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Feasibility Study of Anticipatory Action Project

Country: Bangladesh

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List of Abbreviations

DDMC	District Disaster Management Committee
DC	Deputy Commissioner
UZDMC	Upazila Disaster Management Committee
UNO	Upazila Nirbahi Officer
UDMC	Union Disaster Management Committee
PDMC	Pourashava Disaster Management Committee
GTS	Global Telecommunications System
WHO	World Health Organization
NPDM	National Plan for Disaster Management
SFDRR	Sendai Framework for Disaster Risk Reduction
SDG	Sustainable Development Goals
DRRO	District Relief and Rehabilitation Officer
PIO	Project Implementation Officer
IFRC	International Federation of Red Cross and Red Crescent Societies
BTV	Bangladesh Television
FGD	Focus Group Discussions
KIIs	key informant interviews
DDM	Department of Disaster Management
UP	Union Parishad
CSOs	Civil Society Organizations
CPP	Cyclone Preparedness Programme
EWS	Early Warning Systems
CBDM	Community-Based Disaster Management
UP	Union Parishad
UDMC	Union Disaster Management Committee
FFEWS	Flood Forecasting and Early Warning System

BWDB	Bangladesh Water Development Board
WMO	World Meteorological Organization
BMD	Bangladesh Meteorological Department
SWC	Storm Warning Centre
DPP	Disaster Preparedness Programme
WLs	Water Levels
IMD	Indian Meteorological Department
DL	Danger Levels
DMCs	Disaster Management Committees
NGOs	Non-Government Organizations
BDRCS	Bangladesh Red Crescent Society
DDMR	Department of Disaster Management and Relief
FSCD	Fire Service and Civil Defense
DRR	Disaster Risk Reduction
MoDMR	Ministry of Disaster Management and Relief
UNDP	United Nations Development Programme
ADB	Asian Development Bank
EU	European Union
DMB	Disaster Management Bureau
ADP	Annual Development Program
TCs	Tropical Cyclones
FFWC	Flood Forecasting Warning Centre
SOD	Standing Orders on Disasters
MoFDM	Ministry of Food and Disaster Management
GoB	Government of Bangladesh
NDMC	National Disaster Management Council
IMDMCC	Inter-Ministerial Disaster Management Coordination Committee

NDMC	National Disaster Management Council
NDMAC	National Disaster Management Advisory Committee
CPPIB	Cyclone Preparedness Programme Implementation Board
DMTATF	Disaster Management Training and Public Awareness Building Task Force
DMB	Disaster Management Bureau
FPOCG	Focal Point Operation Coordination Group of Disaster Management
NGOCC	NGO Coordination Committee on Disaster Management
CSDDWS	Committee for Speedy Dissemination of Disaster Related Warning/ Signals

Executive summary

Bangladesh is one of the most disaster-prone areas and the districts Bagerhat and Jamalpur are more susceptible to disasters. To establish an Anticipatory Action Plan for the effective implementation of the Early Warning System, a feasibility study was conducted in Morrelganj, Rampal, Jamalpur Sadar, and Islampur Upazila using participatory methods. The first region, Morrelganj and Rampal, is prone to cyclones, floods, and other hazards. The hazards associated with these risks include strong winds, heavy rainfall, flash floods, and landslides. Vulnerabilities in the region include poor infrastructure, limited resources, low-income levels, inadequate preparedness measures, low-lying areas, inadequate drainage systems, and poverty.

The second region, Islampur and Jamalpur Sadar Upazilla is characterized by floods, flash-flood, river erosion, heavy rainfall and heatwave in terms of disaster. Hazards associated with these risks include widespread flooding, water damage to infrastructure, displacement of people, damage to crops, soil erosion, water contamination, landslides, etc. The vulnerabilities associated with these risks include inadequate infrastructure, poverty, limited access to resources, and lack of preparedness measures. The study revealed that women and children, pregnant women and newborns, disabled people, farmers, fishermen, the elderly population, and low-income groups are among the most vulnerable to disasters. Women and children face physical limitations and may be left behind during evacuations, leading to difficulties in accessing essential services and increased health risks.

The government of Bangladesh uses various methods to disseminate disaster warnings, including mobile networks, electronic media, and community-based systems. However, there are still shortcomings in equipment, resources, and accessibility of information in some areas, with unreliable wireless communication and technical language being major obstacles. False alarms in the past have also contributed to a lack of trust in the warning system. Informal community-based forecasting and early warning systems exist, relying heavily on community elders' guidance and support from local efforts such as public announcement systems in mosques and cyclone warning flags. In some areas, Bangladesh Ansar and local volunteers use megaphones to advise people to move to safe shelters, with support from local efforts such as public announcement systems in mosques and cyclone warning flags. Based on the primary information provided, it can be inferred that while there may be adequate impact-based forecasting on paper, it is not effectively implemented in reality. Most of the community members, including women, children, and people with disabilities, do not understand the warning flags within the study. Impact studies shows, that from 2014 to 2020, there were 15 major disasters impacting 58 of the 64 administrative districts, resulting in 1,053 deaths, 4.6 million damaged houses, and $4.1 billion in economic loss. Flooding is a major concern, covering approximately 20% of the land, and extreme flooding events have resulted in significant economic losses. Monsoon floods caused disproportionately high economic losses, affected 28.39 million people, displaced 2.86 million people,

and damaged 3.73 million houses. Cyclones and storm surges have resulted in significant economic losses and displacement, with Cyclone Amphan in 2020 causing the highest economic loss of $1.5 billion. While developments in early warning, evacuation, and cyclone shelter have decreased deaths, economic damages from cyclones and storm surges continue to increase. NPDM 2016-2020 focused on mainstreaming disability and gender-inclusive disaster risk management.

Two trigger models are used to predict severe monsoon floods and cyclones in Bangladesh. The Monsoon Flood Trigger Model uses gauging station forecasts and sustained trends to determine readiness and action triggers. The Cyclone Trigger Model is activated by BMD forecasts of cyclones with wind speeds over 125 km/h making landfall in Bangladesh.

The government, humanitarian organizations, and development actors in Bangladesh have various capacities for the Anticipatory Action plan for disasters. The government has taken various measures to enhance early warning dissemination but still face some challenges such as inadequate resources and equipment in diverse cross-sections in Bangladesh. Humanitarian organizations and development actors are working in collaboration with the government to improve the effectiveness of the Anticipatory Action plan, including strengthening community-level interventions, implementing innovative forecasting techniques, and enhancing the capacity of local actors but unobserved within the study area. There is a lack of disaster preparedness plans in the study areas on early warning systems, evacuation plans, emergency supplies and shelters, and community training programs. However, the gaps are evident such as inadequate WASH facilities in shelter houses and a lack of designated channels for EWS information dissemination. There are no organized volunteer groups to support the community during the disaster period.

In terms of funding, the Disaster Management Bureau oversees disaster management in Bangladesh and receives funds from the government's Annual Development Program. The DMB distributes funds to agencies and NGOs for disaster preparedness initiatives and ensures coordination with international organizations. It maintains a transparent record of all funds received and disbursed through regular monitoring and evaluation. NGOs such as Uttaran, BRAC, ESDO, Islamic Relief, Torongo, PKSF, and ASHA are working on various development issues in the study areas, including microcredit, women's empowerment, WASH, and health. While none of the organizations worked directly with early warning systems, their interventions on climate change adaptation, disaster risk reduction, and improving access to basic services can indirectly contribute to building resilience in vulnerable communities.

The market assessment recommends launching CVP for disaster assistance in Bagerhat and Jamalpur due to the high frequency of natural disasters and lack of preparedness in these areas. The CVP should partner with local NGOs and government agencies, provide comprehensive support, and establish community training programs and volunteer groups. The program should be sustainable and adaptable, with a strong marketing strategy to raise awareness. This report emphasizes the need for

Anticipatory Action for disaster risk reduction and preparedness measures in Bangladesh, given the unpredictable nature of climate-induced changes. The report calls for sustainable practices, improved infrastructure, and effective preparedness measures to minimize the impact of natural disasters on vulnerable populations.

1. Introduction

In Bangladesh, yearly, natural disasters cause significant damage to the ecosystem of coastal communities, livelihoods, infrastructure and the environment. 19 out of 64 districts face the Bay of Bengal making the population in these areas highly vulnerable. Tropical cyclones in particular are all too common: on average 12-13 depressions form annually, resulting in at least one or two powerful cyclones. Between 1970 and 2015, over 45 devastating cyclones swept across the country causing immense harm to lives, property and coastal livelihoods relating to fisheries, forestry and agriculture. Anticipatory action plans are developed in anticipation of potential disasters in order to minimize the negative impacts of these events. By identifying potential risks and developing plans to address them, communities and organizations can be better prepared to respond to disasters.

The districts of Jamalpur & Bagerhat in Bangladesh are considered disaster-prone areas, with a history of flooding, cyclones, and other natural hazards. The potential for natural disasters in these areas makes it particularly important to have effective anticipatory action plans in place. A feasibility study on an anticipatory action plan in these areas could identify potential risks, evaluate the feasibility of different plan options, and provide recommendations for how to best prepare for and respond to disasters in the region.

Conducting a feasibility study on an anticipatory action plan in Jamalpur & Bagerhat could provide valuable insights into how to better prepare for and mitigate the impacts of natural disasters in the region, and ultimately help to save lives and property.

1.1 Purpose of the study

A feasibility study will be conducted in the selected areas to understand how feasible and ready the area is to prepare Anticipatory Action. The feasibility includes the type of hazards, the readiness of the Early Warning System, the availability of quality forecast data for the selected hazard for the selected area, the local community awareness, and the willingness of local stakeholders, including authority/government to conduct Anticipatory Action.

1.2 Scope of the study

Identify the risk, hazard and vulnerability	Identify the most vulnerable villages/Unions and people	Current community based early warning system	Existing Situation of impact-based forecast and/or multi-hazards	Impact analysis conducted in the area against the existing hazards
Triggers used by the current EWS	Disaster preparedness plan and support to Anticipatory	Market assessment to see the CVP feasibility	Existing Gap and Need Assessment	Stakeholder (Beneficiaries and Decision makers) Consultation

1.3 Expected key outcomes

Outcome 1: Target population has the capacity to conduct anticipatory action in a timely manner

Outcome 2: Collaboration mechanism for anticipatory action is improved

1.4 Areas of inquiries

- Identify the risk, hazard, and vulnerability in selected areas and their frequency
- Identify the most vulnerable villages/unions and people group
- Current community based early warning messages and their availability in the selected upazila
- Does the area have a decent forecast system with good accuracy? What is the frequency of false alarm rate in that area?
- Is there an impact-based forecast and/or multi-hazards early warning system available?
- Is there any impact analysis conducted in the area against the existing hazards?
- What are the triggers used by the current EWS? Is the impact of the hazards included in the triggers?
- Is there any disaster preparedness plan in the area developed by the government and local community? To what extent it can support AA?
- Market assessment to see the CVP feasibility.
- Delivery channel for the early warning message delivery and functionality
- Potential stakeholders/groups for developing a network (formal and informal), and coordination plan for anticipatory action
- Current initiative of local government institutes and other relevant stakeholders on anticipatory action
- Current status and functionality of disaster management standing committee of Union Parishad
- Identify the available service providers and their ability in selected locations, Business with institutions/organizations and what types of services are provided
- What are the existing gaps and need?
- Is there any local level readiness for anticipatory action?
- What is the national level current financing mechanism and practices?
- What are the government policy and strategy regarding anticipatory action?

2. Methodology

The information was gathered using a combination of the following survey techniques.

2.1 Questionnaire interviews

Questionnaire interviews were conducted in the study area through a simple random sampling method. Communities were interviewed at home and courtyard sites. Approximately 8 to 10 key informant interviews were conducted on a given day, and each interview required about an hour. The interviews were scheduled for communities to address issues of their past, present, and future opportunities, and existing socio-economic conditions.

2.2 Participatory Rural Appraisal (PRA)

The term Participatory Rural Appraisal (PRA) is being used to describe a growing family of approaches and methods to enable local people to share, enhance and analyze their knowledge of life and conditions, to plan and act (Mascarenhas, 1991). The PRA tools, such as poverty ranking, resource mapping, Focus Group Discussion (FGD), resource analysis, constraints analysis and key informant interviews were used with community people in the study area. Consideration was made on women, men, and mixed (men and women) groups utilizing the PRA tools. A total of 12 FGD sessions were held, with each FGD group comprising 6 to 12 community people. FGD sessions were held in front of houses, courtyards, under large trees, and in front of respondents' houses, wherever there was a spontaneous gathering and where participants could sit, feel comfortable, and be easily observed. Key informant interviews were carried out in the respective working stations of the informants like the office room.

2.3 Data processing and analysis

Using Microsoft Excel software, data from various sources were coded and entered into a database system. To ensure the accuracy of the data entered, preliminary results sheets were compared to the original coding sheets. Data were checked, edited, and coded at the field level at each stage of the survey. The data were analyzed using a statistical method such as the Statistical Package for Social Science (SPSS). Descriptive statistics were used to summarize the data.

2.4 Study area

The study was carried out in two upazilas (Morrelganj and Rampal) located in the Bagerhat District, which are the most disaster-prone areas among the 41 coastal districts of Bangladesh. Bagerhat District is frequently affected by natural disasters such as cyclones, tidal surges, north-wester, and

severe salinity, and has suffered from various types and ranges of cyclones that have devastated the area and left its inhabitants in a vulnerable state (Hasan, 2016).

On the other hand, Jamalpur is a district situated in the northern part of Bangladesh. Its total area is 2115.12 square kilometers, with 18.16 square kilometers covered by forests. The district is located between 24° 34 and 25° 26 north latitudes and 89° 40 and 90° 12 east longitudes The climate in Jamalpur is warm and temperate. The winter season receives significantly less rainfall than the summer season. According to Köppen and Geiger's classification, the climate in this area is categorized as CWA. The average annual temperature in Jamalpur is 26.0°C, and the district receives an average of 1963 mm of rainfall annually. The maximum and minimum average temperatures range from 33.3°C to 12°C, respectively. Compared to other districts, Jamalpur is relatively warmer. The district is home to several significant rivers, including the Jamuna, Brahmaputra, Jhenai, Banar, Jirjira, and Chhatal. The district is vulnerable to river floods every monsoon season. Among the five upazilas in Jamalpur, Dewanganj, Islampur, Madarganj, Melandaha, and Sharishabari are relatively lower areas and suffer the most from annual floods (Haque et al., 2022) (Figure 1).

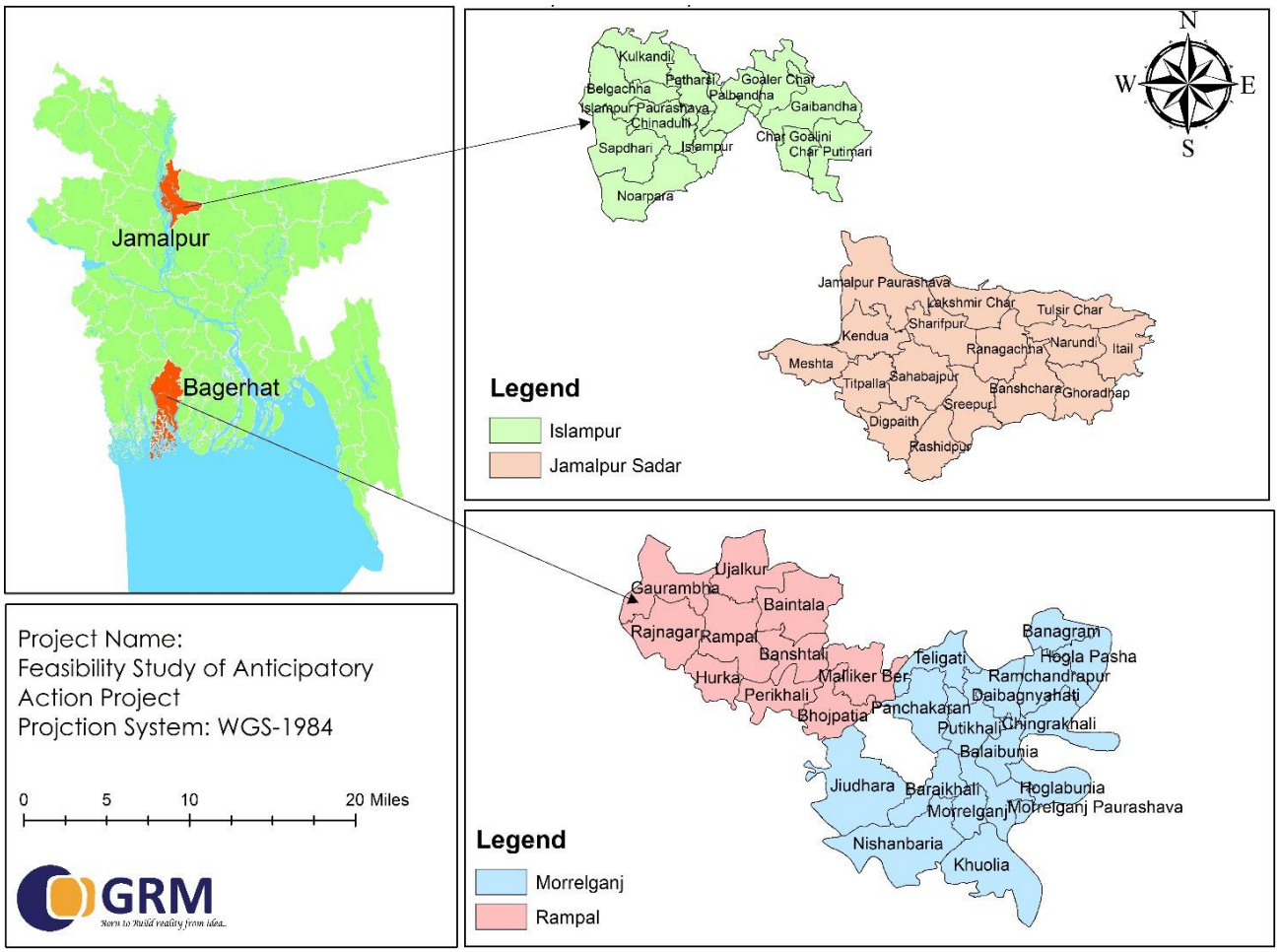

Figure 1 Study area for feasibility study

2.5 Study team

The following experts provided their valuable inputs to this report.

Name of the Expert	Designation
Md Abdul Hamid	Principal Coordinator
Polin Kumar Saha	Team Leader
Md Faisal Imran	Qualitative Expert
Jamshed Al Jubaidi	Research Officer
Jannatul Bakia Sweety	Research Officer
Najmun Nahar Prity	Junior Research Officer
Mokbular Rahman	Data Acquisition
Mr Arif Alam	Data Acquisition

3. Results and discussion

3.1 Identification risk, hazard, and vulnerability

Cyclones are devastating natural disasters that frequently occur along densely populated coastlines worldwide, particularly in low-lying delta regions like Bangladesh. Almost every year, a cyclone strikes the coast of Bangladesh. The majority of the people residing in this coastal region are impoverished, lack land ownership, and rely heavily on natural resources. As a result, cyclones have significant impacts in Bangladesh, causing loss of life and livelihood, damaging agricultural lands, infrastructure, and settlements, and disrupting communication networks (Quader *et al*., 2017). Despite various efforts to manage floods in Bangladesh, it remains a daunting task due to the frequency and severity of floods that the country experiences. Floods, along with cyclones, storm surges, flash floods, drought, tornados, riverbank erosion, and landslides, are the major natural disasters that affect Bangladesh. Among these, floods are the most frequent and constitute about half of all- natural disasters in the country, resulting in the regular disruption of life and livelihoods (Ali et al., 2018)

Bangladesh is experiencing a rise in climate-induced changes, such as frequent extreme cyclones, devastating tidal surges, severe floods, treacherous river erosion, excessive rainfall, and overwhelming salinity intrusion. These changes are occurring in an unpredictable manner, posing significant challenges to the country (Ur-Rahman, Amin, Haigh, Amaratunga, & Kulatunga, 2011). Morrelganj upazila has a score of 0.543 based on the average reported number of past floods, droughts, and cyclone events. Additionally, 14% of households in the upazila did not receive any warning of disasters (Hossen, 2016).

Table 1 shows the different natural vulnerability indices for several hazards in the districts of Bagerhat and Jamalpur. The vulnerability indices range from 0 (no risk) to 5 (very high risk). In Bagerhat, Rampal has high vulnerability to cyclones (3) and storm surges (5), and very high vulnerability to flash floods (5) Morrelganj has moderate vulnerability to cyclones (3), low vulnerability to flash floods (0), and moderate vulnerability to riverine floods (3).

In Jamalpur, both Jamalpur Sadar and Islampur have no or very low vulnerability to cyclones and salinity intrusion. They have moderate vulnerability to cold waves (3) and heat waves (3), and low to moderate vulnerability to riverine floods (2-3). Islampur has no vulnerability to salinity intrusion, while Jamalpur Sadar has low vulnerability (2). Overall, the vulnerability indices suggest that these areas are susceptible to multiple hazards, with flash floods and storm surges being the highest risk factors in Bagerhat and riverine floods being the highest risk factors in Jamalpur.

Table 1 Different natural vulnerable index for cyclone, flash flood, cold wave, heat wave, salinity intrusion, storm surge, riverine flood, one-day maximum rainfall.

District	Upazila Name	Cyclone	Flash flood	Cold Wave	Heat Wave	Salinity Intrusion	Strom Surge	Riverine Flood
Bagerhat	Rampal	3	5	2	3	2	5	5
	Morrelganj	3	0	2	2	3	0	3
Jamalpur	Jamalpur Sadar	0	1	3	3	0	2	3
	Islampur	0	1	3	3	0	2	3

(Here 0=No risk, 1=Very low, 2=low, 3=Moderate, 4=High, 5=Very high).

Source: Bureau of Research, Testing and Consultation (BRTC) & Bureau of Bangladesh University of Engineering and Technology (BUET), 2020.

Following the humanitarian response 2021, Table 2 provides an overview of the disaster and hazard risk levels of two districts located in Bangladesh, namely Bagerhat and Jamalpur, based on several indices. Bagerhat district has encountered a moderate level of impact caused by cyclones, with a Disaster Impact Index score of 3.6, ranking it sixth in terms of disaster impact risk. Additionally, the Hazard Exposure Index for Bagerhat is classified as very high at 6.7, placing it twenty- fourth in terms of hazard exposure risk. The Vulnerability Level of the district is rated as moderate at 5.0, which leads to a Multi-Hazard Risk Index score of high at 24, indicating that there is a significant risk from multiple hazards.

In contrast, Jamalpur district has been exposed to a high level of impacts caused by floods, with a Disaster Impact Index score of 7.4, ranking it second in terms of disaster impact risk. Furthermore, the Hazard Exposure Index for Jamalpur is also classified as very high at 8.5, placing it third in terms of hazard exposure risk. The Vulnerability Level of the district is rated as high at 7.0, which results in a Multi-Hazard Risk Index score of very high at 2, indicating an exceedingly high risk from multiple hazards. In general, the data reveals that both districts are exposed to significant risks arising from natural disasters and hazards, with Jamalpur district facing a higher level of risk than Bagerhat.

Table 2 Disaggregated data on disaster risk and vulnerability

District Name	Major Disaster_Primary	Disaster Impact Index (2014-2020)	Disaster Impact Risk level	Rank of Disaster Impact	Hazard Exposure Index	Hazard Exposure Risk level	Rank of Hazard Exposure	Vulnerability Level	Multi-Hazard Risk Index	Multi-Hazard Risk level	Rank Multi-Hazard Risk
Bagerhat	Cyclone	3.6	Medium	29	6.7	Very High	24	Medium	5.0	High	24
Jamalpur	Flood	7.4	Very High	2	8.5	Very High	3	High	7.0	Very High	2

According to the consultations with local community, the hazards and vulnerabilities associated with five different disaster risks in Morrelganj and Rampal are: Cyclones, Floods, River Bank Erosion, Excessive Rainfall, and Salinity. The identified hazards include strong winds, heavy rainfall, flash floods, landslides, soil erosion, etc. The identified vulnerabilities include poor infrastructure, limited access to resources, damage to the crops and trees, safe water contamination, loss of habitat and land and infrastructure damage low-income levels, inadequate preparedness measures, low-lying areas, inadequate drainage systems, poverty, and dependence on agriculture. Table 3 shows the disaggregated information on the risks and hazards of Morrelganj and Rampal Upazila, Bagerhat, Bangladesh.

Table 3 Risks and hazards of Morrelganj and Rampal Upazila, Bagerhat, Bangladesh

Areas	Risks from Disaster	Possible Hazards	Vulnerability	Frequency
Morrelganj and Rampal	Cyclone	Strong winds, heavy rainfall, storm surges, tidal waves, Flashfloods, and infrastructure damage.	Damages of crops and trees, Poor infrastructure, limited access to resources, low-income levels, limited access to information, and inadequate preparedness measures.	Pre-monsoon (April-May) and Post-monsoon (October-November) season.
	Flood	Heavy rainfall, overflowing rivers and water bodies, flashfloods, landslides, infrastructure damage, and Displacement of people.	Low-lying areas, inadequate drainage systems, poor infrastructure, poverty, limited access to resources, and lack of preparedness measures.	Monsoon (June-September) season
	River Bank Erosion	Soil erosion, sedimentation, water contamination, loss of land, infrastructure damage, and displacement of people	Limited access to resources, lack of protective measures, poverty, inadequate infrastructure, and poor land-use practices.	Increasing due to climate change
	Excessive Rainfall	Soil erosion, water contamination, infrastructure damage, and Displacement of people.	Inadequate drainage systems, poor infrastructure, poverty, limited access to resources, and lack of preparedness measures.	Monsoon (June-September)
	Salinity Intrusion	Soil salinity, water contamination, reduced crop yields, loss of agricultural land, and displacement of people.	Coastal areas, limited access to resources, poverty, dependence on agriculture, and inadequate adaptation measures.	Increasing due to climate change

Source: Field data, 2023.

Table 4 highlights the disaster risks, possible hazards, and vulnerabilities associated with each of the identified disaster risks in Islampur and Islampur Sadar Upazilla, under the Jamalpur district in Bangladesh. Jamalpur Sadar and Islampur in Jamalpur are susceptible to various natural hazards, with flooding being the main hazard. The region is situated close to several rivers, including the Brahmaputra and the Jamuna. The disaster risks include floods, flash-floods, river erosion, cyclones, heavy rainfall, and heatwaves. The hazards associated with these risks include widespread flooding, water damage to infrastructure, displacement of people, damage to crops, soil erosion, water contamination, landslides, and extreme heat.

The vulnerabilities associated with these risks vary and include factors such as inadequate drainage systems, poor infrastructure, poverty, limited access to resources, and lack of preparedness measures. Identifying these vulnerabilities is critical in developing effective strategies for disaster risk reduction and preparedness measures in Bangladesh.

Table 4 Risks and hazards of Jamalpur Sadar and Islampur Upazila, Jamalpur, Bangladesh

Areas	Disaster Risks	Possible Hazards	Vulnerabilities	Frequency
Jamalpur Sadar and Islampur.	Flood	Widespread flooding, water damage to infrastructure, damage to crops and loss of livelihoods, displacement of people.	Low-lying areas, damage of the croplands and fish firm, inadequate drainage systems, poor infrastructure, poverty, limited access to resources, and lack of preparedness measures.	Monsoon (June-September)
	Flash-flood	Sudden and unpredictable flooding, infrastructure damage, loss of life and property.	Poor infrastructure, limited access to resources, low-income levels, inadequate preparedness measures, and lack of early warning systems.	Flash floods occur during pre- monsoon (April- May)
	River Erosion	Soil erosion, sedimentation, water contamination, loss of land, infrastructure damage, and displacement of people.	Limited access to resources, lack of protective measures, poverty, inadequate infrastructure, and poor land-use practices.	More frequent in recent years
	Cyclone	Strong winds, heavy rainfall, storm surges, tidal waves, flashfloods, landslides, and infrastructure damage.	Poor infrastructure, limited Access to resources, low-Income levels, limited access to information, and inadequate preparedness measures.	Pre-monsoon (April-May) and Post-monsoon (October-November) season
	Heavy Rainfall	Flash floods, landslides, soil erosion, water contamination, infrastructure damage, and displacement of people.	Inadequate drainage systems, poor infrastructure, poverty, limited access to resources, and lack of preparedness measures.	Monsoon (June-September) Occurs annually during the monsoon season

	Heat Wave	Extreme heat, dehydration, heat exhaustion, and heatstroke.	Poor infrastructure, limited access to resources, low-income levels, inadequate preparedness measures, and lack of public awareness.	Increasing recently due to climate change

Source: Field data, 2023

3.2 Most vulnerable villages/Unions

Identifying the most disaster-vulnerable villages/unions and people groups is critical in the Anticipatory Action Plan and its management. The study process involves analyzing qualitative data to determine the extent of the risks and vulnerabilities of the communities and groups to specific hazards. The study team used qualitative data gathered from interviews with key informants, focus group discussions, and secondary sources to identify the most vulnerable villages/unions and people groups.

Rampal Upazila:

The Rampal Sadar Union, is situated in close proximity to the coastal region, rendering it highly susceptible to cyclones. Contributing factors to this vulnerability include inadequate infrastructure, a lack of cyclone-resistant structures or shelter houses, unauthorized tree-cutting, and limited shelter options. In addition, the Union is located near a large river, which further compounds the risk of cyclones. This precarious situation exposes approximately 75% of the population to the perils of such disasters.

Likewise, the Hurka Union, encompassing wards 1, 3, 4, 7, 8, and 9, is at high risk of cyclones. Similarly, the Rajnagar Union, encompassing wards 1 through 6, the Baintola Union, encompassing wards 1, 2, 3, 6, 7, 8, and 9, and the Molliker Ber Union, encompassing wards 1, 2, 6, and 9, are all highly vulnerable to cyclones. Meanwhile, the Perikhali Union, encompassing wards 1 through 4, and the Ujolkur Union, encompassing wards 5, 7, 8, and 9, have a moderate level of vulnerability to cyclones. The Bash Toli Union, which encompasses wards 1, 2, 7, 8, and 9, is similarly at high risk.

In terms of saline intrusion, the Rampal Sadar Union, particularly in wards 5, 7, 8, and 9, is moderately vulnerable due to several factors, including the absence of sluice gates, illegal storage of brackish water for shrimp and fish farming, the lack of shelter options for domestic animals, insufficient and delayed rainfall, the absence of embankments, the lack of salinity-tolerant agriculture, and the shortage of freshwater sources. This vulnerability puts approximately 80% of the population at risk of saline intrusion.

Similarly, the Hurka Union and Baintola Union are highly vulnerable to saline intrusion, while the Molliker Ber Union and Rajnagar Union are also at high risk. The Perikhali Union and Ujolkur Union have a moderate level of vulnerability to saline intrusion. The Bhojpatia Union is moderately vulnerable to saline intrusion in all its wards, while the Bash Toli Union, specifically in wards 1, 5, 7, 8, and 9, is highly susceptible.

Table 5 Vulnerability at Rampal Upazila

Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Population
Cyclone	Rampal Sadar- Union-Ward 1,2,3,4,5	High	• Close to the coastal area • Unplanned and weak infrastructure • Lack of tornado and cyclone resistant structures or shelter house • Cutting down tree illegally • No having adequate shelter house; • Close to the large river;	75% of populations are vulnerable
	Perikhali Union Ward-1,2,3,4,5	Moderate		
	Hurka Union Ward-1,3,4,7,8, 9	High		
	Ujolkur Union Ward-5,7,8,9	Moderate		
	RajnagarUnion-Ward-4,5, and 6.	High		
	Bhojpatia Union-all wards	Moderate		
	Molliker Ber Union-Ward-1,2,6,9	High		
	Baintola Union-Ward 1,2,3,6,7,8,9	High		
	Bash Toli Union-Ward-1,2,7,8,9	High		
	Gourombha Union-Ward 1,2,3,6,8,9	Moderate		
Saline Intrusion	Rampal Sadar- Union-Ward 5,7,8,9	Moderate	• No sluice gate; • Illegal storage of brackish water for shrimp and fish farming; • Absent of "Matir Killa" or shelter house	80% of populations are vulnerable
	Perikhali Union-Ward-1,2,3, and 4	Moderate		
	Hurka Union Ward-1,3,4,7,8, 9	High		
	Ujolkur Union Ward-5,7,8,9	Moderate		

Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Population
	Rajnagar Union-Ward-1,2,3,4,5and 6	High	• for domestic animals. • Late and insufficient rainfall. • Lack of salinity tolerant agriculture. • Not having embankment. • Lack of fresh water sources.	
	Bhojpatia Union-all wards	Moderate		
	Molliker Ber Union- all wards	High		
	Baintola Union-Ward 1,2,3,4,5,6, and 9	High		
	Bash Toli Union-Ward-1,5,7,8,9	High		
	Gourombha Union-Ward 1,2,3,6,8,9	Moderate		
Flood	Rampal Sadar Union-all wards	Moderate	• Lower area • Houses, and various infrastructure are located in low-lying areas • Heavy rainfall and increase of tides • Shrimp culture illegally • Lack of adequate culverts and sluice gates to divert flood water	60% of populations are vulnerable
	Perikhali Union-Ward-1,2,3,and 4	Moderate		
	Hurka Union Ward-1,3,4,7,8, 9	High		
	Ujolkur Union Ward-5,7,8,9	Moderate		
	Rajnagar Union-all wards	High		
	Bhojpatia Union-all wards	Moderate		
	Molliker Ber Union- all wards	High		
	Baintola Union-Ward 1,2,3,4,5,6, and 9	Moderate		
	Gourombha Union-Ward 1,2,3,6,8, and 9	High		
		Moderate		

Source: Field Data and DM Report, 2015.

Morrelganj Upazila

In close proximity to the coastal region, the Morrelganj Upazila, which has 15 unions, is very vulnerable to cyclones and floods. These regions are particularly vulnerable to cyclones and floods: Telikhali Union, Panchakaron, Chingrakhali, Hoglapasha, Bangram, Balaibunia, Hoglabunia, and Bahorbunia Union. These unions are at high risk and considered as most cyclone-prone areas.

Another significant threat to the unions in the Morrelganj, Bagherhat district is flooding. The following Morrelganj Upazila unions are moderately vulnerable to cyclones and floods: 3 no Putikhali Union, 4 no Daibaggahati Union, 5 no Ramchandrawpur Union, 12 no Juidhara Union, and 13 no Nishan Baria Union. In this region, 28,000 people are extremely susceptible, and 37,000 people share the risk of flooding and cyclones.

The high risk of riverbank erosion areas is 11 No Bahorbunia Union, 14 No Baroikhali Union, 16 No khaulia Union. The other remaining unions are moderately susceptible to river erosion. The reasons behind river bank erosion are the low depth of the river bank and insufficient piling and plantation. On the other hand, the remaining unions of Morrelganj Upazila are similar, the Juidhara Union is highly vulnerable to saline intrusion. The Bahorbunia Union and Nishan Baria Union have a moderate level of vulnerability regarding salinity. About 40,000 people are closely affected by saline water intrusion, which is alarming.

Table 6 Moreelganj at Rampal Upazila

Disaster	The Unions that are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
Cyclone	1 no Telikhali Union	**High**	• Geographic location adjacent to the coast. • Embankments are not high enough. • Lack of awareness.	
Cyclone	2no Panchakaron Union	**High**		
Cyclone	3 no Putikhali Union	**Moderate**		
Cyclone	4no Daibaggahati Union	**Moderate**		28,000 people are very vulnerable in this area. 37,000 people in the middle of sharing risk
Cyclone	5no Ramchandrawpur Union	**Moderate**		
Cyclone	6 no Chingrakhali union	**High**		
Cyclone	7 no Hoglapasha union	**High**		
Cyclone	8 no Bangram Union	**High**		
Cyclone	9 no Balaibunia Union	**High**		
Cyclone	10 no Hoglabunia Union	**High**		
Cyclone	11no Bahorbunia Union	**High**		

Disaster	The Unions that are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
Cyclone	12 no Juidhara Union	**Moderate**		
Cyclone	13 no Nishan Baria Union	**Moderate**		
Cyclone	14no Baroikhali Union	**High**		
Cyclone	16no khaulia Union	**High**		
Flood	1 no Telikhali Union	**High**		
Flood	2no Panchakaron Union	**High**		
Flood	3 no Putikhali Union	**Moderate**		
Flood	4no Daibaggahati Union	**Moderate**		
Flood	5noRamchandrawpur Union	**Moderate**		
Flood	6 no Chingrakhali union	**High**	Geographical, physiographic, and hydro-meteorological factors responsible for floods	
Flood	7 no Hoglapasha union	**High**		
Flood	8 no Bangram Union	**High**		
Flood	9 no Balaibunia Union	**High**		
Flood	10 no Hoglabunia Union	**High**		
Flood	11no Bahorbunia Union	**High**		
Flood	12 no Juidhara Union	**Moderate**		
Flood	13 no Nishan Baria Union	**Moderate**		
Flood	14no Baroikhali Union	**High**		
Flood	16no khaulia Union	**High**		
River Erosion	11no Bahorbunia Union	**High**		
River Erosion	14no Baroikhali Union	**High**	Vulnerable riverbank	

Disaster	The Unions that are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
			During the monsoon, extensive riverbank spills	
River Erosion	16no khaulia Union	**High**		
Salinity	13 no NishanBaria Union	**Moderate**	Adjacent to the coastal area, Cultivation of Excessive shrimp	40,000people are affected closely
Salinity	11no Bahorbunia Union	**Moderate**		
Salinity	12 no Juidhara Union	**High**		

Source: Field Data and DM Report 2015.

Islampur Upazilla:

Bangladesh's Islampur Upazila, which is part of the Jamalpur district, is vulnerable to several natural calamities, including floods, river bank erosion, and drought. Due to the region's low-lying terrain, lack of dam-roads, dense population, and poor infrastructure, unions are particularly vulnerable there.

The biggest threat to unions in Islampur Upazila is flooding. Kulkandi Union, Wards 1, 2, 3, and 4, Islampur Union, Wards 3,4,5,6, 7, and 8, and Chargoalini Union, Wards 3,5,7, and 8, are the flood- prone areas. In contrast, locations like Pathorshi, Polbandha, Gaibandha, and Charputhimari Union are somewhat susceptible to flooding. These places lack a dam-road, are low-lying, and do not have a sewer system. If it rains in the highlands, they flood.

There are around 57,000 impacted people, according to estimates. The population in these places is more vulnerable because of the inadequate infrastructure and drainage system, which makes it challenging to adequately handle catastrophes.

The places most prone to river bank erosion are Kulkandi, Belgacha, Chinaduli, and Chargoalini. About 31,000 houses are thought to be affected, and the grounds for river bank erosion are a lack of the necessary number of protection embankments, a shallow riverbed, and an inadequate amount of piling and vegetation.

All unions, including the Char section of the Islampur Upazila, are prone to drought. About 50,000 homes are thought to be affected, and the reasons for the drought are a lack of alternative irrigation infrastructure and a lack of rainwater conservation.

Many individuals run the risk of losing their homes, means of support, and even their lives in the event of a flood. It is challenging to respond to emergencies successfully in these places due to a lack of a good infrastructure and drainage system, further increasing the population's susceptibility.

Appropriate measures must be created and put into place to reduce the danger of natural disasters in these susceptible locations. Infrastructural improvements like dam-roads and drainage systems, sufficient plantation and piling to stop river bank erosion, and drought-prevention agricultural techniques are a few examples of these strategies.

These can include early warning mechanisms, evacuation strategies, and safe havens. Several steps can be taken to lessen the population's susceptibility and to safeguard their safety and way of life in Islampur Upazila.

Table 7 Vulnerability Islampur Upazila

Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
Flood	Union: Kulkandi, Ward-1,2, 3 & 4	**High**	Low-lying without any dam-road. If it rains on the high lands, they have Nosewerage system.	
Flood	Union: Belgacha, Ward-3,4, 5, 6 & 7	**High**	Adjacent to the river and highly prone to flood	
Flood	Union: Sapdhori, Ward-1,5 & 9	**High**	Low-lying land, increase of water level of Jamuna River	
Flood	Union: Chinaduli, Ward-1,2, 3. 4, 5, 6 &7	**High**	Rising of water level and low-lying area adjacent to the river	About 57,000 households
Flood	Union: Noarpara, Ward- 2, 4, 7, 8 & 9	**Moderate**	Lower land elevation. During rainy season, water level of adjacent river gets higher	

Flood	Union: Islampur, Ward- 3,4,5,6, 7, 8 & 9	**Moderate**	Low-lying without any dam-road. If it rains on the high lands they have no sewerage system.	
Flood	Union: Pathorshi, Ward- 1,2, 5, 7, & 8	**Moderate**	Not so adjacent to the river	
Flood	Union: Polbandha, Ward- 1, 3, 5 & 6	**Moderate**	Close to the riverbank. Medium to low-lying land.	
Flood	Union: Goalerchar, Ward- 1, 3, 5,6, 7 & 9	**Moderate**	Very close to the river. If it rains on he high lands, they have no sewerage system.	
Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
Flood	Union: Gaibandha, Ward- 1,2, 5 & 9	**Moderate**	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	
Flood	Union: Charputhimari, Ward- 1,3,7, 8 & 9	**Moderate**	Low laying area and Homestead plinth is low.	
Flood	Union:Chargoalini, Ward- 3,5,7,8 & 9	**High**	Overflown of river water. If it rains on the high lands, they have no sewerage system.	
River Bank Erosion	Union: Kulkandi, Ward- 3, 4 & 5	**High**	Near to the river, No Sufficient plantation.	
River Bank Erosion	Union: Belgacha, Ward- 4, 5, 6 & 7	**High**	Lack of required number of protection embankments.	
River Bank Erosion	Union: Chinaduli, Ward- 1, 3, 4, 5, 7 & 8	**High**	Broken river banks by waves, Low depth of riverbed.	

River Bank Erosion	Union: Sapdhori, Ward- 2,5 & 8	**Moderate**	Lack of dredging Of riverbed in proper time.	
River Bank Erosion	Union: Noarpara, Ward- 1,2, 4, 7 & 8	**Moderate**	Lack of repair and maintenance of embankments	Approximately 31,000 households
River Bank Erosion	Union: Pathorshi, Ward- 1 & 2	**Moderate**	Low depth of river bed, Lack of repair and maintenance of embankments	
River Bank Erosion	Union: Polbandha, Ward- 1, 3, 5 & 6	**Moderate**	Low depth of river bank;	
River Bank Erosion	Union: Goalerchar, Ward- 3, 4, 5, 6 & 7	**Moderate**	Disrupt the normal speed of the river	
Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
River Bank Erosion	Union: Gaibandha, Ward- 1,6 & 9	**Moderate**	Low depth of river bank;	
River Bank Erosion	Union: Charputhimari, Ward- 1 & 8	**Moderate**	Lack of repair and maintenance of embankments	
River Bank Erosion	Union: Chargoalini, Ward- 3, 5 & 7	**High**	Lack of required number of protections Embankments,	
Drought	All Unions including Char area of the Upazila	**N/A**	Lack of alternative irrigation facility, Lack of rainfall conservation of rain water, decrease of water level	Approximately 50,000 HHs
Northwester	Any place of the Upazila may be affected (no specific area of vulnerability)	**N/A**	Weak infrastructure of the houses	Approximately 60,000 HHs
Coldwave and fog	All Unions of the Upazila	**N/A**	Due to presence of river, there is dense fog in and around river,	Approximately 60,000 HHs

Source: Field Data and DM Report, 2015.

Jamalpur Sadar:

Jamalpur Sadar, located in the district of Jamalpur, Bangladesh, is a region that is prone to various natural disasters such as floods, river bank erosion, and drought. The vulnerability of the unions in this area is due to their low-lying geographical location, lack of dam-roads, high population density, and inadequate infrastructure.

Floods are the most significant threat to the unions in Jamalpur Sadar. The flood-prone areas are Union Ward-1,2,5, 4,5,8 and Rashidpur Union, Ward 3,4,5, and 7. These areas are low-lying without any dam-road, and if it rains on the highlands, they have no sewerage system. The estimated number of affected individuals is 15,000, 20,000, and 1,000 respectively. The lack of a proper infrastructure and drainage system in these areas also increases the vulnerability of the population, making it difficult to respond to emergencies effectively.

The river bank erosion-prone areas are Sharifpur Union, Lakhkhir Char Union, Tulshir Char Union, Etail Union, Norundi Union, Ranagach Union, Teetpola Union, Mesta Union, Digpait Union, and Rashidpur Union. The intensity of river bank erosion is high in Sharifpur Union, Lakhkhir Char Union, Tulshir Char Union, Digpait Union, and Rashidpur Union, and moderate in Norundi Union, Ranagach Union, and Teetpola Union. The estimated number of affected individuals ranges from 10,000 to 26,800, and the reasons for river bank erosion are the low depth of the river bank and no sufficient piling and plantation.

The drought-prone areas are Kendua Union, Sharifpur Union, Lakhkhir Char Union, Tulshir Char Union, Etail Union, Ghoradhap Union, Bashchora Union, Ranagach Union, Sreepur Union, Shahabazpur Union, Teetpola Union, Mesta Union, Digpait Union, and Rashidpur Union. The intensity of drought is high in Kendua Union, Sharifpur Union, Lakhkhir Char Union, Tulshir Char Union, Etail Union, Ghoradhap Union, and Rashidpur Union, and moderate in Bashchora Union, Ranagach Union, Sreepur Union, Shahabazpur Union, and Teetpola Union. The estimated number of affected individuals ranges from 15,000 to 29,000, and the reasons for drought are the lack of sufficient plantations, natural imbalance, and no sufficient plantations.

The high population density in these unions further increases the vulnerability of the local population to natural disasters. In the event of a flood, a large number of people are at risk of losing their homes, livelihoods, and even their lives. The lack of a proper infrastructure and drainage system in these areas makes it difficult to respond to emergencies effectively, further increasing the vulnerability of the population.

To mitigate the risk of natural disasters in these vulnerable areas, appropriate measures need to be developed and implemented. These measures may include the construction of proper infrastructure such as dam-roads and drainage systems, adequate plantation and piling to prevent river bank erosion,

and sustainable agriculture practices to prevent drought. Additionally, it is crucial to create awareness among the local population about disaster preparedness and response. This can include early warning systems, evacuation plans, and emergency shelters. By implementing these measures, the vulnerability of the population in Jamalpur Sadar can be reduced, and their safety and livelihoods can be protected.

Table 8 Vulnerability at Jamalpur Upazila

Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
Flood	Union: 1 no. Kendua Union, Ward- In 3, 6, 7	High	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	30,500 Nos
Flood	Union:2 no.Sharifpur Union, Ward- 1 & 9	Moderate	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	20,200 Nos
Flood	Union: 3 no. Lakhkhir Char Union, Ward- 3, 7, 8,9-In 1, 3, 4, 8, 9	High	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	26,800 Nos
Flood	Union-4 No Tulshir Char Union, Ward-1,3,4,8,9	Moderate	Low-lying without any dam-road. If it rains on the high lands, they have nosewerage system.	14,000 Nos
Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
Flood	Union: 5 no. Itail Union, Ward- 1, 3, &7	Moderate	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	23,000 Nos
Flood	Union-6 No Norundi Union, Ward-1,2,3 and 4,	Moderate	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	20,000 Nos
Flood	Union: 7 no. Ghoradhap Ward 2,4,5,7,8	Moderate	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	16,000 Nos
Flood	Union: 8 no. Bashchora Unio, Ward- 1, 2, 4,5,6,7 & 9	Moderate	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	29,900 Nos
Flood	Union: 9 no. Ranagach Union, Ward- 1,2, 3, 8 & 9	Moderate	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	20,000 Nos

Flood	Union: 12 no. Teetpola Union, Ward- 5, 6,7,8 & 9	Moderate	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	25,000 Nos
Flood	13 no. Mesta Union, Ward-1,2,5	High	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	15,000 Nos
Flood	14 no. Digpait, Ward-4,5, and 8	High	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	20,000 Nos
Flood	15 no. Rashidpur Union, Ward 3,4,5 and 7	High	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	1,000 Nos
River Bank Erosion	Union: 2 no. Sharifpur, In all wards	High	No Sufficient plantation	20,200 Nos
River Bank Erosion	Union: 3 no. Lakhkhir Char Union, Ward- 3, 7, 8,9	High	No Sufficient plantation	26,800 Nos
River Bank Erosion	Union: Tulshir Char Union, Ward-1,3,4,8,9	High	No piling	14,000 Nos
Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
River Bank Erosion	Union: 5 no. Etail, Ward- 3, &7	Moderate	Low depth of river bank;	23,000 Nos
River Bank Erosion	Union-Norundi Union, 1,2,3, and 4	Moderate	Low depth of river bank;	20,000 Nos
River Bank Erosion	Union: 9 no. Ranagach Union, Ward- 1,2, 3, 8 & 9	Moderate	No piling	15,000 Nos
River Bank Erosion	Union: 12 no. Teetpola Union, Ward- 5, 6,7,8 & 9	Moderate	Low depth of river bank;	20,000 Nos
River Bank Erosion	13 no. Mesta Union, Ward-1,2,5	Moderate	No piling	10,000 Nos
River Bank Erosion	14 no. Digpait, Ward-4,5, and 8	High	Low depth of river bank;	10,000 Nos
River Bank Erosion	15 no. Rashidpu r Union, Ward 3,4,5 and 7	High	No piling	10,000 Nos
Drought	Union: 1 no. Kendua ward 3,4,6, and 7	High	Low-lying without any dam-road. If it rains on the high lands, they have no sewerage system.	20,200 Nos
Drought	Union: 2 no. Sharifpur, In all wards	High	No Sufficient plantation	20,210 Nos

Drought	Union: 3 no. Lakhkhir Char Union, Ward- 3, 7, 8,9	High	No Sufficient plantation	28,000 Nos
Drought	Union: Tulshir Char Union, Ward-1,3,4,8,9	High	No Sufficient plantation	14,000 Nos
Drought	Union: 5 no. Etail, Ward- all wards	High	No Sufficient plantation	20,000 Nos
Drought	Union: 7 no. Ghoradhap Ward -all wards	High	No sufficient plantation, Natural Imbalance	25,148 Nos
Drought	Union: 8 no. Bashchora Unio, Ward- 1, 2, 4,5,6,7 & 9	Moderate	No Sufficient plantation, Natural Imbalance	29,000 Nos
Drought	Union: 9 no. Ranagach Union, Ward- 1,2, 3, 8 & 9	Moderate	No sufficient planation	20,000 Nos
Drought	Union: 10 No Sreepur Union, Ward: 1,2, 4, 5,6,7, & 9	Moderate	No sufficient planation	15,000 Nos
Drought	Union:11 No Shahabazpur Union, Ward: 1,2, 4, 5,6,7, & 9	Moderate	No sufficient planation	20,000 Nos
Drought	Union: 12 no. Teetpola Union, Ward- 2,3, 6,7 and 8	Moderate	No sufficient planation	20,000 Nos
Drought	13 no. Mesta Union, Ward-1,2,5	High	No sufficient planation	20,000 Nos
Disaster	The Unions are mostly disaster prone	Vulnerability	The reason behind the disaster	Vulnerable Population
Drought	14 no. Digpait, Ward-4,5,8 and 9	High	No sufficient planation	20,000 Nos
Drought	15 no. Rashidpur Union, Ward 3,4,5 and 7	High	No sufficient planation	20,000 Nos

Source: Field Data and DM Plan,2015.

3.3 Vulnerable people group

During the focus group discussions (FGDs) and Key Informant Interviews (KIIs), data were collected on the vulnerability of different groups to disasters in the study area. The information collected provided a more in-depth understanding of the vulnerabilities of the different groups and the reasons behind their vulnerability.

Women and children were found to be the most vulnerable to disasters, due to physical limitations, such as reduced mobility or difficulty accessing transportation, which hinder their ability to evacuate

quickly or seek shelter during a disaster. They are often left behind during evacuations and may face difficulties in accessing food, water, and healthcare. Women and children in the study area are also vulnerable to displacement, loss of livelihoods, and access to essential services (healthcare, sanitation, and hygiene facilities) during disasters. These problems lead to a higher risk of health issues, including infections and diseases. They face challenges in accessing reproductive healthcare and hygiene products, which can lead to additional health risks. Additionally, women are responsible for caregiving and household duties, which can be disrupted during disasters and put additional pressure on their already vulnerable position.

Pregnant women and newborns: Pregnant women face physical limitations due to their pregnancy, such as reduced mobility or difficulty accessing transportation, which hinders their ability to evacuate quickly or seek shelter during a disaster. Newborns, on the other hand, have immature immune systems and are more susceptible to illnesses and infections. Pregnant women and newborns lack the necessary resources to prepare for or cope with disasters. This includes access to clean water, adequate food, and medical care. Disasters can disrupt healthcare services, which can be particularly detrimental for pregnant women and newborns who require regular check-ups and specialized care. Pregnant women and new mothers experience increased stress during disasters, which can negatively impact their mental and physical health as well as their ability to care for their newborns.

Farmers were found to be among the most vulnerable groups in the study areas due to their dependence on agriculture for their livelihoods. They are severely affected by disasters such as floods, droughts, and cyclones, which can lead to crop loss and damage to infrastructure, such as irrigation systems. Farmers in the study area primarily rely on traditional farming practices and lack access to modern technology, irrigation facilities, and agricultural extension services. They often face crop loss due to the impact of natural disasters, leading to a loss of income and food security.

PWDs: PWDs face unique challenges during a natural disaster due to their physical, sensory, and cognitive impairments, which make them more vulnerable than the general population. The vulnerability of PWDs is compounded by inadequate infrastructure, lack of awareness, and limited access to resources and services, making them more susceptible to the adverse effects of natural disasters.

In Jamalpur, PWDs are at a higher risk of being affected due to the limited mobility caused by their impairments. PWDs who use wheelchairs or crutches face difficulties in moving around when the floodwaters rise. The lack of ramps and other assistive devices in public buildings and evacuation centers further complicates their mobility, making it difficult for them to access safe areas. Similarly, PWDs who are deaf or hard of hearing face communication barriers in receiving warnings and information, making them less likely to evacuate in time.

Moreover, the unavailability of accessible transportation exacerbates the vulnerability of PWDs in flood-prone areas. PWDs who use wheelchairs or other mobility aids require specially adapted vehicles to evacuate, which may not be available during an emergency. As a result, PWDs may be left behind and exposed to the risks of floodwaters, further putting their lives at risk.

In Bagerhat, the risk of injury and death from flying debris, falling structures, and strong winds is high for PWDs. PWDs who use mobility aids are particularly vulnerable due to their reduced mobility and inability to take shelter quickly. The lack of accessible shelters and insufficient knowledge of evacuation procedures further exacerbate their vulnerability. PWDs with visual impairments or cognitive disabilities may have difficulty understanding instructions and may require additional assistance during evacuation.

Furthermore, PWDs who rely on medical equipment, such as ventilators, dialysis machines, or oxygen tanks, face a higher risk of disruption of their treatment during a natural disaster. The loss of electricity and other essential services may lead to life-threatening situations for PWDs who depend on these devices. The unavailability of backup power and insufficient supplies of medical equipment and medication further increase the vulnerability of PWDs during a natural disaster. Additionally, PWDs who are deaf or hard of hearing are vulnerable due to communication barriers and may miss important warnings and information. PWDs who rely on medical equipment are also at risk due to the potential loss of power and essential services during a natural disaster.

Fishermen were found to be another vulnerable group, as fishing is the primary source of livelihood for a significant population in the coastal areas. They are vulnerable to cyclones, floods, and sea-level rise, which can damage their boats and fishing equipment and make it difficult to fish.

The elderly population is also at high risk during disasters, as they often have limited mobility and may require special care and attention. This can be particularly challenging during evacuations and in temporary shelters, where they may not have access to the necessary support and care.

Low-income groups were found to be among the most vulnerable to disasters, as they often lack access to resources, have limited coping mechanisms, and live in areas that are more susceptible to disasters. They may not have the financial resources to prepare for or recover from disasters and may be forced to rely on external aid. The list below shows (Table 9) vulnerable people and their vulnerability to disasters.

Table 9 List of vulnerable people and vulnerability to disaster

Groups	Vulnerability to Disasters
Farmers	Depend on agriculture for livelihoods and are affected by floods, droughts, and cyclones
Fishermen	Reliant on fishing as a primary source of livelihood and vulnerable to cyclones, floods, and sea-level rise
Women and Children	Most vulnerable to displacement, loss of livelihoods, and access to essential services during disasters
Elderly	High risk during disasters due to limited mobility and may require special care and attention
People with disabilities (PwD)	Physical, sensory, and intellectual disabilities limit their ability to evacuate, access safe shelter, and access to essential services during and after disasters.
Low-income groups	Most vulnerable due to limited access to resources, lack of coping mechanisms, and living in areas that are more susceptible to disasters

Source: Field data, 2023

3.4 Current community based early warning message

Community participation is crucial in achieving sustainability in managing natural disaster risks in Bangladesh. The country is frequently affected by various natural hazards such as tropical cyclones, floods, tornados, and river bank erosions that cause significant damage to lives and resources. While it may be impossible to completely prevent natural disasters caused by natural factors, their occurrence can be reduced through effective planning, management, and community participation (Mohammad & Huq, 2016).

The Bangladesh Department of Disaster Management (DDM) has developed three mobile-network-based warning message dissemination methods for coastal residents and disaster management committees. These include the **Cell Broadcasting System, Interactive Voice Response, and Short Message Service**. The Cell Broadcasting System targets residents in coastal areas, while the Interactive Voice Response allows residents to listen to a recorded warning message by calling a number. The Short Message Service is designed for field-level disaster management committees, providing updated information about approaching tropical cyclones via text messages on their mobile phones (MoDMR, 2014). Electronic media played a significant role in disseminating warning messages during both Sidr and Mahasen in Bagerhat. Megaphone was also important during Mahasen. Other media, such as newspapers and signal flags, did not significantly contribute. Electronic media had the

highest odds ratio and was found to be the most effective method of warning dissemination in Bagerhat (Roy, Sarkar, Åberg, & Kovordanyi, 2015).

An example can be given from 14-NOV-2007, the Disaster Management Information Centre Disaster Management Bureau (DMB) under the Ministry of Food and Disaster Management Special Weather disseminated a special Bulletin on Cyclonic Storm "SIDR" over North Bay of Bengal "*The severe Cyclonic Storm "SIDR" with a core of Hurricane winds over North Bay of Bengal was centered at 09 AM and may cross Khulna - Barisal coast by evening today (the 15 November 2007). The maritime port of Mongla has been advised to keep hoisted Great Danger Signal no. Ten (r) Ten. Maritime ports of Chittagong and Cox's Bazar have been advised to keep hoisted Great Danger Signal no.Nine (r) Nine. All fishing boats and trawlers over North Bay must remain in shelter till further notice*".

Also, "*The Severe Cyclonic Storm "Sidr" (Ecp 942 Hpa) with a core of Hurricane winds over North Bay of Bengal moved northwards and was centered at 09 am today (15th November 2007). About 500 kms South-Southwest of Chittagong Port, 435 Km Southwest of Cox's Bazar Port and 415 Km South of Mongla Port (Near Lat 18.6° N & Long 89.2° E). It Is likely to intensify further and move in a northerly direction and cross khulna-barisal coast by evening today (15 th November 2007)*".

There was nothing significant in these warning messages for the local residents about the situation and no clarification/indication of what to do or where to go for shelter. In a study at Bagerhat, the top reasons for non-evacuation during Mahasen (another Tropical cyclone (TC)) were identified through Principal Component Analysis (PCA) and revealed four main components that explained 70.215% of the variance of non-evacuation reasons. The first component was the unreliability of early warnings, which represented the original variable of mistrust in the warning message. This suggests that some individuals did not believe the warning messages and may have been hesitant to evacuate due to doubts about the accuracy of the information provided.

The second component was related to the unclear warning message and the distance to shelters, which were aggregated from the original variables of not understanding the instructions in the warning message and the distance to the shelter. This indicates that some individuals may not have fully understood the warning message or may have felt that the distance to shelters was too far to travel.

The third component was the need to protect property while minimizing risk, which was aggregated from the original variables of sending family members to shelter, family head staying at home to protect the property, and guessing that the intensity of the TC would not be strong by looking at the surrounding situation. This suggests that some individuals may have been hesitant to evacuate because they were concerned about protecting their property or did not perceive the storm as a significant threat.

The fourth component was difficulties with transportation, which represented the original variable of poor road-transport conditions. This suggests that some individuals may have been unable to evacuate due to issues with transportation, such as poor road conditions or a lack of available transportation. These findings suggest that there were multiple factors that contributed to non- evacuation during Mahasen in Bagerhat, including doubts about the reliability of early warning messages, unclear instructions, concerns about property, and difficulties with transportation. These findings highlight the importance of addressing these issues in disaster preparedness and response plans to improve evacuation rates and protect vulnerable populations during natural disasters (Roy et al., 2015).

The field study undertaken in Morrelganj and Rampal divulged the existence of informal yet functional community-based forecasting and early warning systems, leading to a dearth of synchronized early warning dissemination, evacuations, or prompt responses. The communities rely heavily on the discernment of their elders, who provide guidance based on the state of the sky and the wind's velocity. On occasion, the Union Parishad (UP) disseminates information to the community leaders, both men and women, who act as Civil Society Organizations (CSOs) by the Upazilla Social Welfare.

*"I received information about the disaster through a megaphone at the mosque, which prompted me to go to the shelter house. However, due to the distance, we do not have access to information disseminated through the mosque. Moreover, the absence of any Cyclone Preparedness Programme (CPP) volunteers in our area is concerning. While I was in contact with or getting messages from Union Parishad representatives prior to the disaster. So, the current absence of Early Warning Systems (EWS) is a matter of concern."-**Sufia Begum, Women CSO, Khaulia Union, Morrelganj**. "Sometimes Union Parishad disseminates EW using a megaphone, but it's carried away by the river. Many times, we are unable to hear the announcements in our area."-**Sharmin Akhter, Posurbunia, Morrelganj.***

*"We rely on TV and radio for information. The government does not inform us directly here."-**Muzaffar Shekh, Shoilta khali, Rajnagar.***

In Bangladesh, flooding is a major natural disaster that affects a significant number of people frequently. To mitigate the impact of flooding, the government has implemented the Community-Based Disaster Management (CBDM) approach, which operates at the Union Council (UC) level. Each UC has a Union Disaster Management Committee (UDMC) responsible for managing disasters at the community level. Dissemination of flood risk information is a critical part of the flood forecasting and early warning system (FFEWS) in Bangladesh (Al-Mueed et al., 2021).

The flood-forecasting observation systems have become more advanced, information regarding impending floods is primarily communicated to government and other agencies, and it fails to reach vulnerable communities in a comprehensible format. Even when such information is disseminated, it is often too sophisticated and communicated through technologies that are either inaccessible or

incomprehensible to many at-risk populations ("Community-Based Early Warning-Bringing Institutions, Science, and Society Together" 2013).

Community relies on television and Local Authorities for Flood Early Warning in Two Upazilas of Jamalpur. The study finds that, in two upazilas of Jamalpur district, local people also rely on messages from the Bangladesh Water Development Board (BWDB) and Union Parishad for early warning of floods. Additionally, representatives from the local communities, including school headmasters and respected individuals, Women CSOs, receive messages from the upazila administration and disseminate them to their respective communities. However, they lack the necessary equipment, such as safety vests, helmets, torch lights, solar panel lights, and handheld microphones.

The role of local government in disseminating early warning messages during a disaster is crucial in ensuring the safety of the local population. Local government institutions such as Union Parishads, and Upazila are responsible for disseminating early warning messages to the people living in their respective areas. One of the key roles of the local government is to ensure that early warning messages are delivered in a timely and effective manner. This involves having a well-established communication network that can quickly disseminate the warning messages to the local population. The local government is responsible for ensuring that this communication network is in place and functioning properly.

Another important role of the local government is to ensure that the warning messages are easily understood by the local population. This involves translating the messages into the local language and using simple, easy-to-understand language. The local government can also use local radio stations and other media outlets to disseminate the warning messages.

In addition, the local government is responsible for coordinating with other government agencies and non-governmental organizations (NGOs) to ensure a comprehensive and coordinated response to the disaster. This involves working closely with the Bangladesh Meteorological Department, the Department of Disaster Management, and other relevant agencies to develop an effective disaster response plan.

To receive early warning messages, some community members call the hotline number 1090. The imams of local mosques are also responsible for disseminating flood warning messages through the mosque's public address system. It is noteworthy that people also need to be informed about the eastern flow of rivers for early warning to be effective.

Despite some shortcomings, the community's involvement in the early warning system has proven to be effective in saving lives and minimizing damage during floods. However, there is a need for better equipment and resources to improve the system's efficacy and ensure the safety of the community

during emergencies.

3.5 Impact based forecasting system

Impact-based forecasting and warning services are designed to bridge the gap between those who produce and those who use warning information. These services aim to connect different components of early warning systems to increase their effectiveness. In Bangladesh, impact-based forecasting and warning services have enormous potential.

The World Meteorological Organization (WMO) recognizes the need for impact-based forecasting and warning services to overcome the gaps hindering effective early warning systems, as highlighted during the Third UN World Conference held in Sendai in 2015. The term "impact-based" focuses on end-users by forecasting the expected consequences of hazards for different sectors of interest. Although recently introduced, best practices in impact-based forecasting and warning services can be found in national meteorological services such as the UK Meteorological Office and the United States National Weather Service, as well as in international programs led by WMO through dedicated workshops. However, integrating these services requires significant institutional changes such as an inter-facing agency or team, adjusted policy frameworks, and new resource allocations for skills development and technological innovation from national to local levels. (Sai, Cumiskey, Weerts, Bhattacharya, & Haque Khan, 2018).

According to DRRO, Jamalpur "*Bangladesh has implemented an Impact-based Early Warning System (EWS) to forecast and warn communities about the impacts of natural disasters such as floods, cyclones, and landslides. The system is designed to provide warnings based on the expected impacts on communities and infrastructure, rather than just the severity of the hazard event. The Bangladesh Meteorological Department (BMD), the Department of Disaster Management (DDM), and other agencies work together to operate and maintain the EWS. The system uses a range of tools and technologies including weather radar, river level gauges, and satellite imagery to forecast potential hazards and their likely impacts. The EWS also includes an alert system that sends messages to community members via mobile phones, community loudspeakers, and other communication channels to ensure that people can take appropriate actions to protect themselves and their families*". Following the SoD, 2019, the study team found the following impact- based early warning system for Bangladesh which is shown in Table 10.

Table 10 Impact based early warning system prescribed in SoD, 2019.

For Sea Ports		For River Ports		Wind (km/h)	Probable Effects/Impacts
Sl. No.	Revised Signals for	Sl No.	Revised Signals for		
1	Distant Cautionary Signal Number I			51-61	
2	Distant Cautionary			62-88	
For Sea Ports		**For River Ports**		**Wind (km/h)**	**Probable Effects/Impacts**
Sl. No.	**Revised Signals for**	**Sl No.**	**Revised Signals for**		
3	Local Warning Signal Number III	1	Local cautionary Signal Number III	40-50	• Branches of small trees may be broken. • Roofs of lighthouses may be blown away or damaged. • May damage the crops if the depression gains power.
4	Local Warning Signal Number IV	2	Local Warning Signal Number IV	51-61	• Some coconut trees may be broken and some of the big trees may be uprooted. • Crop fields may be severely damaged. • Kacha and semi-paka houses may be partially or fully damaged.

5	Danger Signal Number VI	3	Danger Signal Number VI	62-88	• Many coconut trees may be broken and destroyed. • Many big trees may be uprooted. • Crops may be severely damaged. • Roofs of most of the *kacha* and semi- *pucca* houses may be blown away or damaged.
For Sea Ports		**For River Ports**		**Wind (km/h)**	**Probable Effects/Impacts**
Sl. No.	**Revised Signals for**	**Sl No.**	**Revised Signals for**		
6	Great Danger Signal Number VIII	4	Great Danger Signal Number VIII	89-117	• Areas within the warning area may experience severe negative impacts. • Uncounted coconut and other big trees may be destroyed or uprooted. • Standing crops may be fully damaged. • All the *kacha* and semi- *pucca* houses may be severely damaged. • Selected areas and their low-lying areas may be flooded with ft height tide. • Light to moderate brick structures may also be significantly affected.

7	Great Danger Signal Number IX	5	Great Danger Signal Number IX	118-170	• Areas within the warning area may experience severe negative impacts. • Uncounted coconut and other big trees may be destroyed or uprooted. • Standing crops may be fully damaged. All the *kacha* and semi-*pucca* houses may be severely damaged. Light to moderate brick structures may Selected areas and their low-lying areas may be flooded with ft height tide.be heavily disrupted also be significantly affected. Electricity supply and communications.

8	Great Danger Signal Number X	6	Great Danger Signal Number X	More than 171	• Areas within the warning area may experience severe negative impacts. • Uncounted coconut and other big trees may be destroyed or uprooted. • Standing crops may be fully damaged. • All the *kacha* and semi-*pucca* houses may be severely damaged. • Light to moderate brick structures may also be significantly affected. • Electricity supply and communications may be heavily disrupted. • Selected areas and their low-lying areas may be flooded with ft height tide.

Source: SoD, 2019.

However, the field study reported that the information provided by the local government before a disaster does not include the "extent" of the damage that will be incurred. When making announcements at the union level, people are told to take shelter in safe places or in the designated shelter house when there are signs of a disaster. However, there is no information on how much damage will be caused or which areas will be affected the most. Also, these messages are not reaching everyone, as discussed earlier. There are several institutes that develop impact forecast models for various hazards, including floods and cyclones, in Bangladesh. Some of the major institutes involved in this work are the Bangladesh Meteorological Department (BMD), Institute of Water Modelling (IWM), Centre for Environmental and Geographic Information Services (CEGIS), Bangladesh University of Engineering and Technology (BUET), Practical Action Bangladesh, etc. The Bangladesh Meteorological Department (BMD) has developed an impact forecast model to better predict the potential impacts of weather- related disasters such as cyclones and floods. The model was developed in collaboration with

international partners, including the United States Agency for International Development (USAID), and is designed to improve early warning and preparedness efforts in Bangladesh. The IWM's impact forecast model uses a combination of hydrological and hydraulic models to forecast the potential impact of flooding on different areas of Bangladesh. The model takes into account a range of factors, including rainfall data, river water levels, and topographical data, to create a detailed map of the areas that are likely to be affected by flooding. The Centre for Environmental and Geographic Information Services (CEGIS) developed an impact forecast model for Bangladesh. The model is called the Flood Inundation Simulation and Vulnerability Evaluation Model (FISVEM). It is a comprehensive model that takes into account various factors such as topography, land use, soil types, rainfall, river flow, and other meteorological parameters to simulate and forecast the flood situation in different regions of the country. FISVEM also uses remote sensing and Geographic Information System (GIS) technologies to provide detailed information on the extent and severity of flood inundation. It can provide forecasts of the potential impacts of floods on various aspects of life, including agriculture, livestock, transportation, health, and infrastructure.

Bangladesh University of Engineering and Technology (BUET) has also developed an impact forecast model for flood forecasting and management. The BUET flood forecasting model is based on a two-dimensional hydraulic model that can simulate the water level and velocity of water flow in a river system. The model uses data from multiple sources, including satellite imagery, remote sensing, and ground-based measurements, to simulate the behavior of the river system under different flood scenarios.

3.6 Impact assessment within the area

According to Quader et al., 2017, the impact of cyclone “Sidr” was highly visible in all components of direct loss, with vulnerable unions on the central coast being moderate to very seriously impacted. A comparison of risk and impact maps revealed that the places of very high death and injury by cyclone Sidr in the southern part of the central coast matched with very high-risk areas of equal hazard and non-mitigated risk maps shown in figure 2.

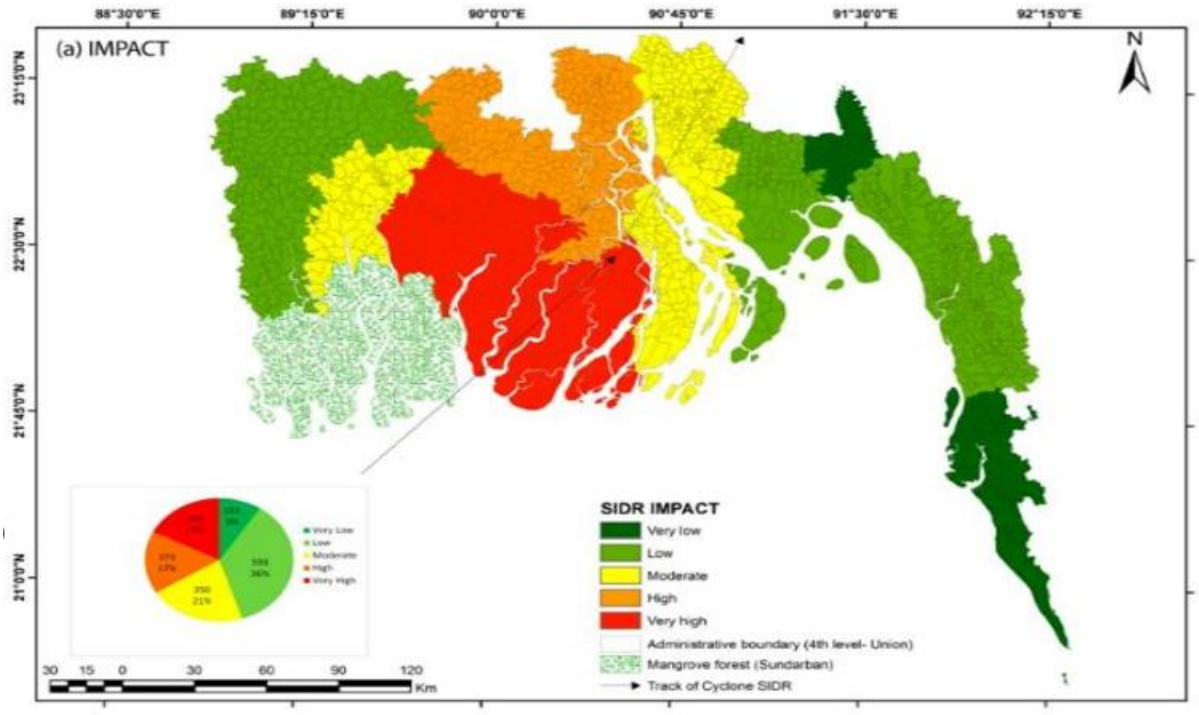

Figure 2 Impact of cyclone "Sidr" as per Quader et al, 2017

Another study reported that, Bangladesh is vulnerable to climate risk due to heavy rainfall and high temperatures, and vulnerability is worsened by their proximity to the sea, putting the population living in these areas, particularly at risk. Given the climate extremes that households in the coastal areas of Bangladesh face, it is crucial to focus on understanding available climate risk and adaptation strategies in the region. Upstream diversions may also aggravate future salinity problems in Bagerhat districts. Furthermore, the study areas are prone to extreme weather events, such as heavy pre-monsoon season storms and cyclones, which often lead to waterlogging (Aryal et al., 2020).

Quader et al., 2017, also evaluate the regional risk of cyclone casualties and damage at the lowermost administrative level of Bangladesh. Cyclones in Bangladesh pose a significant threat to the poor, landless coastal inhabitants who rely on natural resources. Cyclones have caused loss of lives, and damage to agriculture, infrastructure, settlements, and communication networks. One of the major concerns for policymakers in Bangladesh is the number of human deaths and injuries caused by cyclones, particularly those associated with storm surges. Although the number of casualties has decreased from major cyclones over the years, the probability of human loss due to future cyclones remains significant. Factors affecting the number of casualties include landfall time, synchronization with high tides, wind speed, and the proper dissemination of accurate warnings. The number of casualties from cyclones depends on multiple conditions, and similar warning signals can have different impacts due to variations among the characteristics of the people living along the coast, their exposure, and their ability to respond. The government has taken measures at both policy and implementation levels to reduce the number of casualties, such as enacting standing orders on disasters, building

polders and cyclone shelters, and implementing cyclone preparedness programs.

The information provided in the table highlights some of the deadliest and costliest cyclones that have affected coastal regions of Bangladesh in recent decades. It is evident from the data that cyclones in Bangladesh have been responsible for significant human and economic losses, especially in the southern coastal regions.

The deadliest cyclone in Bangladesh's history, Cyclone Bhola, struck in 1970, killing more than 500,000 people in the southern coastal areas. It remains one of the worst natural disasters in recorded history. Other major cyclones, including Gorky in 1991, Nargis in 2008, and Sidr in 2007, have also caused extensive human casualties and significant economic losses. The economic losses from these cyclones have been significant, with some storms causing billions of dollars in damages. For example, Cyclone Amphan in 2020 resulted in an estimated $14 billion in damages, while Cyclone Nargis in 2008 caused an estimated $10 billion in damages.

Cyclones in Bangladesh pose a significant threat to the population and the economy. While the government and various organizations have taken steps to mitigate the impact of these storms, there is still much work to be done. This includes improving early warning systems, preparing emergency response plans, and investing in infrastructure that can withstand the impact of these storms. It is crucial that the government and other stakeholders continue to prioritize measures that can protect the population and the economy from future cyclones.

Table 11: Losses during different kinds of cyclones

Cyclone Name	Date	Wind Speed	Affected Areas	Human Loss	Economic Loss
Bhola	1970	222 km/h	Southern coast	500,000+	Unknown
Gorky	1991	250 km/h	Coastal regions	140,000	$1.5 billion
Sidr	2007	240 km/h	Southern coast	3,363	$1.7 billion
Aila	2009	120 km/h	Coastal regions	339	$40 million
Roanu	2016	88 km/h	Coastal regions	29	$100 million
Amphan	2020	170 km/h	Coastal regions	128	$14 billion
Fani	2019	205 km/h	Coastal regions	89	$1.8 billion
Nargis	2008	215 km/h	Coastal regions	138,000+	$10 billion
Mora	2017	81 km/h	Coastal regions	7	$10 million
Bulbul	2019	120 km/h	Coastal regions	20	$1.2 billion

Titli	2018	150 km/h	Coastal regions	70	$211 million
Bijli	2009	100 km/h	Coastal regions	10	$3 million

Source: Secondary Data

The cyclone damage costs app. 15,65,90,000 in Bdt for Human Resources, Agriculture, Infrastructure, and Health in Morrelganj and Rampla Upazila. River Erosion damages cost 10 crores specifically on Agriculture, Infrastructure, and Communication. Nevertheless, Salinity costs 5 crores on damage to Fisheries and Agriculture sectors.

Table 12 Losses during different kinds of cyclones in Morrelgani and Rampal

Name of disaster, year, amount of damage and affected sectors in Morrelganj and Rampal.	Year	Loss (BDT)	Sector
Cyclone	2007-2008	15,65,90,000/=	Human Resource, Agriculture, Infrastructure, and Health.
River Erosion	2010-2013	10 crores	Agriculture, Infrastructure, and Communication
Salinity	2008	5 crores	Fisheries & Agriculture.

Source: Upazila Disaster Management Report (DM Report), 2015.

Bangladesh is also prone to different types of floods such as flash, pluvial, fluvial, and coastal floods. Flash floods occur during the pre-monsoon season, typically between March to May, in the north-eastern region due to heavy rainfall in the hilly regions of India. Rain-fed flooding is caused by drainage congestion and heavy rainfall in secondary water courses called khals. Coastal flooding mostly occurs during the pre-monsoon and post-monsoon seasons. The economic loss caused by floods is a major obstacle to the country's development.

One of the most catastrophic floods was in 1987, which lasted from July to September and affected 50 out of 64 districts. The flood caused over 2,000 human casualties and economic losses of 1.4 billion USD. The next year, in 1988, another flood hit 50 out of 64 districts, causing over 1,000 human casualties and economic losses of 369 million USD.

In 1998, a flood affected 68 out of 460 upazilas, resulting in 918 human casualties and economic losses of 2.2 billion USD. The floods of 2004, 2007, and 2008 also caused significant human and economic losses, affecting a total of 105 out of 192 districts in the country. The 2007 floods affected 35 out of 64 districts, causing over 2,800 human casualties and economic losses of 1.2 billion USD.

The floods of 2009 affected 28 out of 64 districts and caused 141 human casualties and economic losses of 962 million USD. The following year, in 2010, floods affected 32 out of 64 districts, causing 176 human casualties and economic losses of 1.0 billion USD. The floods in Bangladesh are not limited to the monsoon season. In 2011, Southeast Asia experienced severe flooding from July to September, affecting 32 out of 64 districts in Bangladesh. The floods caused 224 human casualties and economic losses of 1.0 billion USD.

In recent years, floods have continued to cause significant human and economic losses in Bangladesh. The floods of 2012, 2013, 2014, 2015, 2016, and 2017 affected various districts across the country, causing human casualties and economic losses. The floods of 2017 affected 32 out of 64 districts, causing 160 human casualties and economic losses of 3.1 billion USD.

The floods in Bangladesh have been a recurring issue for the country, causing significant human and economic losses. The country has taken various measures to mitigate the effects of floods, such as building embankments, creating flood shelters, and improving early warning systems. However, with the increasing frequency and severity of floods due to climate change, more efforts are needed to protect the population and economy from future flood events.

Table 13 Disaggregated data on flood and loss

Flood Name	Date	Affected Areas	Human Loss	Economic Loss (in USD)
1987 Floods	July-Sept 1987	50 out of 64 districts	2,041	1.4 billion
1988 Floods	June-Sept 1988	50 out of 64 districts	1,050	369 million
1998 Floods	July-Sept 1998	68 out of 460 upazilas	918	2.2 billion
2004 Floods	July-Aug 2004	36 out of 64 districts	767	503 million
2007 South Asian Floods	July-Aug 2007	35 out of 64 districts	2,862	1.2 billion
2008 Floods	July-Sept 2008	34 out of 64 districts	1,110	1.2 billion
2009 Floods	July-Aug 2009	28 out of 64 districts	141	962 million
2010 Floods	July-Sept 2010	32 out of 64 districts	176	1.0 billion
2011 Southeast Asia Floods	July-Sept 2011	32 out of 64 districts	224	1.0 billion
2012 Floods	June-Aug 2012	22 out of 64 districts	161	257 million
2013 Floods	June-Sept 2013	27 out of 64 districts	147	2.3 billion

2014 Floods	June-Sept 2014	28 out of 64 districts	91	2.2 billion
2015 Floods	June-Sept 2015	31 out of 64 districts	178	1.8 billion
2016 Floods	June-Sept 2016	25 out of 64 districts	115	2.2 billion
2017 Floods	June-Aug 2017	32 out of 64 districts	160	3.1 billion

Source: Secondary data.

Islampur and Jamalpur located in Jamalpur district of Bangladesh, have experienced various natural disasters in the past few decades. The disasters include floods, river erosion, north-wester, drought, heavy rainfall, fog, and cold wave. Floods have been a recurring problem in the area, and have hit the region in 2001, 2003, 2004, 2007, and 2010. The damage caused by floods is estimated to be around 138 crore Bangladeshi Taka, affecting various sectors such as livelihood, agriculture, homestead, transportation/roads, bridge/culvert, fisheries, health, and education. River erosion has also been a major issue in Islampur, affecting the area in 2001, 2003, 2005, 2006, 2007, 2009, 2011 and 2013. The estimated damage caused by river erosion is around 97 crore Bangladeshi Taka, affecting sectors such as land, agricultural crops, fisheries, roads, bridges, educational institutions, livelihood, and vegetation. North-wester, a weather phenomenon that causes high winds and heavy rainfall, has affected the area in 2001, 2003, 2006, 2009, and 2011, causing damage of approximately 7 crore 22 lac Bangladeshi Taka. This disaster has affected crops, houses, trees, infrastructure, educational institutions, and other sectors. Drought also affected the region in 2006, 2007 and 2010, causing damage of approximately 15 crore 7 lac Bangladeshi Taka. The drought has affected crops, livelihood, vegetation, livestock, and health. In 2009, heavy rainfall caused damage of approximately 1 crore 2 lac Bangladeshi Taka, affecting sectors such as livelihoods, crops, and vegetables. Fog and cold waves affected Islampur in 2009, 2010, 2011 and 2012, causing damage of approximately 83 lac Bangladeshi Taka. This disaster has affected sectors such as livelihoods, crops, vegetables and health.

Table 14 Disaggregated data on loss in Islampur and Jamalpur Sadr Upazila for flood

Name of the disaster	Year	Amount of Damage	Affected Sectors
Flood	2001, 2003, 2004, 2007 & 2010	Approximately about 138 crores	Livelihood, agriculture, homestead, transports/roads, bridge/culvert, fisheries, health, education, etc.
River Erosion	2001, 2003, 2005, 2006, 2007, 2009, 2011 and 2013	Approximately about 97 crores	Land, agricultural crops, fisheries, roads, bridges, educational institutions, livelihood and vegetation
North-wester	2001, 2003, 2006, 2009 & 2011	Approximately about 7 crore 22 lac	Crops, houses, trees, infrastructure, educational institutions, etc.
Drought	2006, 2007 and 2010	Approximately about 15 crore 7 lac	Crops, livelihood, vegetation, livestock, health, etc.
Heavy rainfall	2009	Approximately about 1 crore 2 lac	Livelihoods, crops, vegetables, etc.
Fog and Cold Wave	2009, 2010, 2011 and 2012	Approximately about 83 lacs	Livelihoods, crops, vegetables, health etc.

Source: Upazila Disaster Management Report (DM Report), 2015.

During severe floods, 68% or more of the country's land area is affected, while in an average year, up to 25% of the land area is flooded. For instance, the flood in 1988 affected 90,000 km² of the country, resulting in approximately US$ 2.0 billion in damages, 2,330 deaths, and affected 45 million people. Agricultural damages are the primary cause of flood damages, although industries in the Pabna and Sirajganj areas also suffered substantial losses during the floods of 2004 and 2007. In 1998, the flood caused US$ 2.8 billion in damages and resulted in 1,100 deaths, while the flood in 2004 was estimated to cause about US$ 2 billion in damages (Ali et al., 2018).

According to this current study in Bagerhat, the most immediate and devastating impact of cyclones is the loss of human life and injuries. Storm surges cause flooding that leads to widespread property damage, including damage to homes, infrastructure, and crops. Cyclones also lead to the displacement of large numbers of people who are forced to seek temporary shelter in evacuation centers or with relatives. In addition, the economic impacts of cyclones were significant, particularly in regions that rely heavily on agriculture or fisheries.

In Jamalpur, flooding causes loss of life and damage to buildings, homes, and infrastructure such as

roads and bridges. This forced people to leave their homes and seek shelter elsewhere, leading to displacement, disruption of livelihoods, and other related issues. Floodwaters are contaminated with bacteria, viruses, and other harmful pathogens, leading to water-borne diseases such as cholera, typhoid, and dysentery. This causes soil erosion, sedimentation, and nutrient depletion, leading to long-term damage to agricultural land and ecosystems. Floods result in significant economic losses due to damage to property, crops, and infrastructure, and disruption of business activities.

3.7 Triggers used by the current EWS

The Bangladesh Meteorological Department is responsible for issuing cyclone warning messages through its Storm Warning Centre (SWC), which has upgraded its warning system using computer methods to reach vulnerable coastal and offshore island populations. The SWC analyses synoptic charts and meteorological information, including wind speed and direction, pressure, cloud, temperature, humidity, rainfall, and satellite imageries, from various sources. Low pressure is identified, and alert messages are disseminated quickly to coastal people via radio, television, news media, and other agencies. Daily and monthly weather forecast reports are prepared, and warning messages are disseminated by radio and television at frequent intervals during disaster times. The system aims to save human lives and minimize losses (Akhand, 2003).

The Bangladesh Meteorological Department (BMD) uses various triggers to predict and warn about potential hazardous events in the country. These triggers include wind speed and direction, pressure, cloud, temperature, humidity, rainfall, and satellite imagery, which are obtained from various sources. For cyclones, the BMD uses a benchmark wind speed of 62 kilometers per hour (km/h) to issue a danger signal number one. When the wind speed increases to 88 km/h, danger signal number two is issued, and when it reaches 117 km/h, danger signal number three is issued. If the wind speed exceeds 166 km/h, a special warning signal is issued.

Table 15 Triggers and threshold benchmarks

Trigger Name	Threshold Benchmark
Wind speed	62 km/h
Wind direction	Change of 45 degrees
Pressure	Drop of 1.6 hPa/hour
Cloud cover	Increase of 2 octas
Temperature	Decrease of 2-3 degrees Celsius
Humidity	Increase of 10-15%
Rainfall	More than 15 mm in an hour
Satellite imageries	Observation of cloud formation or depression

Source: BMD Data.

For floods, the BMD uses rainfall data to predict the likelihood of flooding. A benchmark of 50 millimeters (mm) of rainfall within 24 hours is used to issue an advisory, while a benchmark of 100 mm of rainfall within 24 hours is used to issue a warning. If the rainfall exceeds 200 mm within 24 hours, a special warning is issued. The benchmark triggers used by BMD for temperature monitoring in Bangladesh include different ranges of temperature values for different timeframes. For example, if the maximum temperature recorded at a station exceeds 40°C, it is considered a heatwave warning and is expected to last for more than two days. Similarly, if the minimum temperature drops below 4°C, it is considered a cold wave warning and is also expected to last for more than two days.

The BMD's benchmarks for rainfall are based on the amount of rainfall received in a particular area over a 24-hour period. The benchmarks are as follows:

- Light rain: 2.5-7.5 mm of rainfall in 24 hours
- Moderate rain: 7.6-35 mm of rainfall in 24 hours
- Heavy rain: 35.1-60 mm of rainfall in 24 hours
- Very heavy rain: 60.1-100 mm of rainfall in 24 hours
- Extremely heavy rain: More than 100 mm of rainfall in 24 hours

The BMD also uses rainfall data from various sources, including its own network of rain gauges, Doppler radar, and satellite imageries, to assess the severity of rainfall and issue warnings accordingly. In addition to the BMD, other organizations such as the Flood Forecasting and Warning Centre (FFWC) and the Water Development Board (WDB) also monitor rainfall and issue warnings for potential floods and other disasters. The FFWC, for example, issues flood warnings based on the amount of rainfall received in various rivers and tributaries across the country. The WDB, on the other hand, uses rainfall data to manage water resources and prevent floods by regulating the flow of rivers and canals.

During flood events in Bangladesh, the BMD uses several benchmarks to issue warnings at different timeframes. These benchmarks are based on the water level of different rivers, which are monitored continuously by the Bangladesh Water Development Board (BWDB) and other agencies. For instance, during a flood event, the BMD may issue warnings based on the following benchmarks:

Within 3 days (72 hours): The BMD may issue a flood outlook warning if the water level of a river is expected to exceed the danger level within the next 3 days. This warning provides an early indication of potential flooding, allowing people to prepare for evacuation or other measures.

Within 2 days (18-24 hours): If the water level of a river is likely to cross the danger level within the next 2 days, the BMD may issue a flood warning. This warning is more urgent than the outlook warning and indicates that flooding is imminent.

Within 1 day (12-18 hours and 6-12 hours): If the water level of a river is expected to cross the danger level within the next 1 day, the BMD may issue an urgent flood warning. This warning indicates that flooding is highly likely, and people should take immediate action to protect themselves and their property. The BMD also provides updates on the water level of different rivers and issues revised warnings as necessary. These warnings are disseminated through various channels, including radio, television, and social media, to reach as many people as possible.

The triggers for **cyclone alerts** include low-pressure areas forming over the Bay of Bengal, depression intensification, deep depression intensification, and cyclonic storm intensification. The benchmarks used by BMD for cyclone alerts and warnings are as follows:

Cyclone alert: Within 3 days - BMD issues an alert when a low-pressure area forms and shows the possibility of intensifying into a cyclone within the next three days.

Cyclone warning signal no. 3: Within 2 days (18-24 hours) - BMD issues warning signal no. 3 when a depression intensifies into a deep depression and is likely to intensify further into a cyclonic storm within the next 18-24 hours.

Cyclone warning signal no. 4: Within 1 day (12-18 hours) - BMD issues warning signal no. 4 when a deep depression intensifies into a cyclonic storm and is likely to intensify further into a severe cyclonic storm within the next 12-18 hours.

Cyclone warning signal no. 5: Within 6-12 hours - BMD issues warning signal no. 5 when a severe cyclonic storm is likely to cross the coast within the next 6-12 hours.

The cyclone warning signals are broadcast to the public and relevant authorities through various media channels, including radio, television, and online platforms, to ensure that they take necessary precautions and evacuate to safe places.

By predicting the occurrence of a cyclone, its potential destructiveness can be minimized, leading to a significant reduction in loss of lives and properties. **Special Weather Bulletins are immediately sent via various means, such as fax, teleprinter, and telephone, to radio, television, press media, the Cyclone Preparedness Programme (CPP), and the Disaster Preparedness Programme (DPP) for necessary action**. The warnings are also relayed to the Prime Minister's Office, the Ministry of Disaster Management and Relief, the Directorate of Relief, and concerned ministries, airports, seaports, and naval bases. When a depression forms in the Bay of Bengal, an early warning for a cyclone is issued. Radio and television broadcast the warning beyond their normal transmission hours as soon as a cyclone warning advising to hoist signal number 3 is issued. Before a cyclone crosses the coast, warnings are issued 18-24 hours in advance for an intensifying depression into a cyclonic storm, 12-18 hours for danger warnings, and 6-12 hours for great danger warnings. Weather Bulletins with the code

address "Hurricane" are issued to all heads of government medium in case of a danger warning, and warning bulletins with the code address "Typhoon" are disseminated to all concerned and police stations in case of great danger. Now, early cyclone warning signals can be disseminated to the community through various information media at frequent intervals to ensure preparedness for the event of a cyclone strike (Akhand, 2003).

Table 16 Triggers used by various organizations

Trigger	UN	IFRC	START Ready
Hazardous events	Extreme weather events (floods, cyclones, droughts, etc.), geological events (earthquakes, landslides, etc.), and human-induced events (industrial accidents, conflicts, etc.)	Natural disasters and conflicts	Climate-related and weather-related disasters (cyclones, floods, droughts, etc.), geological disasters (earthquakes, landslides, etc.), and human-induced disasters (industrial accidents, conflicts, etc.)
Impact	Death, injury, displacement, damage to infrastructure and property, loss of livelihoods, and other negative consequences	Death, injury, displacement, damage to infrastructure and property, loss of livelihoods, and other negative consequences	Death, injury, displacement, damage to infrastructure and property, loss of livelihoods, and other negative consequences
Vulnerability	High population density, poverty, weak governance and institutional capacity, and other socioeconomic factors	High population density, poverty, weak governance and institutional capacity, and other socioeconomic factors	High population density, poverty, weak governance and institutional capacity, and other socioeconomic factors
Preparedness	Early warning systems, emergency response plans,	Early warning systems, emergency response	Early warning systems, emergency response plans,
Trigger	**UN**	**IFRC**	**START Ready**
	disaster risk reduction strategies, and capacity building for communities and authorities	plans, disaster risk reduction strategies, and capacity building for communities and authorities	disaster risk reduction strategies, and capacity building for communities and authorities
Response	Humanitarian assistance, including food, water, shelter, and medical care, and support for recovery and reconstruction	Humanitarian assistance, including food, water, shelter, and medical care, and support for recovery and reconstruction	Humanitarian assistance, including food, water, shelter, and medical care, and support for recovery and reconstruction

Actors	UN agencies, national and local authorities, civil society organizations, and affected communities	National Red Cross and Red Crescent Societies, international organizations, national and local authorities, civil society organizations, and affected communities	National and local authorities, scientific and technical institutions, civil society organizations, and affected comm

Source: Secondary source.

Table 16 compares the triggers of disasters used by the United Nations (UN), the International Federation of Red Cross and Red Crescent Societies (IFRC), and the START Network's START Ready program. All three organizations recognize extreme weather events, geological events, and human-induced events as hazardous events that can trigger disasters. The impact of disasters, according to all three organizations, includes death, injury, displacement, damage to infrastructure and property, loss of livelihoods, and other negative consequences. They all also recognize that vulnerability is influenced by socioeconomic factors such as high population density, poverty, weak governance, and institutional capacity. In terms of preparedness, all three organizations emphasize the importance of early warning systems, emergency response plans, disaster risk reduction strategies, and capacity building for communities and authorities. The response to disasters involves providing humanitarian assistance, including food, water, shelter, and medical care, and support for recovery and reconstruction.

The actors involved in disaster response include UN agencies, national and local authorities, civil society organizations, and affected communities for the UN. The IFRC involves the National Red Cross and Red Crescent Societies, international organizations, national and local authorities, civil society organizations, and affected communities. For START Ready, actors include national and local authorities, scientific and technical institutions, civil society organizations, and affected communities.

It is important to note that the Government of Bangladesh also has its own triggers for disaster, which include natural hazards such as floods, cyclones, tornadoes, earthquakes, landslides, and droughts, as well as man-made disasters such as fires, chemical spills, and building collapses. The government's disaster response efforts involve preparedness and prevention measures, including early warning systems, disaster risk reduction programs, and capacity building for communities and authorities. The response to disasters includes search and rescue operations, medical care, food and water distribution, and support for recovery and reconstruction. The actors involved in disaster response include national and local authorities, the armed forces, civil society organizations, and affected communities.

At a national scale, hazard for flood risk was calculated for various return periods (25, 50, 100, and 150 years), while vulnerability was assessed based on population, housing, livelihoods, critical facilities, and infrastructures by the DDM in 2016. The FFWC, which operates under the Bangladesh Water Development Board (BWDB), is responsible for monitoring and predicting water levels (WLs). Currently, a deterministic 5-day forecast is available for 54 representative stations along 21 rivers.

The required precipitation data for the forecast is collected from the Bangladesh Meteorological Department (BMD) and the Indian Meteorological Department (IMD) for the part of the GMB basin located in India, as stated by the BWDB in 2014. The Flood Forecasting and Warning Centre (FFWC) in Bangladesh is responsible for monitoring and forecasting water levels in 21 rivers across the country. The FFWC issues flood warnings based on predetermined "danger levels" (DL) set by the Bangladesh Water Development Board (BWDB) for each station. DLs are defined as the level above which floods may cause damage to nearby crops and homesteads. The FFWC uses a color-coded system to indicate the severity of flooding. Flood forecast bulletins are disseminated to government and non-government organizations, media groups, and other concerned parties. The Disaster Management Committees (DMCs) at different levels coordinate warning dissemination and response actions. The framework for flood risk management in Bangladesh involves a combination of hazard and vulnerability assessments, early warning systems, and response actions (Sai et al., 2018).

In the focus group discussion, the community members stated that they occasionally receive flood warning messages, but these are usually through radio or television. Sometimes they also receive news from the market or community representatives. However, these sources of information are not always sufficient.

3.8 Disaster Preparedness plan of the study area

In general, disaster preparedness plans include early warning systems, evacuation plans, emergency supplies and shelters, and training programs for community members. It's important for local governments and communities to work together to identify and address the specific risks and needs of their area, as well as to regularly review and update their disaster preparedness plans to ensure their effectiveness.

According to DRRO Jamalpur and PIO Morrelganj, the **flood forecasting and early warning system** (**FFWC**) is responsible for monitoring and forecasting water levels in Bangladesh's rivers and issuing flood warnings. The center provides deterministic forecasts up to five days in advance at **54 representative stations on 21 rivers**. The **BMD provides weather forecasts and warnings** for Bangladesh. The department uses a network of weather stations, radars, and satellites to monitor weather patterns and issue warnings for severe weather events. Also, the CPP is a community-based early warning system that focuses on cyclones. The program trains volunteers in coastal communities to disseminate warnings and help people evacuate to safe shelters**. Unfortunately, there is no CPP activity in Jamalpur and Bagerhat (only present in Mongla Upazila) districts**. In addition, the EEWS is a newly established system that aims to provide early warnings for earthquakes in Bangladesh. The system uses a network of sensors to detect seismic activity and issue warnings to vulnerable communities. The DMIC is also responsible for disseminating warnings and coordinating disaster response efforts in Bangladesh. The center works with various government agencies and stakeholders to ensure timely and effective communication of warnings and response actions.

According to the Union Parishad member, Jamalpur Sadar, for both cyclones and floods, evacuation plans typically involve moving people to designated shelters, often located in schools or other public buildings. These shelters are identified and maintained by the local government and are equipped with basic facilities such as water, sanitation, and medical aid. During flood events in Jamalpur, the government and local community leaders use boats to evacuate people from flooded areas to safer locations. In addition to physical evacuation plans, the government and local communities also have communication plans in place to disseminate information about evacuation orders and the location of shelters. This includes the use of loudspeakers, mobile phone messages, and other forms of communication. But there are no organized volunteer groups to work actively on the evacuation process in the upazilas in Jamalpur.

According to the PIO, Morrelganj, there are several government and non-government organizations (NGOs) working on disaster preparedness in Bangladesh. The Red Crescent Society (BDRCS) is one of the primary organizations responsible for disaster management and response in the country. They work with communities to build awareness and prepare for disasters, including providing training and

support for evacuation plans, emergency supplies, and shelters but their activities are found absent in the Morrelgnj upazila. Other government organizations involved in disaster preparedness include the Department of Disaster Management and Relief (DDMR) and the Fire Service and Civil Defense (FSCD).

According to the community representative in Amurbunia, Morrelganj, "*Despite the efforts of these organizations, there are still gaps in disaster preparedness in union parishad, particularly in remote and hard-to-reach areas. There is a need for more resources and support for these areas, as well as greater coordination between government and NGO efforts*".

"*We are ready to form women group volunteers, men group volunteesr or special volunteer groups for the disabled and elderly. But we need assistance from the union parishad*"-Women CSO, Khaulia, Morrelganj, Bagerhat.

To effectively address the challenges of disaster management in Bangladesh, there are several key elements that must be in place. These include clear Disaster Risk Reduction (DRR) plans and legislation, which would enable the strengthening of legal frameworks. Coordination among national services is also essential for sharing information and disseminating warnings that take exposure and vulnerability of the elements at risk into account.

In addition, promoting communication and dissemination systems that ensure warnings are received at all community levels, through clear protocols and procedures that are regularly tested, evaluated, and maintained, is crucial. Emergency preparedness, including education on how to appropriately use weather-, water-, and climate-related information and early warnings, is also important.

Implementation of local to national emergency response plans with clear and regularly updated procedures, practiced through simulation exercises, is necessary to ensure an effective response to disasters. Assigning clear roles and responsibilities for all organizations and stakeholders at different territorial levels would improve the efficiency, credibility, trust, and cost-effectiveness of the risk management procedure.

Elaborating feedback mechanisms between national to local governments, national services, and the community, would facilitate the evaluation and improvement of the warning system. In-depth collaboration through developing institutional networks and participatory strategic plans with multi-disciplinary research and multi-stakeholder participation is also crucial. Finally, promoting the availability of economic and human resources would establish proper priorities and allow for their secure allocation.

3.9 National-level current financing mechanism

The government of Bangladesh **allocates funds in the national budget to support various institutions responsible for disaster management**, including the Ministry of Food and Disaster Management, the Disaster Management Bureau, and the Directorate of Relief and Rehabilitation. In times of emergencies, other agencies such as the Armed Forces Division, Bangladesh Police, Bangladesh Ansars, Fire Service, and Civil Defense Directorate also contribute. The National NGO Coordination Committee on Disaster Management provides a mechanism for coordinating government and NGO activities (Habib et al., 2012).

The costs of operating and maintaining the Bangladesh Meteorological Department and other early warning systems are covered by the government budget and donations from international organizations and countries. The Ministry of Food and Disaster Management has established special funds for disaster response and recovery, risk reduction, sectoral planning, and disaster management. The National Disaster Response and Recovery Fund and the National Risk Reduction Fund have been established by the government for disaster response and recovery and projects related to prevention, mitigation, and preparedness.

Relevant ministries, divisions, directorates, and departments also provide funding in their annual budget to support disaster risk reduction programs outlined in their Sectoral Development Plans. Additionally, disaster management committees at the district, upazila, union, city corporation, and paurashava levels arrange for their own Disaster Management Fund to implement programs and activities outlined in their respective Disaster Management Plans. These funds are operated under government-formulated guidelines and may be funded by the government, local government, and local donations. (Habib, Shahidullah, & Ahmed, 2012).

In Bangladesh, disaster management activities are coordinated at the national, divisional, district, upazila, and union levels. At the district level, there is a district disaster management committee (DDMC) that is responsible for coordinating disaster management activities within the district. The DDMC is chaired by the deputy commissioner (DC) of the district, and its members include representatives from different government agencies, non-governmental organizations (NGOs), and the private sector.

At the upazila level, there is an upazila disaster management committee (UDMC) that is responsible for coordinating disaster management activities within the upazila. The UDMC is chaired by the Upazila Nirbahi Officer (UNO), and its members include representatives from different government agencies, NGOs, and the private sector. At the union level, there is a union disaster management committee (UDMC) that is responsible for coordinating disaster management activities within the

union. The UDMC is chaired by the union parishad chairman, and its members include representatives from different government agencies, NGOs, and the private sector.

The coordination process at each level involves the following activities:

Disaster risk assessment: The DDMC, UDMC, and UDMC conduct disaster risk assessments to identify the risks and vulnerabilities within their respective areas. Planning and preparedness: Based on the risk assessments, the committees develop disaster management plans and ensure that the necessary resources and capacities are in place to respond to disasters. Response and recovery: When a disaster occurs, the committees coordinate the response activities, such as search and rescue, evacuation, and providing relief supplies. They also coordinate the recovery activities, such as rebuilding infrastructure and restoring livelihoods. Monitoring and evaluation: The committees monitor and evaluate the effectiveness of the disaster management activities and make necessary adjustments to improve the response and recovery efforts in the future.

The coordination process at the district, upazila, and union levels in disaster management in Bangladesh involves a multi-sectoral approach that involves different stakeholders working together to ensure a coordinated and effective response to disasters. In Bangladesh, the financial/fund process at the district, upazila, and union levels in disaster management involves various actors and mechanisms, including:

National Disaster Management Fund (NDMF): The government of Bangladesh allocates a portion of its annual budget for disaster management to the NDMF, which is used to finance disaster preparedness, response, and recovery efforts at the national, district, and upazila levels. District Disaster Management Committee (DDMC): Each district has a DDMC that coordinates disaster management efforts at the district level, including the allocation and disbursement of funds for disaster preparedness, response, and recovery. Upazila Disaster Management Committee (UDMC): Each upazila has a UDMC that coordinates disaster management efforts at the upazila level, including the allocation and disbursement of funds for disaster preparedness, response, and recovery.

Union Parishad Disaster Management Committee (UPDMC): Each union parishad has a UPDMC that coordinates disaster management efforts at the union level, including the allocation and disbursement of funds for disaster preparedness, response, and recovery.

Donor agencies: In addition to government funds, donor agencies and international organizations also provide financial support for disaster management in Bangladesh. These funds are typically channeled through the government or local NGOs and are used to support various disaster management activities, including relief distribution, shelter construction, and livelihood rehabilitation.

The financial/fund process at the district, upazila, and union level in disaster management in Bangladesh involves a coordinated effort between government agencies, local communities, and donor agencies to ensure that funds are effectively allocated and disbursed to support disaster preparedness, response, and recovery efforts.

By investigating, SoD,2019, KIIs and FGDs, the primary financing mechanism for disaster preparedness in Bangladesh is through the government's annual budget allocation. The Ministry of Disaster Management and Relief (MoDMR) is the key government agency responsible for disaster management and preparedness in the country. The MoDMR receives an annual budget allocation from the government, which is used to fund various disaster preparedness and risk reduction initiatives. In addition to the government budget, there are also external funding sources available for disaster preparedness in Bangladesh. Many international organizations such as the United Nations Development Programme (UNDP), World Bank, Asian Development Bank (ADB), and the European Union (EU) provide funding for disaster preparedness and risk reduction initiatives in the country.

NGOs and civil society organizations also play an important role in disaster preparedness in Bangladesh. They work closely with the government and international organizations to implement disaster risk reduction initiatives and provide support during disasters. To ensure the efficient use of funds, the government has established a number of financial management procedures and guidelines for disaster preparedness projects. For instance, project proposals need to be aligned with national disaster risk reduction strategies and guidelines, and project implementation and reporting procedures must be transparent and accountable.

In recent years, Bangladesh has also made significant progress in establishing innovative financing mechanisms for disaster preparedness. One such mechanism is the government's Disaster Management Fund, which was established in 2015. The fund is financed by a levy on mobile phone operators and is used to support disaster preparedness initiatives across the country.

Commonly, the national-level financing mechanism for disaster preparedness in Bangladesh involves a combination of government budget allocation, external funding sources, and innovative financing mechanisms portrayed in Table 14. The government and other stakeholders work together to ensure that funds are used efficiently and effectively to reduce the risks associated with disasters.

Table 17 Current Financial mechanism for disaster preparedness.

The Disaster Management Bureau (DMB) under the Ministry of Disaster Management and Relief is responsible for coordinating disaster management activities in Bangladesh.
⬇
The government of Bangladesh allocates a budget for disaster management activities in the Annual Development Program (ADP).
⬇
The DMB prepares a budget proposal for disaster management activities and submits it to the Ministry of Disaster Management and Relief.
⬇
The Ministry of Disaster Management and Relief reviews and approves the budget proposal, and submits it to the Ministry of Finance for inclusion in the ADP.
⬇
Once the budget is approved, the DMB receives the allocated funds and disburses them to relevant agencies and organizations for implementing disaster preparedness plans.
⬇
Non-governmental organizations (NGOs) and international organizations also provide financial support for disaster preparedness activities in Bangladesh.
⬇
The DMB coordinates with these organizations to ensure that their activities align with the national disaster preparedness plans.
⬇
The DMB also maintains a database of all funds received and disbursed for disaster preparedness activities, and conducts regular monitoring and evaluation to ensure accountability and transparency in the use of funds

Source: SOD, 2019.

However, the local people especially in Morrelganj and Rampal Upazilas do not have such easy access to finance prior to, during and after disasters. In particular, a female representative who worked on disaster relief efforts shared her experience during Cyclone Sitrang,

"I sheltered 45 people in my home. I contacted the Union Parishad members to inform them of the situation and was able to arrange some dry foods for them during Sitrang (2022)"- Women Social Volunteer.

"*Currently, we only provide assistance to the river-affected people. The person list is provided by UNO and we have given ten thousand takas to each person who lost their houses for river bank erosion.*"- Social Welfare Officer, Morrelganj, Bagerhat.

3.10 Disaster risk financing in Bangladesh

A. Government

The Finance Division in the Ministry of Finance is the core body that allocates domestic disaster-related funding across different governmental and nongovernmental layers. Budgetary matters including allocations are outlined in the annual budget document at the beginning of each financial year. In particular, the Finance Division allocates the required budget to each line ministry, which adds up to the central government budget.

The budgetary system in Bangladesh involves several small pockets of money dedicated to disaster management. Some of the identified pockets are as follows:

- **Disaster Risk Reduction Fund.** It is dedicated specifically to disaster risk reduction. The amount available could not be identified but is likely to be modest.
- **Emergency Fund Disaster Management.** It is allocated to the Deputy Commissioner at the district level. The amount is confirmed to be small.
- **Fund for Unforeseen Incidents.** It is available each year amounting to one billion taka (approximately $ 14.28 million). This funding can be allocated for any purpose in an ordinary year.
- **Palli Karma-Sahayak Foundation.** It is a microfinance wholesaler and implements

Climate Resilience Fund under the Ministry of Finance. Headed by the Ministry, a high- level committee decides on the distribution of funds to participating nongovernment organizations (NGOs). When there is a domestic funding gap following catastrophes, typically the foreign financing mechanism is initiated. The Economic Relations Division of the Ministry of Finance mobilizes foreign financing through multilateral and bilateral development partners

B. Bangladesh Bank

Bangladesh Bank issued Environmental Risk Management Guidelines to banks and financial institutions to assess environmental risk in their credit portfolio. As a pioneering initiative, Bangladesh Bank created a separate fund named Bangladesh Bank Disaster Management and Corporate Social Responsibility Fund in 2013. This fund is utilized for capacity building in different disaster risk management and socially responsible projects. Under this fund, it is envisaged that each of the 88 institutions deposits Tk50 million, potentially adding to Tk4.5 billion (approximately $64.3 million),

that could be made available for post-disaster response, disaster risk management, and capacity building.

C. Insurance Sector

The micro insurance products offered by the general insurance companies are health and flood insurance. Several leading microfinance institutions (MFIs), including Grameen Bank and Proshika, have implemented small-scale livestock microinsurance programs to protect their investment loans for dairy cattle and water buffalo livestock producers.

There is a "meso-level" index-based flood insurance being piloted in Sirajganj area by the **Swiss Agency for Development and Cooperation, Oxfam, Pragati General Insurance, Palli Karma- Sahayak Foundation (PKSF), Manab Mukti Sangstha** and **Swiss Redcross**. The insurance coverage is for the peak flood period (16 August–30 September), and the maximum payout is Tk8,000.

D. Microfinance Sector

BRAC, a microfinance NGO, has made specific arrangements for flood disasters: (i) clients can withdraw savings up to a specific pre-established amount; (ii) regular loan repayments can be suspended; (iii) interest rates can be reduced for up to 2 months; (iv) loans can be restructured for clients with marginal disaster losses; (v) loans can be refinanced for clients with high disaster losses; (vi) new loans are offered for productive asset replacement of up to 12 months at 15% interest; and (vii) an option of disbursement in the form of seeds, animals, and other in-kind materials is also available. After the 1998 floods, BRAC extended loans to 240,000 families for repairing and rebuilding homes.

PKSF has also set up a Disaster Management Program under which it waives the entire outstanding loan amount if the income-earning person in the household is killed due to a disaster. This is an important risk management approach because PKSF's microcredit programs have a total outreach of 35 million people. To help them cope with and recover from disasters, PKSF has created a fund called SAHOS ("courage" in Bangla) under its Disaster Management Program to provide quick financial assistance to poor families. SAHOS provides emergency medical services, water, and sanitation. As of June 2014, 149 partner organizations participated in this program, and they disbursed Tk5.0 billion (approximately $63 million) to 120,698 borrowers. Most of the loans were made during tropical Cyclone Sidr (2007) and Cyclone Aila (2009).

BURO Tangail, an NGO, has a contingency fund for major disaster events or other emergencies. Funding for climate-related disasters has majorly come from institutional donors, pooled funds, private funds, and other miscellaneous sources that contributed to a smaller segment. The majority of the funding has come from institutional donors represented by foreign offices of developed nations and economic regional entities. One institutional donor- the Foreign Commonwealth and

Development Office (FCDO) out of 17 institutional donors contributed 32% of the overall funding alone, followed by the European Civil Protection and Humanitarian Aid Operations (ECHO) which attributed 14% of the total funding. The Central Emergency Response Fund (CERF) attributed 12% of total funds[11].

[11] *Source: Disaster Risk Financing in Bangladesh, ADB South Asia Working Paper Series No. 46, September 2016*

Table 18 Summary of the anticipatory initiatives implemented in 2020

Crisis	Flood			Cyclone	Riverbank Erosion	Disease Outbreak
Name of Initiative	FbA cash distribution and evacuation support for 2020 Flood	UN Flood Anticipatory Pilot 2020	'Supporting Flood Forecast-based Action and Learning in Bangladesh' (SUFAL) August 2019 – January 2021	Forecast based Actions for Cyclone AMPHAN 2020	Start Fund Bangladesh Riverbank Erosion 2020	Start Fund Bangladesh Dengue Anticipatory Response 2020
Funding Agency	DREF and Swiss RC	CERF	ECHO	DREF	FCDO, UK Aid through Start Fund Bangladesh	FCDO, UK Aid through Start Fund Bangladesh
Fund disbursed (USD)	279,393	5,340,000	1,339,976	203,398	68,365	70,755
Partner	BDRCS	WFP, FAO, UNFPA	CARE, Concern Worldwide, Islamic Relief Bangladesh	BDRCS	CARE	SEEP
Geographical Coverage	Kurigram, Gaibandha, Jamalpur	Bogura, Gaibandha, Kurigram, Jamalpur, Sirajganj	Kurigram, Gaibandha, Jamalpur	Barguna, Patuakhali, , Pirojpur, Satkhira, Khulna, Bagerhat, Bhola, Lakshmipur, Noakhali, Jhalokathi	Kurigram	Dhaka

Key Interventions	Cash, Evacuation	Cash, Fodder and Storage, Improved	Risk Communication, Evacuation, Shelter,	Dry Food, Evacuation	Cash, NFI, Hygiene Kit	Risk Communication, Disinfection,
Crisis	**Flood**			**Cyclone**	**Riverbank Erosion**	**Disease Outbreak**
		access to services and protection	WASH			Model Simulation

(Sources: FBA/AA Technical Working Group Mapping of Anticipatory Actions 2020)

3.11 Potential stakeholders for AA plan

In the implementation of the Anticipatory Action Plan in the area, various stakeholders may play vital roles in ensuring the success of the program. The Chairperson of the National Disaster Management Advisory Committee provides strategic guidance on policies and plans for disaster risk management. The Director of Administration for the CPP determines strategic policies to operate the actions of the program, while the representative from the Local Government Division ensures the appropriate use of all resources submitted to the board for release.

The Bangladesh Space Research and Remote Sensing Organization (SPARRSO) evaluates the understanding of communities on cyclone warning signals and recommends required revisions. The Bangladesh Meteorological Department assists in preparing and updating contingency plans and organizing regular drills on earthquakes, fires, floods, cyclones, and other natural disasters.

The Disaster Preparedness Programme develops and implements district disaster management plans that combine the Risk Reduction Action Plan and Contingency Plan. The International Federation of Red Cross and Red Crescent Societies (IFRC) assists in executing other activities for the smooth implementation of the Cyclone Preparedness Programme.

The Bangladesh Water Development Board provides specific recommendations to take measures for timely dissemination of weather bulletins among the last mile users, while the District Representative of electronic media, community radio, and Betar conducts effective publicity campaigns to make disaster forecasts and warning messages understandable to the people and build their awareness.

The District Information Officer undertakes necessary steps to speedily disseminate early warning messages to the last mile, and all UNOs under the concerned district provide necessary assistance for the formation and functioning of the Union Disaster Management Committee. All Upazila Parishad Chairpersons of the concerned district assist the Union Committee to assess vulnerability and risk and

undertake initiatives for integrating them into the risk reduction action plans prepared by the Union Committees, then sent to the District Disaster Management Committee and Department of Disaster Management.

Lastly, the Upazila Project Implementation Officer undertakes necessary initiatives for pre-disaster preparedness at household and community levels and enhances awareness for risk reduction while also taking measures to disseminate disaster forecasts quickly and effectively. All Ward Councilors inform the local people about risk reduction measures at the family and community levels and provide support to build their capacity for their implementation. Through the collective efforts of these stakeholders, the Cyclone Preparedness Programme can effectively prepare and respond to potential natural disasters in Bangladesh. Details of the stakeholders are listed in Table 19.

Table 19 Potential stakeholders for AA Plan preparation

Potential stakeholders	Roles
Chairperson of the National Disaster Management Advisory Committee;	**Role:** Provide strategic guidance on policies and plans for disaster risk management
Director (administration), Cyclone Preparedness Programme (CPP)	**Role:** Determine strategic policy to operate the actions of the Cyclone Preparedness Programme (CPP);
Representative, Local Government Division	**Role:** Appropriate use of all resources of the programme that are submitted by the Cyclone Preparedness Policy Committee to the board for release;
Representative, Bangladesh Space Research and Remote Sensing Organization (SPARRSO)	**Role**: Evaluate understanding of communities on cyclone warning signals and recommend required revisions.
Representative, Bangladesh Meteorological Department	**Role**: Assist in preparing and updating contingency plans organizing regular related drills on earthquakes, fires, floods, cyclones, etc.;
Representative, Disaster Preparedness Programme	**Role:** Develop and implement district disaster management plans combining Risk Reduction Action Plan and Contingency Plan
Representative, International Federation of Red Cross and Red Crescent Societies (IFRC)	**Role:** Assist execution of other activities for the smooth implementation of the Cyclone Preparedness Programme;
Representative, Bangladesh Water Development Board	**Role:** Provide specific recommendations to take measures for timely dissemination of weather bulletins among the last mile users;
District Representative of electronic media, community radio and Betar (one from each)	**Role:** Conduct effective publicity campaigns to make the disaster forecasts and warning messages understandable to the people and build their awareness;
District Information Officer	**Role:** Undertake necessary steps to speedily disseminate early warning messages to the last mile;
All UNO under the concerned district	**Role:** Provide necessary assistance for formation and functioning of the Union Disaster Management Committee;
All Upazila Parishad Chairperson of the concerned district	**Role:** Assist the Union Committee to assess vulnerability and risk and undertake initiatives for integrating them into the risk reduction action plans prepared by the Union Committees then send to the District Disaster Management Committee and Department of Disaster Management;
Potential stakeholders	**Roles**

Upazila Project Implementation Officer (PIO)	**Role**: Undertake necessary initiatives for pre-disaster preparedness at household and community levels and enhance awareness for risk reduction. Undertake measures to disseminate disaster forecasts quickly and effectively;
All Ward Councilor	**Role:** Inform the local people about risk reduction measures at family and community levels and also provide support to build their capacity for their implementation
Youth forum	**Role:** Youth forums can actively participate in AA planning meetings and contribute their ideas and insights to ensure that the plan is comprehensive and inclusive. • Youth forums can help to mobilize the community and raise awareness about the importance of AA, the early warning system, and the actions to be taken in case of an emergency. • Youth forums can help identify vulnerable groups, including the elderly, disabled, and marginalized communities, and assist in developing tailored plans to meet their specific needs. • Youth forums can assist in data collection and analysis of disaster risk and vulnerabilities in their communities. They can also help in the monitoring and evaluation of AA interventions. • **Youth** forums can leverage technology to support AA, such as using social media and mobile applications to disseminate early warning messages, conduct surveys, and track response efforts. • Youth forums can help raise funds and mobilize resources for AA activities, including equipment and supplies needed for early response.
Potential stakeholders	**Roles**
Women's CSOs/CBOs	• **Role:** Women's CSOs/CBOs can play a critical role in ensuring that women's voices are heard in community-based early warning systems. They can work with local communities to identify the most effective ways to disseminate early warning messages to women, who are often more vulnerable to the impacts of disasters. • Women's CSOs/CBOs can play a key role in conducting gender-sensitive risk assessments. They can work with local communities to identify the specific risks faced by women and girls in disaster- prone areas, and develop strategies to address these risks. • Women's CSOs/CBOs can advocate for policies that address the specific needs of women and girls in disaster-prone areas. This can include policies related to access to healthcare, education, and livelihoods, as well as policies that address gender-based violence in the aftermath of disasters. • Women's CSOs/CBOs can work with local communities to build resilience to disasters. This can include developing early warning systems, improving infrastructure, and promoting sustainable livelihoods. Women's CSOs/CBOs can work to ensure that women's voices are heard in decision-making processes related to disaster management. They can advocate for the inclusion of women in decision-making bodies at the local, national, and international levels.

PwD CBOs	• PwD CBOs can advocate for the inclusion of PwDs in all aspects of disaster management, including AA planning. They can provide insights into the specific needs and challenges of PwDs during disasters and contribute to the development of appropriate AA measures. • PwD CBOs can also work with local authorities and other stakeholders to ensure that AA measures are accessible and inclusive for PwDs. For example, they can advocate for the inclusion of sign language interpretation or accessible communication methods in AA alerts and warnings. PwD CBOs can also help to ensure that AA shelters and evacuation routes are accessible for PwDs and that necessary medical supplies and equipment are available. In addition, PwD CBOs can play a vital role in educating their communities about the importance of AA planning and the specific needs of PwDs during disasters. They can collaborate with other CSOs and NGOs to organize awareness-raising campaigns and training programs on disaster risk reduction and preparedness.
Potential stakeholders	**Roles**
Farmers CBOs	• Farmers CBOs can be engaged in various ways. • Firstly, they can provide valuable input into the early warning systems and risk thresholds that are being developed. By sharing their knowledge and experience, they can help ensure that the early warning systems are effective and relevant to the local context. ▪ Secondly, farmers CBOs can be engaged in the development and implementation of the response plans that are triggered by the early warning systems. They can provide input into the selection of appropriate response measures, such as seed distribution, water management, and livestock protection. • Thirdly, farmers CBOs can help to ensure the sustainability of AA interventions by supporting the development of long- term resilience measures, such as crop diversification, soil conservation, and agroforestry. They can also play a key role in disseminating information about the AA interventions to other farmers in the community

3.12 Market Assessment and CVP

In the study area, a feasibility study was conducted to assess the viability of providing cash or in-kind assistance to the community. The study team also conducted a rapid market assessment to evaluate the functioning of local markets and the availability of financial service providers (FSPs). The community's preferences were found to be in favor of cash assistance due to the flexibility it offers in making their own choices.

The market assessment showed that the local markets were functioning well, and products were readily available. This meant that cash or in-kind assistance was feasible, considering the lack of guaranteed income and potential price fluctuations on essential commodities. However, both the voucher modality and cash assistance were suitable for the study. The assessment also revealed that almost all the communities were familiar with mobile-based financial services, and FSPs were actively utilized even in local markets. The accessibility of mobile phones was mostly controlled by men and young people. Different FSPs were compared, and it was found that bKash, Nagad, Rocket, and banks functioned well at the community level. Finally, the assessment showed that 85% of communities were familiar with the cash payment process through an FSP. The beneficiaries' preference for cash was due to the flexibility it affords. The market assessment recommended using cash as the primary modality and vouchers where cash was not feasible.

According to the Focus Group discussion, following NGOs Uttaran, BRAC, ESDO, Islamic Relief, Torongo, PKSF and ASHA have been working in the possible intervention areas to address various development issues, including microcredit, women's empowerment, WASH and health. These organizations have been involved in diverse interventions that have positively impacted the lives of many people in Bangladesh. But it is confirmed, that none of the organizations worked with EWS within the area.

In Morrelganj, Uttaran has been working on issues related to land rights, climate change, and disaster risk reduction. The organization has been working to help vulnerable communities in the coastal areas of Bangladesh adapt to the impacts of climate change, such as rising sea levels and increased frequency of cyclones. Uttaran has also been working to help communities secure their land rights, which is a crucial issue in a country where many people live in informal settlements.

In Jamalpur, BRAC, one of the largest NGOs in the world, has been working on various development issues in Bangladesh, including education, health, and poverty reduction. One of the organization's flagship programs is its microcredit program, which has helped millions of people in Bangladesh access small loans to start businesses and improve their livelihoods. BRAC has also been working to promote women's empowerment and gender equality in Bangladesh.

In Jamalpur, ASHA, another prominent NGO in Bangladesh, has been working on various health issues,

including maternal and child health, family planning, and HIV/AIDS prevention. The organization has been working to improve access to health services in rural areas of Bangladesh, where many people do not have access to basic health services.

ESDO, an environmental organization, has been working with USAID on various projects related to climate change and disaster risk reduction. The organization has been involved in the NOBODIP project, which aims to help vulnerable communities in Bangladesh adapt to the impacts of climate change. ESDO has also been involved in the Shuhardo project, which is a joint initiative between CARE and USAID that aims to improve the livelihoods of women and girls in rural areas of Bangladesh.

These organizations have been working on diverse interventions in Bangladesh that have positively impacted the lives of many people. While they may not be directly involved in early warning systems, their work on issues such as disaster risk reduction and climate change adaptation can indirectly contribute to building resilience in vulnerable communities.

3.13 Assessing the area's forecast system and the frequency of false alarm rate

The Early Warning System (EWS) for floods in Bangladesh was developed by the Flood Forecasting and Warning Centre (FFWC), under the Water Development Board (BWDB) and was established in 1972. Also, the Storm Warning Center (SWC) is a specialized unit of BMD, and is responsible for forecasting and issuing warnings for tropical cyclones (TCs) in Bangladesh (Table 17) (Roy, Sarkar, Aberg, & Kovordanyi, 2015).

The Anticipatory Action Plan for flood-prone areas in Bangladesh uses impact-based forecasting to trigger actions based on a predefined trajectory. The forecast-derived anticipatory impact analysis includes the probability of flood intensity, exposure of location, population, and economic resources, and the susceptibility of exposed elements to suffer adverse effects when affected by a hazard. The plan uses the Global Flood Awareness System (GloFAS) as one of the sources to provide a location-specific forecast of flood severity and probability. Localized forecast sources such as the Flood Forecasting and Warning Centre (FFWC) river point-based forecast will also be considered for readiness and response activation.

To maximize the use of available forecasts, the plan employs a two-step trigger mechanism. The readiness trigger is reached when the GloFAS 30-day forecast predicts a 50% probability of reaching 2 to 5 years or the worst return period of a flood, which should match with the FFWC 15-day probabilistic forecast of water level rising for three consecutive days among any two of the three observation points. The response activation trigger is reached when the GloFAS 10-day forecast predicts a 50% probability of reaching 2 to 5 years or the worst return period of a flood, which matches with the FFWC 5-day deterministic forecast of water level flowing over danger level or rising three consecutive days

among any two of the three observation points. It also matches with the FFWC 10-day probabilistic forecast of water level rising for three consecutive days among any two of the three observation points (Joint Contingency Plan of Start Network, 2022).

Table 20 BMDs alert system prior to a cyclone

Cyclone Stages	Warning message
Cyclone alert stage	BMD issues a cyclone alert message and informs the maritime ports, the river ports, and the media about the approaching TC
Cyclone warning stage	This second stage is initiated at least 24 hours before a predicted landfall, when wind speeds get between 51 km/h and 61 km/h. A cyclone warning message is sent to the respective authorities and media, containing information about: (a) the current and forecasted position of the TC, (b) the TCs movement direction and rate of movement, (c) 3 maritime ports and areas likely to be hit, (d) current maximum wind speed, (e) forecasted height of the storm surge, and (f) suggested safety measures for fishing boats
Cyclone disaster stage	This stage is initiated at least 18 hours before landfall. If the maximum wind speed within the TC exceeds 61 km/h, a cyclone danger warning is issued, and an updated danger-warning message is disseminated every 30 minutes.
Cyclone great-danger stage	This last stage is initiated at least 10 hours before the predicted landfall. If the wind speed exceeds 89 km/h, a cyclone great-danger warning message is issued and the residents are urged to evacuate at this point (DDM report,2009). Updates to a great-danger warning message are usually disseminated every 15 minutes

Source: Total Disaster Risk Management -Good Practice 2005.

During TCs in Bagerhat, a majority of respondents received warning messages (83% during Sidr and 93% during Mahasen). Reasons for not receiving messages included living in remote areas and lack of access to radio/television. Of those who received messages, megaphones were the most common method (76%), followed by radio/television (73%), signal flags (21%), and word of mouth (4%) (Roy et al., 2015).

The Flood Forecasting Warning Centre (FFWC) in Jamalpur produces various weather reports, flood maps, and warning messages, but this information is only accessible to institutions and not the communities (Kumar, 2021).

Lack of accuracy and reliability in flood prediction models has led to false alarms being triggered, causing a loss of faith in the information and systems within the community. (Concept Note on Dynamic Flood Risk Model under Flood Preparedness Programme Department of Disaster Management Ministry of Disaster Management and Relief, 2021)

Based on the findings of the study, it is evident that households' decisions to evacuate were influenced more by social, individual, and household factors than by the warning messages received. The study

attributes this to the lack of credibility of the warning messages, which failed to provide specific and accurate information such as the expected time of landfall, wind speed, and surge heights.

Furthermore, the study highlights several false alarms. In 2007, Cyclone Sidr, a category 4 tropical cyclone, struck Bangladesh. The warning messages lacked specific and accurate information, including the time of possible landfall, exact trajectories, wind speed, and surge heights. As a result, many households were influenced more by social, individual, and household attributes than the actual warning messages themselves.

Two years later, in 2009, Cyclone Aila, a category 1 tropical cyclone, hit Bangladesh. Once again, the warning messages lacked specific and accurate information, leading to households relying on social and household factors in making evacuation decisions.

In September 2007, a false alarm for a tsunami warning was issued, causing panic and fear among the population. Cyclone Rashmi in October 2008 and Cyclone Bijli in April 2009 also had warning messages that were inaccurate and caused confusion among the population.

In 2013, Cyclone Mahasen hit Bangladesh, and the warning messages once again lacked specific and accurate information, including the time of possible landfall, exact trajectories, wind speed, and surge heights. The situation was no different in 2022 when Cyclone Sitrang struck Bangladesh, and the warning messages once again lacked specific and accurate information. These false alarms further eroded the credibility of the warning system and raised questions about its accuracy.

Table 21 Frequency of false alarm

Disaster	Reason for False Alarm
Cyclone Sidr, 2007	Lack of specific and accurate information in warning messages, including time of possible landfall, exact trajectories, wind speed, and surge heights
Cyclone Aila, 2009	Lack of specific and accurate information in warning messages, including time of possible landfall, exact trajectories, wind speed, and surge heights
Tsunami warning in September 2007	False alarm
Cyclone Rashmi in October 2008	False alarm
Cyclone Bijli in April 2009	False alarm
Cyclone Mahasen, 2013	Lack of specific and accurate information in warning messages, including time of possible landfall, exact trajectories, wind speed, and surge heights
Cyclone Sitrang, 2022	Lack of specific and accurate information in warning messages, including time of possible landfall, exact trajectories, wind speed, and surge heights

Source: Field data, 2023.

In light of these findings, it is important for the Bangladesh warning system to provide accurate and timely information to households during disasters to ensure their safety. This requires investing in advanced technologies and developing better communication strategies to disseminate information effectively. It is also essential to consider the social and cultural factors that influence households' decisions to evacuate and develop tailored messages that address these factors. Ultimately, a robust warning system that is credible, reliable, and responsive is crucial in protecting communities during disasters.

This study finds that, indigenous knowledge plays a significant role in the study area, as people have come to depend on it. This type of knowledge refers to the accumulated knowledge of local communities who have lived in a particular environment for generations. The elderly population, in particular, have faith in their traditional practices, which involve using natural elements such as frogs, ants, birds, and clouds to forecast floods.

Cloud: The presence of a black cloud in the western sky is considered as a sign of heavy rain and potential flood.

Frogs, Ants, or different insects: People believe that if frogs, ants, or other insects climb up onto the roof of a house or tree, it indicates the possibility of a heavy flood.

Bird: A bird named “Suichora” gives them a signal of the heavy flood. A flock of these birds roaming around the area signifies the risk of floods and drowning in the area.

However, the existing early warning system faces several challenges. The language used in warning messages is often technical and official, making it difficult for most people to comprehend. Additionally, access to early warning messages is limited, as wireless communication can be unreliable at times. False alarms have also contributed to a lack of trust in the warning system. Research shows that forecasts produced by the Bangladesh Meteorological Department (BMD) are only reliable for up to 12 hours, and the signals used by the Cyclone Preparedness Programme (CPP) are derived from those used for maritime and river ports issued by the BMD.

Considering all these, it is easily assumable that there is decent forecasting in pen and paper but in reality, these are absent.

3.14 The government policy and strategy regarding anticipatory action

Bangladesh has a well-established regulatory framework for disaster risk reduction. This framework includes:

- A Disaster Management Act.
- A National Plan for Disaster Management.
- A National Disaster Management Policy.
- Standing Orders on Disasters (SOD) – guidelines for Government at all Levels

The regulatory framework of the Bangladesh Government for disaster management offers a legislative, policy, and best practice framework that manages and implements the activity of Disaster Risk Reduction and Emergency Management in Bangladesh.

3.14.1 Disaster Management Act

A Disaster Management Act was enacted with a view to creating the legislative tool under which disaster risk and emergency management actions are undertaken in Bangladesh and providing the legal basis under which activities and actions are identified, undertaken, and managed. It also establishes the roles and responsibilities of Ministries, committees, and appointments. The objectives of the Act are to:

- Assist communities in mitigation of potential adverse effects of hazardous events;
- Prepare for managing the response to the effects of a disastrous event;
- Assist in effectively responding to and recovering from a disaster or an emergency;
- Prepare for and adapt to potential adverse effects of climate change;
- Provide for effective disaster management for Bangladesh;
- Establish an institutional framework for disaster management; and
- Establish risk reduction as a core element of disaster management.

3.14.2 National Plan for Disaster Management

The Ministry of Food and Disaster Management is responsible for preparing the National Plan for Disaster Management, which aims to foster a culture of prevention through various means. This includes incorporating disaster management education into school curricula and professional courses, enhancing the capacity of disaster managers through better training facilities, and promoting awareness of disaster preparedness at all levels. The plan also places great emphasis on involving communities, particularly those that are more vulnerable, in disaster preparedness efforts, and encouraging community-level initiatives. In addition, the plan calls for the development of appropriate zoning regulations, design standards, building codes, and performance specifications to ensure safe

construction practices. All development projects in vulnerable areas must undergo a disaster mitigation analysis to assess the feasibility of the project in relation to the area's vulnerability. Disaster mitigation components are also incorporated into all development projects and are financed under the Plan as part of the approved project costs.

3.14.3 National Disaster Management Policy

The Bangladesh government has formulated a National Disaster Management Policy, which aims to define the national perspective on disaster risk reduction and emergency management. The policy outlines a strategic framework and sets out the national principles of disaster management in Bangladesh. As a strategic document, it describes the overarching national objectives and strategies for disaster management, providing a broad framework for disaster management initiatives.

3.14.4 Standing Orders on Disasters

The Standing Orders on Disaster (SOD) provide a comprehensive outline of the roles and responsibilities of various committees, ministries, and organizations involved in disaster risk reduction and emergency management activities in Bangladesh. It also establishes the necessary actions required to implement the country's Disaster Management Model. The SOD is a crucial document that guides disaster management efforts and ensures that all relevant parties are aware of their responsibilities in case of a disaster. An updated version of the SOD is currently being considered by the Government of Bangladesh.

3.14.5 Guidelines for Government at all Levels (Best Practice Models)

Best practice guidelines for disaster risk management are implemented at all levels of government and used to assist Ministries, Directorates, Institutions and Divisions under the Ministry, NGOs, disaster management committees, and civil society in the effective implementation of disaster risk reduction and management measures.

The following is a list of guidelines and templates prepared to assist in the EWS process:

- Disaster Impact and Risk Assessment Guideline
- Local Disaster Risk Reduction Fund Management Guidelines
- Emergency Fund Management Guidelines
- Indigenous Coping Mechanism Guidebook
- Community Risk Assessment Guidelines
- Damage and Needs Assessment Methodology
- Hazard Specific Risk Assessment Guidelines

- Emergency Response and Information Management Guideline
- Contingency Planning Template
- Sectoral Disaster Risk Reduction Planning Template
- Local Level Planning Template
- National Risk Reduction Fund Management Guideline
- National Disaster Reduction and Emergency Fund Management Guideline
- Local Disaster Management Fund Guideline
- Guideline for road and water safety
- Guideline for industrial safety
- Guideline for Disaster Shelter Management
- Monitoring and Evaluation Guidelines for the Implementation of the Plan
- Guideline for international Assistance in disaster emergency

3.14.6 National to Local Emergency Planning and related Linkages to EWS

In Bangladesh, disaster risk management planning follows a hierarchical structure. The National Plan for Disaster Management serves as a strategic framework, while the District Disaster Management Plan is compiled from Upazila (sub-district) Disaster Management Plans within the district. The Upazila Disaster Management Plan, in turn, represents a compilation of Union (village-level) Disaster Management Plans prepared by the Union Disaster Management Committees. The responsibility for conducting risk assessments and preparing ground-level plans lies with the Union and Paurashava (municipality-level) Disaster Management Committees. These ground-level plans are sent to the next higher level of DMCs for verification, compilation, and identification of resource requirements. This disaster management-planning framework in Bangladesh ensures a hierarchical and organized approach to disaster risk reduction and emergency management.

3.14.7 Organizational Structure for Implementing the Plans

The Ministry of Food and Disaster Management (MoFDM) of the Government of Bangladesh is responsible for coordinating disaster management efforts across all agencies. To guide and monitor disaster management activities, the ministry issued the Standing Orders on Disaster (SOD) in January 1997. The SOD aims to ensure that concerned individuals understand and fulfill their responsibilities regarding disaster management at all levels. The National Disaster Management Council (NDMC) and Inter-Ministerial Disaster Management Coordination Committee (IMDMCC) coordinate disaster-related activities at the national level. At the district, upazila, and union levels, coordination is undertaken by the respective Disaster Management Committees. The Disaster Management Bureau assists them in facilitating the process. A series of interconnected institutions have been established at both national and sub-national levels (see Fig. 3.5) to ensure effective planning and coordination of disaster risk reduction and emergency response management.

3.14.8 Sendai Report

The Sendai Framework for Disaster Risk Reduction (SFDRR) is a focal guidance document for all UN member countries' contemporary Disaster Risk Reduction (DRR) strategies. This section discusses the issues and strategic actions of Bangladesh's DRR policy in alignment with SFDRR priority areas to highlight the interlinkages and synergies in pursuing risk-resilient development pathways (Progress in Disaster Science 12 (2021) 100206).

3.14.9 Existing law/regulation for INGO to immediately conduct AA

In Bangladesh, INGOs are required to obtain approval from the government before implementing any project or program. This process involves submitting a project proposal, undergoing several rounds of

review, and obtaining approval from the relevant government authorities. This process can be time-consuming and may delay the implementation of urgent activities in disaster-prone areas.

However, the government of Bangladesh has established some provisions for emergency response activities that can be undertaken by INGOs without prior approval. These provisions are outlined in the "**Guidelines for the Operations of International Humanitarian Organizations in Bangladesh**" issued by the Ministry of Disaster Management and Relief.

According to these guidelines, INGOs can undertake immediate response activities in disaster-prone areas without prior approval if the activities are in line with the national disaster management plan and the INGO has a Memorandum of Understanding (MoU) with the government. The INGOs are required to inform the relevant government authorities of their activities as soon as possible. Additionally, the government of Bangladesh has established a system of Disaster Management Committees (DMCs) at the national, district, and sub-district levels. INGOs can work with these committees to coordinate and implement emergency response activities in disaster-prone areas.

3.15 Laws to protect NGOs, stakeholders, and communities to activate AA and government to disburse aid

The legal framework for disaster management is provided by the **Disaster Management Act 2012**. This act provides the legal basis for disaster risk reduction and management activities, including early warning and response. Under the act, non-governmental organizations (NGOs) and other stakeholders are recognized as important partners in disaster management. **Section 16** of the act allows for the establishment of Disaster Management Committees (DMCs) at different levels, including district, upazila (sub-district), and union. These committees can include representatives from NGOs, civil society organizations, and other stakeholders.

Furthermore, the act recognizes the importance of early warning systems and mandates the establishment of such systems at all levels of government. Section 18 of the act specifically mentions the need for timely dissemination of warnings to the public. In terms of protection for NGOs and other stakeholders involved in activating early warning and response, Section 45 of the act provides immunity from legal action for any act done in good faith and with reasonable care during a disaster response operation. The Disaster Management Act 2012 of Bangladesh is a comprehensive legal framework that empowers the government to take necessary measures for disaster management, including the use of early warning systems. The Act provides a legal basis for the disbursement of aid before a disaster or using the EWS, which is essential for timely and effective disaster response and mitigation.

Section 19 of the Act allows the government to establish a Disaster Management Fund to provide financial assistance for disaster preparedness, response, and recovery. The fund can be used to provide financial assistance to individuals, organizations, or authorities for disaster management activities, including the implementation of early warning systems. This provision ensures that necessary resources are available to implement and maintain effective early warning systems.

Section 13 of the Act empowers the government to take necessary measures to reduce the risk of disasters, including the implementation of early warning systems. This provision provides the legal basis for the government to take proactive measures to prevent disasters from occurring or mitigate their impacts.

Section 14 of the Act allows the government to declare a disaster situation and take appropriate measures to respond to it. This provision provides the legal basis for the government to activate early warning systems and disburse aid before a disaster occurs. It also ensures that the government can take timely and effective measures to respond to disasters and mitigate their impacts.

The Disaster Management Act 2012 of Bangladesh provides a strong legal framework and authority to the government for the disbursement of aid before a disaster or using the EWS. This legal basis is essential for effective disaster management, as it ensures that necessary resources are available to implement and maintain early warning systems and that the government can take proactive measures to prevent disasters or respond to them in a timely and effective manner.

3.16 Joint advocacy in cyclone prone area

There are several joint advocacy efforts to support disaster management in cyclone-prone areas of Bangladesh. One such initiative is the Comprehensive Disaster Management Programme (CDMP), which is a joint effort between the government of Bangladesh and various development partners, including UNDP, UNICEF, and the World Bank. The CDMP aims to reduce disaster risks and build resilience in communities by promoting multi-hazard early warning systems, improving disaster preparedness and response, and supporting post-disaster recovery efforts.

Another joint advocacy initiative is the Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP), which is a collaboration between the government of Bangladesh, the World Bank, and various NGOs. The project aims to enhance the resilience of vulnerable communities to climate change and natural disasters through the promotion of community-based afforestation and reforestation activities.

Other joint advocacy efforts include the Coastal Livelihood and Environmental Action Network (CLEAN), which is a network of NGOs working to promote sustainable development and disaster resilience in coastal communities, and the Cyclone Preparedness Programme (CPP), which is a joint initiative between the government of Bangladesh and the Bangladesh Red Crescent Society to build community preparedness and resilience to cyclones and other natural disasters.

One such initiative is the Joint Response Plan (JRP), which is a coordinated effort by humanitarian organizations and the government to respond to natural disasters, including cyclones. The JRP outlines the response strategies and actions required in the event of a disaster, and aims to ensure a timely, effective, and coordinated response. Another joint advocacy initiative is the Disaster Risk Reduction Network (DRRN), which is a platform for civil society organizations, academics, and practitioners to share knowledge and best practices related to disaster risk reduction. The DRRN also engages in advocacy and lobbying efforts to promote disaster risk reduction policies and practices at the national and local levels. Additionally, the Bangladesh Cyclone Preparedness Program (CPP), which is a joint initiative of the government, NGOs, and international partners, works to enhance early warning and preparedness for cyclones in coastal areas of Bangladesh. The CPP includes community-based disaster preparedness and response mechanisms, as well as the establishment of cyclone shelters and early warning systems.

3.17 Joint advocacy in flood-prone area

There are various joint advocacy efforts in Bangladesh to support natural disaster management in flood-prone areas. Floods are a recurring problem in Bangladesh, and joint advocacy is often needed to raise awareness and mobilize resources to address the impacts of flooding. One example of joint advocacy is the "**Flood Action Plan**," which was developed in the 1990s in response to devastating floods that occurred in Bangladesh. The plan was a joint effort of the government of Bangladesh, NGOs, and donor agencies, aimed at developing an integrated approach to flood management that involved disaster preparedness, response, and recovery. In addition, various NGOs and civil society organizations in Bangladesh work together to advocate for better disaster management policies and practices. For example, the Disaster Risk Reduction Network (DRRN) is a coalition of NGOs and other stakeholders in Bangladesh that works to promote disaster risk reduction and support disaster-affected communities.

The Joint Needs Assessment (JNA) is a tool used by multiple organizations, including the government of Bangladesh, NGOs, and international agencies, to identify and prioritize the needs of flood- affected communities. Through JNA, the organizations can jointly develop plans and strategies for providing emergency relief and longer-term recovery and rehabilitation programs.

Another example is the Bangladesh Water Partnership, which is a joint advocacy initiative comprising

government agencies, NGOs, and academic institutions working to improve water governance and flood risk management in the country. The partnership promotes the integration of community- based approaches and traditional knowledge into flood risk management and advocates for policies and regulations that prioritize flood risk reduction

Moreover, the Bangladesh Red Crescent Society (BDRCS) and other humanitarian agencies often work together in flood-prone areas to provide emergency relief and support to affected communities. They may also engage in joint advocacy efforts to raise awareness of the impacts of flooding and mobilize resources to support disaster management initiatives.

3.18 Gap analysis

An effective Early Warning System (EWS) is critical in reducing the impact of disasters and saving lives. In Bangladesh, although several EWS initiatives have been implemented, there are still gaps that need to be addressed to enhance the country's disaster risk management efforts. One of the major gaps in the EWS in Bangladesh is the lack of coordination and communication among stakeholders. The existing EWS infrastructure is fragmented, with different agencies responsible for different components of the system. As a result, there is often a lack of integration and sharing of data, which can lead to delays in issuing timely and accurate warnings. Another gap is the limited coverage of the EWS. Although the EWS covers many areas prone to disasters, there are still vulnerable areas that are not adequately covered. This is due to a lack of resources, including funding, infrastructure, and trained personnel.

Additionally, there is a need to improve the accuracy and reliability of the EWS. While the existing EWS has been successful in issuing warnings, there have been instances where false alarms have been raised, causing unnecessary panic and confusion. This can be attributed to several factors, including technical faults, inadequate training, and limited access to real-time data. To address these gaps, there is a need to develop a more integrated and comprehensive EWS that covers all vulnerable areas and is supported by adequate resources. This would require stronger coordination among stakeholders, including government agencies, NGOs, and local communities. There is also a need to invest in training and capacity-building to ensure that all stakeholders are equipped with the necessary skills. The following GAPs (Table 19) were identified during this study.

Table 22 Current GAP on EWS in both national and local level.

Agenda	GAP in details
Adequacy of EWS infrastructure	• Insufficient number or coverage of monitoring stations: The EWS infrastructure shuld have enough monitoring stations or sensors to detect potential hazards across the entire area of concern. • Inadequate communication systems: The communication systems between monitoring stations and warning centers may not be robust enough to ensure timely and accurate transmission of data. • Limited capacity for data analysis: The EWS infrastructure not have the necessary tools or expertise to analyze the data collected by monitoring stations and provide reliable warnings to at-risk communities.
	• Inadequate warning dissemination: The EWS infrastructure not have effective mechanisms for disseminating warnings to at-risk communities in a timely and understandable manner.
Risk Assessment and Monitoring	• Insufficient data collection and analysis systems to identify and monitor risks; • Inadequate risk assessment methodologies and tools; • Lack of capacity and expertise in conducting risk assessments and monitoring; • Inadequate communication and dissemination of risk assessment and monitoring findings to relevant stakeholders; • Inadequate funding and resources for sustained risk assessment and monitoring activities; • Lack of coordination and collaboration among different agencies and organizations involved in risk assessment and monitoring;
Information dissemination and response	• Limited reach of the warning messages to vulnerable communities due to inadequate dissemination channels and communication equipment's. • Lack of a structured and coordinated response mechanism at the local level to ensure timely and effective response to warning messages. • Insufficient capacity of the local authorities and responders to interpret and act upon the warning messages. • Inadequate public awareness and preparedness to respond to warning messages. • Limited availability of real-time information on the impacts of disasters, which hinders timely response and decision- making.

Knowledge and capacity gap	DRRO and PIO are the only executive staff of DDM at district and upazila level, but their capacity for DM duties is weak. Local DMCs' knowledge and capacity are also weak despite guidance. Active support from local DMCs is crucial for effective DM execution.
Community engagement and awareness	One potential gap related to community engagement and awareness in the context of early warning systems in Bangladesh is a lack of sufficient community-level education and training. This can include gaps in public awareness campaigns about the importance of early warning systems and what actions to take in response to warnings, as well as inadequate training for community members on how to respond effectively to different types of hazards. In addition, there may be challenges in ensuring that warning messages are communicated clearly and effectively to all members of
Agenda	**GAP in details**
	the community, including those with limited literacy or access to information technology. Addressing these gaps may require targeted education and training programs, as well as efforts to strengthen community-level communication and engagement channels.
Cyclone Preparedness Programme (CPP)	The study areas are not included under current CPP.
Coordination and cooperation among stakeholders in EWS	• Lack of clear roles and responsibilities among different stakeholders in the EWS, leading to confusion and duplication of efforts. • Inadequate communication channels and mechanisms for sharing information and coordinating actions between different stakeholders, including government agencies, NGOs, and communities. • Limited participation of communities in decision-making processes related to EWS, leading to a lack of ownership and commitment to the system. • Insufficient training and capacity building programs for stakeholders involved in EWS, especially at the local level, resulting in ineffective coordination and cooperation during emergency situations. • Absence of a formalized platform or mechanism for stakeholders to come together, share experiences, and learn from each other, leading to a fragmented and disjointed EWS.

Effective Early Warning System	• Lack of coordination and communication among different agencies involved in early warning systems. • Inadequate infrastructure and technology for timely and accurate dissemination of warnings to at-risk communities. • Limited community participation and awareness of early warning systems and response plans. • Insufficient funding and resources for the maintenance and sustainability of early warning systems. • Inadequate integration of early warning systems with disaster risk reduction and preparedness programs.
UDMC	Mostly absent. If present than they have- • Lack of training and capacity building for committee members in disaster management. • Insufficient resources allocated to the committee to carry out its duties effectively. • Limited coordination and communication with other stakeholders in disaster management.
Agenda	**GAP in details**
	• Weak linkages between the committee and local communities, resulting in limited community participation and ownership in disaster preparedness and response. • Lack of clear guidelines and standard operating procedures for the committee's functioning and decision- making processes.
Institutions	Improving the National Plan for Disaster Management (NPDM) by providing more detailed and practical guidance can help streamline disaster management efforts. This can be done by developing standard operating procedures (SOPs) for the Disaster Management Committees (DMCs) and guidelines for the integration of disaster management duties into regular operations. Without clear guidance, there can be confusion and inefficiencies in disaster management efforts. By reviewing and revising the NPDM, disaster management at the national level can be more effective.
Funding	The funding gap at the union level of disaster management in Bangladesh is significant. While the Union Disaster Management Committees (UDMCs) are responsible for coordinating disaster management efforts at the local level, they often lack the necessary resources and funding to effectively carry out their duties. This can result in delays and inefficiencies in disaster response and recovery efforts. Closing this funding gap and providing adequate resources to UDMCs is essential for improving disaster management at the local level.

4. Brief anticipatory action plan based on feasibility study

From the overall study, to effectively prepare for disasters and minimize the damage they cause, it is important to have a well-functioning early warning system (EWS) in place. This system involves various components, including risk assessment, infrastructure, early warning systems, information management, community engagement, training and capacity building, coordination, contingency planning, funding, and legal compliance.

To start, the first step is to conduct a risk assessment in vulnerable areas to identify the types of disasters that are likely to occur and assess the level of risk they pose. This task can be accomplished within a month, and it falls under the responsibility of the local government and the World Vision Bangladesh (WVB).

Once the risk assessment is complete, the next step is to identify gaps in EWS infrastructure and develop an improvement plan. This task can be accomplished in two months and requires the collaboration of WVB and government agencies.

The third step is to install and maintain early warning systems in vulnerable areas. This involves identifying the most suitable technology for the area and ensuring that the systems are properly maintained. This task can be accomplished in three months with the support of WVB and government agencies.

Information management is also a crucial component of the EWS. Establishing a reliable system for gathering and disseminating information in real-time is essential to ensure timely response to disasters. This task can be accomplished in four months with the support of WVB and government agencies.

Community engagement is another key component of the EWS. It is important to conduct community awareness campaigns on EWS and preparedness to ensure that people understand the risks and are prepared to respond. This task can be accomplished in six months and falls under the responsibility of WVB and the local government.

To ensure effective response and recovery, it is necessary to train local responders and communities on EWS, preparedness, and response protocols. This task should be ongoing and requires the collaboration of WVB, local government, and NGOs.

Strengthening coordination mechanisms among stakeholders is also crucial to ensure effective response and recovery. This requires ongoing efforts and the collaboration of WVB, local government, and NGOs.

Developing and testing contingency plans to ensure timely and effective response to disasters is another ongoing task that requires the collaboration of WVB, local government, and NGOs.

Securing funding for the implementation and sustainment of the anticipatory action plan is crucial to ensure its success. This requires ongoing efforts and the collaboration of WVB, government agencies, and NGOs.

Finally, ensuring compliance with local laws, policies, and the Standard Operating Procedures (SoD), 2019 is an ongoing task that requires the collaboration of WVB, government agencies, local government, and NGOs.

To sum up, establishing a well-functioning EWS is a complex and ongoing process that requires the collaboration of various stakeholders. However, by following these components and taking a comprehensive approach, it is possible to effectively prepare for disasters and minimize their impact.

Table 23 An anticipatory action plan on EWS based on feasibility study

Component	Actions	Timeline	Responsibility
Risk assessment	Conduct risk assessment in vulnerable areas	1 month	Local government, WVB
Infrastructure	Identify gaps in EWS infrastructure and develop an improvement plan	2 months	WVB, government agencies
Early warning system	Install and maintain early warning systems in vulnerable areas	3 months	WVB, government agencies
Information management	Establish a reliable system for gathering and disseminating information in real-time	4 months	WVB, government agencies
Community engagement	Conduct community awareness campaigns on EWS and preparedness	6 months	WVB, local government
Training and capacity	Train local responders and communities on EWS, preparedness, and response protocols	Ongoing	WVB, local government, NGOs
Coordination	Strengthen coordination mechanisms among stakeholders for effective response and recovery	Ongoing	WVB, local government, NGOs
Contingency planning	Develop and test contingency plans to ensure timely and effective response to disasters	Ongoing	WVB, local government, NGOs

Funding	Secure funding for implementation and sustainment of the anticipatory action plan	Ongoing	WVB, government agencies, NGOs
Legal compliance	Ensure compliance with local laws, policies, and SoD, 2019	Ongoing	WVB, government agencies, local government, NGOs

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