Early Warning System for Severe Thunder Storms in Bangladesh

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1. Introduction:

The great Himalayas stand out to the north and the vast funneling Bay of Bengal flanks on the south of Bangladesh. Due to its peculiar geographic location having complex coastal configuration and shallow bathymetry, Bangladesh has become a disaster prone country. It is the most vulnerable country to tornadoes and severe thunderstorms related disasters in the world. The Bay of Bengal and the criss-cross river systems in Bangladesh supply warm and moist air (moisture) and the orographic features of the north and the east (provide cold and heavy air and give lifting) help form severe thunder storms during pre-monsoon (March – May) and post monsoon (October – November) seasons (Fig. 1).

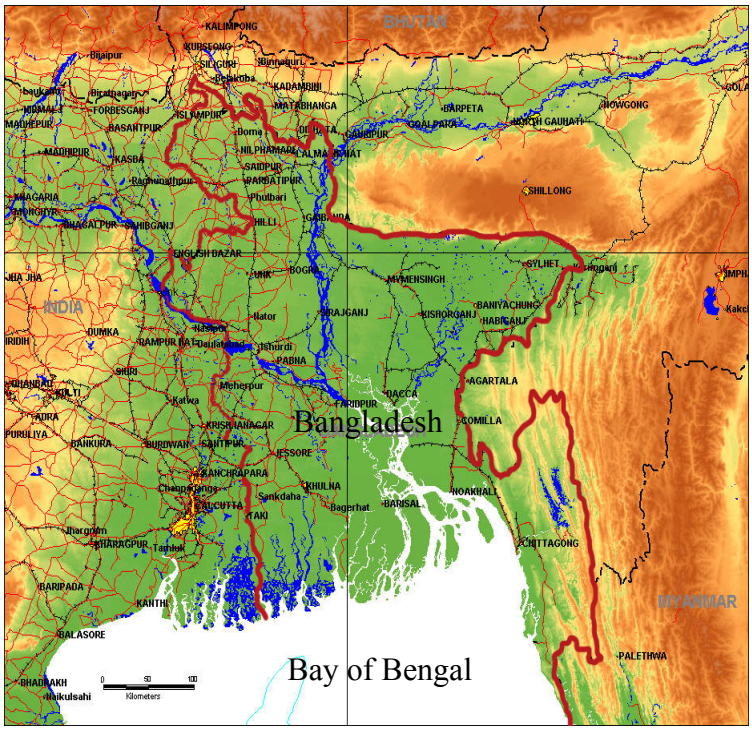


Fig. 1: Topographic map of Bangladesh showing orographic features on the east and north.

Apart from local thunder storms, some thunder storms that form over Chhoto Nagpur, West Bengal and northeastern India also move towards Bangladesh and create havoc. Pre-monsoon thunder storms which attain wind speed of 50 - 60 kms/hr or more are termed as nor'westers (locally known as "Kal Baishakhi"). A few of them turn out to tornado exceeding wind speed of 150 kms/hr.

Tornado statistics alone shows great amounts of damage in Bangladesh in the past few decades. There occurred a severe tornado on the 14th April of 1969 in Demra area of Dhaka in

which maximum wind speed was estimated to be 644 kms/hr. In that incident, 922 people were killed, 16,511 people were injured with a loss of properties in the tune of Rs. 40-45 million. In 1996, the Tangail Tornado (with estimated wind speed 320-400 kms/hr.) killed 570 people and injured 30,000 people. The Manikganj (Saturia) Tornado (with estimated wind spedd 388-419 kms/hr.) in 1989 killed over 1000 people. Local newspapers reported 10,766 tornado deaths during the period from 1961 to 1996. The list of hazards (thunder storms and associated events in the ellipse) that affect Bangladesh is given in the following Table 1:

Table 1: Major hazards that affect Bangladesh

Hazard Rank	Hazard	National Agency for Mandate	Type of the Hazard	Remarks
1	Cyclones	BMD	I	
2	Storm surge	BMD	I	
3	Thunderstorm (Nor'wester), Lightning	BMD	I	
4	Tornado	BMD	I	
5	Hailstorm	BMD	I	
6	River flooding	FFWC (BWDB), BMD, SPARRSO	II	
7	Flash flood	FFWC (BWDB), BMD, SPARRSO	II	
8	Coastal flooding (due to storm surge/tsunami)	BMD	I	
9	Drought	BMD, BWDB, DAE	II	
10	Heat Wave	BMD	I	
11	Cold Wave	BMD	I	
12	Dense Fog	BMD	I	
13	Landslide/Mudslide (due to heavy rain)	BMD	I	
14	Earthquake	BMD	I	
15	Tsunami	BMD	III	Tsunami Watch Information (TWI) Bulletins are received from PTWC and JMA
16	Turbulance/Icing	BMD	I	
17	Strong winds	BMD	I	
18	Wind driven surge	BMD	I	
19	Air pollution	DoE, AEC	II	
20	Waterborne hazards	ICDDRB, DoE	II	
21	River Erosion	BWDB	I	

Note: Hazard rank is based on the historical figures of casualties and economic losses attributed to the respective hazards.

AEC Atomic Energy Commission
BMD Bangladesh Meteorological Department
BWDB Bangladesh Water Development Board
DAE Department of Agriculture Extension
DoE Department of Environment
FFWC Flood Forecasting and Warning Centre
ICDDRB International Centre for Diarrheal Diseases Research, Bangladesh

2. Early Warning Systems

The magnitude of casualties from all the thunder storms that occur in a year is almost equivalent to that of a cyclone in Bangladesh. That is why it is a dire need to address impacts of this disaster properly. In view of this Early Warning System (EWS) for thunder storms was introduced to certain extent. The EWS evolved historically in Bangladesh Meteorological Department (BMD). India Meteorological Department (IMD) was established by the British Empire in India in 1875, just one year before the Bakerganj Cyclone of 1876 which took away lives of 2,00,000 people when the total population of Bengal (West Bengal and Bangladesh) was only 20 million. So, BMD inherited old signal systems from IMD and later on from Pakistan Meteorological Department (PMD) as Bangladesh was a part of Pakistan up to 25th March 1971. After the independence Bangladesh Meteorological Department was reorganized. Cyclone centres were built but the approach to disaster management remained almost the same as before like 1970s and 1980s. The 29th April Cyclone of 1991 killed about 1,38,882 people and made a colossal economic loss. Some remarkable floods occurred in 1980s and 1990s. Especially the flood of 1998 which stayed for the longest period and flooded the largest area in the history of Bangladesh.

- After these two catastrophic flood disasters the Government of Bangladesh (GoB) had come to a point we may call it 'the phase of paradigm sift'.

- In 1993 the GoB established the Disaster Management Bureau (DMB), Disaster Management Council and Disaster Management Committees from national to field levels and renamed the Ministry of Relief and rehabilitation as Ministry of Disaster Management and Relief.

- DMB performs its professional support function in collaboration with administrative authorities at different levels and concerning ministries under the overall authority of Inter-Ministerial Disaster Management Co-ordination Committee.

- The DMB has responsibilities:
    - To create public awareness on hazards and preparedness.
    - To formulate programs and projects for vulnerable communities and public officials disaster preparedness.
    - To coordinate all activities related to disaster management from national to grass-root level.
    - To maintain liaison with Government Agencies, Donors and NGOs.

- The Ministry of Disaster Management and relief was renamed again as the Ministry of Food and Disaster Management (MoFDM) in 2004. It has the following responsibilities:

    - Food management.
    - Planning, coordination, monitoring and evaluation of all activities related to disaster management.
    - Coordination among other organizations during disaster period.

- Assisting other Ministries and Organizations in disaster related works.
- Formulation of policy and its implementation for food assisted projects and programmes management of external food aid and other relief assistance.
- Management of all other food and disaster related activities on the Government side.

- In 2003, a Comprehensive Disaster Management Programme (CDMP) of MoFDM was designed to help upgrade capabilities for all disaster management agencies with the help of UNDP and DFID UK.

- After liberation of Bangladesh from Pakistan in 1971 the International Federation of Red Cross and Red Crescent withdrew from direct implementation through CPP.

- CPP turned out to be a joint venture programme of the government and Red Crescent society. In which the implementation part is mainly maintained by CPP through its community based preparedness programme.

2.1. Governance and Institutions (Legal Framework)

Bangladesh Government's Legislative Framework is aimed at fostering the activities for Disaster Risk reduction and Emergency Management in Bangladesh. It includes:

i. Disaster Management Act: Enactment of this law provides the legal basis for activities and actions which are identified, undertaken and managed during the periods of disasters and are designed to increase and enhance the capability of preparedness and management.

ii. National Plan for Disaster Management: The National Plan for Disaster Management is prepared by MoFDM. This plan incorporates public awareness building and development of planning procedures from top level to grass root levels in a community based participatory manner.

iii. National Disaster management policy: It is a strategic Framework which reflects the national perspective and principle of risk reduction and emergency and disaster management.

iv. Standing Orders on Disaster (SOD): SOD describes in detail the roles and responsibilities of different committees, ministries and other organizations involved in disaster related activities. It is key document which is followed by all concerned organizations in Bangladesh.

v. Guidelines for government at all Levels: Guidelines for Government are implemented and used and are used to assist Ministries and all other organizations (Govt. & NGOs) for disaster risk management.

The flow chart of the Disaster Management Regulative Framework is shown below (Fig. 2):

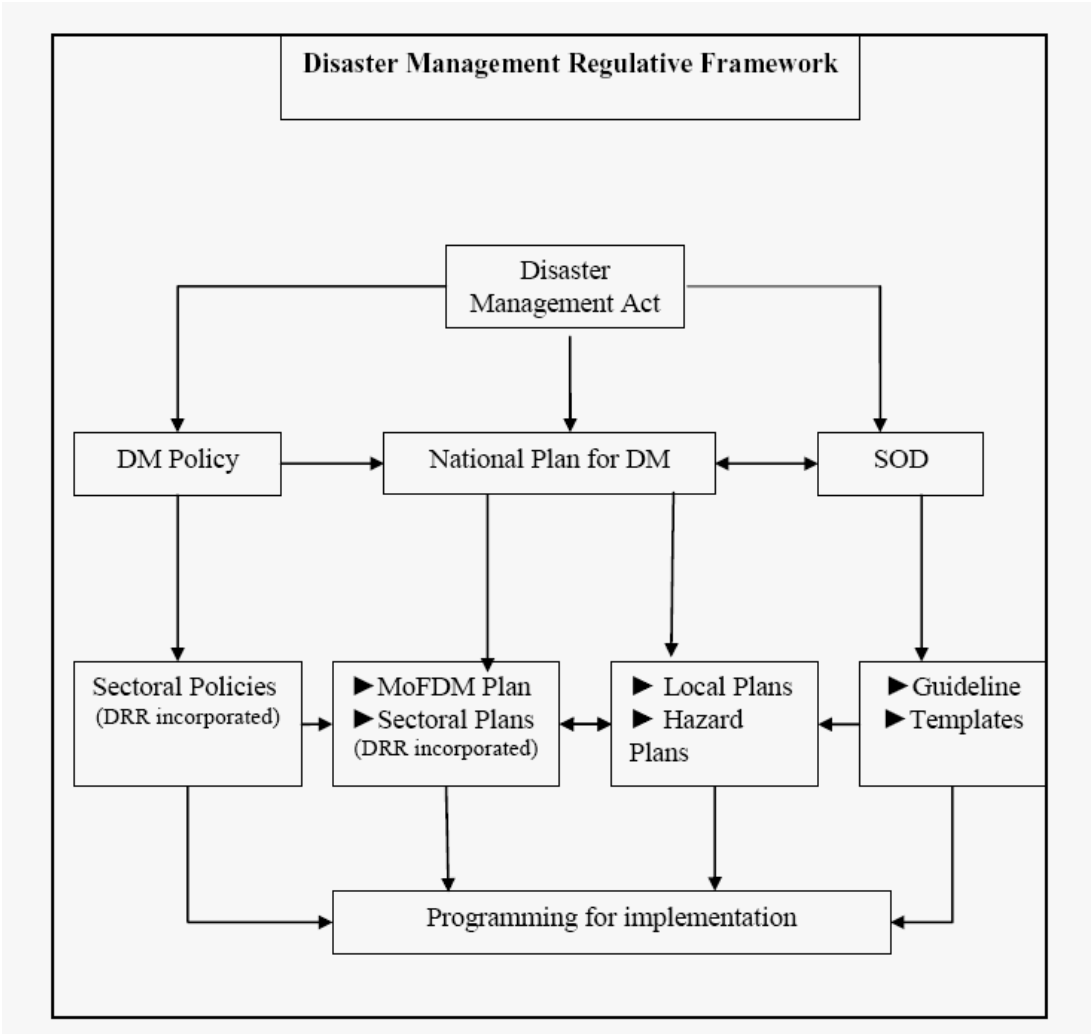


Fig. 2: Disaster Management Regulative Framework.

vi. National to local emergency planning: It is an umbrella plan which provides overall guideline for all concerned sectors and institutions at all levels to prepare and implement their area of roles specific plans. The MoFDM takes the lead role in disaster risk reduction and emergency management planning. There would be

I). Hazard specific plans.
II). Area at different levels (administrative unit) specific plans.

vii. Disaster Management Plans: The Disaster Management Plan is shown below (Fig. 3):

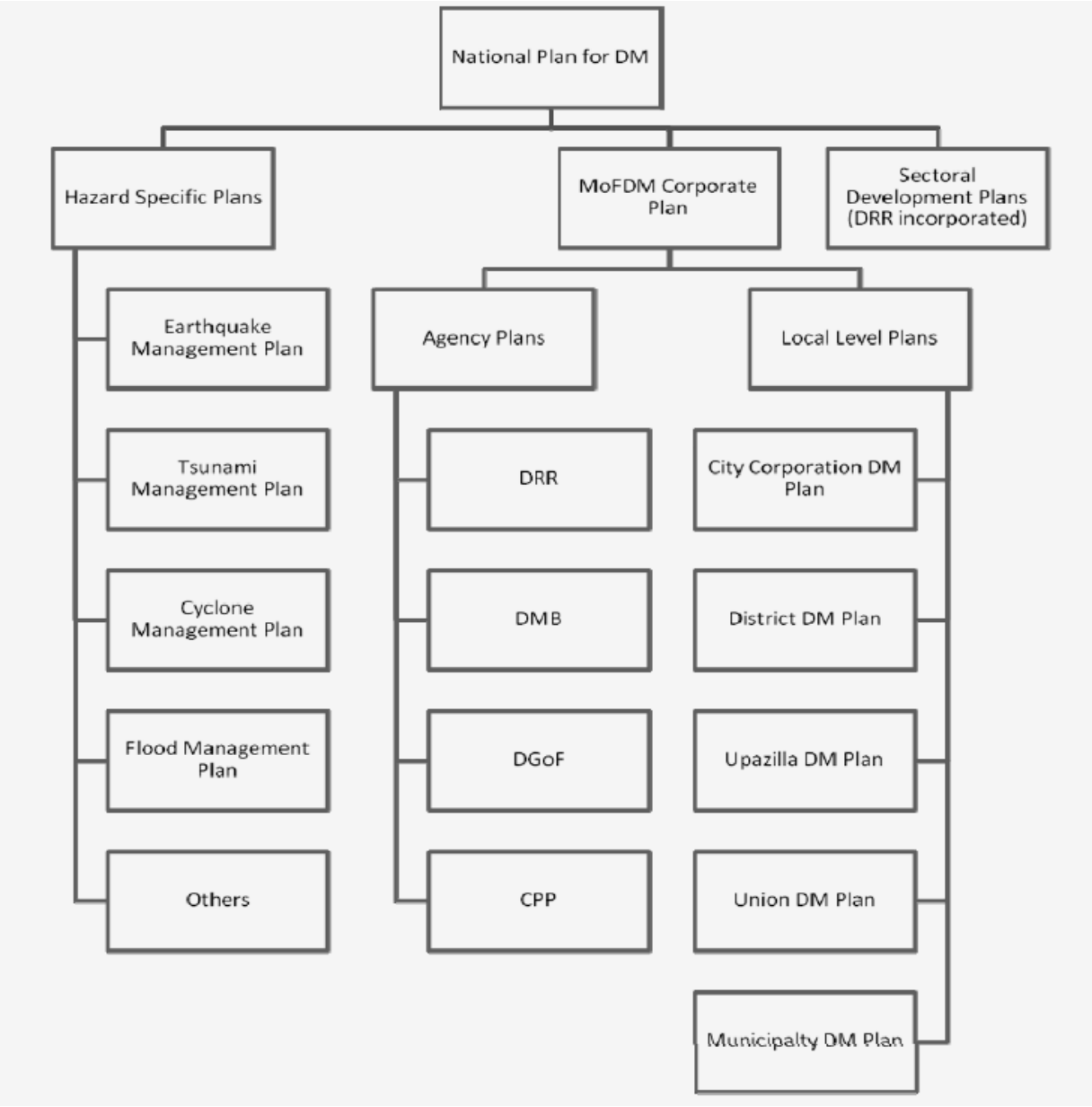


Fig. 3: Disaster Management Plan.

2.2. Existing (old) Signal System

Earlier there was an Inland River Port Warning System comprising of four signals of which Riverine Cautionary Signal Number One and Riverine Warning Signal Number Two were used for nor'westers or thunder storms (i.e. for Kal Baishakhi). When gusty or gusty/squally winds (speed 50-60 kms/hr) were likely from some weather system namely thunder storm, river ports were advised to hoist Cautionary Signal Number One. But when squally winds (speed 61 kms/hr or more) were likely from some weather system namely thunder storm (severe nor'wester or Kal Baishakhi), river ports were advised to hoist Riverine Warning Signal Number Two.

In the Inland River Port Warning System, Danger Signal Number Three was used for a weak or moderate cyclonic storm while Danger Signal Number Four was used for a severe cyclonic storm/ severe cyclonic storm with a core of hurricane winds / Super Cyclone. But for maritime ports there were Distant Cautionary Signal Number One and Distant Warning Signal Number Two for cyclones in the distant Bay of Bengal. In the Maritime Warning Signal System, Danger Signal Numbers Five through Seven were used for a weak or moderate cyclonic storm depending upon the landfall point. Where as Great Danger Signal Numbers Eight through Ten were used for a severe cyclonic storm/ severe cyclonic storm with a core of hurricane winds / Super Cyclone depending upon the landfall point. Local Cautionary Signal Number Three was used when maritime ports were likely to be threatened by squally weather or by Kal Baishakhi. Local Warning Signal Number Four was used when there was a disturbance in the Bay of Bengal from which a cyclonic storm might form. Hence, confusion in hearing/listening was likely between inland and maritime signals as reported by the NGOs, prominent personalities and media. With a view to removing the confusion, the Government of the People's Republic of Bangladesh formed a Committee with Disaster Management Bureau (DMB) under the Ministry of Food and Disaster Management (MoFDM) as the coordinator. The previous Standing Orders for Disasters (SOD) was renamed as the Standing Orders for Disaster Management (SOD) and the new signal system came into being after having critical reviews for more than twelve years. At last it was Okayed by the Care Taker Government in 2008.

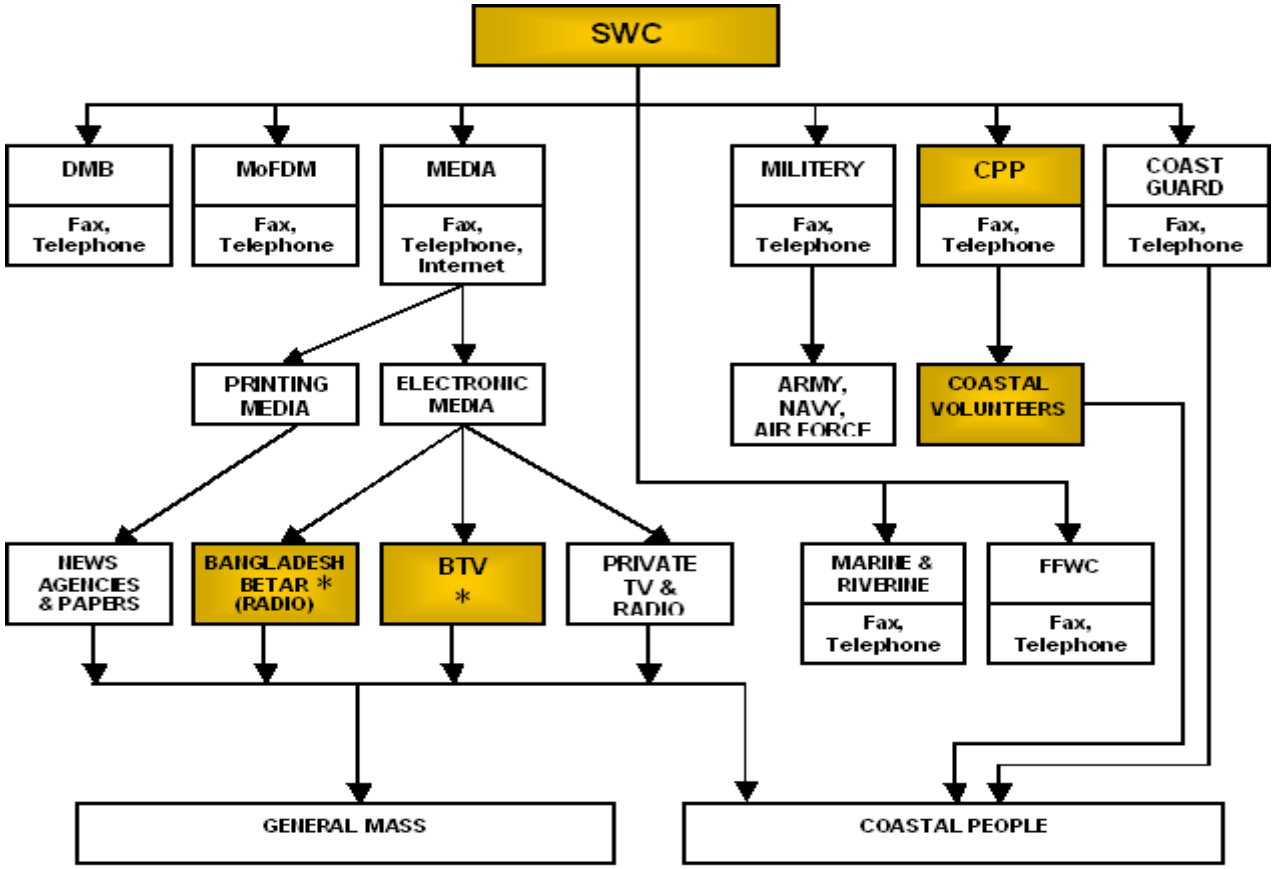
2.3. New Signal System

New Signal System for maritime and river ports is a unified signal system based on the wind speed where maritime and inland signals have been synchronized. Steps in the Beaufort scale have been maintained as before while devising new signal system. Now there are eight sets of signals. They are tabulated below:

New Maritime Signals			**New Riverine Signals**	
Sl. No.	**Signal**	**Wind Speed (KPH)**	**Signal**	**Wind Speed (KPH)**
1.	Distant Cautionary Signal No. I	51-61	Not applicable	
2.	Distant Warning Signal No. II	62-88	Not applicable	
3.	Local Cautionary Signal No. III	40-50	Local Cautionary Signal No. III	40-50
4.	Warning Signal No. IV	51-61	Warning Signal No. IV	51-61
5.	Danger Signal No. VI	62-88	Danger Signal No. VI	62-88
6.	Great Danger Signal No. VIII	89-117	Great Danger Signal No. VIII	89-117
7.	Great Danger Signal No. IX	118-170	Great Danger Signal No. IX	118-170
8.	Great Danger Signal No. X	>170	Great Danger Signal No. X	>170

3. Warning dissemination mechanisms

Without proper and timely dissemination of the EWS, mitigation of sufferings of people and reduction of loss of lives and properties can not be achieved. The dissemination plan of the EWS is given below:



* Mandated to continuous broadcasting of Special Weather Bulletins containing Warning round the clock in case of Cyclones

Fig. 4: Dissemination plan for Early Warning System (EWS).

4. Early Warning System (EWS) can save millions

In respect of raising public awareness, motivation and effective early warning dissemination at the community level; the loss of lives and properties of the community can be reduced.

During the November 1970 cyclone, with a wind speed of 223 km/hr, almost 500,000 people lost their lives in the coastal area. Whereas, in April 1991 cyclone, with a wind speed of 225 km/hr, only 1,38,882 people lost their lives although the population in the coastal area has been doubled since 1970. In November 2007 cyclone 'SIDR' of the similar intensity hit the coastal region with a wind speed of 220 km/hr and only 3,347 people lost their lives. The Disaster Management System in Bangladesh thus proved the effectiveness and fruitfulness of the EWS and proper and timely dissemination.

5. Tools for EWS

The present state-of-the-art technique in weather forecasting is the Numerical Weather Prediction (NWP) technique. Since thunderstorms or tornados are meso-scale phenomena (in the order of 10^2 km) they can be well captured by non-hydrostatic meso-scale model (NMM) like Weather Research and Forecasting (WRF) - Advanced research WRF (ARW). To obtain the higher accuracy in forecasting local data need to be assimilated into the WRF-ARW Model. Again to get high resolution spatial and upper-air data density of observatories is to be increased. Data from the Automatic Weather Stations (AWS) have to be accessed on real-time basis through sustainable TCP/IP or other suitable network and be made available to the NWP System. Initial Condition (IC) and Lateral Boundary Condition (LBC) data may be downloaded from National Centers for Environmental Prediction (NCEP), European Centre for Medium Range Weather Forecasts (ECMWF) or Japan Meteorological Agency (JMA).

5. Conclusion

To achieve the Millennium Development Goal (MDG) and tackle the Climate Change Issues, Bangladesh has to go a long way in order to make Early Warning System (EWS) for Disaster Management System (DMS) a success. For the sustainable economic development best efforts are needed in terms of efficient disaster management. As the disasters, many a times, stop the wheel of development, good governance, good understanding about disasters and good management of disasters are required.