

CYCLONE WARNING IN BANGLADESH AND PREPAREDNESS EFFORT



A Dissertation for the Degree of Masters in Disaster Management

By

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ABSTRACT

Historically the impact of cyclones on Bangladesh has been catastrophic, sometimes killing hundreds of thousands of people. Usually the country faces the threat of cyclones on a yearly basis but the strength and ferocity of these cyclones are being further escalated with the increased threats of climate change with warming sea water and rising sea levels in the Bay of Bengal. Climate change may increase the frequency and will cause more damage with the rising sea level including inundation of newer areas affecting larger coastal communities for example, Cyclone Roanu in May 2016 mainly impacted six coastal districts of Bangladesh but affected more than 1.3 million people and displaced 200,000 even though the storm was considered to be a low to medium strength.

Since the 1970s, the Bangladesh Red Crescent Society (BDRCS) and the Government of Bangladesh (GoB) have been jointly managing a Cyclone Preparedness Program (CPP) based on a wireless communication and network of over 50,000 volunteers. This programme has been globally acknowledged for its efforts in reducing the number of deaths during the past major cyclone events and is seen as the flagship program of BDRCS. Although early warning messages issued by the BMD and CPP have saved several lives over the decades – which was reflected in the Cyclone Mohasen and tropical Cyclone Mora where CPP and BDRCS volunteers together managed to evacuate thousands of vulnerable people to safe shelter – however, there is still a need of signalling system which can be more relevant for the residing population at the coasts of Bangladesh.

The main problems identified on the existing early warning system are that the language it uses to circulate the warning messages is official and is not comprehensible for most of the people. Hence, people don't pay attention on that since they don't understand the technical information. In many cases access to early warning message is also a problem as some time the wireless communication is out of order. There were number of times when the warnings were false, so people don't have full trust on that as well. A study found that the forecasts produced by BMD are not reliable for longer than 12 hours. Another analysis also says that the early warning signals that Cyclone Preparedness Programme (CPP) use is mostly derived from the signals used for maritime and river ports issued by the Bangladesh Meteorological Department (BMD).

However, in the past 50 years, Bangladesh has significantly reduced cyclone related deaths. Therefore, it is evident that the CCP is effective to a certain extent but, still can be made to reach a higher potential.

Acronyms

BDRCS	Bangladesh Red Crescent Society (BDRCS)
BMD	Bangladesh Meteorological Department
BoM	Bureau of Meteorology
CPP	Cyclone Preparedness Programme
DMC	District Disaster Coordinators
EWS	Early Warning System
EEWS	Effective Early Warning System
GA	Geoscience Australia
IPCC	Intergovernmental Panel on Climate Change
RSMC	Regional Specialized Meteorological Centre
SMRC	SAARC Meteorological Research Centre
STEEPER	Steering and Persistence
STP	Storm Track Prediction
SWC	Storm Warning Centre
TC	Tropical Cyclones
WMO	World Meteorological Organization

Table of Contents

Acknowledgement	2
ABSTRACT.....	3
Acronyms	4
Chapter 1.....	7
Introduction.....	7
1.1 Background.....	7
1.2 Research Problem	9
1.3 Objectives	10
1.4 Methodology:.....	10
1.5 Limitation of the study:.....	10
Chapter 2.....	11
Literature Review:	11
Chapter 3.....	18
Operational definition of Cyclone:	18
3.1 Definition of cyclone	18
3.2 Overview of Cyclone, Typhoon and Hurricane:.....	18
3.3 Early Warning System in India and Sri Lanka.....	20
3.4 Names of Cyclones, Hurricanes and Typhoons.....	21
3.5 Hurricane Katrina: Why was it so damaging?	23
3.6 Major Cyclonic Event in Bangladesh	24
.....	27
Chapter 4.....	28
Cyclone Early Warning System in Bangladesh	28
4.1 Background.....	28
4.2 Cyclone preparedness Program (CPP).....	28
4.3 Warning Equipment and logistics	32
4.4 BMD Operational Method	34
3.5 Signaling System	37
3.6 Structure of CPP	40
Chapter 5.....	42
Discussion, Summery and Conclusion.....	42
5.1 Discussion:.....	42
5.2 Summery:.....	43

5.3 Conclusion:44
References:45

Chapter 1

Introduction

1.1 Background

In Bangladesh, cyclone takes the leading role when it comes to natural hazard. It is one of the most vulnerable countries for tropical cyclonic induced disasters; mostly due to its disaster prone geographical position. The country is situated on the bank of the Bay of Bengal which serves as a funnel in favour of cyclones in the region. Compared to other disasters, cyclones have taken a huge number of lives and damaged a lot of properties over the centuries in this regional part of the world, making it the deadliest threat to the lives of people in this country.

Geographic location, the unique natural setting of the country and its tropical monsoon climate modify and regulate the climatic condition and make the country more vulnerable to cyclones and storm surges (As-Salek 1998; Madsen and Jakobsen 2004; Paul and Rahman 2006; Paul 2009a). The physical and meteorological conditions necessary for generating tropical cyclones exist in the Bay of Bengal (Murty and El-Sabh 1992; Haque 1997), which is considered to be one of the ideal grounds for cyclone formation as it has 6– 10 % of tropical cyclones of the world (Gray 1985; Haque 1997; Murty and El-Sabh 1992; Paul 2009a, b). On average, annually 12–13 depressions are formed and at least one powerful cyclone strikes Bangladesh each year (Mooley 1980; Haque 1997; Paul 2009a, b). Global warming is thought to be an important cause of increased cyclone events in the Bay of Bengal (IPCC 2001; Emanuel 2005; Ahmed 2005). The Intergovernmental Panel on Climate Change (IPCC 2001) reports that cyclone tracts will remain unchanged, with the possibility of increasing peak intensities by 5–10 % under current climate change conditions.

In Bangladesh, there are two cyclone seasons- March-April and October- November, and during these periods, several small to large cyclones make landfall in Bangladesh. SAARC Meteorological Research Center (SMRC) report of 1998 says that, from 1582 to 1974, 46 large-scale cyclones hit the coastal region of SAARC countries; most of which made landfall in Chittagong, Cox's Bazar, Khulna, the Sundarbans, Noakhali, Feni, Teknaf, Kutubdia and other coastal areas of Bangladesh (SMRC 1998- No.1). Out of which, the Bhola Cyclone of 1970 alone claimed almost half a million people's lives, making it the deadliest disaster in the history of this region. In the post war Bangladesh, several large and small cyclones have also let its presence to be known. Among them, the cyclone of 1991 itself killed almost one and a half lac people including a loss of more than 1.5 billion dollars. Other significant cyclones in

Bangladesh are Cyclone Sidr, Cyclone Aila, Cyclone Mahasen, Cyclone Roanu, and the most recent one is Cyclone Mora. Though the massive scale cyclones have kept on hurting the population and infrastructure of the country, the death toll has fallen to a significant number in over the past few years for the evolving preparedness measures of the country.

There are 19 districts in Bangladesh which are considered as coastal districts where 37 million people live. Out of 19 districts, fourteen coastal districts are high or moderate cyclone-risk areas. Around 37 million people live these exposed districts. To ensure the safety of population in the coastal areas, the Bangladesh government has been investing considerable effort into developing a suitable approach to manage cyclone emergencies. Hence, peoples' response to evacuation orders has improved compare to the past. However, peoples' current evacuation response rate is still not satisfactory and there has been a need to improve the current cyclone early warning system.

According to World Meteorological Organization (WMO) factsheet, Effective Early Warning System (EWS) include four components: (1) detection, monitoring and forecasting the hazards; (2) analysis of risks involved; (3) dissemination of timely and authoritative warnings; and (4) activation of emergency preparedness and response plans. These need to be coordinated across many agencies at the national and community levels for the system to work. It also emphasis that, failure in one component, or lack of coordination, can lead to the failure of the whole.

Irrespective of hazards, the main objective of warning is to reduce disaster impacts through enabling people to take precautionary measures. Therefore, the success of warnings depends on appropriate hazard detection, information dissemination, and responses by affected people (McLuckie 1970; Rogers 1985; Sorensen and Mileti 1987; Quarantelli 1980; Haque 1997). Disaster warning is considered as a linear process of communication between warning-issuing organisations and recipients of the warnings (Sorensen and Sorensen 2006).

Bangladesh has a dedicated cyclone preparedness mechanism, called the Cyclone Preparedness Programme (CPP), which works to spread cyclone early warning message to all the people living in the 710 km long coastal region of the country. CPP has been the main responsible agency or mechanism to handle any potential threat of cyclone in the coastal areas of Bangladesh.

CPP undertakes all its operation through its dedicated volunteers and technical skills. CPP volunteers go door to door to the community people during any emerging cyclone to

disseminate early warning messages with megaphones, hand sirens, whistles and public addressing. This enables the community people to have significant time to move to the safe houses or shelter centers before the hazard comes to greet the land.

Despite being poor and vulnerable to a range of natural hazards, Bangladesh has made significant progress in disaster management in recent years (Paul 2009a, b). Studies by Blake (2008), Heath (2007), Hossain et al. (2008), and Shamsuddoha and Chowdhury (2007) confirm that the lower-than-expected death toll and damage caused by Cyclone Sidr in Bangladesh was the result of timely cyclone forecasting and dissemination of warnings, as well as the evacuation of vulnerable people living in cyclone-prone areas.

Although it is significant from the statistics that, remarkable improvement has been brought in terms of reducing death toll through early warning system during any natural disaster- as only 3500 casualties had been reported during cyclone Sidr in 2007, whereas 3,00,000 people died in 1970 Bhola Cyclone, yet there remains a lot of evidence which shows that the current early warning system or matrix is not effective enough to reduce vulnerability of the highest number of people in the costal belt. There are some aspects which leave the scope for pondering about the effectiveness of the current early warning system- its inability to reach each and every one during any natural disaster, being unsuccessful to evacuate and properly protect the people who are likely to be hit by the emerging disaster.

1.2 Research Problem

Although a number of studies have already been carried out in Bangladesh looking at different aspects of cyclone and storm surge, a systematic documentation of the effectiveness of existing cyclone warning system is lacking. Systematic analysis on the warning system with regard to the understanding of the signal by the common people in particular virtually does not exist. It is therefore imperative to collect, compile and analysis the information of cyclone warning system and identify gaps and challenges to ensure its effectiveness. This research report also provides some recommendation and analysis towards rendering improved the existing cyclone early warning system through existing CPP dissemination system. The practical significance of these findings may help advise on interventions for enhancing the effectiveness of current cyclone forecasting systems, with a broader goal of building a disaster-resilient coastal community.

1.3 Objectives

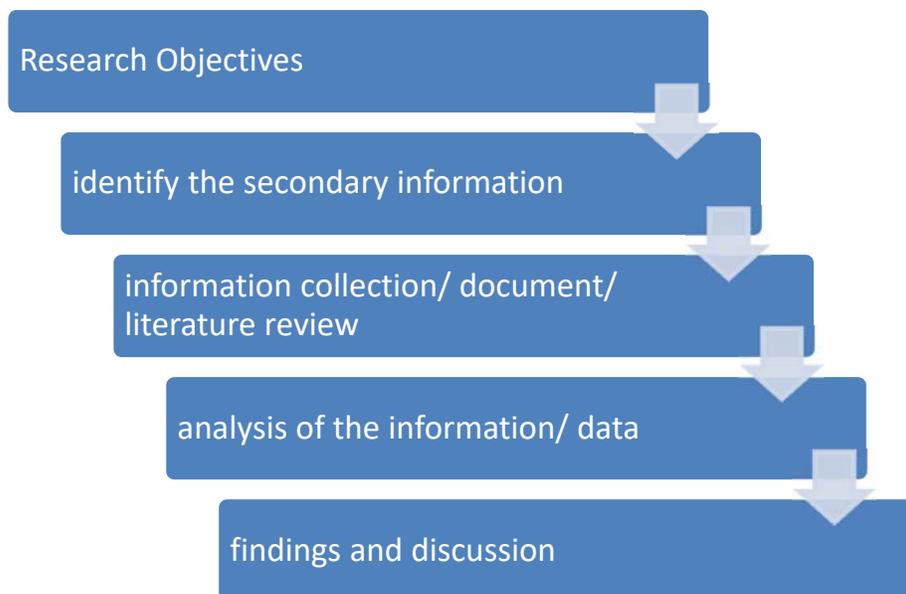
Objectives of this research are as follows:

- To identify the existing cyclone early warning system of Bangladesh
- To know whether the existing system of early warning is enough to reduce the risks of disaster.
- To find whether the current signal numbers of the cyclone warning system is clearly understood by the general people.
- To identify the effective delivery modes of early warning.
- To check whether the preparedness/DRR intervention foster the effectiveness of the warning system?

1.4 Methodology:

Secondary research methodology has been used for this study. The data collection technique mostly depends on the document and literature review. Secondary data/information were collected from books, article, study reports, web searching relevant to the research questions.

The methodology of the study is described in the below flow chart:



1.5 Limitation of the study:

The entire research is done based on secondary information. The authenticity and reliability of the data could not be validated.

Chapter 2

Literature Review:

Being a cyclone prone country, Bangladesh has always been a matter of attraction to the researchers and other scholars that how this country is becoming capable of bouncing back, again and again after being struck by yearly massive cyclones. It is true that, we have literatures written on the cyclone early warning system of our country but most of them were written by the foreign writers. Recently, there has been an increase of literatures written by our country's researchers and academicians.

Amongst those books, one is **“The current cyclone early warning system in Bangladesh: Providers' and receivers' views”**⁽¹⁾ by Chandan Roy et al. They conducted individual in depth interview among the meteorologist of BMD and also questionnaire survey among the residents of the coastal areas. The result of the study revealed that, the cyclone warning doesn't come or stay more than 12 hours. This is why; long term warning may cause unreliability among the residents. Another finding is, the residents don't follow the evacuation order due to mistrust on the early warning system. The residents have asked for a more reliable and effective EWS which will reduce the false number.

One similar literature is **“Disaster Management and Cyclone Warning System in Bangladesh”**⁽²⁾ by Monowar Hossain Akhand. According to the book, a total of 775303 people died in the coastal and offshore areas of Bangladesh within the last 222 years. The reasons of these deaths are mainly, weak cyclone warning and weather forecasting system, huge amount of false cyclone warning, people have no awareness etc. in the cyclone prone areas, and the amount of shelter centre is nowhere near the amount which is required. The amount of people without a proper shelter is about 73.3%. The research has revealed that, the government has now invested in the early warning system and so the people are getting more information by radio, television etc. sources.

“Bangladesh Cyclone Preparedness Program: A vital Component of nation's Multi Hazards Early Warning System”⁽³⁾ by A. Habib, M. Shahidullah, D. Ahmed is another written on the condition of Bangladesh EWS system of Cyclone. This literature emphasizes on the Cyclone Preparedness Program (CPP) which is jointly implemented by Government of Bangladesh and Bangladesh Red Crescent Society (BDRCS) with the help of United Nations, International Federation of Red Cross and Red Crescent (IFRC). CPP has around 50,000

volunteers who are working on disseminating early warning system during the cyclone warning, they help people to evacuate and take them to shelter centres. CPP volunteers work relentlessly to ensure safety of the people at risk and this initiative has been accepted as an example in the cyclone prone countries all over the world.

It is true that, the condition of early warning system of Cyclone has improved nowadays and as a result the mortality rate is also decreasing. Back in the 70s, the death toll was around .5 million but now the amount has reduced to hundreds or thousands. A literature named **“Why relatively fewer people died? The Case of Bangladesh’s Cyclone Sidr”** ⁽⁴⁾ by Bimal kanti Paul has illustrated the significance of improved early warning system and how it has decreased the death toll of cyclone in this country. Cyclone Sidr was a Category IV storm which struck the southwestern coast of Bangladesh on November 15, 2007 killing 3,406 people. Whereas Cyclone Gorky, also a Category IV storm, struck Bangladesh in 1991 causing an estimated of 140,000 fatalities. The relatively low number of deaths experienced with Sidr is widely considered the result of Bangladesh government’s efforts to provide timely cyclone forecasting and early warnings, and successful evacuation of coastal residents from the projected path of Cyclone Sidr. This article used information from both primary and secondary sources and identified the reasons of less mortality in Sidr than in Gorky. The duration of storm surge, landfall time, coastal ecology and improved coastal embankment has played a significant role. This article recommends improvements to the cyclone warning systems, establishment of more public cyclone shelters, and implementation of an education campaign in coastal areas to increase the utilization of public shelters for future cyclone events. The paper also recommends for comparative study between the cyclone Gorky of 1991 and the recent cyclones to understand how the early warning system has contribution in saving lives and economic damages.

A literature named **“Vulnerability to Tropical Cyclones: Evidence from the April 1991 Cyclone in Coastal Bangladesh”** ⁽⁵⁾ by C. Emdad Haque and Danny Blair. This study was done just after two weeks of the cyclone hitting at the coastal area. All the households of two affected communities were surveyed and the people said that, they heard about the warning but they didn’t listen to it as because they hear a lot of false alarms regarding the cyclone warning. So, it can be understood that development of cyclone warning system is required to increase people’s believe in the warning message. We need to take lesson from the event of 1991 cyclone which tells us why people do not take necessary actions to save themselves. If necessary actions are taken, only then the expected result can be achieved. A literature of C.

Emdad haque, named **“Climatic hazards warning process in Bangladesh: Experience of, and lessons from, the 1991 April cyclone”** ⁽⁶⁾ also expresses similar type of necessities. This article says that, it is not in our hand whether a cyclone or any other natural disaster will happen or not, but what we can do is, we can use multifaceted programs to modify the physical and human use system so that the losses from the disaster can be reduced. Without proper warning message dissemination, the adverse effects can never be reduced. Even after proper message dissemination, there are factors like socioeconomic and cognitive, which may disrupt the intervention. The study recommends that, the hazard mitigation policies should be integrated with national economic development plan and to make it more human friendly, human dimensions are to be added in its operational design.

One major reason of the death toll is, people are unaware of the warning system and they do not listen to the warning provided to them. Shitangshu Kuma Paul in his book **“Determinants of Evacuation Response to Cyclone Warning in Coastal Areas of Bangladesh: a Comparative Study”** ⁽⁷⁾ states this problem and ways on reducing it. The objective of the article was to understand why people are non-compliant to the evacuation initiatives during cyclone Sidr and also to do a comparative analysis to find out the major reasons why people are not listening to the warning. In order to do the research, the writer selected 331 households of three villages, which were affected by Sidr. A questionnaire survey was conducted at household level following simple random sampling procedure. Both descriptive and inferential statistics are used to analyze data. The present study finds that more than 90 percent of respondents had received cyclone warning and nearly 41 percent had evacuated in formal and informal cyclone shelters. However, only 13.6 percent had formally evacuated to the designated cyclone shelters. The reasons why people didn't comply with the early warning are, location, age, gender, education, primary occupation, distance from cyclone shelter and access to road and cyclone shelter. Another literature named **“Factors Affecting Evacuation Behavior: The Case of 2007 Cyclone Sidr, Bangladesh”** ⁽⁸⁾ by Bimal Kanti Paul, also reveals the facts why people are not evacuating in time and what are the factors which are making them take their decisions. This study was done directly with the Sidr victims and assessment was done to identify why or why not they did not comply with the cyclone warning message. 277 people were surveyed and 75% of them said that they heard about the cyclone warning but they did not leave house because they do not have trust on the warning system. It was the most important determinant on why they did not leave their house to take shelter in a camp. The next reason was that, the shelter centers are far away from their house and so it was really difficult

for the women, children and the elderly people to leave the house and seek shelter there. The rate of education and awareness is also very poor at those coastal areas and so people do not follow the warning messages.

No matter how much money is spent on the Early warning system, it must be accepted that indigenous knowledge of the local people is also important to consider because they have better idea on the place they are living and so they can implement any intervention in a better way rather than any outsider imposing ideas or activities on them.

A literature named **“Indigenous early warning indicators of cyclones: Potential application in coastal Bangladesh”** ⁽⁹⁾ by P. Howell emphasizes on the necessity of the indigenous knowledge of people. The article expresses that, over the last 30 years, many resources are being invested in Bangladesh for building cyclone shelters and setting up national warning systems, however on the offshore islands and in some rural coastal districts – which are extremely vulnerable to cyclones and tidal surges - protective infrastructure is still scarce. Many people do not fully understand the signal system, women lack information due to lack of education and they cannot leave their house during a signal due to the *purdah* culture. People have a common tendency to start preparation at the eleventh hour when it is already too late. Poor access to information and services is reinforced by social systems, whereby the elite exploit the poor. Thus, a combination of physical, economic and social factors can result in the most vulnerable people being the least forewarned and prepared. In spite of all these odds, it is seen that they can understand that a disaster is coming by watching the animal behaviour and natural phenomenon. This is mainly seen amongst the older generation but the newer generation doesn't rely much on it as because the idea is old aged and 'unscientific'. The older generation has been using it for ages but it is true that, new system of adaption should be taught to them so that they can implement it on their own and make it work.

Another literature focusing on the indigenous knowledge of people is **“Household response to cyclone and induced surge in coastal Bangladesh: Coping strategies and explanatory variables”** ⁽¹⁰⁾ by Shitangshu Kumar Paul and Jayant Routray. The study was done on three cyclone prone coastal villages of Bangladesh to identify the indigenous coping strategy and different variables like demographic, socio-economic etc. which plays a vital role in adopting with the coping strategy. The study finds out that, cyclone being a recurrent phenomenon In coastal Bangladesh, people have their own lifestyle and coping mechanism. These mechanisms depend on age, gender, social class, dissemination of early warning system, locational

exposure, social protection rather than only depending on the magnitude and intensity of the cyclone event. These indigenous approaches significantly minimize the vulnerability of the people. It is vital for their short-term survival and long-term livelihood security. Along with this, if these people are provided with proper early warning message and disaster response activities, such as emergency aid, relief etc. then they can have better and faster rehabilitation.

Government has been trying really hard to reduce the number of casualties and damage to the people, property and infrastructures by dissemination of properly timed early warning system but it must be admitted that, there were always fragments of corruption which has disrupted the intervention. Tanvir Mahmud and Martin Prowse in their article **“Corruption in cyclone preparedness and relief efforts in coastal Bangladesh: Lessons for climate adaptation?”** states the same. This research was conducted based on a random sample survey of 278 households, three focus group discussions and seven key informant interviews. It investigated the nature of the corruption in pre and post disaster interventions in Khulna during Cyclone Aila in May 2009. 90% of the respondents reported the presence of corruption. The ultra-poor people were mainly affected due to the corruption, particularly in public works and non-governmental interventions. The findings of this article can be used so that, a prevention measure can be taken to minimize the rate of corruption because in the presence of corruption, no intervention can work in an effective way, thus the main purpose of cyclone early warning, preparedness etc. can never be successful.

EW is a key component of preparedness against hazards and resilience of the community. Timely access to EW ensures that HHs are getting lead time to save their life, livelihood and asset from disasters and enable to recover quickly. The base line survey conducted by Bangladesh Red Crescent Society and International Federation of Red Cross and Red Crescent Societies in 2012 under Community based Disaster Risk Reduction programme in 4 villages under Bhola districts revealed multiple problems for accessing the early warning before any disasters. Most of the respondents of surveyed area reported that they do not get early warning message as they do not have TV, Radio or Mobile phone. Many respondents reported that early warning signal do not match with their experience or knowledge, and other respondent reported that they do not understand what the meaning of those signals are. The survey used both qualitative and quantitative method.

After completion of 5 years long CBDRR intervention, the programme evaluation was done in 2017 and it was found that overall, 95 per cent of people expressed their satisfaction with the current timing and quality of information they now receive ahead of a disaster. This compares

favourably with data from the baseline which showed that an average of 65 per cent of survey respondents of people were not receiving any form of early warning information. It also found that almost 70 percent of respondents receive early warning messages about cyclone, mainly through the CPP Volunteers. The evaluation identified that the CBDRR Programme is effective and it has played an important role in helping households become more disaster resilient and community-based early warning systems are known by around 66 percent of respondents.

The article titled ‘**Community Resilience to Cyclone Disasters in Coastal Bangladesh**’ written by Bayes Ahmed, Ilan Kelman Heather K. Fehr and Manik Saha analysed that the 4 years long (2013-2016) DRR intervention using the sustainable livelihood approach made the community well-connected with external entities with better access to infrastructure services. Community are trained and have adequate knowledge to tackle the disasters. The data was collected from two coastal communities in Patuakhali district, Nowapara and Pashurbunia. The study found that Community Disaster Management bea98.9% of households get early warnings for multiple but mainly meteorological hazards while the baseline value was 73.3%. It was also identified that the. community disaster management committee played a vital role in disseminating early warning.

A study titled ‘**Identifying gaps, challenges and limitation of access of women, children and PWD of Nijhumdwip to cyclone early warning towards rendering improved early warning services through CPP dissemination mechanism/system**’ by Mallik Sezan Mahmud investigated the underlying causes of non-responsive attitudes of women and children to cyclone early warning signal at Nijhumdwip. Both primary and secondary data were used in the study and it says that radio broadcasting, word-of-mouth from neighbours and CPP volunteers are the most common sources of information dissemination about cyclone early warning. However, women (79%) find neighbors as the most effective medium to know about cyclonic condition. Study found that nearly 70 percent of women and children very poorly interpreted disseminated signals during cyclone. Illiteracy has strong correlation with it where 86 percent of women are illiterate. The study revealed that a majority of the respondents were unable to follow & respond to the cyclone warning. It was identified that though women and children know about the cyclone early warning signal dissemination, but, unfortunately, they cannot interpret them due to lack of proper knowledge.

Similarly, Ubydul Haque, Masahiro Hashizume, Korine N Kolivras, Hans J Overgaard, Bivash Das and Taro Yamamoto in their article ‘**Reduced death rates from cyclones in Bangladesh:**

What more needs to be done? Says that though warning systems in Bangladesh have been improved, pre-cyclone evacuation remains a challenge. Some people do not understand or follow the warnings because of illiteracy, lack of awareness and communication problems. The authors also mentioned that dissemination of warning messages presents another challenge as most residents in coastal areas of Bangladesh have no access to radio or television. Hence, the Bangladesh government and nongovernmental organizations should further strengthen the existing awareness programme and initiate educational campaigns in coastal districts to ensure prompt use of public shelters during cyclones. Emphasis has given to focus on public health and hygiene issues as well.

Chapter 3

Operational definition of Cyclone:

3.1 Definition of cyclone

According to GA (2008) and BOM (1994), Tropical Cyclones (TC) are low pressure systems which develop in the tropics, in the southern hemisphere. They are sufficiently intense to produce sustained gale force winds of at least 63 km/h on average that rotates in clockwise circulations. The severe tropical cyclone is also known as a Hurricane or Typhoon (GA, 2008; BOM, 1994).

While a warm temperature of the sea reaches a threshold level and the wind structure started rising, then a cyclone forms. In other words, TC's derive their energy from the warm tropical oceans and do not form unless the sea-surface temperature is above 26.5°C. However, once formed they can persist at lower temperatures and dissipate over land or colder oceans (BOM, 1994). The eye of the cyclone is the centre of the cyclone where the focus lies. The areas surrounding the eye will be most affected because of the strong wind. Cyclones are measured by a category classification and the cyclone category can vary from different cyclone stages. Category 1 would be of minimal damage with wind gusts up to 125 km/h, and Category 5 would be of destructive and maximal damage with wind gusts exceeding 280km/h. the below table describes the characteristics and effects of each category with two estimations of the damages it may cause. This estimation is especially important for an accurate prediction and appropriate precautions to be taken.

3.2 Overview of Cyclone, Typhoon and Hurricane:

Cyclone, Typhoon and Hurricane are generally three different given names of the same type of natural hazard- the names are given based on the geographical location they take place. A typhoon occurs in the Northwest Pacific- in the countries like Japan, the Philippines, China, Taiwan etc. A hurricane occurs in the Atlantic and the Northeast Pacific- in the countries like the United States of America. A cyclone occurs in the South Pacific and the Indian Ocean (Bangladesh, Myanmar etc.). All this three are tropical storms, formed in the ocean, and can cause serious damage to the lives and substances in land.

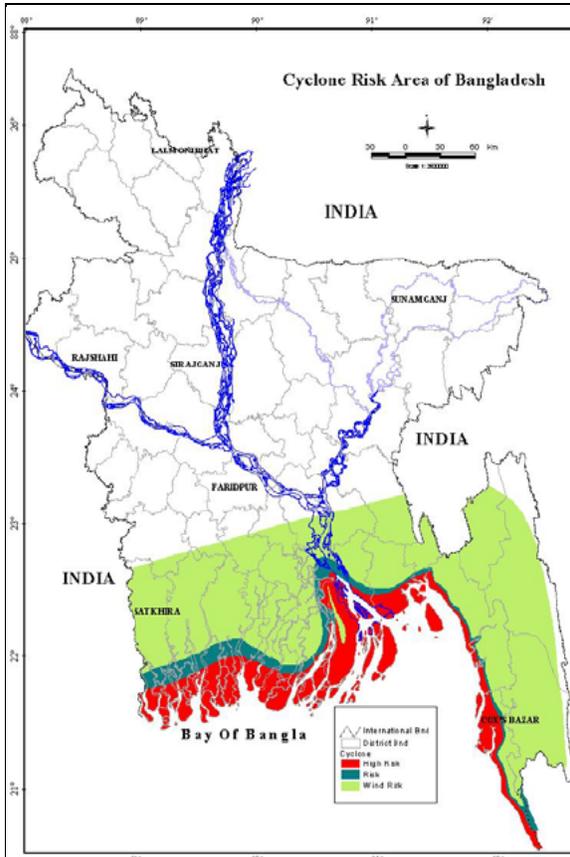
It's a cultural phenomenon for which the names differ in different regions. The name hurricane came from the Carib Indian god of evil '*Hurican*', which is derived from Mayan God

‘Hurakan’. Typhoon is originated from the Chinese “*tai fung*”, which means “great wind”. It is also said that the name is derived from “*Tufan*”, which means storm in Arabic. Cyclone is derived from Greek ‘*kyklon*’, meaning “moving or spin in a circle”.

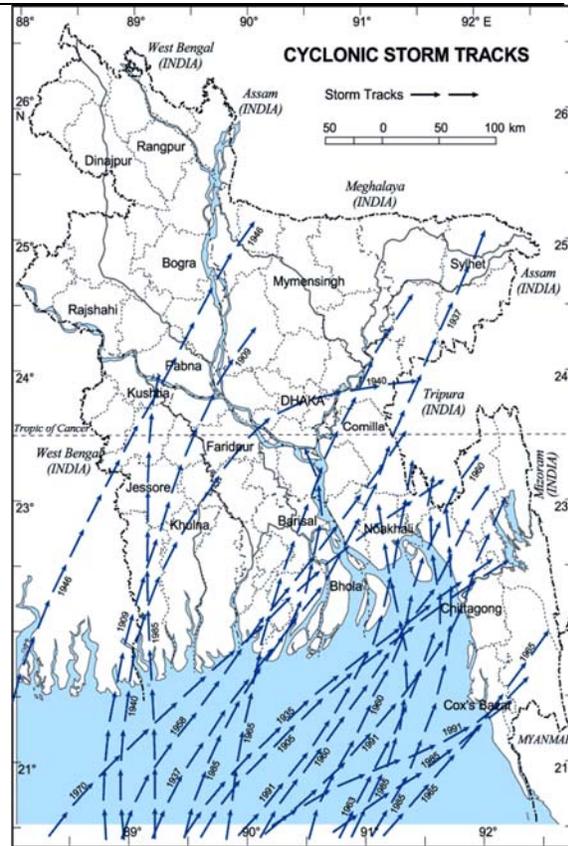
A hurricane, typhoon, and/or cyclone is a kind of tropical storm with winds that reaches at least 74 mph. Anything below 74 mph is just a tropical storm. Hurricanes, typhoons, and cyclones are also categorized from one to five. A category five or severe tropical cyclone corresponds to the highest category on the Beaufort Wind Force Scale. It is the most destructive kind of storm and can fall on land at a wind speed of 280 km/h rate.

Table 1: Cyclone category classification (BoM 2008):

Cyclone Category	Description	Wind Speed (km/h)	Characteristics	Effects
1 - TC	Strong Gale	Less than 125	High waves, may affect visibility	Negligible property damages minimal infrastructure and crop damages
2 - TC	Violent Storm	125-169	Air filled with foam, high waves, Visibility effected	Minor property damages Significant infrastructure and crop damages Local Power failure
3 – Severe TC	Very Destructive Winds (Hurricane)	170-224	Air filled with foam and spray, driving high waves, Visibility effected	Major property damages Significant infrastructure and crop damages Local Power failure Injuries
4 – Severe TC	Very Destructive Winds (Hurricane)	225-279	Air filled with foam and spray, driving high waves, Visibility severely effected	Major property damages Destroy infrastructure and crop damages Widespread Power failure Injuries and Fatalities
5 – Severe TC	Very Destructive Winds (Hurricane)	More than 280	Air filled with foam and spray, driving high waves, Visibility severely effected	Extreme property damages Destroy infrastructure and crop damages Widespread Power failure Injuries and Fatalities



Map 1: Cyclone risk area of Bangladesh (Source: CEGIS, 2006)



Map 2: Bangladesh Cyclone tracks in Bangladesh. Source: Banglapedia

3.3 Early Warning System in India and Sri Lanka

In India disaster prone communities have been encouraged and informed to handle emergency response equipment and to understand warning alerts in order for them to take action. There has been a wide dissemination of training manuals in English and in local languages, so that communities can be alert and can properly take measures to be safe during disasters. To provide an example where this method displayed signs of success we should look at events like cyclone Hudhud and Phailin. Prior to these cyclones, warning messages including coordinates of the impending cyclone's location and intensity, were communicated through constant news coverage via broadcast, print and online media, email and fax, telephone, text messages, and loudspeakers. Additionally, in the 14 most vulnerable districts, satellite phones were distributed to the representatives so that warnings and information were still being communicated during the disaster.

Furthermore, during cyclone Phailin authorities had control and were able to order emergency control rooms to function around the clock to positions and to spread out thousands of rapid-action disaster field officers and in advance, to assist with evacuations and brace for search and rescue operations. Moreover, food, drinking water, and medicine for the disaster affected civilians were stockpiled to ensure rapid relief. In addition, shelters were checked and made ready for evacuated residents of the areas, whilst earthmovers and other road-clearing machinery were requisitioned to facilitate movement of relief materials to hard-hit areas. Since, fisherfolk are usually the worst hit during a cyclone in the coastal areas, they were given training to recognise warning signs to ensure their own safety (UNDP, 2018).

In Sri Lanka, unlike India, advisories and warnings are first broadcasted via radio and television to the central police office. This first broadcast to the police station then issues a warning to the various communities with sirens and announcement systems, to the military, to the DMC-district disaster coordinators, and to the district secretaries. All of these groups disseminate warnings to their various communities (Oxfam, 2006)

3.4 Names of Cyclones, Hurricanes and Typhoons

According to the World Meteorological Organization, the practice of naming storms (tropical cyclones) began years ago in order to help in the quick identification of storms in warning messages because names are presumed to be far easier to remember than numbers and technical terms. Many agree that appending names to storms makes it easier for the media to report on tropical cyclones, heightens interest in warnings and increases community preparedness.

The use of short, distinctive given names in written as well as spoken communications is quicker and less subject to error than the older more cumbersome latitude-longitude identification methods. These advantages are especially important in exchanging detailed storm information between hundreds of widely scattered stations, coastal bases, and ships at sea.

In the beginning, storms were named arbitrarily. An Atlantic storm that ripped off the mast of a boat named Antje became known as Antje's hurricane. Then the mid-1900's saw the start of the practice of using feminine names for storms.

In the pursuit of a more organized and efficient naming system, meteorologists later decided to identify storms using names from a list arranged alphabetically. Thus, a storm with a name

which begins with A, like Anne, would be the first storm to occur in the year. Before the end of the 1900's, forecasters started using male names for those forming in the Southern Hemisphere.

The World Meteorological Organization have a gathered rotating list of names appropriate for each tropical cyclone basin. This contains 6 rotating lists, so the same names get used again after a 6-year time period, for instance the names used in 2015 will again be used in 2021. The original name lists featured only women's names. In 1979, men's names were introduced and they alternate with the women's names. The list is only changed when some names are retired off the list due to some cyclones being very costly and deathly and therefore using the same name in the future may be seen as inappropriate taking into consideration the emotional and sensitivity factor. Some examples of this would-be Sandy (USA, 2012) and Katrina (USA, 2005), (WMO, 2018).

In Bangladesh, the cyclones such as Alia, Sidr, and Mora are also named by the World Meteorological Organization. In the North Indian Ocean Zone there are members from eight South Asian countries which are members of the WMO. The members include, India, Bangladesh, Maldives, Myanmar, Oman, Pakistan, Sri Lanka and Thailand. There is a procedure to name the cyclones in an ocean basin by the Tropical Cyclone Regional Body responsible for that basin. It is important that the name of the cyclone has to be short and easy to understand when broadcasted. Furthermore, cultural significance must be taken into consideration and name should not be culturally sensitive (Yengkhom and Konari, 2009).

More specifically, we can look at an example such as cyclone Mora. Cyclone Mora originated from Sri Lanka but got its name from Thailand. Mora is a Thai word which means “star of the sea” or “sea star”. Moreover, the name Roanu was named by the Maldives, which means “coir rope”. Usually these eight countries will give eight names each, which will make for a list of 64 names which will then be sequentially used for the cyclones. Bangladesh gave the names, Onil, Ogni, Nisha, Giri, Chapala, Ockhi and Fani. Below is the table showing the list (Shams, 2017).

The RSMC tropical cyclones New Delhi gives a tropical cyclone an identification name from the below name list. The identification system covers both the Arabian Sea and the Bay of Bengal.

Table 2: Cyclone Naming List

Contributors	List 1	List 2	List 3	List 4	List 5	List 6	List 7	List 8
Bangladesh	Onil	Ogni	Nisha	Giri	Helen	Chapala	Ockhi	Fani
India	Agni	Akash	Bijli	Jal	Lehar	Megh	Sagar	Vayu
Maldives	Hibaru	Gonu	Aila	Keila	Madi	Roanu	Mekunu	Hikaa
Myanmar	Pyarr	Yemyin	Phyan	Thane	Nanauk	Kyant	Daye	Kyarr
Oman	Baaz	Sidr	Ward	Murjan	Hudhud	Nada	Luban	Maha
Pakistan	Fanoos	Nargis	Laila	Nilam	Nilofar	Vardah	Titli	Bulbul
Sri Lanka	Mala	Rashmi	Bandu	Viyaru	Ashobaa	Maarutha	Gaja	Pawan
Thailand	Mukda	Khai Muk	Phet	Phailin	Komen	Mora	Phethai	Amphan

Source: <https://public.wmo.int/en/About-us/FAQs/faqs-tropical-cyclones/tropical-cyclone-naming>

3.5 Hurricane Katrina: Why was it so damaging?

Hurricane Katrina in the US is still known as the costliest hurricane yet, with 1,800 lives lost and more than a million people left homeless. The Hurricane killed people in 5 states including, Louisiana, Mississippi, Georgia, Alabama and the Florida, but most of the deaths occurred in Louisiana, New Orleans. The two prominent reasons New Orleans was the most affected were levees being breached and poverty. On 29th August more than half of the 5,729 km of levees and flood walls protecting the city and its suburbs were breached, damaged or destroyed, which

allowed a flow of immense amounts of water to surround the area. It was later claimed that this flood protection system in the city was both poorly designed as in faulty and poorly maintained. Additionally, the level of poverty in the New Orleans even before hurricane Katrina was high, which is another contributing factor to the high death toll. It has been documented that around 28% of the population in that area were living in poverty and thus did not own a car which made it difficult to leave for evacuation before the hurricane hit as the evacuation process and plan was based upon public having their own means of transport (Smith, 2015).

3.6 Major Cyclonic Event in Bangladesh

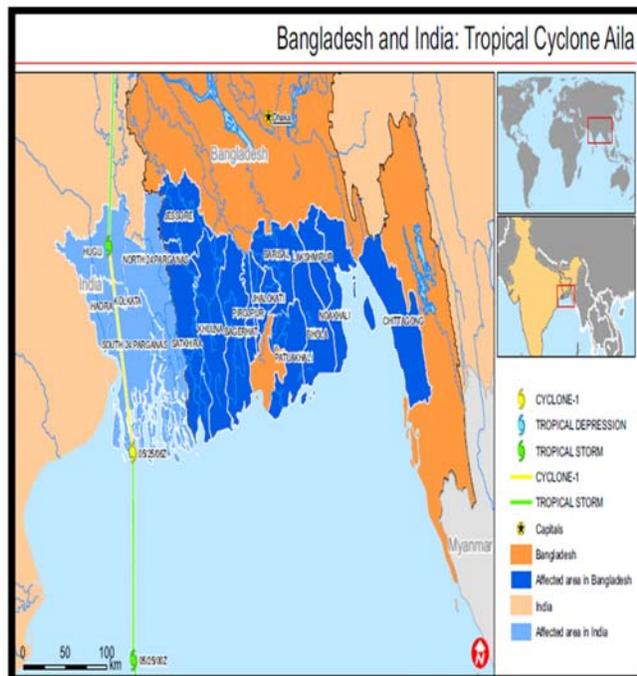
There have been numbers of cyclone hit the Bangladesh coast since 1965, leaving thousands of people dead. With about 700km coastal line Bangladesh is often exposed to cyclone. The one of the reasons for heavy casualties is that cyclones always come with storm surges, Tremendous property damages, and the total disruption of development activities of the country occur almost every year. Some of the massive cyclone disasters that Bangladesh was struck by in the recent past are shown in the table below:

Table 3: Bangladesh cyclone damage:

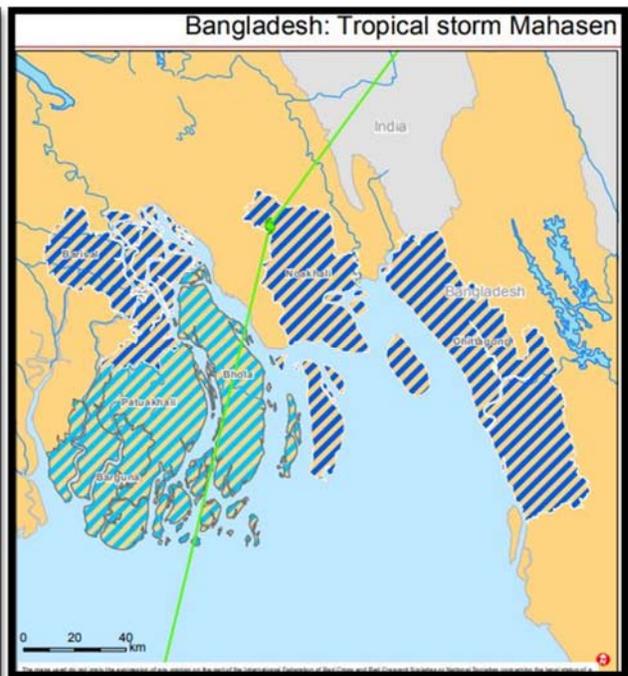
Name	landfall	Area Affected	casualty	Damages
1970 Bhola cyclone	November 12, 1970	Chittagong, Barguna, Khepupara, Patuakhali, north of Char Burhanuddin, Char Tazumuddin and south of Maijdi, Haringhata	More than 500,000	More than 400,000 houses and 3,500 educational institutions were destroyed
1991 Cyclone	April 29, 1991	Chittagong district of	150,000	As many as 10 million people

		southeastern Bangladesh		became homeless
Cyclone Sidr	November 15, 2007	Bagerhat, Barisal, Patuakhali, Pirojpur, Khulna and Satkhira	3,363	Livestock, farms and feeds worth more than Tk 130 crore were destroyed
Cyclone Aila	May 25, 2009	Southwestern coastal regions of Bangladesh	190	6,000 kilometres of roads damaged, more than 500,000 people became homeless, complete destruction of 275 primary schools and damage to 1,942 schools
Cyclone Mahasen	May 16, 2013	Patuakhali, Bhola, Barguna	17	1.5 million people were affected. More than 26500 houses were destroyed and 124500 houses were damaged.
Cyclone Komen	July 30, 2015	Cox's Bazar, Chittagong, Bandarban,	7	1.5 million people were affected by the cyclone

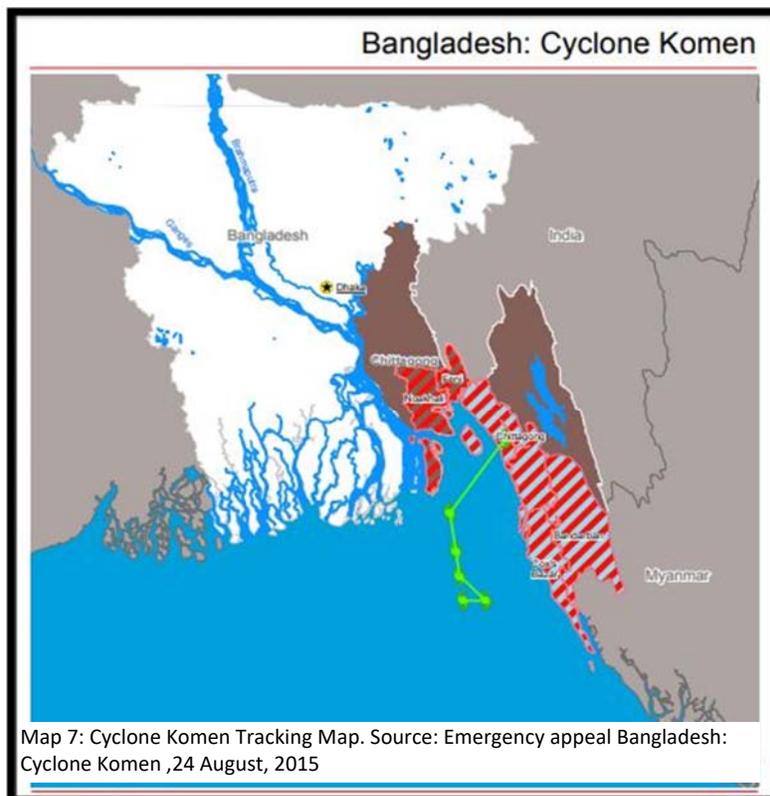
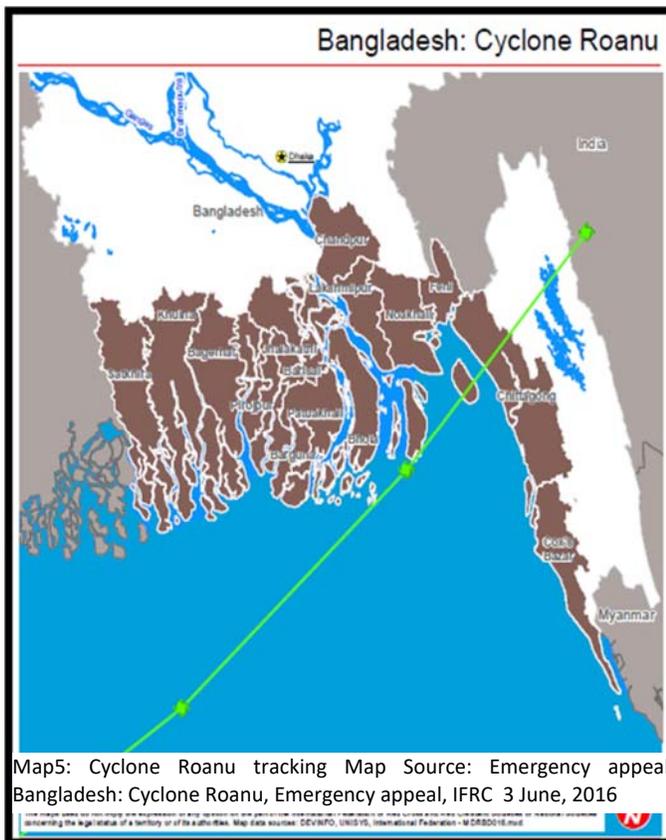
		Noakhali, Feni and Bhola		
Cyclone Roanu	May 21, 2016	Sandwip, Hatia, Kutubdia, Sitakundu and Feni	26	Around one lakh houses were damaged and about 150,000 families were affected
Cyclone Mora	30 May, 2017	Coxs’Bazar, Chittagong, Feni, Chandpur, Noakhali, Laxmipur	7	Around 3.3 million people were affected. 50,000 houses were damaged fully or partially



Map 3: Cyclone Aila Tracking map. Source: Information Bulletin:1, IFRC TC-2009-000105-BGD & IND 26 May 2009.



Map 4: Tropical Cyclone Mohasen Tracing Map. Source: Emergency Appeal: Bangladesh: Tropical cyclone Mahasen, IFRC. 19 July, 2013



Chapter 4

Cyclone Early Warning System in Bangladesh

4.1 Background

Bangladesh Meteorological Department (BMD) under the Ministry of Defence plays the key role in generating warning in Bangladesh. Bangladesh Meteorological Department is responsible for generating warning for all hazards, disseminating the warning through public media and different preparedness units and to follow up the warnings at periodic intervals. The Storm Warning Center (SWC) is a specialized unit of BMD, and is responsible for forecasting and issuing warnings for TCs in Bangladesh. BMD collects meteorological data through 35 ground-based, 10 weather balloon, 5 radar, and 3 radiosonde stations. In addition, BMD receives 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 state of the World Meteorological Organization.

For dissemination of the warnings BMD uses existing cyclone warning network. The network was established in 1973 as Cyclone Preparedness Programme (CPP) which was developed as a joint venture program of Bangladesh Red Crescent Society (BDRCS) and the Ministry of Food and Disaster Management and the Government of Bangladesh. CPP (Cyclone Preparedness Programme) and BMD (Bangladesh Meteorological Department) mainly work together for disaster warning generation and dissemination of the warning to the root level people in Bangladesh.

4.2 Cyclone preparedness Program (CPP)

Cyclone Preparedness Programme (CPP) is a unique institutional arrangement for community preparedness to face and mitigate the challenges of cyclones that frequently hit Bangladesh coasts. CPP is a flagship programme for the Bangladesh to showcase the country's success in saving lives from cyclones. The programme is being jointly run by the Government of Bangladesh and the Bangladesh Red Crescent Society (BDRCS) since 1972. Over the course of time, CPP has evolved with a true spirit of volunteerism for dissemination of warning signals from National Head quarters to Union level through HF and VHF radio network. The programme volunteers disseminate early warning signals to the community issued by the

Bangladesh Meteorological Department, assist disaster affected people to shift to safe shelter, undertake search and rescue operation and provide first aid to the injured.

Bangladesh experienced a catastrophic cyclone in 12 November 1970 killing more than 500,000 people in the coastal belt. The tragic disaster led to the establishment of CPP in 1972 with help from the former League of Red Cross and Red Crescent Societies. In 1973, the League of Red Cross and Red Crescent Societies decided to withdraw their support from the field level programme, but however, considering the vulnerability of the coastal people, the Government of Bangladesh stepped forward to further drive the initiative. The programme then became a “Joint programme of Bangladesh Red Crescent Society and Government of Bangladesh (GoB)”.

Since then CPP has been the protector of the vulnerable communities by minimizing loss of lives and properties. Creating awareness on ‘how to be safe during the life-threatening cyclones’ is another major activity of the programme which has increased the readiness of the coastal people in Bangladesh. The programme volunteers disseminate early warning signals to the community affected by the disaster and promptly shift people to safe shelters, undertake search and rescue operation and provide first aid to the injured.

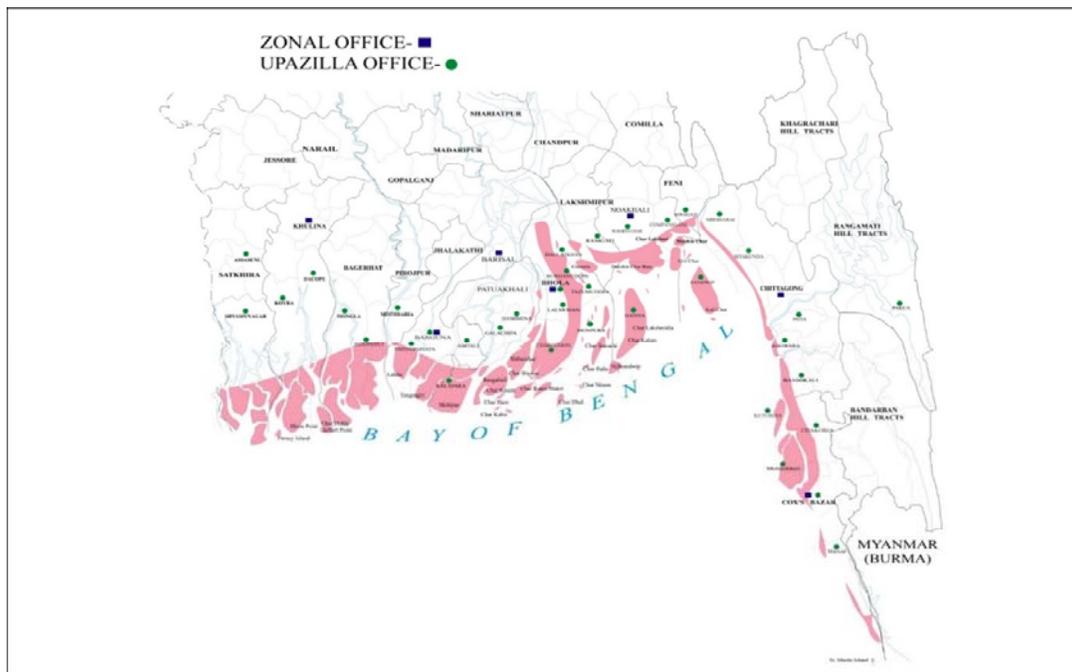
CPP has subsequently been expanded in the last couple of years. The programme currently covers 13 districts in the coastal areas, comprising of 40 Upazila which consists of 350 Unions. It has a total of 203 full-time personnel and 55260 volunteers under 3684 units. Each of the unit has 15 members (10 male and 5 female).

CPP is managed by the Ministry of Disaster Management and Relief (MoDMR), and the Bangladesh Red Cross Society that comprise a Policy Committee and Implementation Board:

- a) The Policy Committee is headed by the Honorable Minister, Ministry of Disaster Management and Relief (MoDMR) who governs the overall policy framework of the CPP. BDRCS Chairman is the vice chairman of the Policy Committee. The committee includes BDRCS and other relevant Ministries as key members.
- b) The Implementation Board is headed by the secretary, MoDMR. The board has a mandate for implementing the policies agreed by the policy committee. This is the

overall administrative body of the programme. BDRCS and IFRC are members of this committee.

- c) At the implementation level, two directors run the -daily business at CPP National Headquarters. As per the gazette 2004, Director of Administration is appointed by the Government of Bangladesh (GoB), and he the administrator of the program with the oversight of staff salary, budgeting, reporting to the GoB. The Director of Operations on the other hand, is appointed from BDRCS with the oversight of the operations of the CPP program such as trainings, insuring the function of the wireless networks, and managing volunteers, etc.



Map 8: CPP coverage. Source: CPP

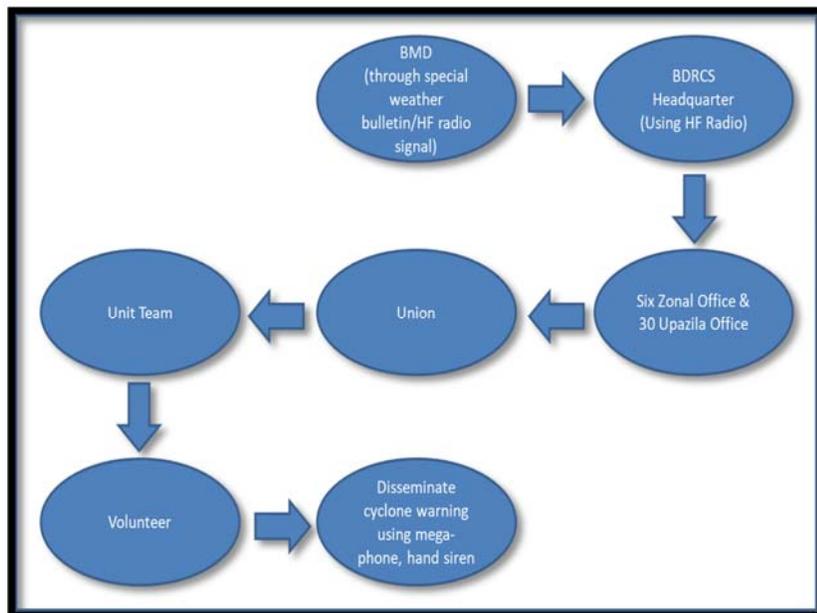
Cyclone preparedness Program was developed with a goal to develop and strengthen the disaster preparedness response capacity of coastal communities vulnerable to cyclones, to increase the efficiency of volunteers and officers, and to maintain and strengthen the warning system ensuring effective response in the event of a cyclone. In order to achieve the goal, CPP is involved with number of pre-disaster, during disaster and post-disaster activities. The following main activities of the program are being implemented to fulfil the objectives of the Cyclone Preparedness program:

1. Disseminate cyclone warning signals issued by the Bangladesh Meteorological department to the community people.
2. Assist people in taking shelter.

3. Rescue distressed people affected by a cyclone.
4. Provide First Aid to the people injured by a cyclone.
5. Assist in relief and rehabilitation operations.
6. Assist in the implementation of the BDRCS Disaster Preparedness Plan.
7. Assist in participatory community capacity build-up activities.
8. Assist in the co-ordination of disaster management and development activities.

Highly motivated by the 7 principles of the RC/RC Movement, the volunteers take pride of being a Red Crescent volunteer. The programme volunteers disseminate early warning signals to the community, issued by the Bangladesh Meteorological Department, evacuate vulnerable people, assist disaster affected people to shift to safe shelter, undertake search and rescue operation and provide first aid to the injured. Besides performing duties related to warning dissemination during the cyclone season, they also undertake awareness raising campaign through mock drill, stage drama etc., and contribute to long term mitigation activities such as tree planting throughout the year. The sincere and relentless efforts of CPP volunteers have significantly reduced the number of casualties during different cyclones. According to the VIVA study 2015, for every 1 taka spent on each volunteer, the CPP receives BDT 42 worth of value from services rendered by them.

The social value of the CPP volunteers is however, not possible to measure in figures. These volunteers do not hesitate to risk their lives to support the emergency situation. 27 volunteers have sacrificed their lives and many others have been injured in their commitment to saving lives during the cyclones.



F Operation method of CPP

4.3 Warning Equipment and logistics

4.3.1. Warning Equipment

Bangladesh Meteorological Department is primarily responsible for generating warnings for hazards which is disseminated to the vulnerable community through the administrative network of Bangladesh Government along with the infrastructure of the Bangladesh Red Crescent Society where CPP is a project of the BDRCS. BDRCS and the CPP units receive messages of warning from BMD through high frequency satellite radio. The unit Team Leaders of CPP is provided with a transistor radio for receiving the messages. CPP then disseminate the warning signals among the villagers through megaphones, sirens, public address equipment, signal lights etc. Signal flags are also provided to each volunteer's teams where number of flags on a mast indicates the severity of the event.

4.3.2 Volunteers' Gears

To facilitate the Volunteers movement in the adverse weather, they are provided with rain coats, gum boots, hardhats, life jackets and torch lights. Besides these, the first aid and rescue Volunteers are provided with first aid and rescue kits.

4.3.3 Telecommunication Network

The Cyclone Preparedness Programme operates an extensive telecommunication network with HF and VHF radio station that directly link Headquarter of CPP with coastal area of Bangladesh.

To receive the meteorological storm warning signals, each Unit Team Leader is provided with a transistor radio. To disseminate warning signals among the community Megaphone, Hand Siren, Signal Flag, Signal Light are Provided to each team of volunteers. Volunteer team leaders are provided with bi-cycles, Motor-bikes to receive and disseminate storm warning signals.

The network consists of a combination of High Frequency and Very High Frequency radios, which covers most of the high-risk cyclone areas. At present CPP has 38 HF & 114 VHF radio

The telecommunication network of the Cyclone Preparedness Programme is composed of three elements as follows:

a) High Frequency (HF) Transceiver Radio:

- With a main base station located at the Dhaka Headquarter
- To transmit information related to the cyclone and the preparedness.
- Field stations send the progress and effects of the cyclone to the headquarter

b) Very High Frequency (VHF) Transceivers:

- To receive and transmit messages from HF field stations to Sub-Stations locate at Union/Islands.

c) Transistor Radio:

- Used by each unit Team leader (3684 teams)
- Receive Meteorological information, cyclone warning signal and special
- Weather transmitted by Radio Bangladesh on regular basis.

Table 5: CPP coverage:

District	Zone	Upazila	Nos-of Union	Nos-of Unit	Nos of Volunteers		Total Volunteers
					Male	Female	
Cox's Bazar	Cox's Bazar	Teknaf	06	66	660	330	990
Cox's Bazar		Cox's Bazar	09	78	780	390	1170
Cox's Bazar		Moiskhal	09	96	960	445	1440
Cox's Bazar		Chokoria	11	70	700	350	1050
Cox's Bazar		Paykua	07	49	490	245	735
Cox's Bazar		Kutubdia	06	55	550	275	825
Chittagong	Chittagong	Chittagong Sadar	0	03	30	15	45
Chittagong		Sitakunda	10	63	630	315	945
Chittagong		Mirsarai	10	80	800	400	1200
Chittagong		Sandwip	15	146	1460	730	2190
Chittagong		Banskhali	11	71	710	355	1065
Chittagong		Anowara	07	50	500	250	750
Chittagong		Patiya	05	31	310	155	465
Noakhali	Noakhali	Noakhali Sadar	0	03	30	15	45
Feni		Sonagazi	09	100	1000	500	1500
Noakhali		Companigonj	08	119	1190	595	1785
Noakhali		Suburnochor	09	120	1200	600	1800
Noakhali		Hatiya	11	177	1770	885	2655
Laksmipur		Ramgati	09	101	1010	505	1515
Laksmipur		Komolnagar	09	63	630	315	945

Bhola	Bhola	Monpura	04	55	550	275	825
Bhola		Daulatkhan	09	91	910	455	1365
Bhola		Borhanuddin	06	64	640	320	960
Bhola		Tajumuddin	05	81	810	405	1215
Bhola		Lalmohan	09	137	1370	685	2055
Bhola		Charfession	19	165	1650	825	2475
Bhola		Bhola Sadar	09	87	870	435	1305
Barisal	Barisal	Barisal Sadar	0	03	30	15	45
Patuakhali		Dasmina	07	78	780	390	1170
Patuakhali		Golachipa	13	135	1350	675	2025
		Rangabali	05	64	640	320	960
Perojpur		Mothbaria	08	85	850	425	1275
Bagerhat		Saronkhola	04	45	450	225	675
Patuakhali	Barguna	Kalapara	12	158	1580	790	2370
Barguna		Amtali	08	115	1150	575	1725
		Taltoli	07	58	580	290	870
Barguna		Barguna Sadar	10	146	1460	730	2190
Barguna		Patharghata	07	103	1030	515	1545
Khulna	Khulna	Dacop	10	91	910	455	1365
Khulna		Kayra	07	73	730	365	1095
Satkhira		Asasuni	11	101	1010	505	1515
Satkhira		Shamnagar	12	142	1420	710	2130
Bagerhat		Mongla	07	66	660	330	990
Total=13			40	350	3684	36,840	18,420

CPP operates a total of 142 Radio stations, among those 64 stations are placed in cyclone shelters, built by the BDRCS, in the high-risk cyclone prone areas (CPP, BDRCS, 2002). These radio stations are powered by solar panels and also storage battery. 26 stations have both HF and VHF Radio transceivers operating, and 10 stations where only HF Radio transceivers operating. Only VHF Radio transceivers are located and in operation in 106 stations.

4.4 BMD Operational Method

Bangladesh Meteorological Department(BMD) monitors hazard around the country round the clock and disseminate warning through the organizational network of Bangladesh Government and BDRCS. Different institution of Bangladesh government is immediately informed about

the disaster. The institutions of the government then participate on the dissemination through its organization network. Chart of Bangladesh government that reveals how the warning is disseminated to the local community through the governmental network. Information directly to CPP from BMD also acts parallel.

BMD is responsible for:

- Observing different meteorological parameters both for surface and upper
- Air all over Bangladesh round the clock.
- Preparing and analyzing all weather charts and to make interpretation on
- The basis of analyses.
- Providing weather forecasts for public, farmers, mariners and aviators on routine basis and also to issue warnings for severe weather phenomena such as tropical cyclones, tornadoes, nor'swesters, heavy rainfall, etc.
- Maintaining surveillance of weather radars for probing impending tropical cyclones, nor'swesters and tornadoes.
- exchanging meteorological data, forecasts and warnings to meet national and international requirements
- Receiving round the clock satellite imageries for timely use in operational meteorology.
- Extracting maintain quality control, process, archive and publish climatic data for use of various interested agencies at home and abroad.
- Providing meteorological data, radar echoes and Satellite imageries and weather forecast for flood forecasting and warning centre.
- Monitoring micro seismic events and earthquake round the clock.
- Conducting special studies required for the policy makers and for the development of hydrometeorology and Meteorological sciences in the region.

The Storm Warning Center (SWC) is a specialized unit of BMD, and is responsible for forecasting and issuing warnings for TCs in Bangladesh. BMD collects meteorological data through 35 ground-based, 10 weather balloon, 5 radar, and 3 rawinsonde stations. In addition, BMD receives 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 state of the World Meteorological Organization [14–16]. Currently, BMD employs two techniques: (a) Storm Track Prediction (STP), and (b) Steering

and Persistence (STEEPER) for TC forecasting [17,18]. Technically, neither STP nor STEEPER is sufficiently advanced, and therefore cannot produce forecasts with good accuracy for more than 12 hours ahead [18]

Table 6: Warning System for Maritime ports (Bangladesh Meteorological Department)

Signal No.	Meaning
Distant Cautionary Signal No. I	There is a region of squally weather (wind speed of 61 kms/hour) in the distant sea where a storm may form.
Distant Warning Signal No. II	A storm (wind speed of 62-88 kms/hour) has formed in the distant deep sea. Ships may fall into danger if they leave harbor
Local Cautionary Signal No. III	The port is threatened by squally weather (wind speed of 40-50 kms/hour).
Local Warning Signal No. IV	The port is threatened by a storm (wind speed of 51-61 kms/hour) but it doesn't appear that the danger is as yet sufficiently great to justify extreme precautionary measures
Danger Signal No. V	The port will experience severe weather from a storm of slight or moderate intensity (wind speed of 62-88 kms/hour) that is expected to cross the coast to the south of Chittagong port or Cox's Bazar port and to the east of Mongla port
Danger Signal No. VI	The port will experience severe weather from a storm of slight or moderate intensity (wind speed of 62-88 kms/hour) that is expected to cross the coast to the north of the port of Chittagong or Cox's Bazar and to the west of the port of Mongla.
Danger Signal No. VII	The port will experience severe weather from a storm of light or moderate intensity (wind speed of 62-88 kms/hour) that is expected to cross over or near the port.
Great Danger Signal No. VIII	The port will experience severe weather from a storm of great intensity (wind speed of 89 kms/hour or more) that is expected to cross the coast to the south of the port of Chittagong or Cox's Bazar and to the east of the port of Mongal.
Great Danger Signal No. IX	The port will experience severe weather from a storm of great intensity (wind speed of 89 kms/hour or more) that is expected to cross the coast to the north or the port of Chittagong or Cox's Bazar and to the west of the port of Mongla.
Great Danger Signal No. X	The port will experience severe weather from a storm of great intensity (wind speed of 89 kms/hour or more) that is expected to cross over or near the port.

Failure of Communication No. XI	Communications with the Storm Warning Centre have broken down and local officers consider that a devastating cyclone is following.
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Table 7: Warning system for river ports (Bangladesh Meteorological Department)

Signal	Meanings
Cautionary Signal No. 1	The Area is threatened by squally winds of transient nature.
Warning Signal No. 2	A storm is likely to strike the area (Vessels of 65 feet and under in length are to seek shelter immediately)
Danger Signal No. 3	A storm will strike the area (all vessel will seek shelter immediately)
Great Danger Signal No.4	A violent storm will soon strike the area (all vessels will take shelter immediately)

3.5 Signaling System

Bangladesh Meteorological Department (BMD) is responsible for all kinds of weather forecasting. Cyclone warning system is the only one and well-known warning system used in Bangladesh. The signalling system currently used for cyclone warning was inherited from British India which were developed for maritime and river ports of British India. There were 11 numbers of signals for Maritime ports and 4 numbers of signals for river ports to indicate the severity of weather conditions. Table 1 and 2 reveal the meanings of the signal numbers for maritime ports and river ports respectively. However, the meanings of these signals, which were developed for port system, have been ambiguous to the local community.

CPP has simplified the signalling system through introducing flagging system corresponding to maritime signals. Three flags have been developed to represent the whole range of Maritime Port Signalling System of British India. Meanings of first flag correspond to signal numbers 1 to 3, second flag corresponds to signal number 4 to 7 and the third flag correspond to signal

numbers 8 to 11 of Maritime Port signals. While understanding of the meanings of these flags still remain questionable, increase in the number of flag on a mast generally indicates a greater severity of the cyclone event to the local community. Figure 2.3 shows flag numbers and corresponding maritime port signals.

Operational Method:

CPP is a mechanism which relies on technical skills and volunteers' commitment for ensuring that all potential victims of an approaching cyclone are given sufficient warning to 20 million coastal people so as to enable them to move to safe- sites including cyclone shelters and safe buildings. The system starts with the collection of meteorological data from the Bangladesh Meteorological Department (BMD), which issues bulletins including the designated warning

signals of an approaching cyclone. The bulletins are transmitted to the 6 zonal offices and the 37 upazila level offices(sub-district) over HF radio.

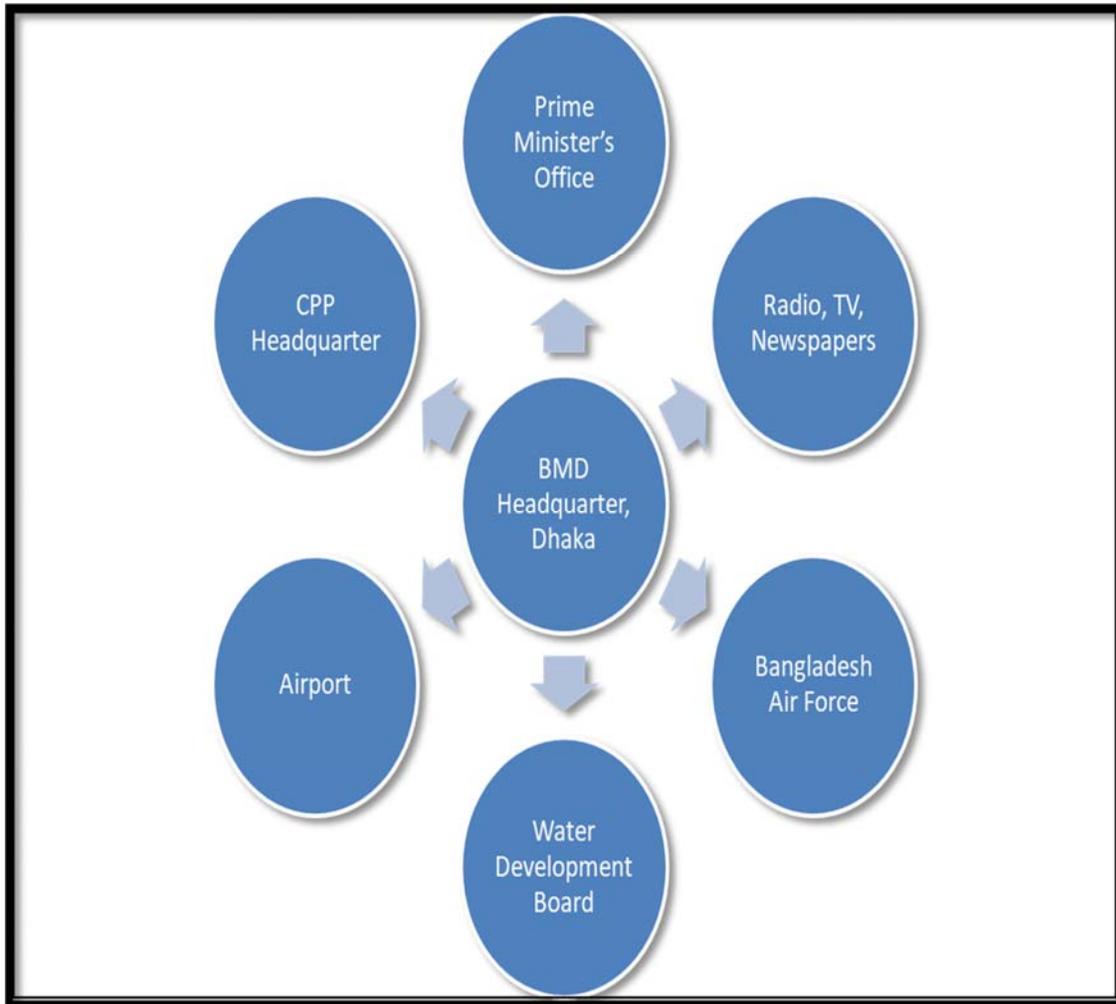
The upazila office in turn, pass it to unions and lower level through VHF radios. The union team leaders then conduct the unit team leaders immediately. The unit team leaders with his volunteers spread out in the villages and disseminate cyclone warning signals almost door to door using megaphones, hand sirens and public address system. The important milestones are:

- Depression in the Bay of Bengal
- Weather Bulletin issued by the BMD
- Passed it to 6 zonal offices – Upazila – Union-unit
- Unit disseminate the warning signal to community at risk

When the situation turns serious the GOB passes the Order for evacuation. The volunteers implement the order, and advise and help people to seek safety in cyclone shelters or other available safe places. After the cyclone is over the volunteers rescue the injured and marooned people, provide first aid to the injured, send serious cases to the local hospital and assist in post cyclone emergency relief operation launched by BDRCS.

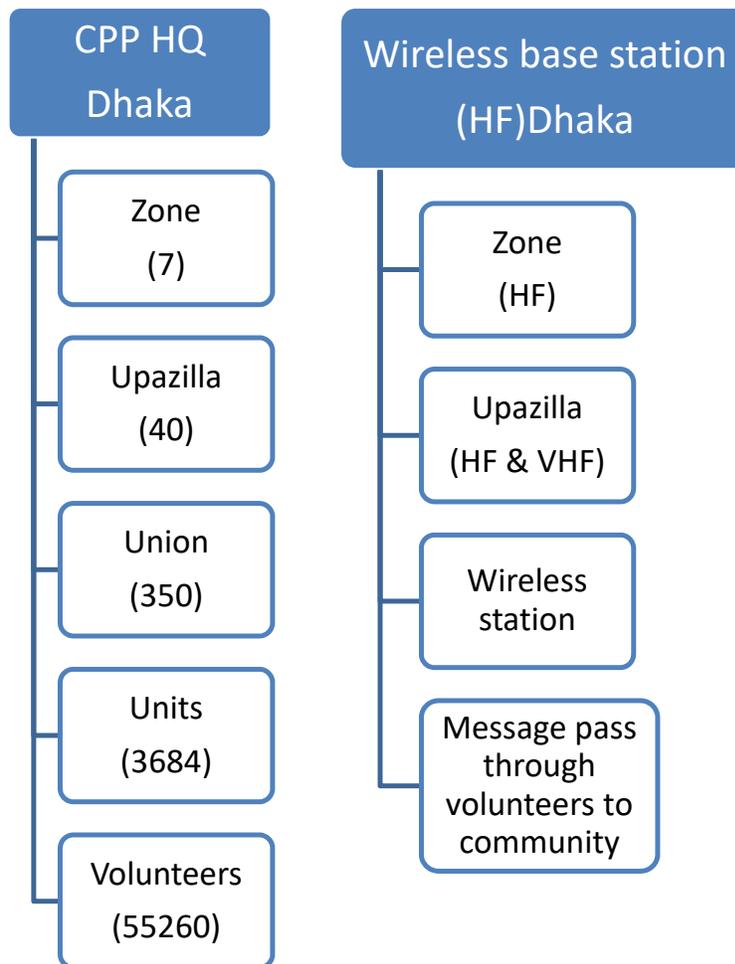
The GOB of Bangladesh introduced its standing orders on Disaster which specify the functions of each concerned Government Ministry, Division, Department and Agency including the specific function of Cyclone Preparedness Programme (CPP). These standing orders lay down the various actions to be taken at different stages by CPP. The CPP plays a crucial role in the dissemination of Cyclone Warning, evacuation, rescue, first aid and emergency relief work

including mobilization of people toward cyclone shelters through its volunteers in the coastal districts.



CPP: Dissemination Network

3.6 Structure of CPP



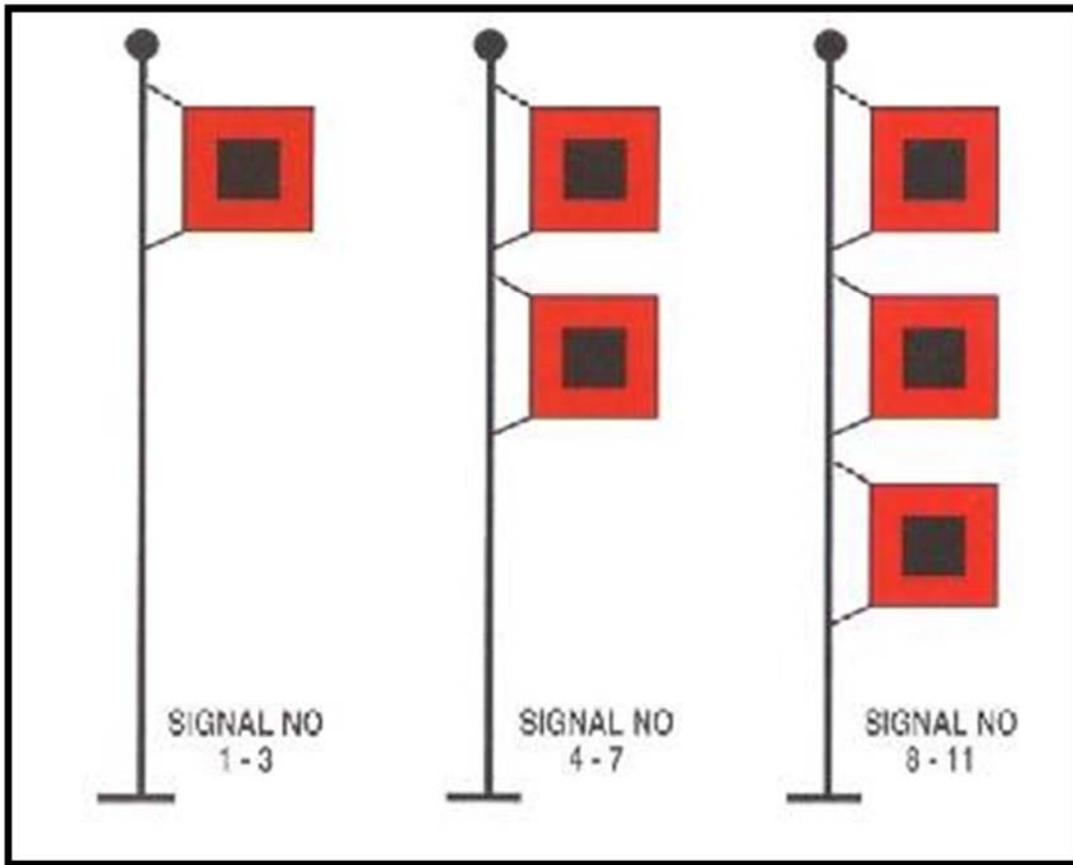
The valiant efforts of the CPP volunteers have saved millions of lives in the coastal region of Bangladesh. Twenty-three volunteers in 1991, and three volunteers in 2007 sacrificed their lives to fulfil their commitment. CPP was awarded with the ‘Smith Tumsaroch Fund Award of 1998’ in Thailand for its outstanding contribution to fight cyclonic disasters in Bangladesh.

Cyclone Preparedness Programme (CPP) is the lifeguard for the coastal people of Bangladesh. Since cyclonic storm cannot be resisted, only preparedness activity can reduce the casualty of life and damage of livelihood. Due to global warming, Bangladesh has been the most vulnerable country among all other countries in the world and two tremendous cyclonic storms SIDR and AILA have proved that already. That is why the importance of CPP has increased a

lot for the preparedness and awareness building functions for the community people living in the coastal area of Bangladesh.

Volunteers are the base of success for CPP. Trained and equipped volunteers can make the programme more effective to save lives and resources of coastal people.

flag numbers and corresponding maritime port signals



Chapter 5

Discussion, Summary and Conclusion

5.1 Discussion:

Cyclones and storm surges are recurrent hazards in coastal Bangladesh, causing significant property damage and total disruption of development activities of the country almost every year. However, the cyclone forecasting system in the country has been improved significantly over time with the existence of the cyclone preparedness programme which ensures disseminating warnings among coastal communities. Even though, there has been some concerns regarding the language of the warning messages, number of signals for river and maritime, response of the communities to the signals etc.

It is found that cyclone early warning system is even now a hoax to most of the people of the coastal areas. The signalling system was made for maritime sailors to let them know about the weather events, as a result it is difficult for general people to understand. When the flags are shown, people may use their perception to understand that the intensity and severity of the hazard event is increasing but they don't know the depth of the signals. When the signals are provided, it is sometime very technical for coastal people to understand because knowing the wind speed doesn't help them much. The signals don't give them proper indication of when to evacuate, when to take shelter or when to stay inside their houses. These clarifications are required to make a warning system more effective.

It must be appreciated that Cyclone Preparedness Programme (CPP) is doing an excellent job in making people understand the cyclone early warning system. They provide the information and orient people about the cyclone signals and warning flags, which make people more familiar with the system. Even then, it must be noted that, not everyone is a recipient of the orientation and thus confusions shall remain as long as it is not generalized for random people reaching a wider population. On top of that the entire coastal community is not under the CPP coverage. The number of CPP volunteers is also not adequate to cover all of the coastal communities. CPP volunteers send the warning messages and evacuate people to the safe shelters. But sometimes it is difficult to reach the people because of rough weather and lack of transportation and communication system. The flags are not visible during night and are easily adrift during high wind speed.

There were couple of evidences when the warnings were false, so people don't fully rely on existing cyclone early warning system, rather they have full trust on the indigenous knowledge-based prediction for any approaching cyclone. Because of lack of faith on the warning system, people often don't comply with the appropriate response to the warning. There are cases, where people received warning but did not move to shelter which resulted into casualties and property damage.

It is also found that there are number of factors for peoples' nonresponsive attitude to the cyclone warning. Due to illiteracy, lack of awareness, communication and mobilization problem, poverty, social and cultural stigma, people often don't have access to the warning.

However, it is evident that the long-term Disaster Risk Reduction intervention ensure access to early warning as well as other services. Community based disaster risk reduction programme played significant role in building disaster resilient communities.

5.2 Summery:

The CPP intervention should be more expanded - covering the entire coastal belt. An initiative should be taken where training programs on cyclone warning system shall be conducted in all the schools of the coastal areas. Most of the students shall be trained through such programs and they can also teach their family members. In this way, culture of safety can be made amongst the communities.

CPP flash lights can be used in addition to the CPP flags for notifying people for any approaching cyclone; which will be effective during night time and will be very useful for everyone.

A new signal system can be made where evacuation instruction, response instruction etc. shall be provided, so that everyone can understand when to leave and where to go at times of emergencies. The existing system has already brought a significant change in the response to the cyclone event, this is why, if a more general form of warning system can be made, it can bring revolutionary change in the response to the cyclone events.

Indigenous knowledge-based cyclone forecasting, and modern early warning systems should be integrated for greater acceptance.

Awareness raising campaign should be conducted on local knowledge and the official warning process. The transfer of such knowledge to the vast majority of the population of the coastal community would lead to better disaster mitigation and emergency management in coastal Bangladesh.

5.3 Conclusion:

The study has found that the early warning system in Bangladesh has been of great help to provide pre-disaster response and support, but, the signal is not meant for the understanding of the general people – there is still a need of signalling system which can be more relevant for the residing population at the coasts of Bangladesh.

Hence, improving the cyclone early warning system with a simplified manner and location specific will increase communities' capacity to efficiently respond to adverse situation.

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