is determined by their dependency on fishing resources for their livelihoods due to the unavailability of alternative livelihoods, lack of financial capital, lack of institutional support for the diversification of income sources, and a lack of human capital to engage in AIGAs [17]. In the coastal area of Bangladesh, cyclone intensity has increased from April to May and September to November [24]. Most of these months fall within the fishing seasons and reduce the fishermen's income by reducing fishing days [3]. Dependency on only one profession like fishing makes the lives more vulnerable as fishing and fish processing have a high exposure to cyclones and flooding [17]. Such natural constraints hamper the adaptation strategies of fishing communities [22].

Some short-term adaptation strategies could restrict the long-term strategies [19] for dealing with climate change. Both the natural and anthropogenic barriers affect the adaptation of these fishing communities such as increasing extreme events, low income, lack of suitable credit, dependency on only one profession, lack of skills and education, poor radio reception and weather forecasts, proper

enforcement of fishing regulations and laws, corruption, nepotism etc. are the main natural, economic, social and institutional constraints. Natural constraints increase the vulnerability of the fishermen to natural disasters [22]. A lack of capital hinders the diversification of income which also places adverse impact on adaptation [34]. A lack of access to credit further deteriorates the situation. It is also clear that direct or indirect impact of social constraints hinder the adaptation process [1]. Institutional constraints also play important roles in adaptation processes such as poor radio reception, wrong weather forecasts, and the weak enforcement of existing laws, which locally constrain the adaptation of fishing communities [22], [2], [26].

Fishermen have nothing to do in adverse climatic conditions during fishing. They stay in place and pray to God to get rid of this condition [33]. Fishermen do not come to the shore during adverse climatic conditions as at that time the availability of fish may increase and they may catch more fish, although this greedy nature often becomes the cause of their deaths. During fishing fishermen wake up early by listening to the radio but if they do not have enough of a charge in the radio's battery. Analyzing the impact of these consequences on the fishermen displays conceptual information, with several analyses of the impacts given in (Table III). From the studies of [16], [15], [31] we can say that between 60% and 95% of the people of these areas received cyclone warnings in time to take the appropriate precautions. Less than 20% of the fishermen that received the warning evacuated and took shelter, which the present study also showed; more than 60% people believed the perceptions about the cyclones and depressions. Again, the family members of the fishermen are also currently in a very vulnerable situation, especially women, children and the elderly. It will be recalled that often women in developed countries are also disadvantaged during natural disasters for a variety of social, cultural, economic, historical and political reasons. To save the lives of the people of these communities, more cyclone centers should be built. The community clinic could also be turned into a cyclone center where people can receive shelter as well as have access to health facilities, where separate places for women, children and old should be provided. This is the important starting point for future research on fishing communities regarding their vulnerability and adaptation to climate change and a way to resolve the basic problems of the relevant fishing communities by considering future development plans to alleviate their situation (Table VI). More studies are needed to identify the most suitable options for reducing the vulnerability of these communities.

V. CONCLUSION

From the above discussion, it is evident that the impact of the phenomena of climate change is incredibly destructive when it comes to the coastal communities. As a low-lying area, these phenomena will affect the region severely in various ways. Thus, the climate change disaster can be mitigated by taking necessary steps. Mitigation measures could refer to the cost-effective methods of dealing with

disasters over the long-term. The people of the coastal belt must be fully incorporated into disaster response strategies and must be made aware of the nature of hazards, their vulnerability, and potential protection measures. Besides the government, private agencies as well should come forward for active participation and should take the proper steps to make people more aware about the impact of climate change for these coastal fishing communities.

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