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Chapter

Coastal Community Adaptation to Climate Change-Induced Salinity Intrusion in Bangladesh

Golam Rabbani, Sirazoom Munira and Samia Saif

Abstract

Bangladesh, a country with a size of 147,570 km^2, has the largest delta in the world with one-third of the country residing a costal shoreline. The livelihood of the inhabitants is exposed to a series of tribulations causing radical setbacks, of which natural disasters like tropical cyclones bring large-scale salinity intrusion. Occurring due to three main causal factors including climate change, sedimentation, and low water flow, salinity poses challenges in agriculture and overall food security, hence impeding the health and livelihood of marginalized women, children, and elderly and explicably the overall vulnerable population at large. Against that backdrop, this chapter will delineate three broad spectra of Bangladesh's approach to "living with salt": (1) the assessment of salt intrusion in water and soil in Bangladesh's coastal zones due to climate change, (2) understanding the vulnerabilities to salinity within marginalized population, and (3) coping or adapting strategies to combat and live with salt. The chapter also includes the findings of a recent case study conducted on Bangladesh coastal zone to demonstrate the current livelihood conditions under salinity, conditions of the actions taken by the government and nongovernment organizations, gaps, and recommendations for a more resilient coastal community.

Keywords: coastal salinity, climate change, adaptation, Bangladesh, resilience

1. Introduction

Bangladesh is one of the most vulnerable countries due to climate change. According to the Global Climate Risk Index 2017, Bangladesh ranked sixth as the most vulnerable country and as the worst affected country by extreme weather. Climate change has increased the frequency and intensity of natural disasters such as cyclone, storm surge, flood, etc. The long-term impacts of climate change are temperature rise due to global warming, sea-level rise, salinity intrusion, drought, heat waves, cold waves, etc. The coastal belt of Bangladesh is severely impacted by salinity intrusion. In Bangladesh, salinity affected 83.3 million hectares of land in 1973 which increased to 102 million hectares in 2000. In 2009, the amount has increased to 105.6 million hectares. Over the last 35 years, salinity has increased to 26% within the country [1].

Bangladesh has a geographically and hydrologically disadvantaged setting and is highly vulnerable to sea-level rise and other related natural hazards, with major impacts on women, children, and food and energy securities [6]. All these multiple

vulnerabilities and climate change impacts are enhancing poverty, migration, and inequality in the country [7]. The government of Bangladesh has been able to identify different eco-zones which are vulnerable to climate change in its own distinct ways. These zones include southwest and central coast of Bangladesh including Bagerhat, Satkhira, Barguna, Patuakhali, and Bhola, which are the major affected coastal districts in the country.

It may as well be noted that IPCC Fourth and Fifth Assessment Report identified a number of climate-sensitive diseases which are waterborne (e.g., diarrhea and cholera). The Government of Bangladesh has been trying through its initiatives and own national funds to ensure that the vulnerable, socially excluded, disadvantaged households are supported with proper water, sanitation and hygiene (WASH) facilities. A number of disasters including flood, cyclone, river bank erosion, waterlogging, landslide, etc. have already hit the country in the past and posed themselves as critical disasters affecting the country's stability in the face of climate change. These disasters affect the entire environmental settings, infrastructure, and natural resource base which are essential for local livelihoods. Cyclone and storm surge, salinity intrusion, coastal flooding, waterlogging, variation in temperature, and rainfall jeopardize coastal livelihoods [8]. The intrusion of excess salinity has pushed the people living in the coastal zones to several dilemmas [9]. However, coastal communities have emerged with their local-level adaptation techniques, being able to set example across the world to "live with salt."

The following chapter summarizes the scenario of climate change induced salinity intrusion and impacts on livelihood communities. It also presents some insights from a research project conducted by Bangladesh Center for Advanced Studies (BCAS) which conducted a case study to understand coastal salinity in Bangladesh. As such, the chapter will provide a narrative on the current problems, present initiatives by the community to address the salinity challenges and way forward.

2. Understanding the vulnerabilities to salinity within marginalized population

2.1 Salinity intrusion and impacts on livelihoods

The salinity intrusion in the coastal belt of Bangladesh is severely affecting the life and livelihood of the community people. People are suffering for pure drinking water, irrigation water, and loss of agricultural lands. The salinity in the river water also changes the aquatic ecosystem and fishery sector. The average share of agricultural production in the national GDP is 35.53% [3]. As soil salinity increases each year, dry season is only favorable for the cultivation of crops in the coastal region. However, dry-season agriculture is becoming difficult due to salinity intrusion in the coastal belt of Bangladesh. Each year this is negatively impacting the crop production across the coastal belt [10]. Since coastal salinity poses great challenges on agriculture, community people are sometimes forced to convert the agricultural land to shrimp fields and other alternative forms of livelihood earning. The salinity also created shortage of grazing land and fodder for the livestock. This is affecting not only the livelihood of the community people but also the health and growth of the children in the area. Due to lack of pure drinking water, people especially the girls have to travel long distance to collect water. These cause dropout from school and sexual harassment. Moreover, intake of salt water causes high blood pressure among the young adults in the coastal Bangladesh [5].

2.2 Impacts of climate change within coastal communities

In Bangladesh about 80% of the land is floodplains with a low mean elevation above the sea level. The average elevation of the southwest coastal zone ranges from 1 to 2 m and in the southeast coastal zone 4–5 m [2]. The geographical location and flat topography of the country make the country more vulnerable to sea-level rise. Climate change has also increased the frequency and intensity of natural disasters. There is evidence of a 5–10% increase in intensity (wind speed) that would contribute to enhanced cyclone storm. Increased intensity of cyclone damages coastal infrastructure including roads, water supply, sanitation systems, administrative buildings, and cyclone shelters.

A devastating cyclone Sidr lashed the coastal region of Bangladesh on November 15, 2007. According to the government, it caused 3363 human deaths, and damage to property, livestock, and crops was estimated to be USD 1.7 billion. Due to severe salinity caused by cyclone Sidr, around 5 lakh hectares of cultivable land in the coastal region have remained uncultivated for the last 10 years [6]. According to the Soil Science Institute, around 4 lakh hectares, out of a total 7.41 lakh hectares of arable land, are highly contaminated by saline water. The farmers of the region are unable to cultivate their land due to the high level of salinity, as much as 16–18 deci-semen per cubic meter water, whereas the tolerable limit is 4–8 deci-semen per cubic meter to cultivate rice [6]. According to the Department of Agricultural Extension due to salinity caused by cyclone Sidr, rice production has decreased by around 4 lakh tons over the last 5 years. Saline water is continuously entering cultivable land through the faulty embankments damaged by cyclone Sidr.

Another devastating cyclone, cyclone Aila, hits the coast of Bangladesh on May 29, 2009. Cyclone Aila dewatered about 10% of the ponds, and 90% of the tube wells were submerged. Women spent an average of 4–5 hours a day collecting water, often walking 2–3 km to reach the nearest safe water sources or collection point [5]. People drank unsafe water or spent their limited financial resources on the collection of safe water or purchasing drinking water. After the cyclone Aila, the surface water and also groundwater of the coastal area of Bangladesh became saltier making drinking water as one of the key challenges in the area [4].

Bangladesh has a coastline of 710 km, and the coastal zone extends over 47,150 km^2 areas. The coastal zone has a population of 38.52 million (BBS 2011). About 20 million people in the coastal areas of Bangladesh are affected by salinity for pure drinking water.

3. Materials and methods

The Bangladesh Centre for Advanced Studies (BCAS) in its recent study conducted a research to understand the context-specific, ecosystem-friendly, and climate-adaptive agricultural and livelihood practices in three vulnerable zones of Bangladesh, which includes coastal, Char, and hilly regions. The study used a mixed-method approach by using both quantitative and qualitative methodological techniques to meet its objectives. For this purpose, national-level policy documents were consulted to understand the gap between existing knowledge and the scenario in the locality at present.

The BCAS research team conducted this study by incorporating focus group discussions (FGDs), key informants interview (KIIs) and household survey using semi-structured questionnaire from the communities. Data collected included demographical information, community's socio-economic condition, resilience planning and disaster preparedness, access to basic services, alternative livelihoods,

people's knowledge and awareness on climate change impacts, options on community-based adaptation options indifferent sectors. The questionnaire also included questions to assess how much capacity building is needed for the communities, local government institutes and other stakeholders including the NGOs, CSOs and CBO communities. The data set was made to be disaggregated (where appropriate) by location, gender, ethnicity, and disability. To collect data and information regarding impacts of climate change, community adaptation options, DRM planning, and other key relevant issues, a checklist was developed to conduct the focus group discussions (FGDs). The FGDs were conducted with mixed group (men and women), and the other was with women participants only. Although the research was conducted using the expertise of a skilled team, it had some inherent limitations. The research was conducted in a number of selected villages of the three eco-vulnerable regions of Bangladesh. Hence, the villages represent a fractional picture of the real scenario and corresponding problems in the area. The respondents of the study were to rely on data which were not only just based on perception and observation but also on the informants' reminiscence of past extreme events and ways of tackling.

Appropriate sampling technique and right size of sample for the best estimation of the population characteristics were two important factors for designing the sampling. Determination of representative sample size is a challenging issue. In most cases, the previous information required to determine the sample size particularly standard deviation of population is not available. The alternative way is to consider $p = q = 0.50$ that allows maximum standard error and also ensure maximum size of sample for specific requirements. The sample size of the baseline study has been estimated in such a way that the obtained result of the study may be within 5% of the true value with 95% confidence interval.

4. Results and discussion

In Bangladesh, agriculture is a central livelihood activity. The people living in the study region, i.e., the coastal zone, blame salinity in the water, too much or too little water, to be harmful for agricultural productivity, but they also have some adaptation strategy and mechanisms to combat these problems. For instance, they have been introduced to stress-tolerant types of agricultural crop varieties to adapt to climatic conditions. The people receive training on various areas including homestead gardening, integrated farm management, integrated pest management, compost preparation, animal manure, and crop rotation management. However, 77% of the respondents from the coastal zone stated that they did not receive any training on agricultural practices, which would be quite useful otherwise. To tackle food security issues, respondents from the coastal zones stated that they depend on less expensive food, they take help from friends and relatives, they intake less than required portions, and they also sometimes go for microcredit when there is food crisis.

The BCAS study also helped to understand the condition of the coastal community at crises and their subsequent shelter stories. The study shows that the community people's access to shelters have a connection with the time of receiving the warning signals. In addition, difficulties in getting early warning message and communication are also reasons for delayed responses to evacuate. The condition of water and sanitation practices of the people in the coastal zone show that the condition of hygiene becomes questionable during extreme events. Although people in the coastal zones have access to a range of sources of drinking water which include deep tube well, shallow tube well, rainwater harvesting (RWH), pond sand filter, ponds/canals and streams, etc., they still have to keep reserves when natural disasters take place. On the other hand, in terms of decision-making at the household level, it can be seen

that in the coastal zones, women are more engaged in some of the key decisions. Both government and nongovernment organizations have initiated awareness programs on the importance of integration of women in household- and community-level decisions. As one of the key results of the study, it confirmed the essence of resilience of the region to changing conditions brought about by climate change.

In Bangladesh, the preparedness to disasters is subject to the availability of proper and correct signals. Early warning signal messages in Bangladesh are provided prior to any extreme event, but some people still do not move from home. Early warning system (EWS) needs to be strengthened and is essential to make sure that each and every person follows the early warning messages. This would complement the adaptive capacities of the coastal communities to address climate adversities with a sophisticated lead time. In Bangladesh, way to safe, accessible and affordable water and sanitation is still hindered by a number of factors. Under the current situation of Bangladesh's coastal zones, people highly benefitted from the various training programs that are conducted to address various climate components to the communities. It can be also assessed that a large number of people help from the training programs that capacitate the communities in critical ways that help to overcome disaster aftermath. Hence, people's expectation to receive adequate training on agriculture and disaster management has been increased at present due to its effectiveness. The needs to have agricultural training should be met by the government to understand the best practices in achieving the highest output for crops, both before and after the climatic disasters. In addition to agricultural training, livelihood training and awareness programs should be thoroughly and regularly conducted to increase the resilience of people at large. Responsible authorities should emphasize on fostering people's knowledge on climate change through knowledge platforms, training, and awareness programs.

The study investigated which route was taken by the households while collecting water for household activities and by whom was the water collected. In all three study locations, it was observed that females bear the major responsibility for collecting household water. Many people from the coastal areas mentioned that they use the neighbor's toilet, the use of which becomes increasingly difficult during the onsets of natural disasters. This is particularly true for women, because of the conservative environment in the country.

During monsoon when there is heavy rainfall, the conditions of the latrines in the coastal zone become even worse. This leads to unsafe and unhygienic conditions within the sanitation facilities, with worsened situation during excessive rainfall which causes waterlogging. During most disasters, people in the coastal zones mentioned through this study that their latrines become dysfunctional. They expect help and support to be extended from the government and nongovernmental organizations to follow up on these conditions. The Bangladesh government is aware that they should address this with serious consideration to prevent diseases and facilitate ease in access, especially for disabled and elderly people. In the coastal zones, some people still go to the jungles and bushes for defecation purposes because of a lack of proper facility installed close to the house. Also, the distance of the latrines is another important concern, especially for the elderly people who cannot walk to the toilets. People in all the regions stated that there is a problem of contamination in the drinking water when natural disasters hit. According to the study, cyclones have been attributed to cause problems in their source of drinking water as mentioned by 81% of the coastal community respondents. On the other hand, storm surge was mentioned by 74% of the respondents, excessive rainfall by 36%, and salinity intrusion in water resources by 23%. This shows that people are having a clear perception of the disaster types and how they are responsible for contaminating the water that they use for drinking and cooking. The following

information was cross-checked through FGD, and according to the discussion, the major sources of drinking water are mainly affected by cyclone in the coastal zones. People in the coastal zones have indicated that their area is largely hit by cyclone and storm surge. It appears evident through the study's FGDs and KIIs that salinity induced by cyclones and storm surge is one of the biggest problems in the coastal zone. These are positions where the community people expect the use of better technologies and support that can help provide fresh drinking water. Many NGOs are already working in the coastal zone to improve the quality of drinking water. However, climate-resilient water supply and sanitation technologies would help the local communities for long-term sustainability.

4.1 Quantitative analysis from the aforementioned field survey

The field survey that was conducted was made comprehensive through the inclusion of interviews and focus group discussions. Some quantitative information from the survey helped to understand the basic concerns of the coastal communities. The following section shows some of the quantitative data that was collected through the survey analyses that explain the impacts of hazards on the livelihoods of the coastal community people.

A team of the BCAS went to the coastal area of Bangladesh where they interviewed a number of people living and dealing with salinity in the coastal zone. Among them, 38% of the respondents were male, and 68% of the respondents were female (**Figure 1**). The informants, cooperative and interactive, mentioned about a number of their problems and issues that they face living in the coastal zones of Bangladesh, which has implications on their livelihood, lifestyle, agriculture, and health aspect.

4.2 Current livelihood options in the study location

Figure 2 demonstrates the percentage of the respondents and their distribution of the livelihood options in the studied areas within the coastal zone. About 35% of the

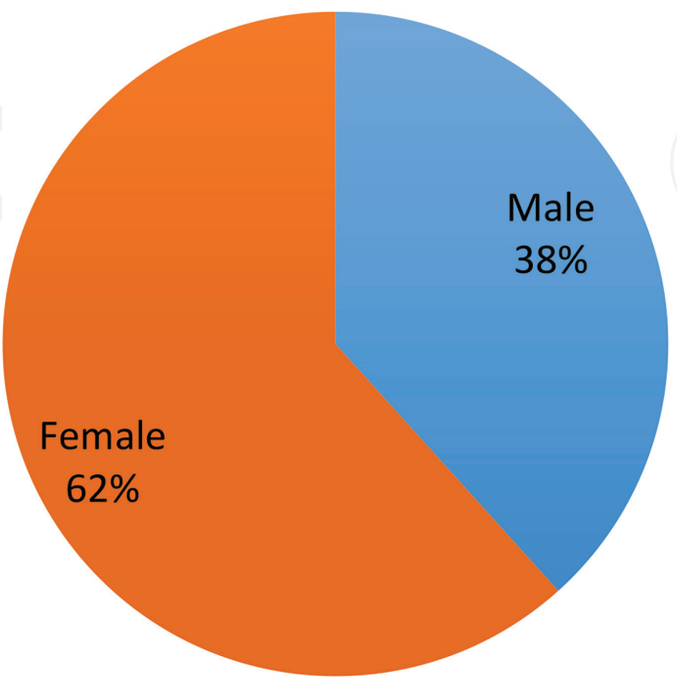


Figure 1.
Percentage distribution of the respondents in the coastal districts during the survey.

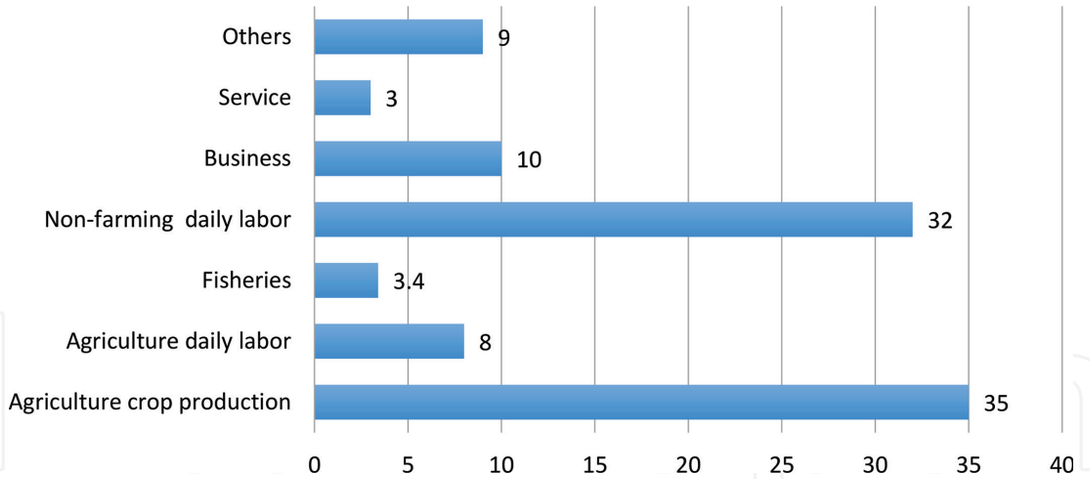


Figure 2.
Percentage of respondents and their distribution of the livelihood options in the study districts of the coastal zone.

people were found to be associated with agricultural crop production. They make their living on producing crops for the benefits of themselves and the community they live in. However, only 3% of the people are service holders. They are the minority in the community of the coastal zones. About 10% of the people make their living running small businesses like grocery shops, running vehicle businesses, etc. Among the second majority, which is 32% of the people, are related to nonfamily daily labor activities. There is an extensive demand on fisheries for supplying fish and food sources; hence, the life of 3.4% of the people depends upon fisheries.

4.3 Sources of drinking water

Figure 3 demonstrates the sources of drinking water in the study areas. From the study, it was found that majority of the people rely on deep tube well, which amounts to 62%, since the groundwater is believed to be pure and risk-free. Nearly 21% of people rely on direct rainwater which they store by means of tank pond and other resources and use them whenever necessary. A minority of the people, which is 5%, depends on river canals. However, due to hygiene concerns, the ones who are in need and do not have sufficient resources for drinking water only rely on canal water. Nearly 23% of the people depend on ponds and canals which they use as household water. About 10% of the people depend on pond sand filters as a source of drinking water. The least number of people can afford rainwater harvesting system (RWHS) which is 2% and 9% of the people who depend on shallow tube well.

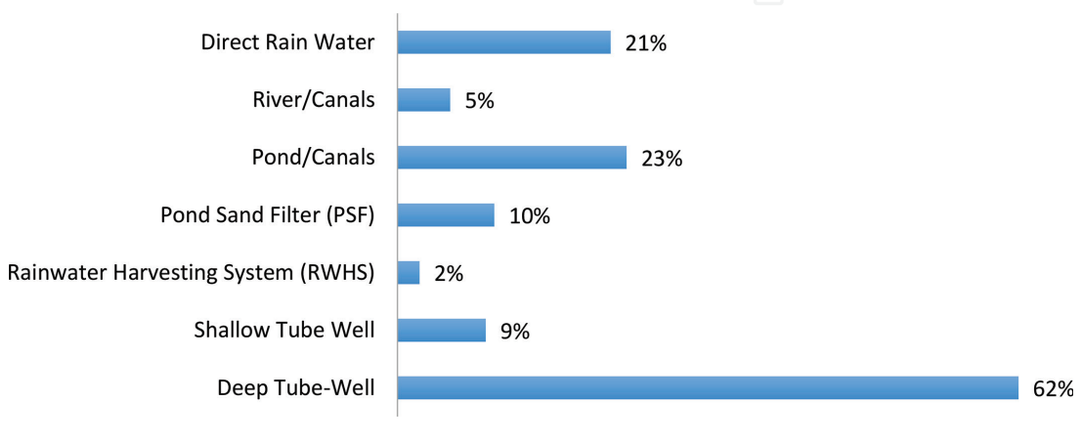


Figure 3.
Percentage of respondents showing their sources of drinking water supply in the study areas.

4.4 Salinity intrusion affects the sources of drinking water in the coast

It is important to note that salinity intrusion not only takes place at the groundwater level but also has been contaminating the surface water. Thus, **Figure 4** demonstrates the impacts of climate-induced disaster on the sources of drinking water. Wherever there is a cyclone like that of Aila that occurred in May 23, 2009 and Sidr in November 2007, a huge extent of the areas had been inundated extensively. The land was flooded, and saline water from the Bay of Bengal intruded the land and merged with the surface water. Nearly 35% of the respondents stated that due to the cyclone, the salinity of the water increases due to the intrusion of the bay water into the surface water, hence overlapping with drinking water. On the coastal areas, saline water also percolates down to the surface water and causes impacts on drinking capacity, and such statements have been stated by the majority of the respondent (as stated by 43% of the respondents). However, in such situations, ponds become a great resource for the coastal communities as a reservoir where freshwater could be collected and stored to be used for future instances. Waterlogging is a major issue when it rains heavily, and due to poor drainage system, the water gets collected on the land surface and that coincides with drinking water and causes climate hazard issues. This has been stated by 2% of the respondents in the study. Drought is a condition where the precipitation is below the average level which creates a crisis in drinking water. The sudden change of rainfall which is signified as erratic rainfall causes drinking water to be affected if it is massive or crisis if it is low. This has been stated by 29% of the respondents. The riverine flood causes intrusion of saline water into the river.

4.5 Impacts of climatic disasters on human life

The field study studied human perception to understand the impacts of disasters on people's lives. Through the survey analysis, it was found that 93% of the people acknowledged to agree that disasters make a huge negative difference to their livelihood, stability, and functioning, which eventually disrupts their sense of stability and rootedness to their origin. Disasters, especially which are of large scales, eventually compel the native communities to adapt to a new condition of living. Others choose to migrate to a potentially "safer" zone, where there could be better economic opportunities for living (**Figure 5**).

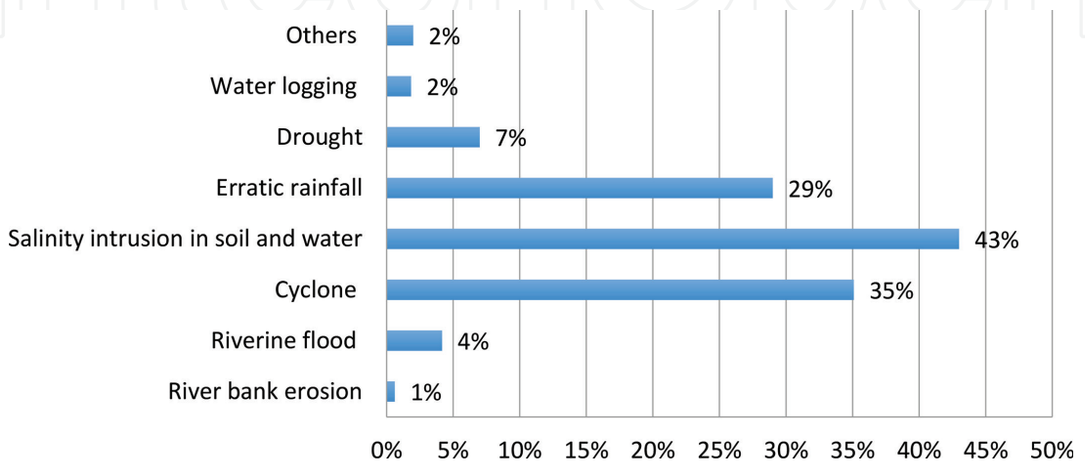


Figure 4.
Percentage of respondents of the impacts of climate induced disasters on the sources of drinking water.

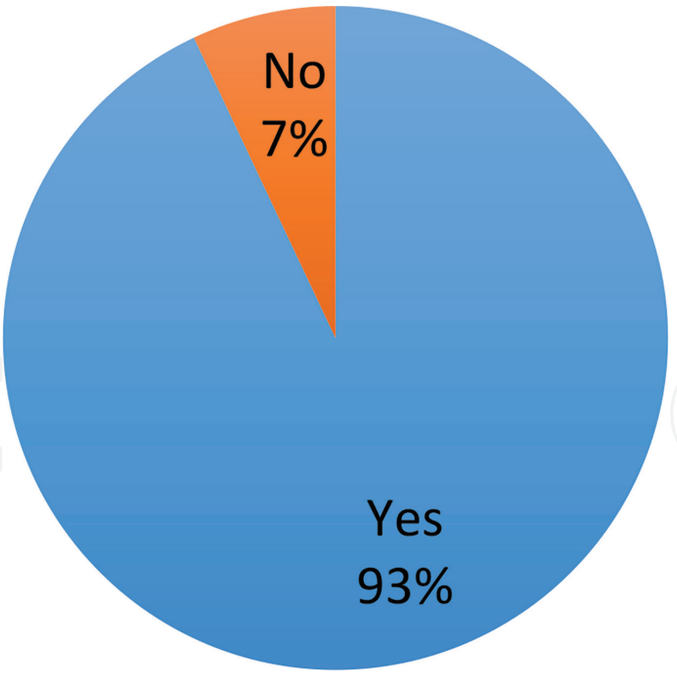


Figure 5.
Do climate disasters have any impact on your life?

4.6 Climate change, coastal livelihoods, and adaptation strategy

A number of climate-induced hazards have a colossal impact on the livelihood of the coastal people. Survey findings show that cyclone has the largest impact on the livelihoods of the communities, followed by salinity intrusion caused by storm surge. Excessive rainfall also has an impact on the livelihood of the coastal community people. It is observed that very small percentage of respondents in the survey mentioned about riverine flood, river bank erosion, drought, and sea-level rise as hazards that disrupt their livelihood.

The coastal area of Bangladesh has its unique characteristics. Communities living in the coastal zones have acquired their own techniques to combat the various climate adversities that hit their localities after a numbered return period or even erratically. However, there are some key roles and responsibilities of the government to ensure that the communities are far aware of the actions needed to be taken during and prior to the hitting of natural disasters. Coastal zone communities are particularly protected by the Sundarbans. However, the biodiversity is still at risk because of being an ecological hotspot within the country. It is imperative that the balance between environmental conservation and development is well understood by the community people to ensure that their adaptation approaches are sustainable in the long run. For this, the responsible authorities should emphasize on fostering knowledge on climate change and adaptation within the coastal zones in Bangladesh.

Coastal communities are at a threat to a number of natural disasters, making the roles of early warning extremely vital. The extent of effectiveness of the early warning systems should be revisited in the coastal zones so that there is sufficient lead time for people to prepare before flight and evacuation. The coastal zones of Bangladesh host a large number of people who contribute to the economic and agricultural sector of the country. These communities become stranded with the loss of lives of family members, livestock, and belonging. All of these could be avoided by a large scale if proper and timely early warnings are provided, which can

be interpreted by the communities in the right way. Hence, training is essential for the people to communicate with the language of the early warning messages so that they can act in the right way. There should be adequate monitoring and evaluation on the condition of the shelters where people reside during the disaster period. This is important especially in the coastal areas of Bangladesh, where there is a need for sufficient lead time for people to move to a safer place prior to when disasters hit. On the other hand, livestock are important assets for the people who live in the coastal zones. The livestock should have veterinary services along with the doctors for the local people, both during and after disaster, as they are valuable assets for these marginalized people in the coastal areas.

The coastal zone communities have been largely benefitted from various trainings which has taken place in the past. This is particularly true for agriculture-based trainings. Audiovisuals can be used to capture the success stories and practices on agriculture, as well as challenges and failures, and should be channeled to the community through the local people. This increases the trust, motivation, and accountability among the community people to adopt the best practices and adapt with climate change.

Coastal livelihood in Bangladesh is largely dependent upon the access to utility services, livelihood, disaster preparedness and management, agriculture, inter alia, understanding the state of women's market access, and several other key factors. Women's involvement and access to the market are essential for the overall growth of the community to head toward resilience. In the coastal areas, salinity is one of the biggest concerns. To have proper access to market especially for women, the barriers to access to the market must be identified and addressed. After natural disasters take place in the coastal region, women have a big role to play to bring the family back to the state it was originally in. Identification of women and their barrier to access to the market may be done by the union with the help of the government or nongovernment organizations. Women's inclusion should be given greater regards including making key decisions and supply and demand of the essentials. Enhancing technical support and engaging local institutions into the grassroots-level advancements are crucial at the same time. In many communities, women are not allowed to make key decisions within the household. But women should be included in all forms of major decision-making processes which relate to disaster preparedness. Since the coastal zone is very susceptible to cyclones, the communities are constantly faced with instantaneous decision-making. The role of women is crucial in such decision-making processes. Hence, institutional approach to help include women in the key decision-making processes is essential, especially in a community like that of the coastal area of Bangladesh, where major decisions are taken by the male members of the family.

Coastal zone has been subjected to a number of big natural disasters in the past. The major cyclones that have hit the area are Cyclone Sidr in 2007 and Cyclone Aila in 2009. This has led to a large number of people to evacuate and move to a safer place. Such migration pattern has taken place in a number of stages, where the families have first moved further inland and then later were forced to move toward the city, where there are more income-generating opportunities. The Government of Bangladesh has been very particular to assessing the trends of migration patterns in Bangladesh within the last few years. As such, the patterns of migration should be traced from the place where they are displaced due to various extreme events or climate change impacts to the migrated area. Migration stories collected can be used for future purposes, and experiences gathered through these stories are assets to be used for future help of the people.

Local adaptation plans in the coastal zones should be strengthened by manifolds because it will help to address the problems of the local communities through locally

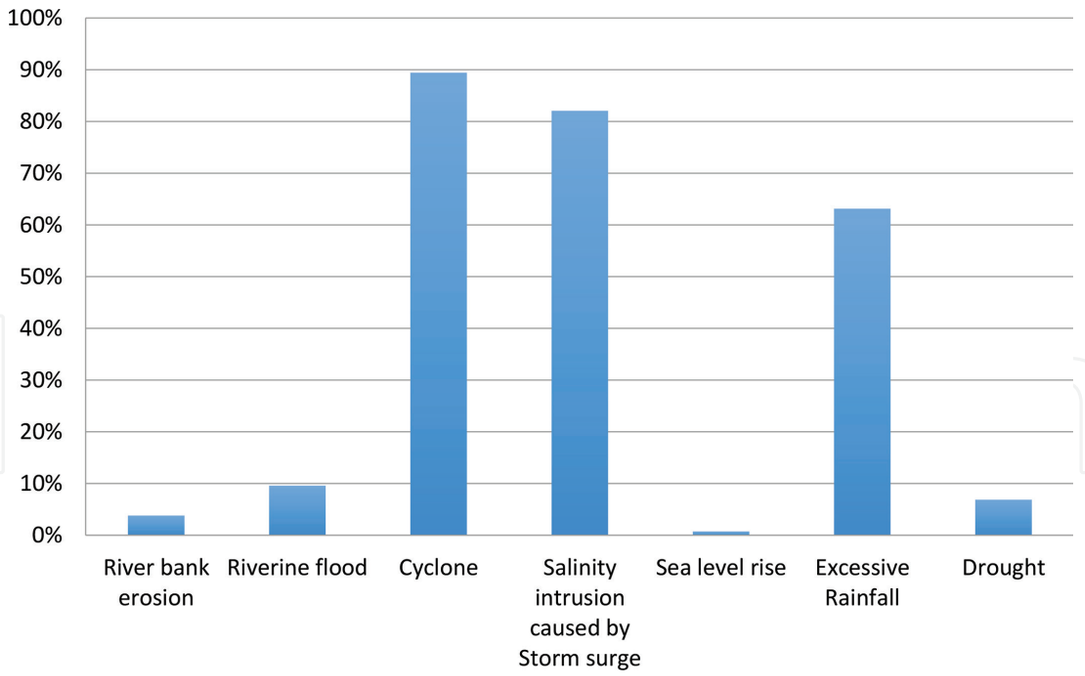


Figure 6.
Climate induced hazards that affect livelihoods of the study communities.

applied solutions. The coastal zone in Bangladesh has its own distinctive characteristic and properties. Area-specific problems must be identified for solutions, which too should be specific to each locality and their local problems. Within the coastal communities, the adaptation techniques should be in line with the region-based problem, which must be identified through further studies. This in turn will help not just the development sector but also the government to identify key strategies and solutions appropriate to lessen and manage local-level complications. Hence, various sectorial impacts should be assessed with scrutiny and be speculated with deeper interrogations and observation.

In the coastal zone of Bangladesh, gradual changes should be monitored and speculated with critical lens, of which cyclone is an example. Cyclone is a phenomenon which occurred quite a number of times in the coastal zone, and, hence, tracking its pathways and return periods is extremely important. Future studies should invest in monitoring how much has deviated in the timeliness of the events and its nature, i.e., gradual change between frequency, timeliness, and intensity of the extreme events, so that precautionary measures and subsequent activities can be executed duly with adequate knowledge. This will help to protect the mass number of people who are at risk of becoming homeless due to the onset of such large-scale disaster (**Figure 6**).

5. Conclusion

A compound impact of climate change and reduction of freshwater flow from the upstream is converting fresh water into saline zones. Climate change is enhancing the salinity problem in the coastal area of Bangladesh. Regional policies, agreements and strategies regarding trans-boundary issues need to be ratified.

The Bangladesh Water Development Board (BWDB) is responsible for maintaining and conducting the rehabilitation project of the polders. The BWDB has categorized 51 and 55 polders as most vulnerable and medium vulnerable, respectively. To address the vulnerability, it is important to repair the faulty infrastructure. Most of

the sluice gates are damaged or broken which allow intrusion of saline water. Not only that, the shrimp farmers cut the embankment to get saline water into their shrimp fields which make the embankment weak. The weak embankment is easily damaged by tidal pressure, particularly during full moon, and thus saline water enters the polders. Regular maintenance of the embankments, dams, sluice gates, and polders are important to maintain the water balance. For this a robust monitoring system can be developed to ensure the accountability of the concern institutes and officials.

Bangladesh has already developed several salinity-tolerant rice varieties. However, with the increasing level of salinity investments, it should be directed toward research and development of saline water submergence-tolerant crop varieties and introduce the varieties in the rural areas. Lastly, livelihood options of the community people have to be ensured to develop their capacity to over any challenge.

Lastly, climate change must not be muddled with the innate geographical and hydrological disadvantage of Bangladesh that leads to cyclones and other disasters. Bangladesh hosts a combination of a myriad number of rivers, and the country also receives 1.2 billion tons of silt. There are other problems including arsenic in the water that many people drink which is not problem driven due to climate change. Climate change-related problems need to be specifically identified for each sector or thematic areas for each of the agroecological zones or hazard prone eco-zones for developing local adaptation solutions to local problems.

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