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Report on

Existing Early Warning Systems (EWS) for Fisheries and Aquaculture in Bangladesh and Recommendations for Improvement



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Project: Community Based Climate Resilient Fisheries
and Aquaculture Development in Bangladesh



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Executive Summary

Climate change is a global phenomenon and Bangladesh is already experiencing the negative consequences of it. The country is even more vulnerable to the effects of climate change in fisheries and aquaculture (F&A) because of its economic, diet and social dependency on this sector. Communities who depend on the F&A sector for their livelihoods are already experiencing losses and damages as a result of climate change impacts, and the future climate projections show that the situation will even worsen, if no adaptation is considered. Currently there is inadequate capacity for climate resilient planning at both the government and community levels, and this presents one of the key barriers to effective implementation of adaptation strategies. Governments and local communities must therefore improve their capacity to assess, plan, implement, and track adaptation to climate change impacts on the fisheries and aquaculture sectors.

Climate change adaptation planning is complex and requires both short and long-term planning to address short term adaptations measures and long-term climate scenarios. Early warning and climate advisory services for different hazards are therefore an important component for climate change adaptation actions. The Government of Bangladesh has taken substantial initiative towards developing early warning system in the country—with Bangladesh Meteorological Department (BMD) and Flood Forecasting and Warning Center (FFWC) of Bangladesh Water Development Board (BWDB) being major scientific organizations generating and transmitting the climate change EW information. Additionally, the Department of Disaster Management (DDM) plays a vital role in dissemination and disaster recovery activities.

However, the existing EWS do not disseminate fisheries and aquaculture specific adaptation measures against climate risk events such as drought, salinity, erratic rainfall, temperature rise, cold spells, etc. except for disaster signals for sea-going vessels. Previously, the Comprehensive Disaster Management Programme (CDMP) established a mobile phone-based early warning system that facilitated information dissemination to users, but it lacked specific information for F&A farmers as to what actions should be undertaken to reduce the climate induced risks and/or hazards. The country does not also have an ICT-based fisheries information service from which fishers and fish farmer communities can access advice on how to adapt to climate change stressors. Thus, the F&A dependent communities lack information to fully understand and plan for climate change threats or risks and impacts on F&A.

This study undertook a comprehensive assessment of the existing EWS for F&A, its uses by the local fishers, identified the gaps and makes recommendations for improving the EWS for F&A in Bangladesh. The study focuses on the EWS situation for local F&A community and their needs, with additional emphasis on gender issues. Additionally, the study recommendations are expected to enhance the inclusion of disaster risk management and early warning in F&A at both national and local level planning.

The project level consultation in the nine Upazillas in north-east haor and coastal area identified the types of early warning information received by local communities, and the communication channels and suggestions for improvement. Major issues for community people include, timely receiving of information, understandable and accurate forecast and lead time of forecast. Fisheries related advisories, in case of disaster events or weather extremes, are not readily available for the communities. Besides, information or data on water quality, location of potential fishing zones etc. are not available nor provided.

Mobile SMS and Direct Voice Calls were identified as the most potential and preferred channels for EWS information amongst the stakeholders in the nine project Upazillas where the study was undertaken. Besides, they also suggested improvement of the weather app and placement of digital dashboards with useful information at nearby locations for the community.

Based on the gaps identified in existing EWS and especially in regards to fisheries and aquaculture, several policy recommendations have been identified, including; the 'Integration of fisheries and aquaculture advisories on Early Warning and Climate Services for climate resilience' in the National Fisheries Strategy and Policy and as a mandate in DoF's 'Citizen Charter'; Formation of a working group or cell at DoF Head Office and designation of Focal points in District and Upazillas; Development of an Integrated Climate Information Service for Fisheries and Aquaculture (ICIS-FA) covering the whole of Bangladesh and its

Exclusive Economic Zone (EEZ) area in Bay of Bengal; and the Development of easily understandable fisheries and aquaculture related advisories for the local communities and enhancing relevant local capacity at a community level.

With DoF providing regular fisheries and aquaculture extension services to the fishers, it should be the lead agency in implementing the ICIS-FA system. And to ensure proper implementation of such a system, the Early Warning working group or cell at DoF should: Undertake translation of early warning and climate information (temp, rainfall, flood warning) into easily understandable language for fishers and community people; Facilitate the development and approval of F&A specific climate hazard advisory messages; Integrate the early warning and advisory services in DoF call center (12126); Facilitate training and orientation of District/Upazilla Officials/ advanced fishers to the information and communication of early warning and advisories to fishers on time; Strengthen Communication Channels for dissemination; and Strengthen collaboration between DoF and BMD, FFWC, DDM in integrating EWS in F&A and learning from existing Flood/Climate Warning initiatives. Besides, DoF need to initiate and maintain the required administrative arrangements to enhance the future collaboration among the agencies. To enhance capacity of the DoF working group, some relevant training, lessons sharing with BMD, FFWC, DDM, DAE and other relevant initiatives in country and abroad might be needed.

There are some improvements needed with respect to lead time and translation of water level to local waterbodies. So, the ICIS-FA should incorporate real time data on present status and forecast of the parameters (temperature, rainfall, wind speed, humidity, evaporation, heat and cold waves, fog etc.) based on availability from BMD, FFWC and other relevant national/international agencies. The Available information in ICIS-FA should include; hazard and disaster related information like, flood/ flash flood water level at community level, extreme weather events, expected storm surge height, drought severity, earthquake, tsunami etc., Climate, disaster and disease advisory information (e.g., what to do under certain climatic condition, potential measures for protecting pond/ waterbody area from flood/ other hazards), potential measures for preventing disease outbreak and treatments in case of a disease outbreak and location specific contact persons list for emergency communication. The ICIS-FA should have a GIS based web portal, linked mobile app and Hotline/ IVR component.

Besides ICIS-FA, substantial efforts should be given for awareness, capacity building and dissemination of the available information among the local communities including women, elderly, disabled, ethnic group and other vulnerable groups. The Communication Channels should be strengthened through; web portal of ICIS-FA, designing aqua-meteorological bulletin 'Motshyo Abhaoa Barta', short video, video filler and their broadcast in BTV and other TV channel, Designing and implementation of digital dashboard 'Motshyo Abhaoa Display Board' in Upazillas, Bazar, Arot, key marketing point etc. Besides these, efforts should be given to enhance and improving reliability of existing mobile apps like BMD weather app, BWDB flood app etc.

The proposed Integrated Climate Information Service for Fisheries and Aquaculture (ICIS-FA) could be initiated as a pilot project focusing on certain pilot areas of Bangladesh and be upscaled with lessons learnt from the project. The project will focus on the designing and implementing of such a system. The pilot activities in smaller areas will lead to identifying the overall issues and challenges for ICIS-FA. Besides, there are strong need for continuous support for effective translation of relevant EW information from BMD and FFWC and close cooperation among BMD, FFWC, DDM and DoF. Successful implementation of these recommendations will facilitate climate risk reduction among the vulnerable communities, save lives and improve livelihoods for the F&A communities.

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Abbreviation

BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
CBOs	Community based Organization
CCA	Climate Change Adaptation
CDMP	Comprehensive Disaster Management Program
CEGIS	Center for Environment and Geographic Information Services
CRVA	Climate change Risk and Vulnerability Assessment
DoE	Department of Environment
DoF	Department of Fisheries
DRR	Disaster Risk Reduction
EbA	Ecosystem based Adaptation
ECA	Ecologically Critical Area
EWS	Early Warning System
F&A	Fisheries and Aquaculture
FAO	Food Agriculture Organization
FD	Forest Department
FFWC	Flood Forecasting and Warning Center
FGD	Focused Group Discussion
GoB	Government of Bangladesh
GOs	Government Organizations
ICT	Information and Communication Technology
KII	Key Informant Interviews
LGIs	Local Government Institutes
MoDMR	Ministry of Disaster Management and Relief
MoEFCC	Ministry of Environment, Forest and Climate Change
MoWR	Ministry of Water Resources
UFOs	Upazilla Fisheries Officers

1 Introduction

1.1 Background

Climate change is a global phenomenon and Bangladesh is already experiencing the negative consequences of it. The country is highly vulnerable to the effects of climate change in Fisheries and Aquaculture (F&A) because of its economic, diet and social dependencies on this sector. The communities who depend on the F&A sector for their livelihoods are already experiencing losses and damages as a result of climate change impacts, and the uncertain future climate appears to be making things worse. On the other hand, inadequate capacity for climate resilient planning at both government and community levels is one of the key barriers to effective implementation of adaptation strategies. Major climate hazards of Bangladesh include flood, flash flood, cyclones and storm surges, drought etc. The F&A sector face damages from all these hazards—and the capacity to assess, plan, implement and track adaptation to climate change impacts on fisheries and aquaculture sectors must therefore be improved at both government and local community levels.

Early warning and climate advisory services for different hazards are an important component of the climate change adaptation actions. As majority of the population in the country are dependent on agriculture and fisheries related livelihoods, climate related disasters can cause substantial damages to the local communities and their livelihoods. Early warning systems for these hazards are therefore an important tool in addressing the disaster impacts and reducing the damages to a certain extent.

This study undertook a comprehensive assessment of the existing EWS for F&A, its accessibility and use by the local fishers, identified the gaps and makes recommendations for improving the EWS for F&A. The study recommendations are expected to enhance the inclusion of disaster risk management and early warning in F&A related local development plans and programs, thus enhancing climate change resilience.

1.2 Report Outline

The report starts with an overall understanding of the Early Warning System (EWS), global perspectives and Bangladesh context of EWS in Chapter 2. Chapter 3 highlights the present status of EWS information availability in the project areas and gaps, issues and challenges for EWS for F&A. Additionally, gender aspects have also been analyzed and presented in Chapter 3. Finally, potential use of EWS information is tabulated in Chapter 3. Chapter 4 presents the recommendations for enhancing EWS for F&A sector and chapter 5 presents conclusion of the study.

2 Early Warning System for Fisheries and Aquaculture

This chapter describes an overview of early warning system and its use for fisheries and aquaculture sector. Additionally, the status of EWS initiatives in Bangladesh and relevant policy landscape is also presented

2.1 Fisheries and Aquaculture Early Warning System (FA-EWS): The Basics

Some of the most common terms and definitions pertaining to the early warning system (EWS) for fisheries and aquaculture (F&A) sector are as follows:

Early Warning System: The Early Warning System (EWS) is a comprehensive system of hazard monitoring, forecasting, prediction, and disaster risk assessment, communication and preparedness activities, systems and processes that enable people, communities, governments, corporations, and other entities to take prompt action to mitigate disaster risks prior to the occurrence of a hazardous event.

Key elements of EWS: Community oriented early warning systems (EWS) are designed to assist individuals and communities in responding to potential hazards in a timely and effective manner, thereby reducing the risk of injury, death, destruction of property and damage to the environment. A comprehensive early warning system must encompass four interconnected elements, ranging from hazard knowledge and vulnerability assessment to preparedness and response capacity. Best-practice early warning systems are characterized by their strong interconnectivity and the ability to communicate effectively between all of these elements.

Risk Knowledge: Risks are generated when hazards and vulnerabilities interact in a particular area. Systematic data collection and analysis is essential for risk assessments, and the dynamics of hazards and vulnerabilities should also be considered, which essentially arise from the effects of urbanization, land-use changes, environmental degradation, and climate change. As the risk information is constantly changing, EWS must be dynamic as well. Risk assessments and maps can be used to motivate individuals, prioritize early warning system requirements, and provide guidance on disaster prevention and response.

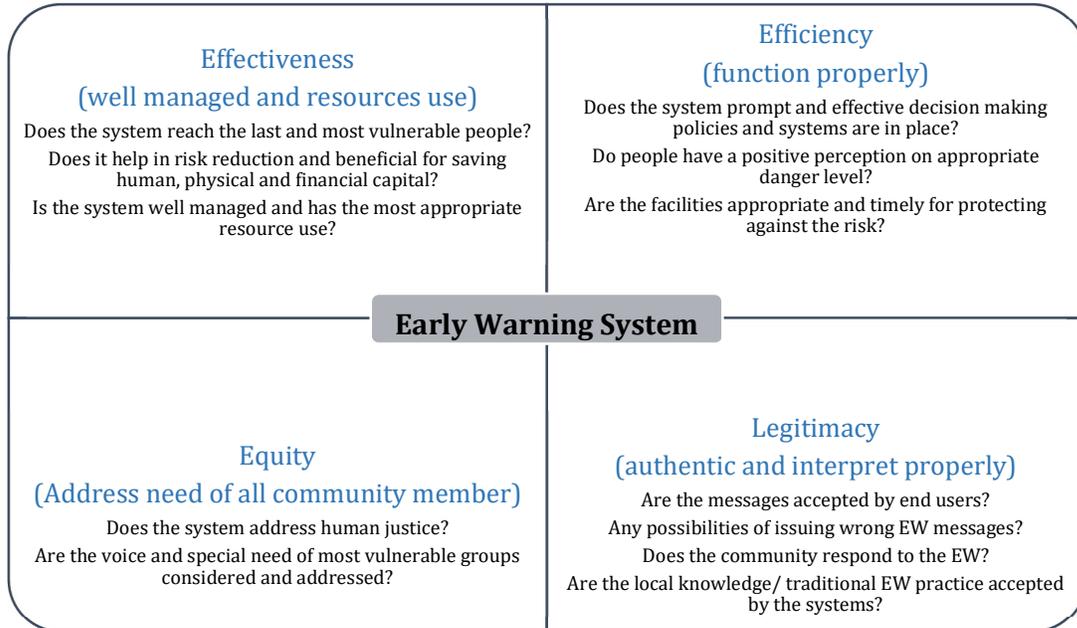
Monitoring and Warning Service: The core of an early warning system is the monitoring and warning services, which are the components of the analysis and delivery of forecasts and alerts. A robust scientific basis is necessary for the prediction and forecasting of hazards, and a dependable forecasting and warning infrastructure that is operational 24/7 is also required in this regard. Precursors and hazard parameters must be continuously monitored for the generation of accurate and timely alerts. Wherever feasible, the warning services for different hazards should be linked to each other in order to benefit from a common institutional, procedural and communication network.

Dissemination and Communication: The dissemination and communication of warnings must be effective, as they must reach those who are at risk. Providing clear messages with straightforward, useful information is essential to enable prompt and effective responses that will help to protect lives and protect livelihoods. It is essential to pre-identify and establish authoritative voices at the regional, national or community level, and to use multiple communication channels to ensure maximum warning effectiveness. This will help to reduce the risk of failure of any single channel, and strengthen the warning message.

Response Capability: The response capability is the centralised understanding, planning, and input required for prompt and appropriate response by authorities and vulnerable communities. It is imperative that communities comprehend, monitor, and understand how to respond based on Early Warning Systems (EWS). This response capability can be increased either through increased public and institutional readiness or through automated emergency responses. In the event of a rapid onset disaster, such as an earthquake, monitoring sensors can trigger actions to disable power and gas supply to prevent

further harm. To be successful in eliciting a response to alerts, it is essential that vulnerable communities have confidence in the Early Warning System. In reality, responses may be compromised if the warning system repeatedly calls for action in circumstances where it is not necessary. An Early Warning System should include routines to reduce false or redundant emergency warnings. Furthermore, disaster management plans should be established, well-executed, and tested. Communities should be well-informed on available safe behaviour options, evacuation routes, and the best way to prevent damage and loss of property.

Essentials of EWS: An Early Warning System (EWS) should be equipped with certain essential features to ensure its effectiveness, legitimacy, impartiality and effectiveness.



Forecast Information types: Forecast information is divided into six main types: outlook, watch, warning, advisory, alert and statement. These have been defined as follows:

Outlook: This means there is a potential for a hazard to occur, but its exact timing and severity is uncertain.

Watch: This means there are favourable conditions for the occurrence of a hazard to occur (development or movement) so people should stay alert.

Warning: This means a hazardous event is happening or is imminent and the people should take immediate protective actions.

Advisory: This means an event is less severe than an event that would require a warning and may cause inconvenience but is expected to be less life-threatening and less property-threatening if the public takes normal precautions.

Alert: The highest level of warning provided by the EWS system which is issued when a hazard is sure to occur.

Statement: This is the in-depth follow-up to alerts, warnings, advisories, watches and outlooks.

2.2 Types of EWS Information

Different types of information are required for the proper functioning of an early warning system (EWS), especially in regards to the fisheries and aquaculture (F&A) sector. These include:

2.2.1 Climate Information

These include information on temperature and rainfall events and extreme events. They affect the decisions on the operation and management of fisheries and aquaculture, which makes this information very important for the dissemination of early warning messages. Information on other meteorological events,

such as cyclones, storm surges etc. are also important to protect the fisheries and aquaculture related activities from the adverse impacts of climate change.

2.2.2 Surface Water Quality

In addition to accurate climate information, the availability of reliable information on the surface water quality is also important for F&A sector. This assists the community people to prepare themselves in terms of managing the F&A resources, ahead of floods and other hazards. The required surface water quality information include pH, Dissolved Oxygen, salinity etc.

2.2.3 Risk Data and Information

It is of paramount importance to disseminate accurate risk data and information, including information on potential new or existing vulnerabilities and hazards. The risk information should be comprehensive and encompass historical and local knowledge, as well as local and national-level data. Simple information regarding hazards, vulnerabilities, and risks, as well as how to mitigate the consequences of a disaster, should be shared with vulnerable populations and decision-makers.

2.2.4 Advisory Information

Advisories are actions or suggestions for agriculture or fish farmers that could help them protect or save their production during an extreme event or disaster. These are required in order to advise, instruct and engage the local population in a manner that increases public safety and reduces the possible loss of resources on which the community depends.

2.3 Global FA EWS Initiatives

Some of the initiatives that have been undertaken regarding the early warning system of the fisheries and aquaculture sector around the world are mentioned below:

2.3.1 Australia:

The aquaculture industry in Australia and in particular the salmon aquaculture industry plays a significant role in the local economy in Tasmania. There are several companies that manage salmon farming in various areas of Tasmania. The salmon are first raised in land-based hatcheries before being transferred to ponds where they remain for 6 – 12 months (Battaglene et al., 2008). After that they are moved into coastal sea cages where they remain for the last 2 years of their life. Whilst in sea cages the fish are exposed to climatic conditions such as changing temperature. Salmon is highly temperature sensitive species. In Tasmania it is common for the temperature to approach the upper limit in the summer. This causes thermal stress on the salmon resulting in poor fish health, an increase in disease occurrences and mortality (Battaglene et al., 2008). This will only become worse as a result of climate change impacts.

The Tasmanian Salmon industry has identified that a better understanding of the marine environment can help to adapt to climate variability and changes (Hobday et al., 2011b). Early warning of both extreme warm and cold-water temperatures can provide farm managers with the opportunity to adjust management strategies to optimise production, balance nutritional requirements, and reduce mortality from disease (Hobday et al., 2011b). As a result, it is essential for most salmon farm managers to receive forecast information a season in advance. To this end, efforts have been made to begin providing climate information to Tasmania Salmon farmers (Hobday et al., 2011b). These forecasts have proven to be effective, however, they were not able to predict accurately enough on unprecedented climate conditions.

In response to this, with the assistance of the Bureau of Meteorology (BOM) and the Commonwealth Scientific and Industrial Research Organization (CSIRO), an ocean temperature seasonal forecasting system has been developed for TSGA. The forecast outputs include probability pie charts of monthly temperature ranges in three possible ranges: upper, middle, and lower for 0-3 months (Spillman and Hobday, 2014). Validation exercises have demonstrated that the forecast is sufficiently accurate for up to three months. With the improved forecasts, TSGA members have been equipped with sufficient lead time to implement adaptive management strategies to ensure that salmon production is maintained and that losses are reduced.

2.3.2 India:

The coastal fishing community is one of the most vulnerable groups among the poor in India. They face series of barriers for their livelihoods, including poverty, high exposure to natural hazards, reducing fish stock, lack of alternate livelihoods and poor access to markets and infrastructure facilities. Additionally, the Coastal poor fishers faced lack of accurate weather condition and Potential Fishing Zones (PFZ).

With their vulnerability and need for early warning information, M.S. Swaminathan Research Foundation (MSSRF) of India developed the Fisher Friend Mobile Application (FFMA) mobile app in 2016. FFMA was developed in collaboration with Qualcomm Wireless Reach and Indian National Centre for Ocean Information Services (INCOIS).

The app has been designed to provide easy access to relevant information and knowledge related to fishing for small craft fishers (CTA, 2018). The app has been developed in several regional languages of coastal India, including Tamil, Malayalam, Odia, Bangla, Kannada, Marathi, and Gujarati. It provides information on potential fishing zone (PFZ), ocean state forecast (OSF), wind speed, wave heights, disaster warnings, global positioning system (GPS) guidance to fishermen, tsunami warning, proximity alert for danger zones in sea, international boundary and no fishing zones, search and rescue information, etc. FFMA provides timely and accurate seafaring information to improve the safety and incomes of fisher folk.

The App was piloted in Nagapattinam district of Tamil Nadu state which is located on the Bay of Bengal coast covering a total population of 1.6 million of which 78% live in the rural areas (Velvizhi et al., 2017). According to Velvizhi et al., 2017, the districts has a coastline of about 190 km, but most areas are situated either below sea level or at not more than 5 m above sea level and the district is highly vulnerable to sea level rise and disasters such as cyclones, floods, drought, and tsunamis. During 2004 Indian Ocean tsunami, the district experienced over 7000 death and damage of 40,000 houses (Velvizhi et al., 2017). So far, local fishers have been using this app for daily early warning, fishing zone and other relevant information (Velvizhi et al., 2017). A survey presented that, fishers got benefits like increased catch, disaster safety for lives and assets (boats, fishing gear etc.), optimized fuel use and cost minimisation (Velvizhi et al., 2017). Most of the users have been regularly using the app for PFZ, OSF, disaster alerts and weather forecasts. The community involvement in the process ensured designing a simple and useful app that is very effective and assistive for the local fisher community.

2.3.3 Gulf of Guinea:

The Gulf of Guinea is a vast and diverse region stretching from Senegal to Angola, covering approximately 6,000 km of coastline (EEAS, 2021). Fishing industry in this region, directly or indirectly, employs around 3 million people. The total fish catch in this region is 1.6 million tons per year valued at about 3 billion USD. Guinea-Bissau and Sierra Leone earns 10% of their GDP from the fishing industry in the gulf region (EEAS, 2021). The area experiences large amount of piracy, robbery and illegal fishing activities. There is about 120,000 artisanal fishermen in West Africa who are mostly poor. They rely on traditional knowledge to navigate and locate fish, assess weather condition at sea and decision on when to go fishing. As a result, death rate is quite high among the fishermen due to accidents in rough weather conditions.

To help improve the safety of fishermen at sea, the Economic Community of West African States (ECOWAS) Coastal & Marine Resources Management Centre started using satellite observations of the marine environment to monitor and anticipate ocean conditions. Early warning on ocean conditions is provided by daily charts of sea surface temperature and salinity, chlorophyll maps, sea surface winds, and notable wave heights (EEAS, 2021). Additionally, a 6-day prediction of ocean conditions derived from models and in-situ data provides information on ocean conditions in the near future and offers fishermen practical planning tools (EEAS, 2021). These products are primarily intended for regional fishermen, especially artisanal and semi-industrial ones, who lack access to advanced gear and are consequently more in danger at sea (EEAS, 2021).

The service generates early-warning messages using mobile phone message services and offers short-term forecast maps to fishermen. Fishing communities' flag combinations are then used by the fishermen to disseminate information to others about the state of the ocean. Commercial fleets are also given information on ocean conditions to help them plan their shipping routes. The early warning system established in Gulf of Guinea is assisting the artisanal fishermen with SMS based forecast and is facilitating the community level dissemination through flag and other techniques (EEAS, 2021).

2.4 EWS initiatives in Bangladesh and FA focus

Several initiatives in Bangladesh have been adopted to develop an effective early warning system for major hazards like, flood, flash flood, cyclone, erosion etc. The EWS initiatives in Bangladesh are led by two scientific agencies and one management agency. As highlighted in Figure 2.1, the scientific agencies are: Bangladesh Meteorological Department under the Ministry of Defence and Flood Forecasting and Warning Center (FFWC) of Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources. BMD is assigned for the EWS for all meteorological and environmental hazards, while FFWC is focused on flood early warning. Both these agencies are working in close cooperation with the World Meteorological Organisation (WMO). The disaster management and early warning dissemination activities are carried out by the Department of Disaster Management (DDM).

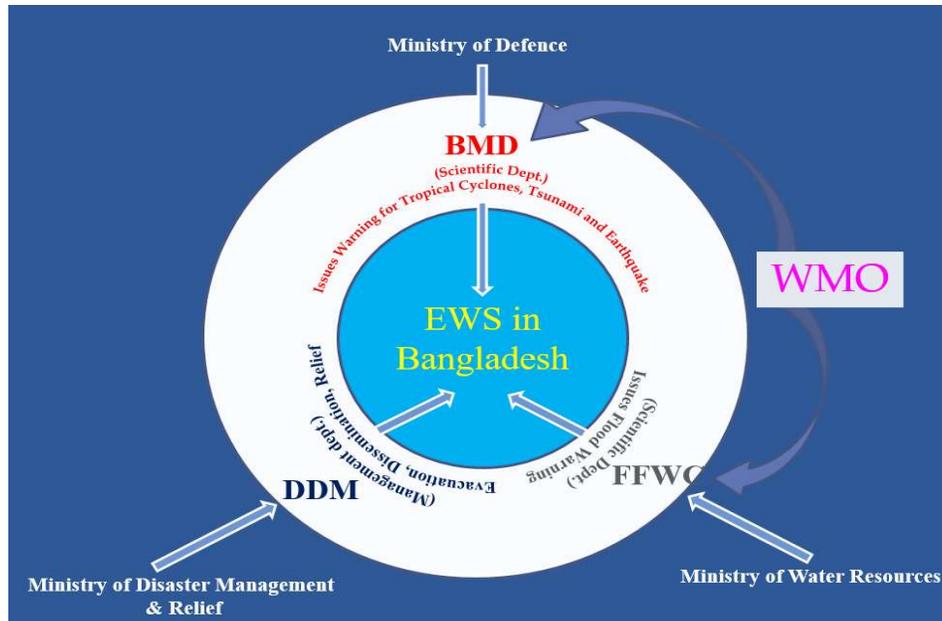


Figure 2.1: Major actors in EWS for Bangladesh

2.4.1 EWS related institutional arrangements

The early warning related institutional arrangement in Bangladesh is very well designed via the Standing Orders on Disaster (SoD) and National Plan for Disaster Management (NPDM). Figure 2.2 presents the overall institutional arrangement in practice (based on figure from GoB, 2010).

According to the NPDM (GoB, 2010), the Disaster management related institutional arrangement starts from national level and spans to union level. The early warning information generation and dissemination process also follow this hierarchy with BMD, FFWC and DDM at national level to Upazilla Disaster Management Committee (UDMC) at union level. Besides these, The DDM also transmit the information to Committee for Speedy Dissemination of Disaster Related Warning/ Signals (CSDDWS), Focal Point Operation Coordination Group (FPOCG), NGO Coordination Committee on Disaster Management (NGOCC), Disaster Management Training and Public Awareness Building Taskforce (DMTATF). The EWS related information is disseminated through DDMC, UzDMC, UDMC, CSDDWS and NGOCC at the local community levels. Beyond this official arrangement, different NGOs and community groups receive information from UDMC members or other sources like TV, Radio, Newspaper, social media, website etc.

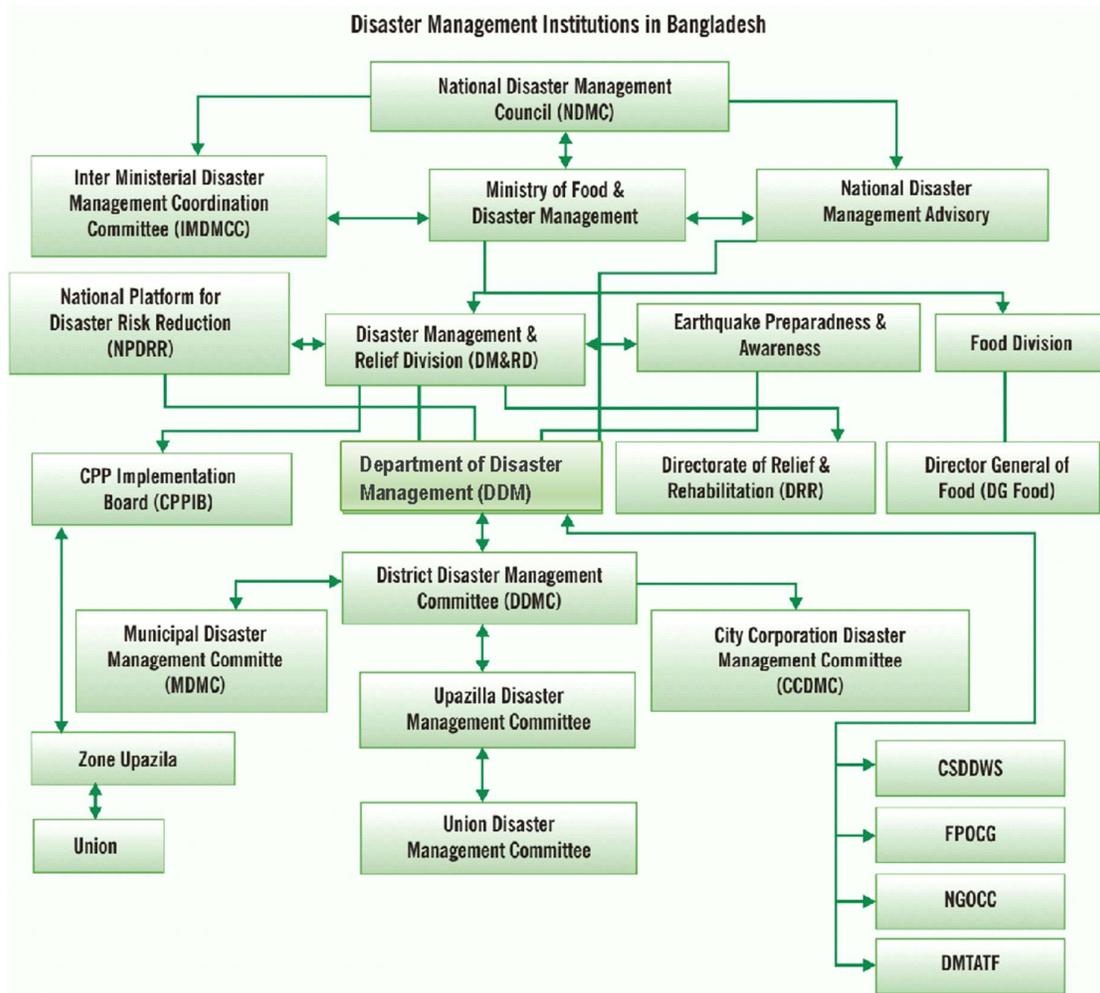


Figure 2.2: Institutional arrangement for disaster management in Bangladesh

2.4.2 EWS Information Generation and Transmission Pathways

The Early Warning System (EWS) of Bangladesh is mainly managed by Bangladesh Meteorological Department (BMD) and Flood Forecasting and Warning Centre (FFWC) on the generation part of the EWS system. The EWS information is generated on the basis of observational weather data, satellite-based information and weather/hydrodynamic model results. The generated information is packaged according to the specific guidelines prescribed in the Standing Orders on Disaster (SoD) of Bangladesh for different levels of stakeholders and beneficiaries.

The SoD has defined and prescribed the roles and responsibilities of various agencies in the generation and dissemination of disaster management information and early warning information (GoB, 2010). BMD and FFWC generate daily weather and forecast bulletins according to the prescribed guidelines. The bulletins are distributed to the designated government officials at the national level, regional level, district level and local level, NGOs, academia and development partners, print and electronic media through email, hard copy through post and fax, and continuous support via telephone. In addition, the Department of Disaster Management (DDM) operates Cell Broadcasting System, Interactive Voice Response (IVR) and Short Message Service (SMS) for the local level Disaster Management Committee (DMC) members. Figure 2.3 presents an overall pathway for the EWS information generation and transmission in Bangladesh.



Figure 2.3: EWS Information generation and transmission pathway

2.4.3 Major Actors in EWS in Bangladesh and their Roles

Bangladesh Meteorological Department (BMD)

The Bangladesh Meteorological Department's (BMD) mission is to deliver reliable meteorological and seismic services to safeguard human life, property, the environment, enhance safety on land, sea and air, improve quality of life and promote sustainable economic development. BMD monitors and issues forecasts and warnings of all meteorological extreme events like tropical cyclone, severe thunderstorm/tornadoes, heavy rainfall, drought, cold and heat wave along with daily routine forecasts round the clock. It Issues short, medium and long-range forecasts for agricultural planning and operation of farmer's daily activities. It also provides Flood Forecasting and Warning Centre with rainfall data, forecasts/warnings, radar and satellite image for the operation of flood forecasting and warning system and seismological information in and around the country along with Tsunami Advisories and warnings to the Government and public. The Bangladesh Meteorological Department (BMD) produces long-range forecast (three months) as well as short-term (weekly) agromet bulletin. These bulletins contain rainfall forecasts and GIS maps, which are accompanied by descriptive and interpretative English and Bengali text. The bulletin also includes a summary of the monitored variables of the preceding week for various stations, collected by administrative divisions. These monitored data include: Total rainfall, Total number of rainy days (bright sunshine hours), Average maximum (and minimum) humidity, Average Maximum (and minimum) temperature, and Average Normal maximum (and minimum) temperature. The Figure 2.4 below highlights types of weather bulletin provided by BMD. Figure 2.4 (A) presents short weekly agromet bulletin and Figure 2.4 (B) presents the spatial distribution of rainfall in Bangladesh.

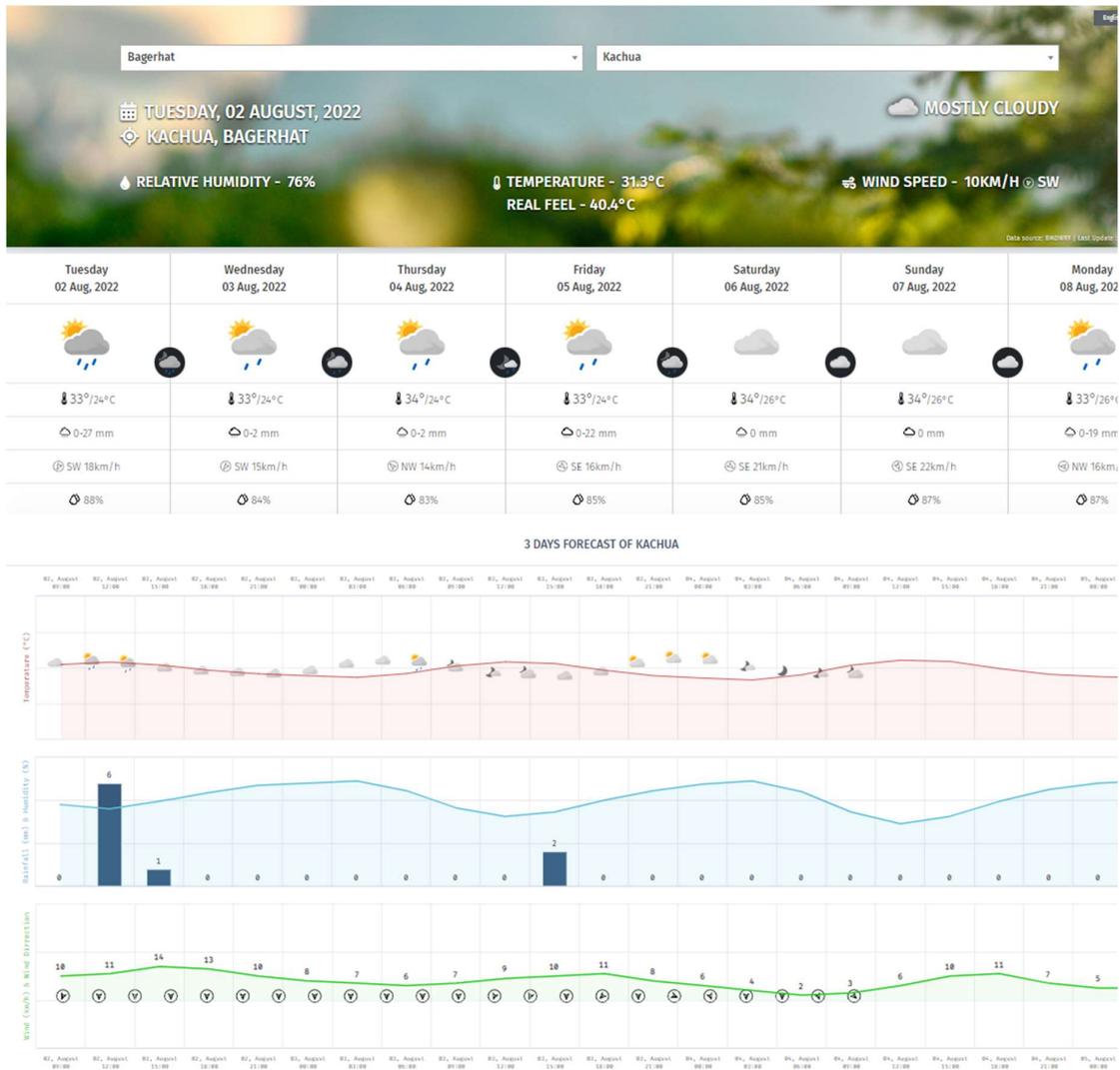


Figure 2.5: Upazilla Specific Forecast Information from BMD Website

BMD also performs numerical weather prediction and presents output as grid wise forecasted rainfall data, district wise rainfall data, temperature data, surface wind speed data. The BMD weather forecast also provides 2nd week, one month and third month forecasted data.

The Bangladesh Meteorological Department (BMD) has a specialized unit, the Storm Warning Center (SWC), which is responsible for the forecasting and issuing of tropical cyclone warnings in Bangladesh. Meteorological data is collected by BMD through 35 ground-based, 10 weather balloons, 5 radar, and 3 rawinsonde stations, as well as weather satellite data, ocean-buoy-recorded meteorological, and sea surface data, and numerical-model-generated weather forecasts from other national and regional meteorological offices as a member of World Meteorological Organization (WMO). BMD is contributing to the safety of the F&A community through its warning system.

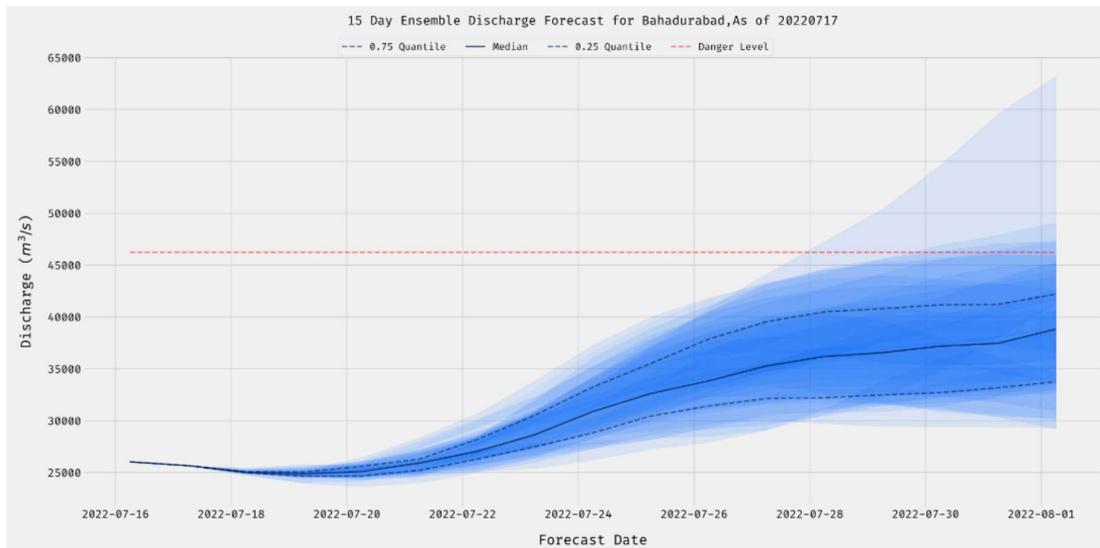
BMD is a very strong organization scientifically and has been providing important EW information. But there is further scope to enhance their service for F&A. Like the agromet bulletins, fisheries specific customized EW information could be generated and distributed.

Flood Forecast and Warning Center (FFWC)

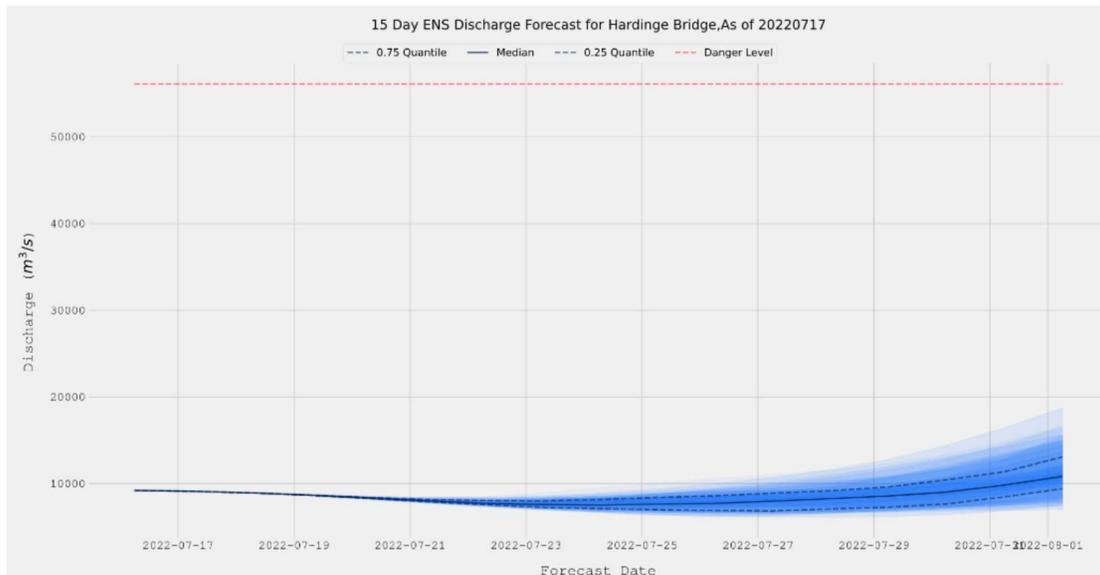
The Bangladesh Water Development Board (BWDB) is the key agency for flood forecasting and warning dissemination in Bangladesh. Under the Processing and Flood Forecasting Circle of BWDB, the Flood Forecasting and Warning Centre (FFWC) was established. Flood forecasting and warning information is

generated and disseminated by FFWC, to improve the disaster management capabilities of national authorities and local communities, utilizing the highest scientific standards, real-time data, weather forecasting data and mathematical models. FFWC works with partners for continuous updating and improvement of Flood Forecasting and Warning Services (FFWS) and capacity of professionals for better services. FFWC collects data from 94 water-level stations and 70 rainfall stations across Bangladesh for hydrological monitoring. FFWC utilizes these data along with upstream (India) rainfall and water level data in the MIKE11 Super Model for deterministic forecast at 54 locations with 5 days extended lead time. Additionally, a probabilistic medium-range flood forecasting model with lead times of up to 10 days at 37 locations in the Ganges-Brahmaputra basin is also used to generate medium range forecasts.

The main outputs of the forecast are the daily statistical bulletin of floods, river situation, a descriptive flood bulletin, forecast for 24, 48, 72, 96 and 120 hours at 54 monitoring points on the major rivers in the form of normal level, warning level, danger level, severe level etc., special flood report along with different graphical and statistical presentation during the monsoon season.



(a)



(b)

Figure 2.6: 15 days ensemble discharge forecast for (a) Bahadurabad, (b) Hardinge Bridge
 Source: www.ffwc.gov.bd

Apart from these, medium range (1-10 days) forecast and 15days extended range flow forecast is also prepared (Figure 2.6). The medium range forecast includes the forecasted water level condition of major rivers of the country along plot of water level vs day. The 15 days extended range flow forecast provides forecasted data of three station i.e. Bahadurabad at Brahmaputra Basin, Harding bridge at Ganges Basin, Bhairab bazar at Meghna Basin.

The bulletins are disseminated to more than 600 recipients including different ministries, offices (central & district level), individuals, print & electronic news media, development partners, research organizations, non-government organizations (NGOs) etc. including President's & Prime Minister's Secretariat. Whenever, the forecasted river stage crosses the Danger level, the concern field offices and limited key officials are informed through mobile SMS. FFWC also generates forecasted flood inundation map. The forecasted 24hr(1day), 48hr(2day), 72hr(3day), 96hr(4day) and 120hr(5day) flood inundation map is available at FFWC website (Figure 2.7). FFWC also provides 5day deterministic flood forecast and medium range (1-10day) flood forecast for all BWDB station along with hydrograph (Figure 2.8).

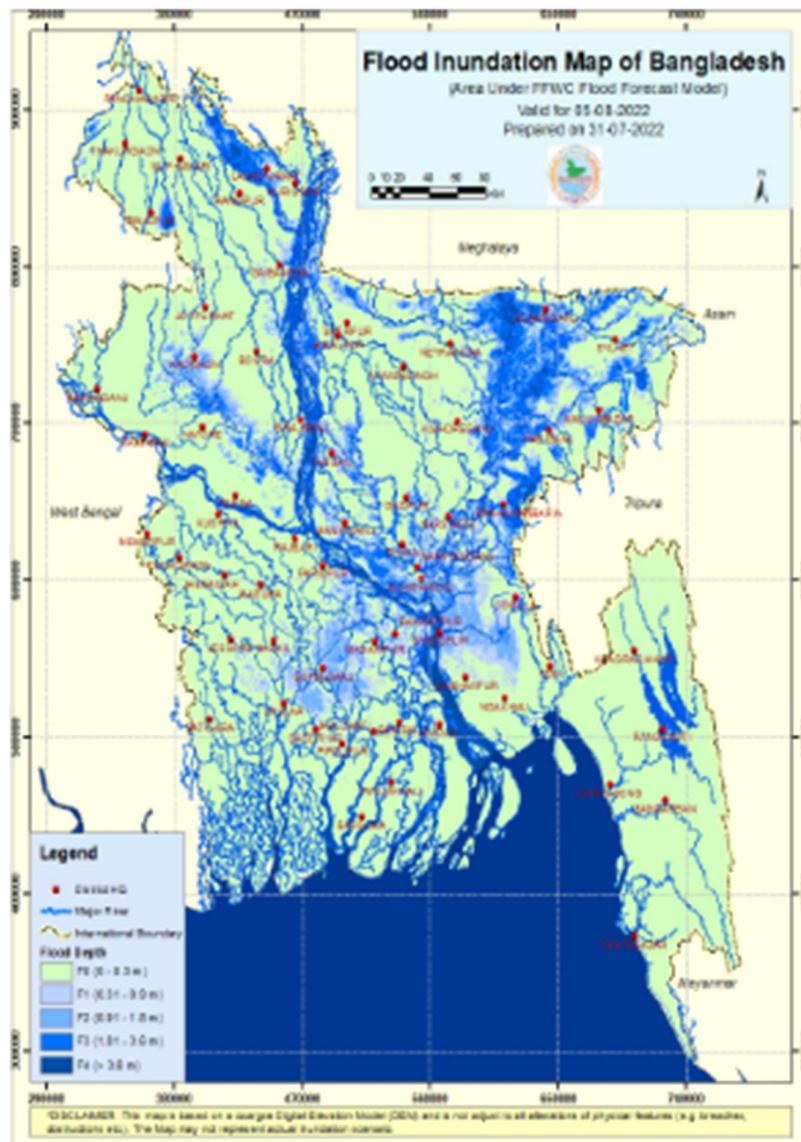


Figure 2.7: 5 day forecasted flood inundation map

Source: www.ffwc.gov.bd

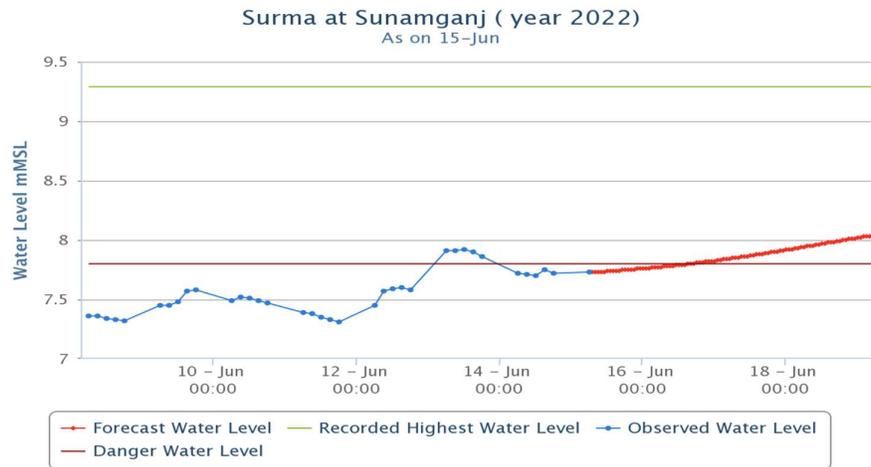


Figure 2.8: Forecasted water level at Sunamganj on Surma River

Source: www.ffwc.gov.bd

The FFWC has recently developed an experimental 3-days deterministic flash flood forecast system during the pre-monsoon period of April-May for the North East region of Bangladesh. 10 water level and 11 rainfall stations have been added for flash flood monitoring and forecasting in addition to the regularly active stations during monsoon in the North-Eastern region (Figure 2.9).

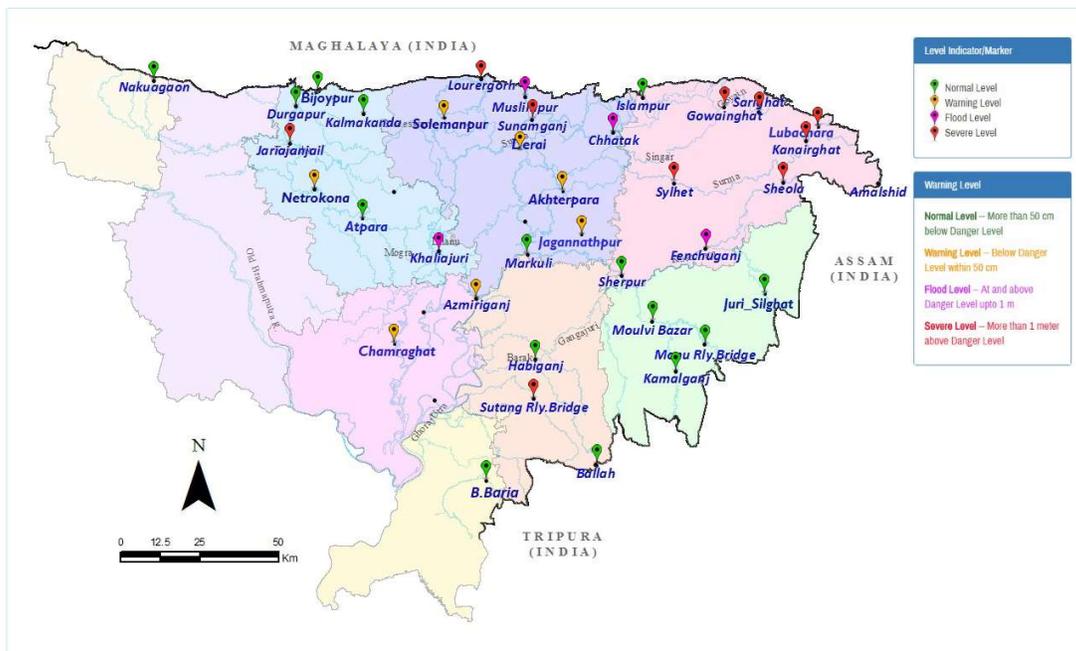


Figure 2.9: Operational Flash Flood Forecasting Stations during Pre-monsoon

Source: www.ffwc.gov.bd

The Flood Alert Service was developed by the FFWC in collaboration with Access to Information (a2i) and Google last year and has sent out a number of public flood alerts to individuals in affected areas across Bangladesh (Fig. 2.10). Flood Alerts provide timely, up-to-date, and essential information that can assist users in making informed decisions regarding the safety of their family and friends. These alerts are accessible to any individual in the affected region using an Android mobile device with location services enabled.

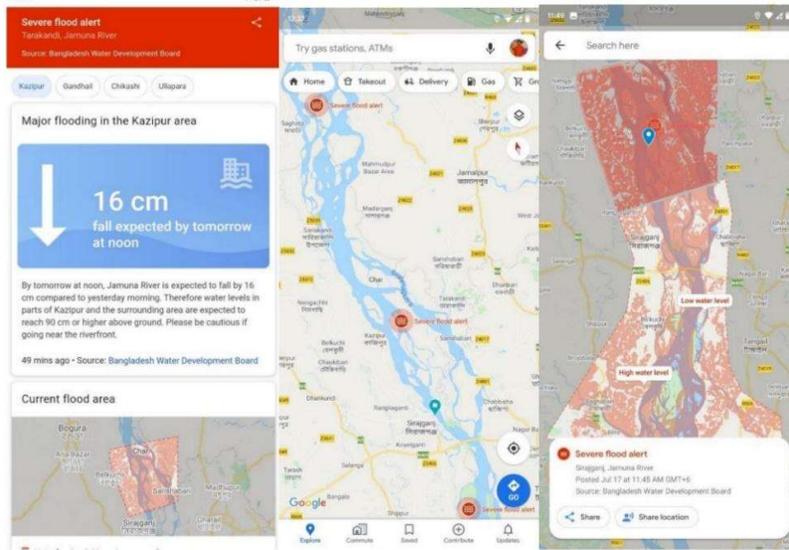


Figure 2.10: FFWC, a2i and Google's flood forecasting initiative

The FFWC has also launched an Interactive Voice Response (IVR) service through mobile since July 2011 through Teletalk. Since 2015, all the mobile operators have started the IVR. The FFWC website is openly accessible to all and contains all flood related information. In addition, FFWC has launched a mobile app since 2018, which is publicly available. The mode of dissemination of FFWC are e-mail; website; media, print and electronic; telephone, mobile and fax; hard/print copy; lobby display; IVR through mobile no 1090; android mobile app (BWDB Flood App).

In relation to F&A sector, FFWC provided information are very important, but there are issues related to location specific EW information. As FFWC provide river based forecasts, translating it to community locations is very important. Without this service in existence, community people could not efficiently use flood forecasts.

Department of Disaster Management (DDM)

DDM under the Ministry of Disaster Management and Relief (MoDMR) is the key disaster management agency of Bangladesh. According to SoD, DDM is the prime agency in all disaster risk reduction and relief actions. The Department also plays a key role in disseminating disaster forecast information and Early Warnings. DDM has developed multiple mobile network based warning dissemination systems for efficient communication. The Cell Broadcasting System is a mobile-network-based warning message dissemination method. It can be used to send warning messages to a targeted population group i.e., residents in the coastal areas. DDM uses SMS based warning dissemination for effective transmission of EW to field-level disaster management committees. Members of these committees continuously receive updated information about an approaching tropical cyclone on their mobile phones during cyclone emergencies.

DDM manages Interactive Voice Response (IVR) Based Disaster Early Warning System accessible through '1090' (Toll Free) from all mobile phone operators. The major information in this IVR include:

- Forecast/ Warning for sea going vessel: 1090-1
- Inland River Port Warning: 1090-2
- Daily Weather forecast/ Warnings: 1090-3
- Cyclone Forecast /Warning: 1090-4

DDM plays a major role in disseminating EW information to local fisher communities. But there are issues with effective last mile dissemination to community for F&A sector. Strengthening community level presence of DDM and utilizing various dissemination channels for effective delivery is essential.

2.4.4 Hazard specific EWS in Bangladesh

Tropical Cyclone

Bangladesh is usually hit by a severe tropical cyclone (wind speed 90–119 km/h) roughly every three years, potentially leading to significant loss of lives, property, and infrastructure as a consequence of climate change. Bangladesh, has many actors and stakeholders involved in cyclone preparation and warning. The BMD, DDM and the Cyclone Preparedness Programme (CPP) are the most strategic actors engaged in vital functions of cyclone early warning, from generations to dissemination and response management.

BMD generates cyclone warnings for rapid dissemination to government officials, the UN, CPP, humanitarian partners, media, and all other relevant actors by fax, email, and telephone. Through a single side band radio, CPP sends warning messages to all 37 offices stationed at the Upazilla level (Figure 2.11). The warnings are then communicated to the village-unit teams by the Union leader over Very High Frequency (VHF) radio or mobile devices. Additionally, during the time when warnings are issued, the village volunteers watch the special weather briefings that are continuously broadcast by the national radio and television networks. Finally, the volunteers broadcast the warning to the entire community at risk by sounding sirens, raising flags, and announcements through loudspeakers, among other methods.

The CPP is a unique institutional arrangement for community preparedness created to mitigate the challenges of catastrophic cyclones that frequently hit Bangladesh coast. The CPP model, a globally acknowledged disaster risk management system, has been implemented with its mandate for disaster management operations in Bangladesh, particularly in the areas of Early Warning System (EWS), search and rescue, evacuation, shelter management, emergency medical care, relief distribution, and rehabilitation. CPP disseminates the weather warning signals with the following steps in the coastal areas of Bangladesh since 1973. The following figure illustrate the signaling mechanism followed by CPP. The Figure 2.11 below illustrates the cyclone early warning dissemination process of CPP.

The cyclone warning system in Bangladesh follows a storm warning approach effective for the ports. As a result, it is not quite clear and usable for community people and F&A farmers. Preparing an effective and easily understandable warning system for local community could be helpful for effective dissemination.



ঘূর্ণিঝড় প্রস্তুতি কর্মসূচী (সিপিপি) CYCLONE PREPAREDNESS PROGRAMME (CPP)

A Joint Programme of Government of Bangladesh and Bangladesh Red Crescent Society

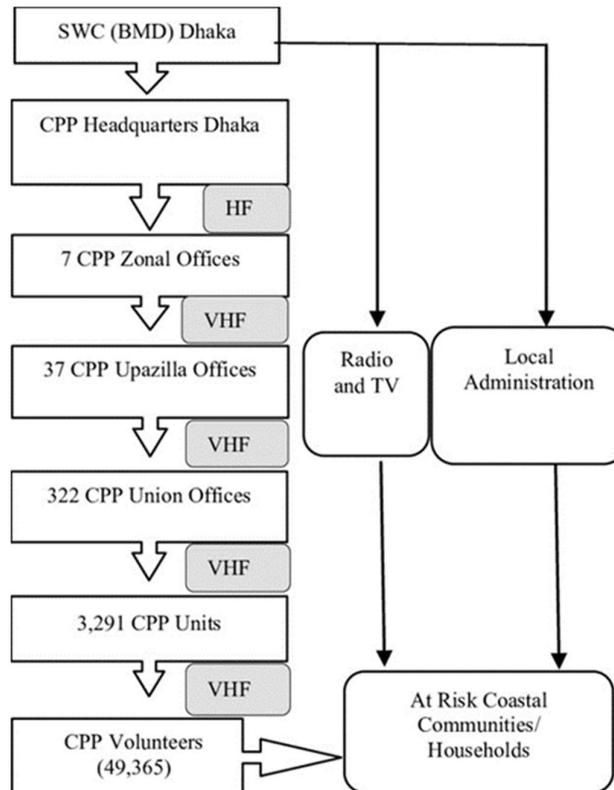
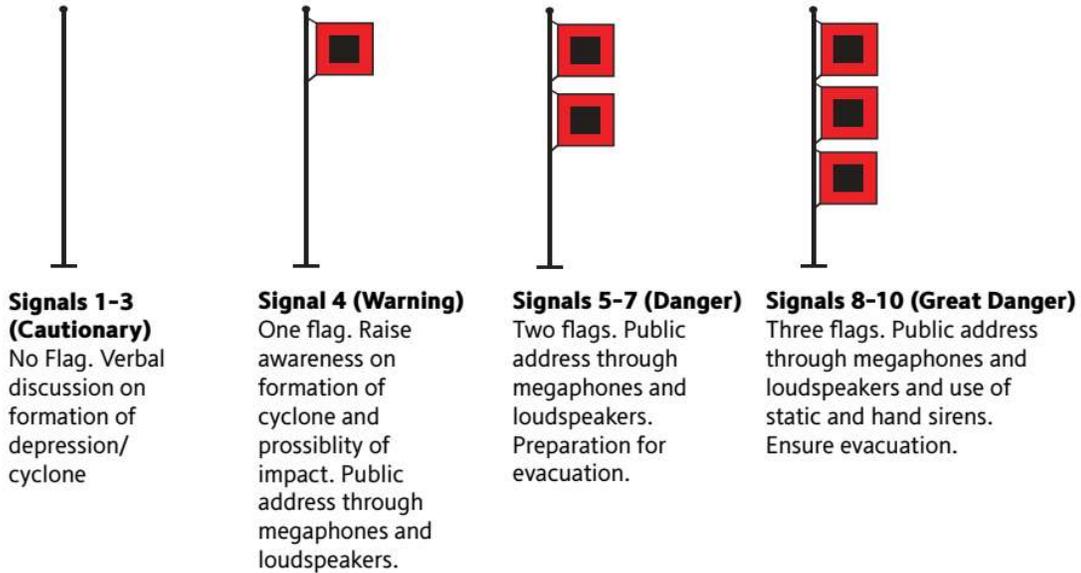


Figure 2.11: Cyclone warning dissemination process in Bangladesh

Source: BDRCS et al., 2021 and Ahsan et al., 2016

Flood and Flash Flood

Bangladesh has achieved remarkable success in the field of Flood Forecasting and Early Warning Systems. A number of organisations are actively working to strengthen these systems, such as the Flood Forecasting and Warning Centre (FFWC), Centre for Environmental and Geographic Information Services (CEGIS), Institute of Water Modelling (IWM), Department of Disaster Management (DDM), and Water Resources Planning Organisation (WARPO) etc. As described earlier, FFWC generates information for river based locations and disseminate via official channels, email, radio, TV, website, IVR etc. So, there are scope for enhancing the outreach further.

Other initiatives include the Community Flood Information System (CFIS) project of CEGIS, which with support of USAID and CARE has, generated and translated flood EWS to community levels in north western region. The CFIS project was designed as a pilot to produce accurate and timely information on current and forecasted flood conditions for floodplain areas. CFIS developed an innovative system for efficient and accurate floodplain modeling, along with an automated dissemination module. Flood forecasts for the study area were generated as a digital map, allowing automated distribution of site-specific forecasts for any location. CFIS explored a number of techniques for disseminating flood information to communities and local governments. Most successful in 2007 was automated SMS text messaging with multiple pathways to local governments, to key opinion leaders—such as school teachers, imams and shopkeepers—and directly to vulnerable households. Recipients had succeeded in, passing on warnings to their neighbors and wider community. A network of flag sites, bulletin boards, and awareness raising exercises reinforced this effort (Figure 2.12). ‘Sustainable End-to-End Climate and Flood Forecast Application’ project of CARE-Bangladesh under the Strengthening Household Ability to Respond to Development Opportunities (SHOUHARDO) program, has tried to expand these techniques.



Flag system in operation in the floodplain



Bulletin Board to disseminate flood forecast

Figure 2.12: Flood Warnings Dissemination at Local Level in CFIS project

Previously, the CDMP established a mobile phone-based warning system that facilitated information dissemination to users, but it lacked specific information for F&A farmers as to what actions should be undertaken to reduce the risks. Bangladesh currently do not also have an ICT-based fisheries information service from which fishers and fish farmer communities can access advice on how to adapt to climate change stressors. Thus, the F&A dependent communities lack information to fully understand and plan for climate change threats or risks and impacts on F&A.

Bangladesh Red Crescent Societies (BDRCS) has implemented community-based resilience programmes to enhance the capacity of the flood vulnerable people to cope with flood and other small-scale disasters. Integrated Flood Resilience Programme (IFRP), one of the interventions of BDRCS, is implemented at four communities of Nilphamari and Lalmonirhat Districts, starting in March 2018 to February 2021. The goal of the programme is to strengthen community resilience for effective and efficient response to multi-hazards and climate-induced phenomena of the targeted community people. The objectives of the programme are to build the capacity of communities to reduce the loss of life and livelihoods in recurrent disaster through community-based approaches. Identifying the vulnerability and initiating different interventions for the community people help them to cope with future disaster and flood situations. For that, Flood Early Warning System (FEWS) was developed by BDRCS at the four communities under the

programme in collaboration with Community Disaster Response Team (CORT), Community Disaster Management Committee (CDMC), Unit Disaster Response Team (UDRT), Community Organizer (CO) and Upazilla and District Water Development Board.

Enhancing early warning system for community-based response in Bangladesh under SHOUHARDO- II project was carried from 2012 to 2014 by Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), ADPC with financial support from USAID through CARE Bangladesh. The project aimed at enhancing the lead time for flood early warning and preparedness in Bangladesh by expanding the generation and application of long-lead probabilistic flood forecast warning information to larger areas in Bangladesh; operationalizing 20-25 days and seasonal forecasts in pilot areas; piloting the flash flood early warning system, and complementing CARE Bangladesh's work in cyclone-prone areas. The project work focused on enabling communities to receive warning, interpret and response on medium or long range (20-25 days) range forecasts and flash flood forecast.

RIMES is currently supporting BMD and FFWC, to build climate resilience in Bangladesh through improved access and use of early warning information among last mile users. Forecast-based anticipatory actions in two pilot sites – Bogura (Northwest) and Cox's Bazar (Southeastern) are implemented through 'Strengthening Last Mile Communication (SLMC) in South Asia' in partnership with UCAR with funding from USAID.

Drought

Drought is a severe disaster in the north western part of the country. The consequences of droughts include the widespread human suffering brought on by decreased crops, low income, unemployment, and rising food prices. Additionally, livestock suffer greatly, with many farmers being forced to sell their cattle for incredibly low rates. This was primarily due to the fact that they lacked the funds to purchase food for them or enough fodder, as the price had increased. The Agro-met Division of BMD and the Department of Agricultural Extension are the main actors among the stakeholders involved in the process of producing weather information linked to drought and disseminating it to farmers. This forecast information includes extreme temperature and rainfall predictions based on numerical weather prediction models and radar and satellite information-based cloud movement etc. This information is disseminated in a similar way like other disaster EW information.

Other Initiatives

In addition to these government entities, some private and development organizations have created early warning systems in partnership with the government. For instance, a new early warning system for Cox's Bazar, has been developed by the Food and Agriculture Organization of the United Nations (FAO) in collaboration with government partners. It is based on risk modeling and uses inputs from satellite imagery, rainfall amounts, and other meteorological data. The FAO is collaborating with the government of Bangladesh to strengthen community preparedness for disasters targeting landslides, which is a substantial advancement based on technological tools. The new approach enables people in risk regions to be informed by email or mobile SMS up to five days in advance of the event. This represents a great improvement, considering that landslide warnings in Bangladesh are mostly issued a few hours before a landslide, giving very little time to respond.

Another initiative is National Livestock Advisory Service (NLAS) by RIMES, which is being implemented under World Bank funded "Climate Adaptation and Resilience for South Asia" or CARE for South Asia project. The project is supporting the region in building resilience to climate change by improving the availability of regional data and knowledge, developing guidelines, tools and capacities, and promoting climate-resilient decisions, policies and investments across key sectors. Under this project, a regional resilience data and analytics service (RDAS) platform and decision-support systems (DSSs) for selected sectors of agriculture, livestock, water, road transport, planning and finance in Bangladesh, Nepal, and Pakistan is being developed for enhancing sector-specific climate-sensitive planning and decision making. The NLAS is being established as a DSS for livestock sector. It is expected to be at the core of the Department of Livestock Services (DLS), Bangladesh's climate resilient extension service. The NLAS includes information on weather, climate, thermal humidity index (THI), disease and population and potential advisory for livestock under different weather events. NLAS utilizes real-time information from BMD.

Bangladesh Weather and Climate Services Regional Project (2017-2023) is a World Bank funded project that is supporting the modernization of the country's weather, water and climate information infrastructure, strengthening both the supply of hydro-meteorological data, information and services and delivery to sectors and communities. It is targeting to do so by modernizing meteorological and hydrological monitoring systems, forecasting, strengthening sector specific information services and targeted community based hazard early warning activities in selected districts. Under this project, Bangladesh Agrometeorological Information System (BAMIS) portal has been developed and is providing community farmers with updated forecast and advisory services for agricultural activities. The project has installed around 500 automatic weather stations (AWS) for localized information collection and generating precise Upazilla level weather forecasts. Additionally, climate risk maps for the whole country have been prepared for the future, based on the available latest climate modelling results. The project provides agromet advisories and capacity building trainings for farmers and local officials.

Capacitating farmers and fishers to manage climate risks in South Asia (CaFFSA) project of WorldFish with support from CGIAR, ICRISAT and CIMMYT (2019-2021) has developed a decision tool for climate information services for aquaculture based on information from communities in four districts (Khulna, Barishal, Patuakhali, Sylhet) of Bangladesh. A study by Hossain et al. (2021) identified community demand for forecast information and lead time for aquaculture practices. The study found out that most fish farmers preferred having at least a 7-day lead time to use forecasts from a CIS, followed by 15- and 5-days lead time (Figure 2.13). Regarding the CIS platform, most of the respondents preferred direct voice calls over the rest, with TV identified as the second choice of preference in relying early warning information.

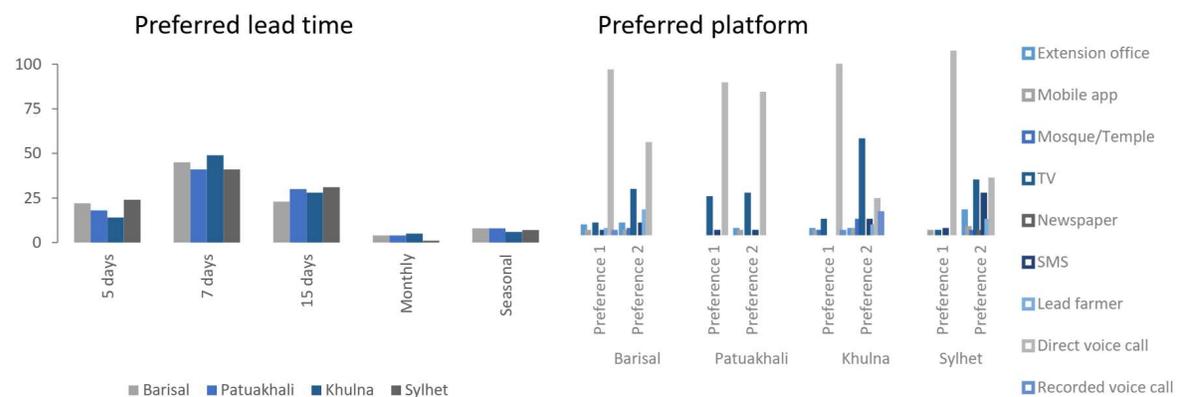


Figure 2.13: Preferred lead times to make decisions to change management practices and preferred platforms for climate information services delivery

Besides these community choices, temperature and rainfall thresholds for aquaculture have been developed under the study, for four major culture fish and shrimp species (Nile tilapia - *Oreochromis niloticus*, Rohu - *Labeo rohita*, Black tiger shrimp - *Penaeus monodon* and Freshwater prawn - *Macrobrachrium rosenbergii*). A set of advisory for the fishers has also been developed to assist them in using the early warning information. The study has successfully developed a set of advisories for F&A sector and also identified preferred lead time and channels for receiving EW information for local population. These outcomes need to be scaled up and utilized in more areas.

2.5 Policy Landscape for FA-EWS in Bangladesh

2.5.1 Review of Policies

National Fisheries Policy

The National Fisheries Policy was formulated in 1998 for fisheries sector having beneficial purposes in freshwater bodies, fish culture and management policy in closed freshwater bodies, coastal fisheries and cultivation policy, and the exploitation, conservation, and management policy for marine fisheries resource development. Additionally, the Fisheries policy seeks to make the best use of marine and coastal resources in order to meet protein needs, advance the blue economy and earn foreign currency through the export of

fish and fisheries products. Despite the immense impact from climate change disasters faced in F&A, the policy does not mention anything related to EWS which is an important tool to adapt to climate change induced disasters and associated damages. This will be a major barrier for ensuring sustainable development of fisheries in Bangladesh.

Coastal Zone Policy

Coastal Zone Policy, was formulated by Ministry of Water Resource in 2005, with the goal of integrated coastal zone management which intends to create conditions, in which the reduction of poverty, sustainable livelihoods development and the integration of the coastal zone into national processes can take place. This policy states about using available opportunities of the coastal zone through sustainable management to enhance living standards of coastal communities by investing in different sectors. Despite climate related hazards especially the frequent occurrence of cyclones and floods in coastal areas, Early warning system was not included in this policy—which presents a policy gap against control and/or mitigation of climate change related hazards in the coastal areas of Bangladesh.

2.5.2 Review of Act and Rules

The East Bengal Protection and Conservation of Fish Act

The East Bengal Protection and Conservation of Fish Act, 1950, formulated by the then Directorate of Fisheries, Government of East Pakistan established regulations on the production, import, marketing, carrying and transportation of appropriate fishing gear (nets, cages, traps, and explosives) as well as the construction of weirs, dams, bunds, and embankments for water management. Additionally, it details the seasons for fishing and not fishing as well as the minimum fish size at which forbidden species cannot be killed or sold. The revised version of this act includes the banning of manufacturing, fabricating, importing, marketing, storing, carrying, transporting, possessing or using of Current Jal. But, there is no mention or suggestion for developing early warning system for fisheries and aquaculture in this policy.

Marine Fisheries Act

Replacing the Marine Fisheries Ordinance, 1983, the Marine Fisheries Act 2020 detailed regulations for fishing operations carried out in Bangladesh's maritime territory by both domestic and foreign fishing vessels. The primary issues discussed by this act are the circumstances associated with the renewal, expiration, and cancellation of licenses, permissions for Bangladeshi boats to collect fish on the high seas, as well as the importation of commercial trawlers and its safety management. In addition to offenses, fines, appeals and other administrative processes in connection to any fishing rule violations are clearly specified in this act. Moreover, establishment of mariculture zones has been also proposed in this policy in order to expand the growth of blue economy. Marine Fisheries Act, 2020 also doesn't include any directives for early warning system in fisheries and aquaculture sectors. But, EWS and satellite observation based information of PFZ are essential for enhancing marine fisheries. Without EWS, the targeted expansion will be difficult to achieve.

2.5.3 Review of Plans, Strategies and Studies

National Fisheries Strategy

National Fisheries Strategy, 2006 was formulated by Department of Fisheries to propose ways in which the policies and in particular the National Fisheries Policy can be implemented and support can be offered to guide the sector, recognising the need for more support for inland and marine capture fisheries to reverse the current decline and to prevent further biodiversity and wetland losses.

Unfortunately, there is nothing discussed regarding the provision of early warning system in fisheries and aquaculture sector—which is a strategic gap as EWS is a major action to reduce damages due to disasters.

Bangladesh Climate Change Strategy and Action Plan

The Bangladesh Climate Change Strategy and Action Plan, 2009 was adopted in order to increase the nation's capacity and resilience to deal with the challenges of climate change in various sectors. The set programs of action in BCCSAP is based on six major pillars.

Thus, for the development of adaptation strategies in the fisheries sector, this policy has suggested actions under the theme 'food security, social protection and health'. Assessing potential threats to fish spawning and growth of fish in the freshwater fisheries sector, marine fish sector, coastal zone and brackish water and the potential impacts on the shrimp sector and the migration of Hilsha fish and developing appropriate adaptive measures have been mentioned as directive actions in this policy.

BCCSAP has included early warning as a major initiative under the Comprehensive Disaster Management Theme. There are specific programmes proposed for flood and cyclone early warning system improvement and dissemination. Additionally, awareness building among population has been considered an important activity.

Master Plan of Haor Area

The "Master plan of Haor area, 2012" formulated by the Bangladesh Haor and Wetland Development Board of the Ministry of Water Resources intends to develop the resources of the Haor region as rapidly as possible in order to improve the welfare of its population, offer standard living conditions, social services, and equal opportunity along with aiming at the widest and most equitable distribution of income and property. Improved water and disaster management; agricultural development for food security; biodiversity enhancement and wetland management; social safety net and improved standard of living; improved physical infrastructure; enterprise and technology development are six broad thematic areas upon which the strategies have been set in this Master Plan of Haor Area.

Development of Early Warning System for Flash Flood prone area in Haor and dissemination to community Level have been suggested as a project by BWDB under water resources area, where 768 lakhs of Taka is planned to be invested.

National Plan for Disaster Management

National Plan for Disaster Management (2016-2020), adopted by Ministry of Disaster Management and Relief of the Government of Bangladesh has set some strategic aims reflecting its alignment with four priorities of Sendai Framework for Disaster Risk Reduction (2015-2030) and a strategy guidance to relevant stakeholders, recognition of emerging risks and phased implementation of prioritized actions.

Strengthening the national forecasting and early warning system, providing support for community-based early warning systems and giving special attention to developing an early warning system for floods, expanding coverage of existing warning systems and developing systems for hazards have been prioritized under Priority 4 stating 'Enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation and reconstruction'.

Moreover, investing in, developing, maintaining and strengthening people-centred multi-hazard, multi-sectoral forecasting and early warning systems, disaster risk and emergency communications mechanisms, social technologies and hazard-monitoring telecommunications systems and developing these systems through a participatory process; tailoring them to the needs of users, including social and cultural requirements, in particular gender; promoting the application of simple and low-cost early warning equipment and facilities; and broadening release channels for natural disaster early warning information have been also highlighted under this priority in this plan.

Bangladesh Delta Plan 2100

The Bangladesh Delta Plan (BDP 2100), a comprehensive development strategy formulated by the General Economics Division of Bangladesh (GED) with the help of the Government of Netherlands. The main purpose of this plan is to set a guideline for the water resource management in Bangladesh for the next hundred years along with boosting economic growth while promoting climate resilience. In this regard, this policy outlines the required cross-sectoral activities, which includes planning, for achieving long-term food security with safe fish products and fair resource management with strong governance.

Climate change and extreme natural disasters are addressed as one of the major threats to Bangladesh's fisheries industry in 'Volume 4: Agriculture Food Security and Nutrition,' of Bangladesh Delta Plan 2100, particularly as a threat to culture fisheries due to flooding, drought, river bank erosion, salinity intrusion from sea level rise, etc. In order to increase the potentiality against climate change and natural disasters, the strategy mentions ensuring identification of potential coping mechanisms and solutions for reducing disaster risk, such as development of early warning system

8th Five Year Plan

8th Five Year Plan, 2021 is the first phase of Bangladesh's Perspective Plan 2041, which intends to bring the country closer to the goals of becoming an Upper Middle-Income Country, achieving major Sustainable Development targets, and ending extreme poverty by FY2031.

This plan describes all the confronting challenges that can constrain the sectors' growth in the future and proposes strategies against these challenges to support sustainable growth in fish and shrimp production with other aquatic resources for domestic consumption and exports by managing open water fisheries resources, exploring blue economy through community participation leading to equitable distribution of the benefits for optimal economic and social growth, and reducing post-harvest loss.

The plan has set its' strategic objectives to enhance fisheries resources and production, alleviate poverty through creating self-employment and improvement of socio-economic conditions of the fishers, achieve economic growth and earn foreign currency by exporting fish and fisheries products, manage resources including manpower development for ensuring optimum productivity, sustainability of production and conservation of fisheries resources, establish and maintain fish and wetland sanctuaries which include ban on fishing in certain eco-sensitive areas, harness the potential of blue economy, stock assessment of marine fisheries and promote sustainable exploitation of marine fishes, especially tuna and tuna like other pelagic fishing, promote value chain in fish and fisheries products, ensure safe and quality fish supplies in the domestic and international market.

Developing modern early warning systems to minimize economic losses from flood and other disasters, extension of the flood warning lead time for better dissemination, strengthening early warning and nutrition surveillance systems are also highlighted as strategies in this holistic plan.

National Adaptation Plan

The NAP formulation was initiated by the Government of Bangladesh under the Ministry of Environment, Forest and Climate Change to provide a viable path towards achieving climate resilience and reducing climate risks and vulnerabilities. Aligning with this, NAP has undertaken around 113 interventions covering 11 climate stress areas all over the country based on developed adaptation pathways and sectors. The NAP primarily encompasses eight distinct sectors, which are, water resources; disaster, social safety and security; agriculture; fisheries, aquaculture and livestock; urban cities; ecosystem, wetlands and biodiversity; policy and institution; capacity development, research and innovations.

Emphasis have been put on prioritization of production of fisheries and aquaculture, development of stress tolerant breed, management of fisheries and aquaculture infrastructures, advancement and extension of technology, initiative of resilient market system of fisheries and aquaculture, exploring blue economy, improvement of livelihoods, achievement of food and nutrition security etc. in this policy.

Moreover, developing and disseminating stressor based early warning system for fisheries has been highlighted as an important activity under the intervention CFL2 which intends to develop climate-ready open water fisheries management. Functional Early Warning System (EWS) and Climate Information Services (CIS) for fisheries and livestock has been proposed as potential indicator under strategies 2.2, 2.3, 2.4 and 6.3 of goal 2 which states the development of climate-resilient agriculture for food, nutrition, and livelihood security. These strategies addressed development of climate resilience, the management of sustainable agro-inputs and transformational value chains, and research and innovations for the agricultural, livestock, fisheries, and aquaculture sectors. Research and innovations on climate resilient fisheries and aquaculture have also been stated as a significant intervention, where the development of early warning and dissemination systems and climate information services have been emphasized as an

activity under this intervention. Also, Pre-matured or early harvesting of cultured fish before any extreme flood or storm surge based on early warning information has been mentioned in this policy as a key adaptation priority related to fisheries and aquaculture for managing climate change risks.

However, despite the fact that a few policies have focused on the need for and prescribed actions for early warning system in the fisheries and aquaculture sector, the majority of fisheries-related policies have mainly reflected some specific elements, such as regulatory matters, the roles and responsibilities of the administration, delegations of powers, licenses, registrations, and certifications of fishing and fishing vessels, local marine fishing operations, prohibited fishing methods, offenses, etc., while inclusion of ecosystem, biodiversity, marine reserves and sanctuaries are being done in the revised versions or newly formulated ones.

3 Status and Potential Use of FA EWS in Project areas

This chapter portrays the evidence of climate induced hazards in study area and use of EWS by fisher community. The chapter also describes the potential use and needs of EWS by FA communities.

3.1 Existing EWS Information and Sources

The project level consultation at the nine Upazillas in north-east haor and coastal area identifies the types of EW information received by local communities. Figure 3.1 shows the major hazards/ disasters for which the community people receive EW information. From the consultations, it was found that, most upazilla receive information on weather forecast, cyclones, floods and flash floods. A large part of the community people gets this information from BMD website, radio or TV and apps, even though the accuracy and usability of apps was reported as difficult for many community members.

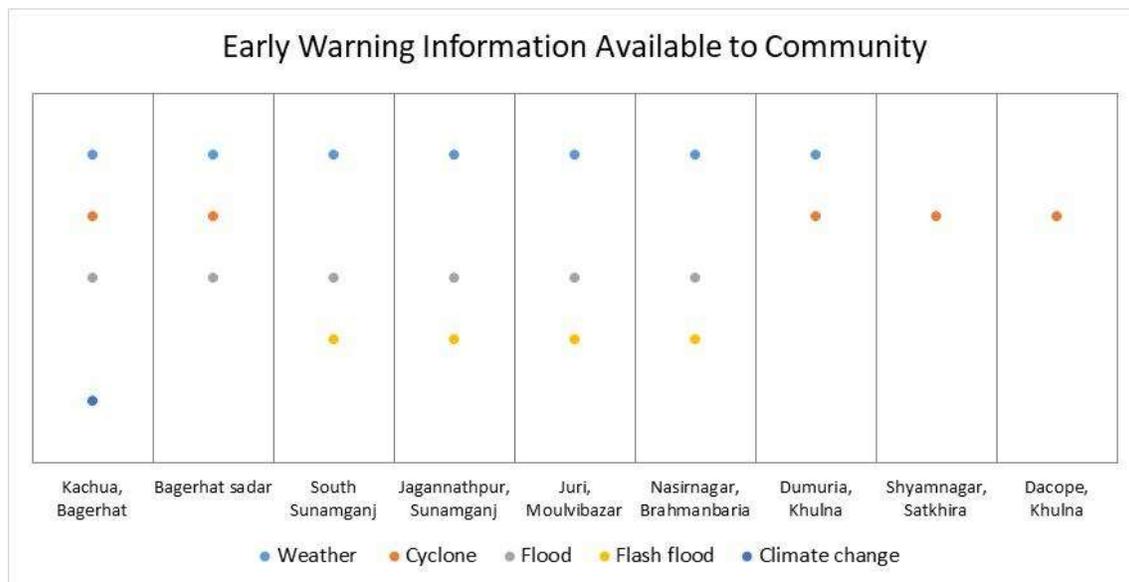


Figure 3.1: Existing EWS Information Available to Local Communities

Flood related forecasts are available to communities in Bagerhat and Haor areas. They receive FFWC generated information from various channels like TV, radio, Local Administration, website/ mobile app, IVR, Local NGOs etc. Similarly, Flash flood forecasts are disseminated to haor areas mainly. Community people in the four upazilla in haor area receives FFWC forecasts through similar channels. But the lead time is very short for them and they could not take proper preparations to save assets in most cases.

Cyclone forecasts are generated by BMD and disseminated by DDM and CPP at the local levels. Local people of the project area upazilla's in coastal region receive this information through miking by CPP volunteers, TV, Local Administration, IVR, Local NGOs etc.

People in the southwest region do know about the early warning system and many of them are involved in disseminating the EW messages prior to major disasters. Before major cyclones, Upazilla parishad, Union Parishad, Union disaster Management Committee (UDMC), and other NGOS get involved in disseminating the warning. People living in this region understand the warning levels of cyclones /storm surges. In most of the cases they try to understand the condition by observing the weather pattern (i.e. wind speed, presence of cloud, and wave). In case of potential high storm surges, gher owners uses net barrier to protect their shrimp/ fish from washing away. This scenario is not the same for the fishermen who catch fish in the deep sea. Due to lack of communication technology, they do not get any warning while fishing in the deep sea, as most of the boats are artisanal and do not possess any GPS, high frequency radio and Bangladesh

Betar do not have area coverage in the Southwestern part of Bay of Bengal region. For warning they have to rely on the forecast of IMD and Indian Radio signals.

For Climate information services, people involved in fisheries and aquaculture do not get any specific information on fisheries and aquaculture. Generic Climate information are available through Google weather Push notifications, Bangladesh Meteorological Department (BMD) website/App, and through disaster management IVR. As most of the gher owners own smartphones and have access to the internet they get info about any hazard/weather information through Facebook or Google Weather push notification. People who does not have smartphones usually get early warning through televisions and radio. Elderly people, illiterate people and people who do not have any communication device get this information from neighbors.

Women in Sarkar Danga of Bagerhat sadar Upazilla get daily weather information from google weather notification through their smartphones and act accordingly in case of any climate emergencies. They urged to develop Interactive Voice Response (IVR) for disseminating fisheries related early warnings. They also suggested that it would be much easier for them if there were any digital dashboard to display warning at local level. At present one or two digital dashboards are present in the upazilla but not in the localities.



In the Haor region, currently the community depends on news of flood situation in the upper region of the river system of Sylhet, Sunamganj and dam opened in India as warning for flood. The community, especially women uses indigenous knowledge with observation of excessive rainfall, wind direction, the rising water level at river, colour of water (more turbidity), snakes and frogs moving at higher land etc. as warning signs of flash floods. The men stakeholders specifically in the Juri and Shantiganj uses advance sources to get early warning from TV, Facebook, Internet/ website, smartphone etc. The miking is specifically done to call people to move in safer places during floods.

Lead time is a very crucial factor for effective use of flash flood/ flood forecast in haor areas. At present, the local community receives information with 1-3 days in Hand. Women responded that their current lead time is 1-2 days while men responded that is 2- 3 days. The expected lead time is 3 to 7 days by all respondents. Women get flood warning later than men. Women depends on others for getting early warning information. The women are interested in saving crops, fish farms and household assets. Increased access of women at early warning directly can save more household resources.

“Great to get expert advise directly on phone at our home, as we don’t go out much ”

Women fish farmers, Shantiganj, after calling 12126



3.2 Existing EWS Information Gaps for F&A

The EWS information generated in Bangladesh follows a generic approach. The gaps in EWS information for F&A is assessed based on stakeholder consultation at nine project upazilla. The identified gaps are as follows:

Weather forecast

- The generated EWS information provide weather information and forecast at upazilla level which does not always match with community level situation.
- There is a Gap in relevant information for F&A sector. The available forecast information is not always related to local conditions (e.g., water level). As a result, local fishers cannot use it for their farm management.
- As water temperature is slightly lower from air temperature and BMD forecasts are for air temperature, fishers could not relate properly the available temperature forecast.
- As the EWS dissemination is organized through government channel mostly, the community level dissemination is not properly done and is confined within the local offices of government agencies, union parishad etc. So, community people face difficulty getting the information.
- Fisheries related advisory in case of disaster event or weather extremes are not readily available and if available are not disseminated as per the requirement of community people.
- F&A sector requires some additional information (water quality information, potential fishing zone etc.) as forecast for effective preparation against disasters.
- The forecasts are not easily understandable for many fishers. So, this information needs to be transformed into effective and understandable format for local fishers and capacity building on understanding the forecasts is also needed.
- Community people need accurate weather forecast at local level from BMD. So, information provided through BMD weather app and website should be improved to be more accurate and effective.
- Local people cannot use BMD weather app as it does not work properly all the time. So, there is a public need to make the BMD weather app more user friendly and enhance its reliability.

Flood Early Warning

- Flood information is disseminated as station based water level in most cases. But this is difficult to connect to flood water level in local areas and could not be used successfully by fishers.
- The lead time of forecast is not always sufficient for the fishers to take proper actions. 1-2 weeks lead time seems appropriate for F&A community.

- As the EWS dissemination channel is not very widely spread in the community level, community people does not get the information always.
- Fisheries related advisory in case of disaster event are not readily available for the community people.
- The forecasts are not easily understandable for many fishers. So, this information needs to be transformed into effective and understandable format for local fishers and capacity building on understanding the forecasts is also needed.

Flash Flood Early Warning

- Flash Flood information is disseminated as station based water level in most cases. But this is difficult to connect to flood water level in local areas and could not be used successfully by fishers.
- The lead time of forecast is very short for the fishers to take proper actions. 1-2 weeks lead time seems appropriate for F&A community.
- As the EWS dissemination channel is not very widely spread in the community level, community people does not get the information always.
- Fisheries related advisory in case of disaster event are not readily available for the community people.
- The EWS information are not easily understandable for many fishers. So, this information needs to be transformed into effective and understandable format for local fishers and capacity building on understanding the forecasts is also needed.

Cyclone Early Warning

- Cyclone warning is not clearly understandable by local people as those are prepared for ports. It should be revised to a more easily understandable format for the local people.
- Fisheries related advisory in case of disaster event are not readily available for the community people.
- Community people expressed their concern related to accommodation and security during evacuation to cyclone shelters—with girls and women especially less willing to go to such shelters.

3.3 Uses of EWS in FA related risk management at Communities

The stakeholder consultation with local community and EWS experts have been done to identify the EWS information access and uses among the communities. Figure 3.2 presents the available EWS information channels for the local communities. From the consultation, it is found that, most of the community people receive EWS information through mobile phone, TV and Radio.

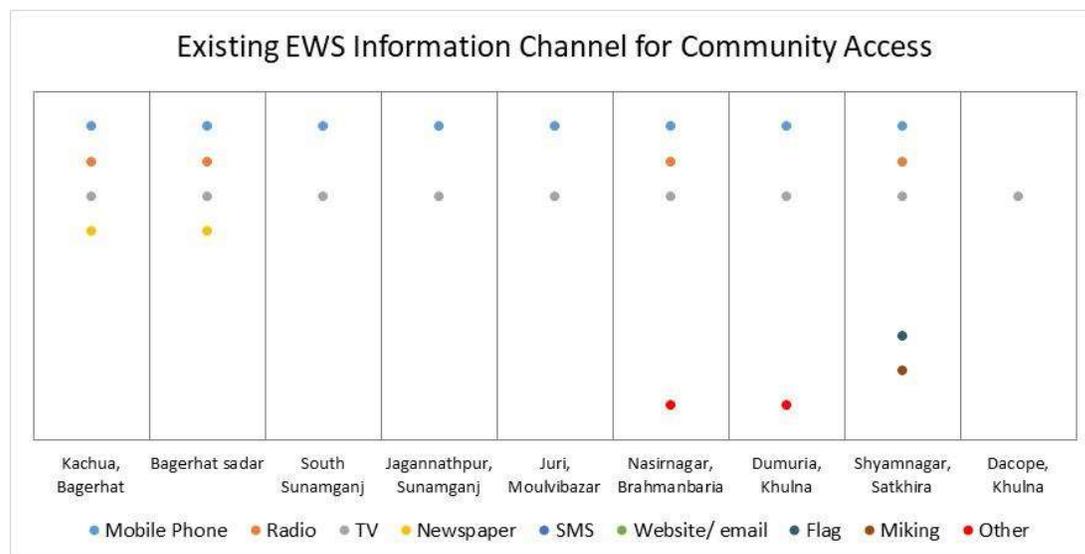


Figure 3.2: Existing EWS Information Channel for Local Communities

Generally, fishers use the EWS information to protect their ponds by net or early harvesting during floods. During high temperatures, they try to maintain certain water depth in ponds and use aeration techniques. So, the available EWS information could be used to prepare for these protective actions.

Community people have certain preferences for EWS information channel. Figure 3.7 shows community preference about EWS information channels.

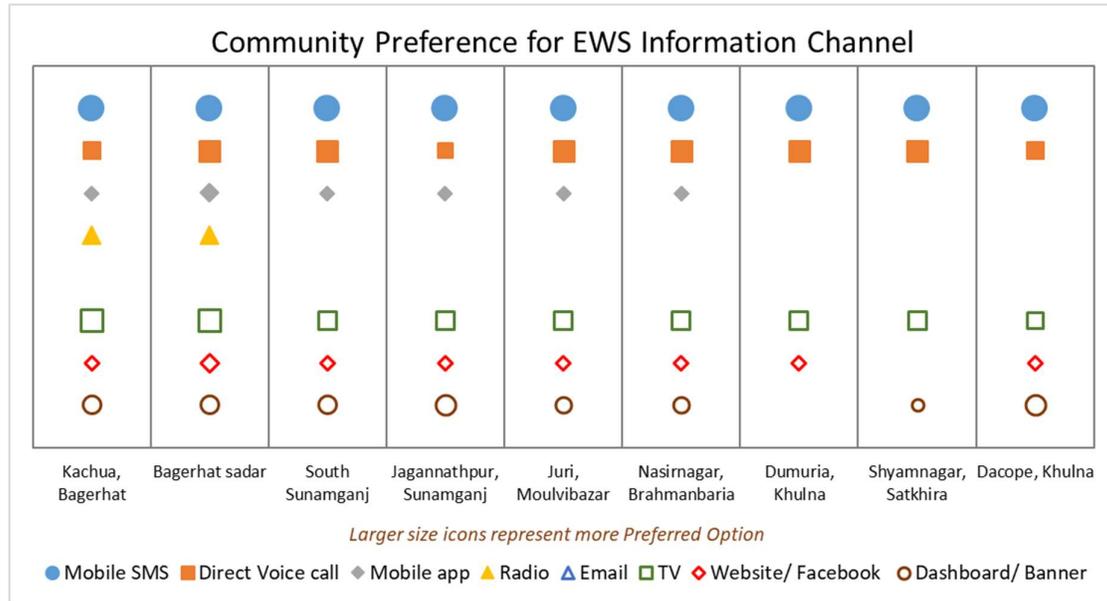


Figure 3.3: Community Preference of EWS Information Channel

The community preferences for potential EWS information channel based on stakeholder choices at the nine project upazilla suggests that, mobile SMS and Direct voice call are the most preferred way for community people. TV and Dashboard/ Banner (Analog/ Digital) are moderate preferred way for communities. Mobile app and website/ Facebook have minor preference among people while email is not preferred.

3.4 Potential EWS Information for FA

Aquaculture and fisheries are two of the fastest growing sectors in Bangladesh, where they have grown to be significant contributors to country's economy, food provision (as primary source of animal protein) and income source for rural households and for processing, transporting, and marketing industries. However, risks brought on by climate change are affecting fisheries and aquaculture in terms of decreased productivity, increased fish infections, etc. Therefore, early warning systems must be installed in Bangladesh to provide the fishing community the real time information to take the required precautions to lower the risk.

Events with high temperatures and flash floods are two major climate restrictions for aquaculture (Siddiqua et al., 2019) and heavy precipitation can affect water temperature, dissolved oxygen levels, and pH levels (WorldFish, 2020). The Bangladesh Meteorological Department's experts established a threshold for heavy rain events of 44 mm/day, and experts in aquaculture consented that when rainfall exceeds a value in the range of 40 mm/day, it can also affect water quality and cause damage to pond infrastructure in addition to the mortality of fingerlings. As a result, we chose 44 mm/day as the minimum amount of precipitation needed to designate heavy rain days for aquaculture activities (Hossain et al., 2021).

Local Community in haor area suggests to improve translation and communication of early warning to fisheries and aquaculture stakeholders. They have emphasized on Piloting of Upazilla level (localize) forecasting and early warning with greater lead time. Study to improve the danger level and parameters specific to fisheries and aquaculture is also recommended by local communities.

Extreme temperature and rainfall events were identified by a wide range of stakeholders as the most significant climatic factors influencing operations and management choices during a recent discussion on climate information services for aquaculture (WorldFish, 2020). Information about adverse meteorological events can assist fish-farmers make decisions on pond preparation, fingerling stocking, production volume, maintenance and harvesting schedule. These climate-sensitive management decisions are crucial for aquaculture operations in managing climate risks, reducing costs and ensuring business profit (Hossain et al., 2021).

Climate induced hazards such as flood, cyclone, storm surge, salinity, lightening are the major hazards that impacts the fisheries and aquaculture sector. GoB already generates data on climatic parameters such as BMD weather forecast provides daily temperature and rainfall data, sunshine hour etc.; FFWC provides 5-day forecasted water level at all station. BMD also developed Bangladesh Agrometeorological Information Portal in collaboration with Department of Agriculture Extension (DAE) in which all the forecasted data and advices required for agriculture sector. However, there is no fisheries and aquaculture specific early warning system in the country but can be developed with the help of BMD and FFWC generated forecast. Information including maximum and minimum temperature, rainfall and water level forecast considering pond and gher's height should be incorporated in fisheries and aquaculture based Early Warning System. Additionally, cyclone track, flood level due to storm surge, salinity concentration could also be potential information for fisheries and aquaculture sector. There is a substantial need among F&A community for water quality parameter forecast. Some kind of community-based arrangement for easily estimating these parameters and taking necessary actions could be highly beneficial for fishers.

Additionally, fishing industry focusing on capture fisheries are lacking specific high accuracy weather information like wind and storm information and potential fishing zone in sea etc. If a mobile app based service could be developed for them to provide location specific forecast, warning and advisory, it would be helpful.

3.5 Gender aspects in EWS information

Women in Bangladesh perform a variety of responsibilities but often unrecognized as food producers, collectors, suppliers, and caregivers according to society's established gender norms. This gender structure, influenced by imposed behaviors and attitudes by the society, makes women more vulnerable than male through establishing unequal power relationship between them. Resource distributions are also uneven as a result of this imbalance of power. According to the population census 2022, total population of Bangladesh is 165.16 million among which 81.7 million are male and 83.3 million are female. National literacy rate is 51.77%, which is higher among male (54.11%) than female (49.44%). Female literacy is further lower in rural areas (49% and 45.38% for male and female). So, women get less access to education and resources around the country, which is far worse in rural areas.

In the fisheries sector, women usually work on making and repairing fishing gear, stocking ponds, feed preparation, feeding, pond supervision, fertilization, liming, and harvesting fish for family consumption, fingerlings sorting, catching shrimp post-larvae, fish processing, small scale marketing etc. They are also heavily engaged in post processing of fish catch in dried fish processing. Participation in fishing, trading, retail, purchase of inputs and other managerial works in fisheries industry is comparatively less, which is influenced by gender division of work.

Access to and control over resources and inputs like land, pond, equipment, information, knowledge, skills, and finances are generally very essential in aquaculture value chains, which is found limited for women in Bangladesh. Due to mobility restrictions, women often can't reach to the vendors at far distance for high-quality inputs like seed, feed and fertilizers. Women become more actively involved in and have greater influence over homestead farming. Low levels of education and literacy among women have been associated with a lack of information and knowledge, and a lack of financial means to buy inputs further demotivate women. Women groups have expressed their hurdles in receiving EWS information properly. They have less communication to union parishad or bazar etc. and depend on males to transmit them EWS information. The latest population census (2022) has illustrated similar aspects from mobile phone (M:

86.7%, F: 58.8%) and internet (M: 46.5%, F: 28.1%) user ratios among adult (18 years and above) male and female population in Bangladesh. Due to less mobility, women prefer receiving early warning information through mobile phones. But their mobile phone ownership is near to 60% which means that around 40% adult women are out of reach. The situation is even worse for internet use access. During disaster event women and girls face mobility and security related issues, which makes it difficult for them to cope with disaster impacts.

In most of the villages of Bangladesh, girls and women are often not encouraged to go alone outside of their house due to security issues, religious beliefs, and social norms. Women in coastal areas expressed that, even in disaster situations, the male family members prefer not to let the young girls and adolescents leave the house to seek safety elsewhere. Because of their restricted movement and communication, they usually lack access to the proper information, including early warning signals. Similarly, in fishing community too, even when women are informed about the disaster, some of them cannot take any actions, as they can't understand the message, owing to little or no education. Again, the majority of women still refuse to leave the house upon receipt of any EW information without permission of family head and without the company of male family member due to security concerns.

In addition, from the latest population census data, the gender bias can be even seen in accessing and using technologies like radio, cell phones or internet. Most of the women from fishing community, living in remote and isolated areas lack adequate access to technology and communication medium. As a result, they often miss out early warning, which has a negative impact on their ability to deal with disasters. There are also notable differences in how men and women get the early warning signal. The majority of women get the information through unofficial sources like word-of-mouth in the neighborhood, family members, or from community volunteers. Additionally, these barriers to access to accurate information about adverse meteorological events result in women failing to manage cost savings and business profit by making vital decisions regarding pond preparation, fingerling stocking, production volume, maintenance, and harvesting schedule.

4 Recommendations on Improving EWS for F&A in Bangladesh

Based on the gaps identified in existing EWS and especially in regard to fisheries and aquaculture, this Chapter highlights the policy, institutional and technical recommendations, which when taken into consideration can improve EWS for fisheries and aquaculture in Bangladesh.

4.1 Policy Recommendations

For improving EWS for F&A, several policy issues should be addressed. The policy recommendations are:

- Inclusion of 'Integration of fisheries and aquaculture advisories on Early Warning and Climate Services for climate resilience' in the National Fisheries Strategy and Policy and as a mandate in DoF's 'Citizen Charter'
- Formation of a working group or cell at DoF Head Office and designation of Focal points in District and Upazillas
- To build a holistic climate information service, including disaster warning and forecast, an Integrated Climate Information Service for Fisheries and Aquaculture (ICIS-FA) should be developed. ICIS-FA should have a coverage of whole Bangladesh and EEZ area in Bay of Bengal.

4.2 Institutional Recommendations

As DoF provides regular fisheries and aquaculture extension advice to the fishers, DoF should be the lead agency in implementing ICIS-FA. For ensuring the proper implementation of such a system the following steps should be followed;

- Early Warning working group or cell at DoF should undertake the following specific roles:
 - Translate early warning and climate information (temp, rainfall, flood warning) into easy to understand language for fisheries and aquaculture.
 - Facilitate the development and approval of fisheries and aquaculture advisory messages specific to climate hazard.
 - Integrate the early warning and advisory services in call center (12126)
 - Facilitate training and orientation of District/Upazilla Officials/ advanced fishers
 - Facilitate communication of early warning and advisories to fishers on time
- Strengthen collaboration between DoF and BMD, FFWC, DDM in integrating EWS in F&A and learning from existing Flood/ Climate Warning initiatives. Required administrative arrangements to enhance the future collaboration among the agencies should be ensured.
- A set of standard operating procedures (SOP) for this EWS should be developed in coordination with BMD and FFWC.
- Enhance capacity of the DoF working group with required training, lessons sharing with BMD, FFWC, DDM, DAE and other relevant initiatives in country and abroad.
- Strengthening Communication Channels through;
 - Print and dissemination of leaflet, posters with advisories
 - Increase awareness and use of call center (12126) number in all trainings, awareness sessions/discussion of DoF and request to Upazilla Chairman/UNO for sharing in courtyard meeting, website, facebook etc.
 - During Flood Season (specifically when flood signal is on), users calling DoF call center (12126) can listen the flood warning before picking up the call, same could be applied for hot summer, cold winter, cyclone warning etc.
 - Increase awareness and use of a dedicated toll free IVR 1090 for aquaculture

4.3 Technical Recommendations

- The EWS information generated in Bangladesh are mostly sufficient in coverage. There are some improvements needed with respect to lead time and translation of water level to local waterbodies. So, The ICIS-FA should incorporate real time data on present status and forecast of the parameters based on availability from BMD, FFWC and other relevant national/ international agencies.
- The available information in ICIS-FA should include;
 - weather parameters like, maximum and minimum temperature, rainfall, wind speed, humidity, evaporation, heat and cold waves, fog etc.,
 - hazard and disaster related information like, flood/ flash flood water level at community level, expected storm surge height, drought severity, earthquake, tsunami etc.
 - Climate, disaster and disease advisory information like, what to do under certain climatic condition, potential measures for protecting pond/ waterbody area from flood/ other hazards, potential measures for preventing disease outbreak and treatments in case of a disease outbreak.
 - Location specific contact persons list for emergency communication and suggestions
- The system should have a GIS based web portal (Decision Support System), linked mobile app and Hotline/ IVR component.
- Besides this system, substantial efforts should be given for awareness, capacity building and dissemination of the available information among the local communities including women, elderly, disabled, ethnic group and other vulnerable groups.
- The advisory and early warning information should be carefully prepared to ensure easy understanding of the community people.
- The Communication Channels should be strengthened through;
 - Create a dedicated fisheries and aquaculture climate web portal (ICIS-FA) like DAE and linked to DoF Website
 - Design Aqua-meteorological bulletin 'Motshyo Abhaoa Barta', short video, video filler, in BTV and other TV channel
 - Design and implement digital dashboard 'Motshyo Abhaoa Display Board' in Upazillas, Bazar, Arot, key marketing point
- Efforts should be given to enhance and improving reliability of existing mobile apps like BMD weather app, BWDB flood app etc.

4.4 Sustainability and scaling up of the FA EWS

The proposed Integrated Climate Information Service for Fisheries and Aquaculture (ICIS-FA) could be initiated as a pilot project focusing on certain areas of Bangladesh. This project could focus on the designing and implementing of such a system. The pilot activities in smaller areas could lead to identifying the overall issues and challenges for ICIS-FA. Based on these identified issues and challenges a future plan for scaling up and sustainability of the ICIS-FA will be formulated.

Besides, there are strong need for continuous support for effective translation of relevant EW information from BMD and FFWC. As, BMD and FFWC are assigned to generate the required forecast, F&A related specific information generation might need additional studies or piloting. A coordinated approach of DoF, BMD, FFWC and others might be needed to establish and operationalize such information.

The scaling up of ICIS-FA for the whole country could be undertaken after pilot activities are completed. As this will enhance climate resilience of the sector, the scaling up of such a system could be financed from national or international climate funds. Besides, to maintain regular service of the system a budget allocation should be made in the respective agency's annual budget from the government.

5 Conclusions

The review of existing EWS information and stakeholder consultation has identified the major issues and gaps of the existing EWS. The community perspectives have been clearly captured in the outcomes and their needs have been clearly presented. Challenges faced by community and consequent damages due to climate induced disasters are the major driving force for enhancing the EWS for F&A.

The recommended actions highlight the policy, institutional and technical aspects need to be implemented for minimizing the gaps and enhance EWS for F&A sector. Successful implementation of these recommendations will facilitate reducing the risk for vulnerable communities and saving lives and livelihoods for the F&A communities.

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