DESIGN AND DISSEMINATION OF COMMUNITY ORIENTED FLOOD WARNING MESSAGE

A Dissertation for the Degree of Master in Disaster Management

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ABSTRACT

Bangladesh is vulnerable to flood due to its geophysical location. Floods continue to be major hazard in Bangladesh. Floods in 1987, 1988, 1998, 2004 and 2007 caused extensive damages in the rural and urban areas and set back in the country's efforts to poverty reduction. The impacts of floods are expected to worsen as the vulnerability of Bangladesh to natural disasters has been increasing due to several factors including high poverty, environmental degradation, high population growth, urban growth, weak governance and institutional factors, and climate change and variability. The experts are strongly recommending that an effective adaptation measure, community based early warning dissemination system can maintain the declining situation within tolerable limit.

As a national source of flood warning message dissemination, **Flood Forecasting and Warning Center** (FFWC) **of Bangladesh** Water **development Board** (BWDB) **is disseminating flood warning since independence**. **Existing flood warning message is not fully gratifying the need of flood vulnerable community and disaster managers. The contents of warning are not well understood by the community and are not reaching to them at right time. Considering** this **reality, the study topic "Design and Dissemination of Community Oriented** Flood Warning **Message" was preferred by the researcher.**

Ideally a flood warning message is a notice of impending flood threat issued to the public by the competent authority so that people and organizations can undertake necessary precautions or protective behavior or help towards their achievement. Flood warning message tells the public and particularly people at risk:

- When the flood is likely to occur
- What is the nature of the flood
- Where the likely impact of flood will occur in a given locality, and
- How people should respond to protect themselves from flood hazard

And it should be issued by credible and official source. Dissemination of flood warning message to the vulnerable community at right time is prime important but unfortunately, dissemination remains the weakest element in the flood warning system. The principle objective of the study was to check effectiveness of the flood warning message and dissemination procedure and based

on field information, design community oriented flood warning message and dissemination method.

The study was carried out in a flood prone Upazila Daulatpur of Manikganj district. The summary of study findings is that there are considerable weaknesses in framing warning messages and dissemination procedure which reduces the effectiveness in enabling people and institutions to take protective action to reduce the negative impact of floods.

Flood warning message should be made in "Bangla", area specific; at least Upazila specific and action oriented. Warning must include the information on the expected rise or fall of the existing water level with probable peak flood level with data and should be communicated in feet and inches in addition to m/cm. Each of the flood-prone Upazila should have reference pillars/flood markers, with a scale on it, in the open water body preferably nearest to the Upazila complex. Deterministic forecast lead-time should be increased to 5 days from existing 3 days. Ten days lead-time for qualitative forecast is most desirable.

During flood time a daily radio and Television broadcast of 5 minutes (preferably just before prime news) on flood situation is suggested. The program likely to cover 1) Flood forecasts and warning messages from FFWC; and; 2) Dos and Don'ts in pre flood, during flood and in post flood situations. Imam of Mosque, primary school teacher, disciplined organization like Ansar, Police, village police and community police should be integrated with the dissemination process at community level. Dissemination of flood warning through cell phone voice service should be introduced by integrating the cell phone companies. A minimum funding supports should be provided to the UDMC as the operational costs.

The study recommends that the existing co-operation between BWDB and DMB be strengthened in order to implement an operational flood warning dissemination system at community level. It is expected that the Comprehensive Disaster Management Project (CDMP) phase-2 under DMB will provide emphasis on this issue as it did in its phase-1 actions.

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Acronyms

ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
BDPC	Bangladesh Disaster Preparedness Center
BMD	Bangladesh Meteorological Department
BRC	Bangladesh Red Crescent
BRTA	Bangladesh Road Transport Authority
BTTB	Bangladesh Telegraph and Telephone Board
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Everywhere
CAT	Coordination Advisory Team
CBO	Community Based Organizations
CDMP	Comprehensive Disaster Management Project
CEGIS	Center for Environmental and Geographic Information Services
CFAB	Climate Forecast Applications in Bangladesh
CFAN	Climate Forecast Application Network
CFIS	Community based Flood Information System
CIDA	Canadian International Development Agency
CPP	Compartmentalization Pilot Project
CSFFWS	Consolidation and Strengthening of Flood Forecasting and Warning Services
CSO	Civil Society Organization (formerly known as Non Government Organization)
DAE	Department of Agriculture Extension
DANIDA	Danish International Development Administration
DCMU	Disaster Coordination Monitoring Unit
DDMC	District Disaster Management Committee
DEM	Digital Elevation Model
DER	Disaster Emergency Relief
DFID	Department for International Development, United Kingdom
DHI	Danish Hydraulics Institute for Water and Environment
DMB	Disaster Management Bureau

DMC	Disaster Management Committee
DMIC	Disaster Management Information Centre
DMIN	Disaster Management Information Network
ECMWF	European Centre for Medium Range Weather Forecast
EMIN	Environmental Monitoring Information Network
EOC	Emergency Operations Centre
EWS	Early Warning System
FAP	Flood Action Plan
FCDI	Flood Control Drainage and Irrigation
FFWC	Flood Forecasting and Early Warning Centre
FHRC	Flood Hazard Research Centre
FHS	Flood Hydrology Study
FMM	Flood Management Model
GATECH	Georgia Institute of Technology
GIS	Geographical Information System
GM	General Model
GoB	Government of Bangladesh
ICIMOD	International Centre for Integrated Mountain Development
IFFWS	Improvement of Flood Forecasting and Warning Services
IMD	Indian Meteorological Department
IMDMCC	Inter-Ministerial Disaster Management Coordination Committee
IWFM	Institute of Water and Flood Management
IWM	Institute of Water Modelling
IWR	Institute of Water Resources
JICA	Japan International Cooperation Agency
LGED	Local Government Engineering Department
LGI	Local Government Institutions
MoFDM	Ministry of Food and Disaster Management
MOU	Memorandum of Understanding
MWR	Ministry of Water Resources
NGO	Non-Government Organization (Civil Society Organization)
NOAA	National Oceanic and Atmospheric Administration
NWMP	National Water Management Plan
PPPDU	Programme, Policy and Partnership Development Unit

PRSP	Poverty Reduction strategy Paper
SFGD	Stakeholder Focus group Discussion
SoB	Survey of Bangladesh
SPARRSO	Bangladesh Space Research and Remote Sensing Organization
SWC	Storm Warning Centre
SWH	Surface Water hydrology
SWMC	Surface Water Modelling Centre
UNDMC	Union Disaster Management Committee
UNDP	United Nations Development Program
UNICEF	The United Nations Children's Fund
USAID	United States Agency for International Development
USGS	United State Geological Survey
UzDMC	Upzilla Disaster Management Committee
WAPDA	Water and Power Development Board
WaRPO	Water Resources Planning Organization
WB	World Bank
WFP	World Food Program
WMIP	Water Management Improvement Project
WMO	World Meteorological Organization

Chapter 1
Introduction and Background

1.1 Introduction

Bangladesh is among the most disaster prone countries in the world. It has suffered large scale of disasters almost every year. The frequency of flooding episodes is growing, with catastrophic "once in a generation" floods occurring more regularly. This includes nine major floods between 1974 and 2007, many of which are considered by hydrologists to be at a size expected only once in every 20 years. They often have disastrous consequences: loss of lives, major damage to infrastructure, and great loss of property, human sufferings and impoverishment of the poor.

Floods are normal events in the deltaic plains of Bangladesh. Although the lifestyle of the people in Bangladesh is well adopted to flood phenomena, the damages due to inundation, riverbank erosion or breach of river structures, etc. still occur in various regions in every monsoon season. They **often have disastrous consequences: major damage to infrastructure, great loss of property, human suffering and impoverishment of the poor.**

The flood problem in Bangladesh is extremely complex. There are a number of reasons: the country is an active delta; it has extensive flood plains which surface water of about 1.7 million sq. km drains; and it has an extensive network of rivers and canals. The country has an average annual rainfall of about 2300 mm, the range being 1500 mm in the west to over 5000 mm in the north-east. Floods occur in Bangladesh almost every year and devastating ones in every 5 to 10 years.

The Ganges, Brahmaputra, and Meghna (GBM) river systems in India and Bangladesh are some of the most flood-prone river systems in the world. Excessive floods present serious risks to the millions of people living in the floodplain areas. In a normal year an estimated 25 percent of Bangladesh is flooded, whereas, in an excessive flood year an estimated 65 percent of the country is flooded.

Due to the flat relief of Bangladesh, a small increase in water level above riverbanks can cause extensive inundation. Affected areas of different return period floods are presented in Table 1-1. The difference in peak water levels between the 2- and 20-year return periods is about two-meters, with a one-meter difference between the 20- and 100-year return periods.

Table 1-1: Area of Bangladesh affected by floods of different return periods

Return period (years)	2	5	10	20	50	100	500
Area affected (% of the area of Bangladesh)	20	30	37	43	52	60	70

Source: (Shajahan, 1998)

In the management of floods, Bangladesh has taken many structural and non- structural measures. Some structural measures (embankments) may give a false feeling of safety to the population, which therefore disregard protective measures and settle in areas still exposed to major floods. One of the main non-structural measures is the flood forecasting and warning system.

The Flood Early Warning System (FEWS) for floods originated when systematic flood management was started in 1964 with the preparation of a water resources master plan. Following the Liberation War in 1971, the government's strategy on flood management started to shift slowly to integrated management of water resources, and, as part of this strategic shift, the Flood Forecast and Warning Centre (FFWC) under the Bangladesh Water Development Board (BWDB) was established in 1972. Since then the role of FFWC has expanded and developed along with flood forecasting and warning services.

The three elements of the Flood Early Warning System are:

- **Forecasting** comprises of data provision and preparation of flood forecasts and warnings. To be useful for forecasting, data need to be accurate and available in real-time. Forecasts and warnings also have to be accurate so that end users have confidence in their reliability. In addition, forecast and warnings have to be understandable by end -users, and available in time for end users to be able to take actions to mitigate the effects of floods.

- **Dissemination** is the process that relays the forecast and warning information to end-users. There are a great number of potential end-users including farmers, disaster managers, municipalities, householders, local government leaders, and infrastructure managers. Key factors in dissemination include the speed at which information can be communicated to end- users, and the packaging of information into forms that are understandable and usable by end-users.

- **Response** to forecasts and warnings requires that the agencies and communities at risk understand and are confident in the forecast and warning information and that they have options to take action to mitigate the impact of floods. The way agencies and communities respond to warnings is a complex issue, but experience in Bangladesh and elsewhere indicates that people respond to forecasts and warnings of floods in different ways: some people at risk may not be notified, others who are notified may not know what to do and some who are notified and know what to do are not capable of taking action to mitigate the impact of the flood.

An early warning system combines all three elements, each of which must work well for the system to be effective. The present early warning system for floods requires systematic development of all the three elements. Flood Forecasting and Warning Center (FFWC) of **Bangladesh Water Development Board** (**BWDB**) **issues 24, 48 & 72hrs. deterministic water level forecasts at different locations and a flood warning message on daily basis.**
The purpose of flood warning is to get the recipients to take action, which reduce the damage caused by flooding. In order to add value from the flood forecasting, an effective warning response system is very important. Response system involves many stakeholders in the process, apart from the vulnerable communities. There are three major forms of response from the people at risk.

- *Fatalism:* People view floods as a kind of fate against which they can do little. They are likely to take protective action as a last resort when the disaster closes in upon them. They require strong community pressure to undertake positive action
- *Skepticism:* People do not take the warning seriously, particularly if they have experienced false warnings in the past. They may also feel they are capable of coping with the flood as well as they have done in the past. They require special persuasion when the flooding is more serious.
- *Activism:* A smaller number of people receive and give more information than others and take initiative in embarking upon protective behavior. They also help support others to take protective measures.

To mitigate the impact of floods, the government has been developing flood preparedness to better equip the country to deal with floods. One of the activities to increase flood preparedness

has been the establishment of a Flood Forecasting and Warning System including the development of flood forecasts, warnings and effective dissemination at community level. For the EWS to contribute effectively to government's flood mitigation strategy, flood forecast and warning information needs to be provided to end users such as farmers, businesses and other groups affected by floods in a timely and understandable form so that they can take action to reduce the negative impacts of floods.

The purpose of the Study is to assess the content of existing flood warning message, procedure of dissemination and, if required, identify interventions to enhance its performance.

1.2 Statement of the Problem

Flood early warning aims at providing improved flood forecasting and warning services; in particular to empower vulnerable people, at grass-roots level, to cope more effectively with flood disasters. The purpose of flood early warning system is to provide information and warnings so that actions can be taken to protect lives and properties and reduce people's suffering and economic **losses** caused by the event that people are being warned about. The need for an early warning system for floods is recognized by government as the National Water Policy states, *"through its responsible agencies, the Government will develop early warning and flood proofing systems to manage natural disasters like flood and drought "* (GoB 1998).

Flood forecast and warning information needs to be provided to end users such as farmers, businesses and other groups affected by floods in a timely and understandable format so that they can take action to reduce the negative impacts of floods. But the main hurdle is the format of flood warning messages and mode of dissemination. The technical language flood warning messages issued by FFWC is not fulfilling the need of flood affected people regarding their preparatory actions based on flood warning messages.

Moreover, dissemination procedure took long time to reach the vulnerable community living in the flood plain. The stakeholders do not have excess to modern telecommunication facilities so the forecast and warning lead-time reduced largely before reaching to the community. Despite constant and pervasive flooding, FFWC does not have an effective system for providing useful flood warning messages and dissemination procedure at the community level. The present system of government-issued flood warnings is presented in both a context and a format that are poorly understood by the floodplain inhabitants and also mode of dissemination took long time to reach the affected community. A user friendly flood warning messages and timely dissemination mode can effectively reduce the loss and sufferings of poor flood affected people.

The construction of effective flood warning **message is** a complex task. Message need to be short, informative and prompt a response from recipients. The study **aims** to scrutinize content of presently provided flood early warning message and will endeavor to develop user friendly model flood warning message at community level.

The effective and timely dissemination **is also** a challenging task in the flood prone terrain of Bangladesh where the communication network is developing slowly and illiteracy is high. A major consequence of flooding is the disruption of all forms of the communication network. The researcher will attempt to stress the need for developing and using all channels: mass media and interpersonal communication, using local dialects for widespread effective dissemination of flood early warning message.

1.3 Research Questions

The research **questions** for this study:

Is the present flood **warning message** fulfilling the need of the community?

Is the **existing warning message understandable** to the flood affected community and **meeting** their need?

- Whether the present mode of dissemination gratifying the want of the flood affected community?

1.4 Objectives of the Study

A flood forecasting and warning effort can only be successful if the forecasts and warning messages are received and understood by proper recipients, and enable them to make decisions and take actions effectively reducing the vulnerability of flood affected people when confronting the flood. It is necessary to identify and understand the "recipients" (also called users, or beneficiaries) need and understandable *FORMAT* of flood warning messages so that they can use the information to mitigate loss and damages. The dissemination of warning does not automatically lead to appropriate response from the vulnerable population. Timely and effective

dissemination is a challenging task in the flood vulnerable areas where the modern telecommunication facilities is being developing and illiteracy is high. A major consequence of flooding is the disruption of all forms of the communication network. The study will attempt to stress the need for developing and using all channels: mass media and interpersonal communication, using local dialects for widespread effective dissemination of flood early warning message.

The specific objectives are:

- Evaluate communities understanding of existing flood warning messages.
- Assess communities need *FORMAT* of flood warning messages.
- Scrutinize existing *FORMAT* of flood warning messages.
- Design community based flood warning messages at different stages of flooding.
- Examine effectiveness of present flood warning message dissemination.
- Study existing mode of flood early warning message dissemination.
- Design communities necessitate based mode of effective timely dissemination.

1.5 Scope of the Study

The scope of work for the **study is:**

i. **Review existing flood forecasting and warning services in Bangladesh** by Flood **Forecasting and Warning** Center (FFWC) **of Bangladesh Water Development Board.**

ii. Undertake representative case study in a flood prone area of the country, collect information by key informant interview, meeting with UDMC and institutional FGD.

iii. Evaluate communities understanding, believe, need and effectiveness of present flood warning services.

iv. Analyze present flood warning dissemination process and communities desired method of distribution.

v. **Consult** with FFWC; **harmonize communities need and capabilities of flood forecasting and warning center.**

vi. Design need based/user friendly model flood warning messages at different stages of flooding.

vii. Propose community based effective flood warning message dissemination procedure.

1.6 Approach of the Study

The Study has started in October 2009 and ended on December 2009. The approach followed was to initially review reports and studies related to the flood Early Warning System in Bangladesh especially flood early warning message and dissemination procedure at community level by the flood forecasting and warning center of Bangladesh water development board. A flood prone study **area** has selected for field qualitative data collection and the researcher brought together information from people's own perspectives to localize the relevant early warning preferences and usability for an effective community based flood warning dissemination system.

The study approach mainly follows:

- Study of existing Flood Warning Message issued by FFWC
- Examining existing procedure of warning message dissemination
- Field information **collection** and consultation with FFWC
- Design of User friendly Flood Warning Message and dissemination procedure.

1.7 Limitation of the study

Field information collection was limited to key informant's interview, institutional focus group discussion (IFGD) and consultation meeting with UDMC. Seven key informants were interviewed representing different spare of society, three IFGD and two UDMC consultation meetings were arranged for field data collection. The sampling procedure was not of high standard compared to population size. The researcher manages to spend 5 days for field information collection which was not sufficient to collect satisfactorily enough information to conduct this study. It was difficult for the researcher to get key informants appointment more the 30 minutes though the check list requires about 1 hour time to collect full information. The field information collection time was in winter season (December) but the research topics was on "Flood Warning and Dissemination" that's why informants has to re-call their memory and sometimes it was *Fun* to them as the researcher working on flood in winter season.

UDMC and institutions were reluctant in providing information to a student for his research purpose. They are more enthusiastic with survey/study from where they will get project/ financial benefit.

The concerned institutions officials were busy with their normal activities and it was very intricate for the researcher to arrange meeting where the officials did not find any significance. The researcher has to postpone two IFGD and one UDMC meeting.

Finally the major limitation of the study was that there was no scope to field test of designed flood warning message and dissemination procedure as the study was conducted in winter season.

1.8 Activity **Flow Chart:**

Formulation of Objectives

T

Identification of Study Area

Data Collection

Primary Data Collection

- Select study area
- Reconnaissance Survey
- Check list preparation

Field Survey of Physical Features of study areas

V

Field Information Collection

- Key Informant Interview
- IFGD
- UDMC consultation

Secondary Data Collection

V

- Base Map Collection
- Previous Studies

- Literature Review about different concept

Data Analysis and Interpretation Questionnaire Survey

Analysis of Primary Data

- Analysis of Secondary Data

Formulation of Findings

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Recommendations and Conclusion

Submission of Report

1.9 Activity **Schedule:**

Task No	Activity	Month (2009)					
		Oct		Nov.		Dec	
		1-15	16-31	1-15	16-30	1-15	16-_
1	Formulation of objectives. preparation of proposal, literature rc\ iew						
2	Analysis of **existing early warning message and mode of dissemination of flood warning in Bangladesh.**						
3	**Consultation** with FFWC, CFGD. **IFGD. discussion** with UDMC & Stakeholders						
4	**Identification of study area**, **reconnaissance** survey, **preparation of questionnaire and secondary data collection.**						
5	Field survey. **Base map and primary data collection**. **Analysis of** Survey **and secondary data.**						
6	**Formulation of Findings. Design User** friendly **flood warning messa**g**e and dissemination at community** level.					=	
L:77	Report writing **and submission dissertation.**						

Chapter 2

Literature Review

2.1 Background

The Flood Early Warning System (FEWS) for floods in Bangladesh developed from the flood forecasting work of BWDB's Flood Forecasting and Warning Centre (FFWC). FFWC was established in 1972, and, since then, FFWC developed a comprehensive system of collecting and processing hydrologic and other data as input to forecasting models; preparing flood forecasts and warnings on a daily basis and disseminating the forecasts and warnings to a range of government and non-government organizations, media groups and other interested parties.

Recent development of the Flood EWS, including the preparation of flood forecasting and warnings, has been supported by several projects including:

- Consolidation and Strengthening of Flood Forecasting and Warning Services (CSFFWS)
- Environmental Monitoring and Information Network (EMIN)
- Community Flood Information Systems (CFIS)
- Climate Forecast Applications in Bangladesh (CFAB) Phase I
- Climate Forecast Applications in Bangladesh (CFAB)-Phase II
- Development of Regional, Basin Flood Forecast Model for use in Bangladesh

In this Chapter, the reports of these projects are reviewed, along with other national and international reports, studies and programs relevant to the development of Early Warning Systems in Bangladesh. In addition, literature on assessing the economic benefits of early warning systems is reviewed, before the main findings of the review are presented.

2.2 FEWS Support **Projects**

*2.2.1 **Consolidation and Strengthening** of Flood Forecasting **and Warning Services** (CSFFWS) Project*

The Consolidation and Strengthening of Flood Forecasting and Warning Services (CSFFWS) **Project started in January 2000 and were scheduled to finish on 3151 December 2006** (**DHI 2005).** CSFFWS **is funded by GoB and Danish International Development Agency** (**Danida) and is**

executed by BWDB's Flood Forecasting and Warning Centre (FFWC) with support from Danish Hydraulics Institute for Water & Environment (DHI) in association with the Institute of Water Modelling (IWM), Bangladesh Disaster Preparedness Centre (BDPC), Prip Trust and Jonokalyan Sangstha.

The three immediate objectives or components of the project were:

- Component A: Development of flood forecast and inundation models;
- Component B: Dissemination of flood forecast information and warning messages; and
- Component C: Making FFWC sustainable by the end of the project.

Under Component A, the forecasting model was upgraded and coverage of the forecasts was increased from 30 locations to 52 locations with up to 72 hours lead-time. The computer system and the software used for preparing forecasts were improved with the installation of new equipment and programmers. The water level and rainfall monitoring system was improved by increasing the number of gauge stations, extending monitoring to the dry season, using radar and satellite images to improve rainfall forecasts over Bangladesh and catchments immediately outside its borders, and improving data exchange with India. River cross-section data were updated using 2003 information.

A separate flash flood forecast model was developed for the North Eastern region but is not yet operational due to the lack of high frequency real time data from flash flood prone areas. Several products related to flood forecasting were developed including rainfall simulation for the last 24-hours, river water levels for the last 24-hours, forecast bulletin for the next 48 hours, flood hydrographs, Thana (upazila) flood status maps. The main weaknesses of forecasting are difficulties in obtaining reliable water level and rainfall data and upstream boundary estimation.

- The performance of the forecasting model by the end of the project is shown in Figure 2-1. The accuracy of the forecasts in the Central Region was good while the accuracy of the forecasts in the North West were mainly average. In the North East where the rivers are flashier, the forecasts were poor close to the boundaries but good in areas away from the boundary. In the southern coastal region, the forecasts were below average.

Under Component B, three national and two regional (Rangpur, Sylhet) workshops were organized to identify stakeholders and discuss ways of improving the dissemination of flood

forecasts and warnings at local levels. Three pilot projects were implemented in collaboration with three NGOs to test different ways of disseminating flood warnings. After carrying out baseline surveys on socio-economic conditions and people's perception on floods and flood forecasts, the NGOs carried out extensive exercises through local government institutions and community organizations during the years 2000-2002. Village-level flood warning dissemination committees were formed to disseminate the flood warning received from FFWC through NGOs. The findings from the pilot project were that reliable flood forecast help communities to mitigate the affects of floods by having time to take actions such as removing household property, cattle and poultry, and harvesting crops. In the pilot areas, villagers said that they trusted the forecast information spread by neighbors and village flood warning dissemination committees.

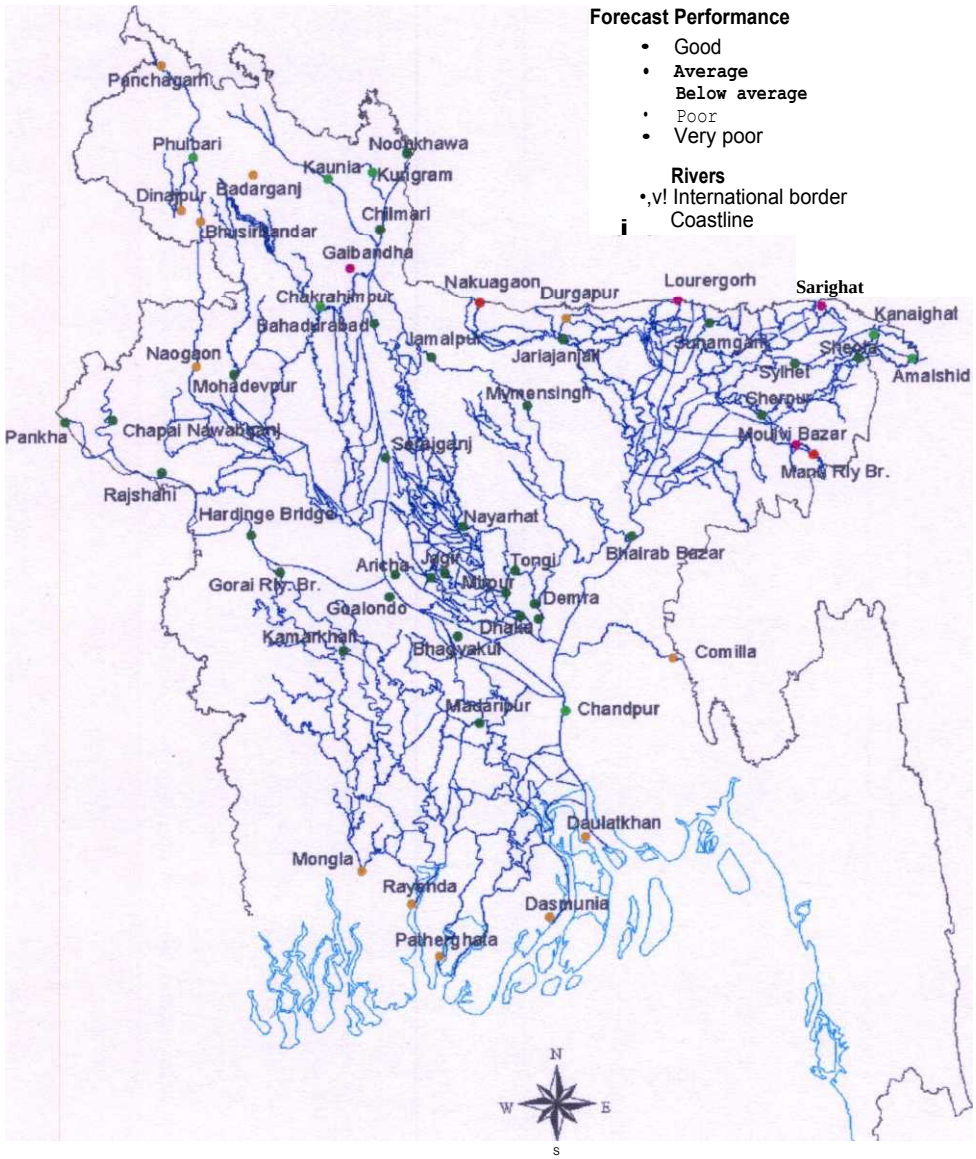


Figure 2-1 Performance of the **flood forecast model** (FFWC 2008)

Scales used for performance evaluation (MAE= Mean Absolute Error)

Scale	Value	
Good	MAE <= 15 centimetre & W - 0.9	
Average	MAE <= 20 centimetre & R	>= 0.7
Below average	MAE <= 30 centimetre & R	>= 0.4
Poor	MAE <= 40 centimetre & R	>= 0.3
Very poor	MAE > 40 centimetre or R	< 0.3

The dissemination pilot projects did not provide an unambiguous answer on how dissemination should be undertaken. One suggestion of stakeholders was that the Disaster Management Bureau (DMB) should play a key role in the dissemination of flood warnings to community level, because of their role in disseminating storm-surge warnings in the cyclone-affected areas. FFWC and DMB co-operate regularly at national level, but DMB becomes active only after a flood situation has been declared as a disaster, at which time they tend to focus on organization and monitoring of relief works. Once the flood situation becomes catastrophic (severe flooding) the DMB system starts to communicate with affected people using the wireless network of the police from Central to Thana (upazila) and Union levels.

Gaps identified by CSFFWS in dissemination of flood forecasts and warnings include the lack of coordination with upazila and union Disaster Management Committees; insufficient communication facilities at and below district level; lack of Internet facilities in UNO offices to use the FFWC's flood forecasts and warning messages; and absence of government circulars regarding the responsibilities of government officials.

Under Component C, staff development plans were prepared for FFWC and FFWC staffs were trained on different aspects of flood forecasting, both in Bangladesh and in Denmark. The capabilities of staff were extended to be able to process data and operate the forecasting models for twice the coverage, including flash flood areas, the coastal zone and brackish areas. All the staff positions in the FFWC and C&I divisions relevant to the expanded forecasting services were filled with trained staff. At the end of the project, FFWC are able to operate the forecasting system using their own staff and resources, but are not able to maintain or develop the system without external assistance. Difficulties encountered include high turnover of staff during the project period and recruitment of new staff. Whether additional government resources will be made available to replace CSFFWS-funded activities when the project ends in December 2006 is not certain.

Key findings and recommendations of CSFFWS include:

- System to provide reliable real-time rainfall and water level data needs to be developed
- More data required from India to improve upstream boundary estimation.
- Updated DEM required to expand forecast coverage
- Further development of flash flood forecasting requires quantitative precipitation forecasts and reliable real time monitoring data at the boundaries

- Improved lead times require development of numerical weather models
- Expand FFWC activities to include preparing warnings for cyclone-induced storm surges, and modelling of low flows and salinity
- Number of forecast locations (stations) may need to be increased to ensure that local flood levels can be correlated with forecast stations.
- FFWC's **institutional status should be raised to provide increased autonomy so that it can better control and utilize allocated resources**
- The **greatest** risk to FFWC **is loss of its professional competence due to** high staff turnover.
- To ensure key technical skills are retained, BWDB's incentive structure for promotion and remuneration should be reviewed to provide professionally and financially rewarding pathways for FFWC technical staff.

Overall, the accuracy and coverage of flood forecasts and warnings have improved. The dissemination of flood forecasts and warning is still mainly at national level and the messages are not entirely fulfilling the need of the community.

2.2.2 Environmental Monitoring Information Network (EMIN)

The Environmental Monitoring Information Network (EMIN) project is an information network that facilitates planning and management of water and land resources in flood and erosion monitoring. This initiative embodies a participatory and needs -based process to improve coordination between key players in flood plain management, such as Bangladesh Water Development Board (BWDB), Flood Forecasting and Warning Centre (FFWC), Water Resources Planning Organization (WARPO) and Centre for Environmental and Geographic Information Services (CEGIS). EMIN provides both a forum and a medium that facilitates co-management of water resources by improving approaches and tools for water management. EMIN started in 2000 and is scheduled to finish in March 2007. EMIN is being implemented by ICT Development Group, RADARSAT International in association with CEGIS and Riverside Technologies Inc., with support from WARPO and FFWC.

The purpose of the project is to implement an information network to facilitate the planning and management of water and land resources **as it relates** to flood and erosion monitoring among national stakeholders and relevant **agencies** in the Brahmaputra-Jamuna rivers region.

EMIN functions at the national level and at the local level. Under national level flood monitoring, EMIN established a national level network connecting key stakeholders such as WARPO, BWDB and DMB. Different types of information (for example River Flood Situation Maps and National Inundation Extent Maps) were generated and disseminated to meet the needs of different stakeholders.

At the local level, EMIN initially carried out an extensive information needs assessment (ICTDG and CEGIS 2004) and then developed a system to bring information on floods to communities living in the flood plain. Community-level flood information was calculated using the WATSURF program developed under the CFIS project. The flood information (water levels related to local reference points and whether water levels were forecasted to rise or fall) was communicated to communities using different media such as SMS on mobile phones, a system of different flags displayed at prominent places, loudspeakers, messengers etc. The EMIN system worked well in 13 pilot mouzas and communities responded to the flood information provided (ICTDG 2005). EMIN Project's key recommendations on floods include the need for updated digital elevation models (DEM); development of flash flood forecasts and warnings; improvement in flood prediction lead time; further development of institutional linkages and information sharing between organizations involved in floods and flood preparedness; development of modes of dissemination to reach women; and raising awareness of local level institutions of how to use flood forecasts and warning effectively for floods preparedness.

2.2.3 Community Flood Information Systems (CFIS)

The objective of CFIS is to disseminate information on the flood extent, duration and depth of water / water levels to the community before the flood occurs. The CFIS project is being implemented by Riverside Technologies Inc., CEGIS and BDPC from 2001 to 2006 and funded by USAID.

The CFIS Project developed GIS-based flood forecasting information software named WATSURF, which implements a correlation model of a 248 km2 study area. WATSURF is a simple gauge-to-gauge correlation-based tool that uses forecasted water levels from the FFWC as input (CEGIS 2005). The calculated water levels are then used to generate flood water levels in the study area using GIS technology. WATSURF has its limitations due to its simple computational method including the calculated water levels are mainly reliable when there is full connectivity of floodwaters on the floodplain and are sensitive to backwater effects.

The CFIS Project, Bangladesh Disaster Preparedness Centre (BDPC) and local non-government organizations disseminated flood warnings derived from WATSURF to three pilot mouzas.

Selected individuals in the community serve as the operators to receive a daily text message with flood warnings and operate the flag system and bulletin board to inform the community of the flood warning. The message and symbols were designed with active participation of the local people (BDPC 2003). The conceptual diagram of the CFIS is shown in following Figure 2-2.

The CFIS project raised awareness amongst local people about the flood forecasts and warnings. Flood warnings were conveyed to local people by change agents and volunteers who explained the implications and interpretation of different types of warnings and helped with flood preparedness. Flood management committees were formed involving local elites, local government elected representatives and officials, and non-government organizations (Martin et al 2006). The CFIS dissemination model varied slightly from the dissemination model used by EMIN. For example, CFIS relied entirely on local volunteers to disseminate flood information. Correlation between the predicted, actual and community-perceived water levels has been good, leading to use of the information by villagers in three pilot mouzas during the pilot development phase.

Based on this study CFIS project developed strategies for replication of this approach to other flood prone areas (CEGIS 2005). The replication will require close coordination of FFWC and other agencies, such as DMB, and will require strong ties to users in the local government and communities. CFIS showed that local organizations are capable of supporting the dissemination of flood warnings to all socio-economic groups.

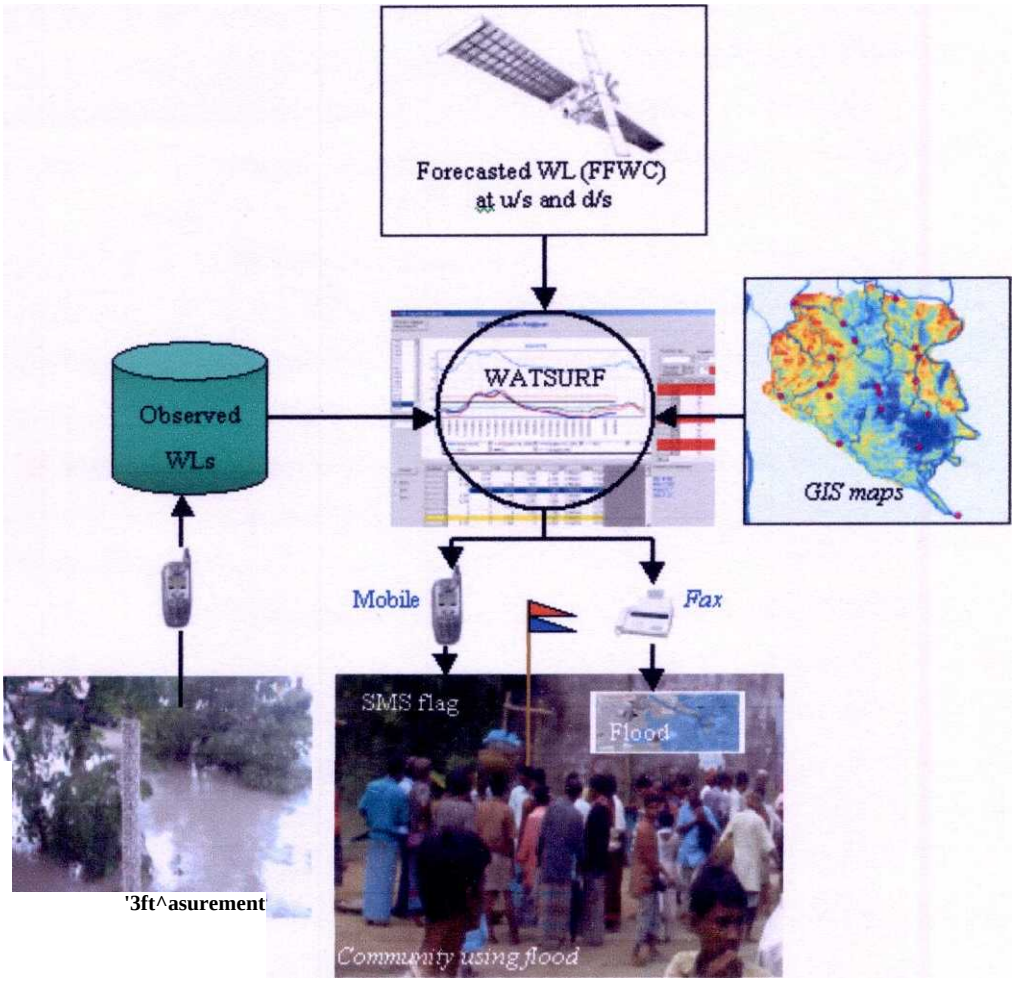


Figure 2-2 The Conceptual Diagram of CFIS

2.2.4 Climate Forecast Applications in Bangladesh (CFAB)

The objective of CFAB is to reduce societal vulnerability to climate hazards such as floods/droughts arising out of climate variability in Bangladesh through the generation and application of climate and flood forecast information.

CFAB's aims are to develop forecasts schemes for short (1-6 days), medium (20-30 days) and long (1-6 months) time scales and incorporate these schemes into the FFWC and BMD. CFAB prepares climate forecast data to improve the performance and the lead-time of flood forecasts.

The development process of CFAB Process is:

- Diagnostics of the Indian Monsoon systems
- Diagnostics of the Indian Ocean zonal mode
- Integrating Atmospheric & Oceanic components

- Research on hydrological systems of Ganges & Brahmaputra Basins
- Reorienting Climate / Weather & Flood forecast to match users need

CFAB project started in November 2000, and was implemented by the Program on Atmospheric and Oceanic Sciences (PAOS) at the University of Colorado/ Georgia Institute of Technology (GATECH), Atlanta, USA, with assistance from the Asian Disaster Preparedness Center (ADPC), Bangkok, Thailand. CFAB was funded by the USAID Office of Foreign Disaster Assistance (USAID/OFDA). The task of the PAOS/GATECH group was to increase the lead-time of flood forecasting in Bangladesh, while the task of ADPC was to identify broader forecast application opportunities and identifying ways to institutionalize CFAB in Bangladesh (ADPC and PAOS 2004).

The project was implemented with the active involvement of key stakeholders in Bangladesh through their participation in the CFAB Steering Committee. The key stakeholders included the Bangladesh Meteorological Department (BMD), Bangladesh Water Development Board (BWDB), Department of Agriculture Extension (DAE), Disaster Management Bureau (DMB), Institute of Water Modelling (IWM), Centre for Environmental and Geographic Information Services (CEGIS) and CARE-Bangladesh.

In 2003, CFAB developed a three-tier, overlapping forecast system, to significantly improve the lead-time of the forecasts being prepared by FFWC and BMD:

- Short-range forecasts of rainfall and river discharge in probabilistic form provided each day with 6-10 days lead time;
- **Medium range forecasts of average 5-day rainfall and river discharges**, updated every five days, with 20-30 **day lead time; and**
- Seasonal outlook starting at the beginning of the monsoon season and updated each month, providing 1-6 months lead-time.

IWM evaluated these forecasts and found that the lead-time for FFWC forecasts could be increased from 48 hours to 120 hours using the discharge data forecasted by CFAB at the upstream boundaries of the model (IWM 2003). Short-range forecasts for 240 hours were also generated in 2004 using CFAB discharge data, but IWM considered that validation using 2-3 months data is not sufficient to assess the performance of the forecast model.

2.2.5 Climate Forecast Applications in Bangladesh (CFAB)-Phase II

Based on positive evaluation results, Government of Bangladesh (GoB) endorsed a project to further develop CFAB to improving climate/flood forecast technology and transferring the technologies to Bangladesh institutions (BMD and FFWC). This was also endorsed by the national workshop on Options for flood risks and damage reduction in Bangladesh (PMO 2004). A TAPP has been prepared for CFAB Phase II and is presently being considered for funding by the Netherlands (GoB 2005).

As an interim measure until CFAB Phase II starts, the Flood Forecast Technology for Disaster Preparedness in Bangladesh Project is being implemented. The project involves the Climate Forecast Application Network (CFAN), Georgia, USA further developing the climate/flood forecast technology and transferring the technology to Bangladesh institutions CFAN is a network comprised of a group of Georgia Institute of Technology scientists from the School of Earth and Atmospheric Sciences dedicated to providing applications of climate forecast products, building capacity and transferring technology to the developing world. The project is funded by USAID and the project period is from 2006 - 2009. The project is being implemented by Asian Disaster Preparedness Center (ADPC), Bangkok, Thailand with support from Climate Forecast Applications Network (CFAN), Georgia, USA, Institute of Water Modelling (IWM) and Centre for Geographical Information Services (CEGIS), Dhaka, Bangladesh and CARE-Bangladesh.

The specific objectives of the project are to acquire flood forecast technology from CFAN, refine and validate flood forecast models that add predictive skill to current prediction efforts and make them functional within Bangladesh and strengthen technical capacity of the personnel of GoB institutions to enable them to acquire the technology and run the forecast models to issue operational flood forecasts on a sustainable basis.

2.2.6 Development of Regional, Basin Flood Forecast Model** for use **in Bangladesh

The objectives of the project are:

- Extend the present 2-day lead-time of flood forecasts to 7 days by developing and i**mplementing an operational** hydrological model for the Brahmaputra River basin;
- Substantially improve forecasting ability by integrating the Brahmaputra and Ganges River basin models with existing FFWC forecasting models; and
- Disseminate the much-needed 7-day forecasts to flood plain communities and a range of other users in high-risk flood-prone areas.

The project is being implemented by RTi, USGS, CEGIS, FFWC and NOAA, and is funded by USAID/Office of Foreign Disaster Assistance. The one-year project started in June 2006 and will develop a pilot, operational forecasting capability, demonstrate and assess satellite precipitation and river basin forecasting techniques, and prepare requirements and work plans for developing a sustainable, operational Bangladeshi capacity for accurate and appropriate river basin forecasting to be integrated with the present forecasting system (RTi 2006).

2.3 Proposed Flood EWS Support Project:

Project Name: Improvement of Flood Forecasting and Warning Services (IFFWS)

The feasibility study for the Improvement of Flood Forecasting and Warning Services was funded by the Government of Bangladesh and the Japan International Cooperation Agency (JICA). The study was aimed at:

- Formulating improvement plan of the flood forecasting and warning system in Bangladesh in order to mitigate flood damage focusing particularly on improvement of the data communication system;
- Conducting a feasibility study of the selected optimal scheme; and
- Transferring technology to Bangladesh counterpart personnel in the course of the Study.

The study was undertaken by Nippon Koei of Japan (Nippon Koei 2003), and is a comprehensive study covering various aspects of the flood forecasting and warning system, including evaluation of its five sub-systems: data collection, data transmission, analysis, dissemination and response. The Studies main findings from their evaluation of these subsystems are:

Data collection: The data collection sub-system comprises of 91 manual and 13 automatic water level gauging stations, and 56 manual and 6 automatic rainfall gauging stations. Problems identified with data collection include:

- Misreading of manual gauges
- Erratic observations and inconsistency of timing of observations (due to insufficient number of gauge readers or inaccessible sites)
- Insufficient clearance of rainfall equipment
- No night-time readings of water levels

- Insufficient O&M of automatic stations (only 5 out of 13 automatic water level stations and 2 out of 6 rainfall stations operating)
- Water level stations being washed out or buried due to shifting of river channels.

Data Transmission: Manually observed data is transmitted to FFWC by voice communication by means of HF wireless. Problems identified include:

- Transmission of faulty information due to noise or miss-operation of wireless equipment
- Weak O&M due to shortage of funds and staff
- Unexpected interruptions of public telecommunication by BTTB and BRTA

Under the CSFFWS project, some of the problems with data collection and transmission were overcome by the Project employing gauge readers at 26 stations directly and providing them with mobile phone to transmit the data collected to FFWC.

Analysis: The analysis sub-system includes:

- Input errors during manual entering of data
- Ineffective use of telemetric data due to lack of interface
- Insufficiency of flash (short cycle) flood forecasts due to one day model simulation
- Low accuracy of flood inundation maps due to outdated topographic information
- No scope for water level forecasts more than 72 hours ahead due to shortage of hydro meteorological information from upstream countries
- Non-availability of manuals for operation of the supermodel

Warning Dissemination: The dissemination problems identified include:

- Flood warning information does not reach local households as there are missing communication links between upazila and union and mouza levels
- Insufficient lead time for households to take mitigation actions
- Local people do not understand the meaning of issued flood warnings due to lack of clarity in the warning messages
- Information on the safety of structures is not included in warning messages

Response: Officially, response activities are the responsibility of upazilalunion DMCs. Problems identified include:

- There is no systematic response to flood fighting leaving individual households to make their own decisions based on their own experiences and judgements
- There are only 95 riverine evacuation centres (flood shelters), while there are 1841 shelters in cyclone-affected areas.
- Lack **of transportation**
- Bad environmental conditions at evacuation sites
- Households reluctant to evacuate due to lack of security of their houses and properties
- Lack of knowledge amongst communities about flood response and flood fighting
- Lack of evacuation areas for livestock

The feasibility study also reviewed the present institutional setup for flood forecasts and warnings, and concluded there were serious bottlenecks in delivering efficient flood forecasting services. Problems identified included:

- Institutional weakness of BWDB (centralized administration, inadequate organizational setup of for Hydrology Services, insufficient O&M procedures or budget; weak accountability; poor monitoring system, inadequate staff training, seniority-based promotion, lack of incentives and lack of interdisciplinary staff)
- Weak local government institutions
- No definition of NGO participation in disaster management
- Inadequate access upstream data
- No specific targets or execution course for flood forecasts and warnings in the National Water Management Plan (GoB 2004).

The Study recognized flood forecasting and warning services as one of the essential supporting measures for damage reduction and recommended replacing 23 manual stations in border areas with automatic stations with the purpose of improving data reliability. In addition, the Study recommended decentralization of FFWC and related hydrology services to BWDB Regional Offices. Decentralisation would commence with the Sylhet region on a pilot basis and then the other four regions would follow. The study also investigated flood forecasting lead-time requirements of different end-users, and found that a flood forecasting system with at least 5 days lead-time was required. Other recommendations of the Study include forecast coverage be

extended throughout Bangladesh and requirement for more detailed and accurate assessments of flood damage.

BWDB accepted this recommendation on decentralisation in principle and agreed to a pilot study in their North-**East Region where many of the proposed automated hydrologic recording stations would be located**. **The recommendation on de-centralisation** of FFWC/**BWDB Hydrologic Services was endorsed** by the CSFFSW project (DHI 2005).

The IFFWS study was criticised at the EWS National Consultation Workshop because a full evaluation of BWDB's Hydrology Services was not carried before recommending such a major restructuring.

2.4 Other Reports **and Studies**

*2.4.1 National Workshop **on Options** for Flood **Risk and Damage Reduction in Bangladesh***

After the devastating flood of 2004, a national workshop on Options for Flood Risks and Damage Reduction in Bangladesh was held on 7-9 September 2004. The workshop was organised by the Office of the Prime Minister, and was attended by about 900 participants including Government officials, members of civil society, national and international experts and donor representatives. The objectives of the workshop were to develop and design a set of policy recommendations for flood management in Bangladesh and evaluate the experiences of flooding and flood management initiatives and lessons learned from earlier investments (PMO 2004).

Flood forecasting and warning was recognised as a key component of integrated flood disaster reduction in Bangladesh, and key recommendations for the improvement of flood forecasts and warnings were:

- A basin-wide flood management approach should be developed to extend the lead time of forecasts in Bangladesh, focusing on the exchange of flood related data with upstream riparian countries and developing numerical weather prediction models
- The present flood forecasting system should be extended to cover the transportation network and other key infrastructure.
- Flood early warnings should be region and location specific.
- Family and community level flood preparedness and contingency planning should be promoted

- Planning all aspects of flood risk management should take account of gender issues.
- Mechanism for continuous monitoring and routine feedback should be established in the forecasting and warning system.
- Storm water drainage and sewerage system management should be integrated with flood prevention in the flood prone urban areas of the country, especially for Dhaka Metropolitan Area.
- Flood damage assessment studies and guidelines for disaster damage assessment are required.

In line with the recommendations of the Workshop, the government made BWDB the focal point for technical support for the implementation and coordination of the 108 recommendations related to the water sector. 79 recommendations will be implemented directly by agencies under MoWR. Currently the government is seeking donor support and local funds to implement the recommendations of the workshop.

2.4.2 Investigation of Hydrological Aspects of Flood 2004 with special emphasis on Dhaka City

This study was prepared by Institute of Water and Flood Management, BUET (IWFM 2005). The Study investigates the causes and effects of the 2004 floods including early flash floods in the North East Region, floods in the major river basins, flooding of Dhaka city including storm drainage, and the effects of tides and tropical depressions in the Bay. The study also analyses both the positive and negative effects of flood control and drainage (FCD) structures on the changing characteristics of floods.

Although this study does not deal directly with flood forecasting and warning, it mentions the importance of short-, medium-, and long-term flood forecasting for both flood preparedness and crop damage reduction. In the light of the increasing frequency of large floods, this study recommends the need of prompt dissemination of flood forecasts and warning to allow local people to fight the floods in a meaningful way.

The IWFM study identified the need for the following improvements to the present forecasting systems:

- increased forecast lead times

- Access to additional rainfall data from upstream countries
- Installation of modern radar systems to measure rainfall in the Northeast and over the Indian catchments
- Inclusion of data on tropical depression weather systems to forecast high tides in coastal areas
- Improved topographic data
- Improved forecast for Dhaka city flooding, taking account of internal drainage conditions
- Inclusion of FCD structures in flood forecasting models

This study identified management and legal issues affecting water management and flood forecasting including:

- Absence of commitment from the political leaders
- The complexity of issues affecting flooding in Dhaka (Figure 2-3) including encroachment and unauthorized land-filling by powerful actors, such as real estate companies
- No enforcement of existing drainage policies. For example, development of land in Dhaka requires at least 12% on-site storm-water retention area or equivalent compensation for off-site land acquisition in land development projects (RAJUK, 1997).

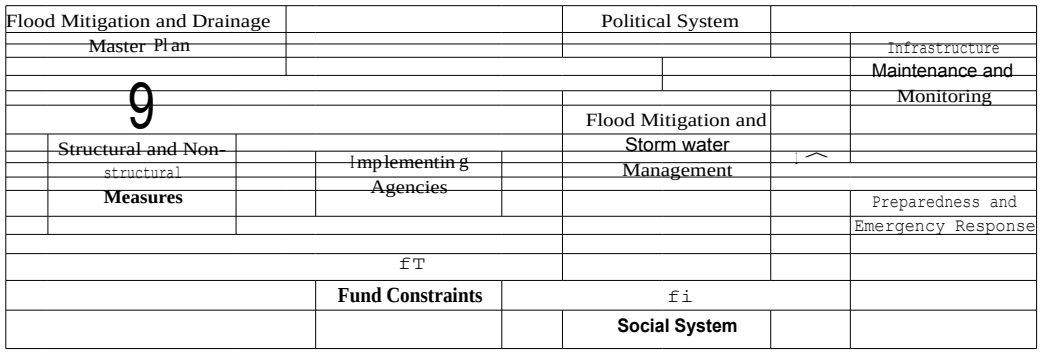


Figure 2-3: **Dependence of storm water management on relevant sectors** (SUET, 2005)

2.4.3 Flood Hydrology Study and Flood Hydrology Study Update

After the 1988 flood (recognized as the recorded maximum flood), the Flood Action Plan (FAP) was formulated through the mobilisation of international aid. FAP has incorporated 11 main components and 15 supporting activities. One of the 15 supporting activities, FAP 25, Flood Modelling and Management, consists of three components one of which the Flood Hydrology Study (FHS) was conducted with the objective of establishing the hydrological basis for defining unified engineering design criteria along the major rivers and recommending a unified methodology for establishing similar criteria along the secondary river network (Kruger Consult and BCEOM 1992).

The main finding of the Study on issues related to flood forecasts and warnings were that data quality in broad terms is satisfactory but there is a scope for improvement both in observation methods as well as in data processing.

The study highlighted the importance of strengthening the BWDB Hydrology Services in order to ensure the collection and processing of quality data. These data are the basis for all subsequent hydrological and meteorological analysis for the design of FCD structures and other infrastructure on the flood plains.

The Flood Hydrology Study was updated in 1995 and 2001 (SWMC 1995, 1999 and 2001). During the initial Flood Hydrology Study, simulation was carried out with the General Model (GM) developed in SWMC for 25 years covering 1965 to 1989, and the results were processed to generate water level and discharge for design frequencies along the major rivers of Bangladesh. The update of the FHS took place after the validation of the GM for 1992-94 as was recommended by the Coordination Advisory Team (CAT). The simulation period covered 28 hydrological years from 1965 to 1994. Frequency analysis were carried out for the simulated peak water level, peak discharges and mean seasonal discharges for selected stations to attain design values on the major rivers. The design values were calculated and compared with the result of the initial FHS. The results indicated improvement of the Ganges and Padma but no visible change on the Old Brahmaputra and Meghna.

The FHS was again updated during the National Water Management Plan (NWMP) study in 2000. As part of the update a revision of the boundary flow data using 35 years of data instead of the 25 years of data used previously. The revised data provided a better basis for planners and designers of FCD projects and was also used in NWMP.

The Flood Hydrology Studies provide the basis for developing historical floods, the information from which infrastructure managers could use to review the impact of earlier floods on their infrastructure. From the review, infrastructure managers could identify preventive actions/maintenance to reduce flood damage should a similar flood occur again.

2.4.4 Flood Management Model Study and Flood Management Model Update Studies

The Flood Management Model (FMM) study was one component of FAP 25: Flood Modelling and Management. The objective of the FMM Study was to establish a modelling system for flood management. The flood management model developed by the Study integrated flood models and a GIS (Geographic Information System), and when combined with agriculture, fisheries, societal, infrastructure and other data, opened up new avenues for multi-sectoral flood management practices. Also the long term objective of the Study was to achieve an on-line computer system, linked with the flood forecasting model, which would provide information to assist in the management and control of floods in real-time (Euroconsult and BCEOM 1994). Findings of the Study include:

- FMM generated maps can provide project design specifications, monitor and assess the performance of flood control and drainage structures, and distribute flood forecasts in a readily acceptable form to the general public.
- Three pilot FMMs at national, regional and compartment levels were developed, demonstrated and made available for further use.
- The National FMM is limited in its applicability for flood mapping in the flood plains as the models have only a rough representation over the floodplain.
- The Regional level FMM application is practical and usable, and is recommended for planning and pre-feasibility studies, and for flood forecasting.
- The Compartment level FMM provides significant enhancement for understanding flood behavior and helps in public participation exercises, which seek to convey the effects of complex flood control processes.
- The usefulness of FMM for flood forecasting has been demonstrated in the regional level with the potential for mapping predicted inundation levels.

- The quality of the DEM is fundamental to the quality of FMM output. A well-prepared DEM is necessary for visualizing the floodplain topography on the computer screen and most importantly, for accurate flood mapping.

The study highlighted the importance of developing of FMMs and their usefulness for the generation of flood maps, flood forecasts, flows around embankments, flows through structures and identifying the impacts of physical interventions on the flood plain. The FMM concept should be used by all infrastructure managers and necessary guidelines have to be setup in this regards.

In the Floodplain Management Modelling Update Study (IWM 2005), 2-D floodplain modelling using MIKE FLOOD was tested in the Manikganj area. The major break through in analyzing the floodplain flows was the change from the previously quasi 2-dimensional approach in Mike I I used in the previous FM Model to the fully 2-dimensional approach in Mike FLOOD. This not only improved the accuracy of the modelling but also enabled the visualization of the flow paths and depth-duration mapping in the floodplains. This approach has been used in the Dhaka-Aricha-Ghior road project of Road and Highways Department (RHD) to determine the flood spill flow from Jamuna and the cross drainage required for the safety of the proposed road embankment and structures. In a project of FFWC, the MIKE FLOOD was used in combination with flood forecasting model to predict the forecasted flood levels along the Dhaka-Mawa road. It has also successfully been used in the Eastern By-Pass cum Embankment Project of Dhaka City (see Figure 2.4). Currently the MIKE FLOOD technology is being used in Haor Rehabilitation Project in the northeast region.

2.5 Other Programmers

2.5.1 Comprehensive Disaster Management Programme.

The Comprehensive Disaster Management programme (CDMP) was approved by GoB as a key strategy to advance whole-of-government and agency risk reduction efforts in the country. CDMP follows a strategic institutional and programming approach that is designed to optimize the reduction of long-term risk and to strengthen the operational capacities for responding to emergencies and disasters including actions to improve recovery from these events (CDMP 2005). The project is being implemented by MFDM and is funded by GoB, UNDP and DFID.

CDMP seeks to reduce the level of community vulnerability and enhance sustainable development initiatives through a range of integrated strategies containing the five strategic focus areas shown below.

Strategic Focus	Corresponding Components
Professionalizing the Disaster Management System	I a PPPDU
	lb Professional Development
Partnership Development	2a Advocacy and Awareness
	2b Capacity Building
Community Empowerment	3a Programme Gap Analysis
	3b Risk Reduction Planning
	3c Local Disaster Risk Reduction Fund
Expanding mitigation, preparedness and response across a broader range of hazards	4a Urban search and rescue
	4b Climate Change and Research
Strengthen Emergency response systems	5a Disaster Management Information Centre (DMIC) and emergency procedures

Implementation agencies are drawn from government and non-government sources with overall coordination provided by the PPPDU. One CDMP component that is of importance to the Flood EWS is the development of the Disaster Management Information Centre (DMIC) and emergency procedures. The goal of DMIC is to implement effective information sharing among disaster management agencies and communities for all hazards in all sectors, in normal times and emergencies, throughout the nation and regionally, to support sustainable risk reduction and emergency response capacity (Tupper 2006). There is potential for DMIC to provide an efficient mechanism for disseminating flood warnings to communities throughout flood-affected areas.

2.5.2 The Rights-based Planning and Monitoring: Disaster Preparedness (2002-2006).

Key activities and outputs of the UNICEF-funded project are to strengthen the capacity of the Government, NGOs and the civil society to enhance disaster management skills through a combination of activities such as training, workshops, and community mobilization; Raise general awareness of the people regarding disaster preparedness and management; Formulate Disaster Action Plans in disaster-prone Districts and Upazillas to increase local initiative in protecting people and coping with disaster situation; improve effectiveness of warning and warning dissemination systems, use of shelters and preparation for evacuation; promote

prevention and preparedness at all levels on various disasters; and help line ministries and departments in the preparation of Disaster Management Contingency Plans.

2.5.3 Water Management Improvement Project

The Water Management Improvement Project is being formulated by the World Bank and GoB. When preparation started in 1999, the main focus of the project was on reorientation of BDWB's role in the water sector by divesting small water sector schemes to water management organizations (WMOs), and to enable BWDB to operate and maintain larger schemes more effectively. WMIP evolved over the next five years, and by the time of appraisal in 2004, the primary project objective was to improve national water resources management by enabling communities to play an expanded role in all stages of scheme management, from planning and design to operation and maintenance. The second project objective is to enhance institutional performance of the country's principal water institutions, particularly BWDB and WARPO. WMIP has three components: Systems improvement and management transfer; O&M performance improvement, and Institutional Improvement. One focus of the Institutional Improvement Component is to restructure BWDB as a water resource agency rather than a development agency. There are no details on how BWDB's Hydrologic Services will be improved or how improvements will affect FFWC. GoB and WB have to agree on aspects of WMIP before the project proceeds.

2.6 Benefits of Early Warning Systems

2.6.1 Background

The development of flood forecasting and warning systems is an essential element in regional and national flood preparedness strategies, and is a high priority in many countries including Bangladesh. Flood EWS are being considered as an alternative for dealing with flood problems, partly because these systems are less expensive compared to structural schemes. Despite the high priority accorded to flood warnings in flood risk management by governments, there is a lack of good data on the benefits and costs of these systems (Wallingford 2006). Methods for estimating benefits to damage reduction measures such as flood alleviation are well established (Penning-Rosewell and Green 2000a and 2000b), but there are contexts in which the estimation of benefits is more difficult. Estimating the benefits of flood warnings is one of the more problematic contexts.

Calculating benefits from the flood Early Warning System has no precedents in Bangladesh, unlike other activities related to the water sector (for example, flood control and drainage, irrigation etc.) where methods of calculating benefits are well established.

The benefits of an early warning system can be calculated by assessing the possible savings of the quantity of flood damage to private and public assets resulting from action taken in response to the warning. This flood reduction benefit BEws can be expressed as:

$$BEWS = X_{without} - X_{with} \quad (1)$$

Where $X_{w.;,hO_{„}}$ without project economic flood damage; and

$X_{,;,,,}$ = economic damage if the project is implemented.

The quantity of flood damages has many variables but tend to be dominated by the depth of floodwater. The role of other variables in determining flood damages may be significant depending on the local flood environment. For example, in the deeply flooded haors of North-Eastern Bangladesh, dissipation of wave energy to protect erosion of the earthen village mounds is more important than the depth of water for determining flood damages in most years (Tod, Hasan and Uddin 2005).

2.6.2 Review of Literature on the benefits of Early Warning Systems

The benefits of flood early warning systems come from the savings in flood damages. Floods are random events that cause damages and hence flood damages are also random or probabilistic events: the probability of any specific amount of flood damage depends on the probability of the flood event necessary to cause those damages. Determining flood damages combines a risk assessment in terms of the probability of future flood events to be averted, and a vulnerability assessment in terms of the damage that would be caused by those floods and, therefore, the economic savings to be gained by their reduction.

Flood damages can be either direct or indirect. Direct damages are physical and are usually `visible' losses arising out of direct contact with water (e.g. water damage to household structures, personal possessions etc.). Indirect damages are the consequences of direct damages such the interruption and disruption of economic and social activities (e.g., production losses due to flood damage of machinery). From an economic perspective, flood damages belong to two further categories: tangible and intangible. The tangible impacts are those to which a monetary value can be assigned in order to estimate them. Intangible impacts are identified as those that cannot directly be evaluated in terms of money (Parker and Penning-Rowsell 1972; Parker et. al. 1987).

Research o n flood damage assessment has been extensive (e.g., White 1945; Parker and Penning-Rowsell 1972; Penning-Rowsell and Chatterton 1977; Parker 1976; Smith et al. 1979; Green et al. 1983a; Parker and Penning-Rowsell 1984; Parker et al. 1987; Green et al. 1988; Thompson 1989). In the UK, the research has mainly been undertaken by the Flood Hazard Research Centre (FHRC) at Middlesex University. FHRC developed basic methods of assessing benefits from flood alleviation schemes including EWS (Penning-Rowsell and Chatterton 1977 and Parker et al 1987). These methods have received widespread application in several countries including Australia and the USA (Greenway and Smith 1983; Higgins and Robinson 1981; US Army Corps of Engineers 1979 and 1981).

Carsell et al (2005) identified three approaches to calculating savings in damages due to flood EWS.

Day's Method: Day (1970) proposed that the tangible benefits of a Flood Warning System (FWS) could be estimated as a function of warning time due to the system (Figure 2-4). The graphical representation of this work is widely known as the `Day Curve'. This predicts damage reduction in terms of the percentage of maximum potential inundation damage as a function of time. The Day Curve suggests that no matter how great the warning time, the maximum possible reduction is about 35% of the total damage due to the flood. This is logical, as some property including most structures cannot be moved.

Institute of Water Resources (IWR) methods: The IWR also proposes the use of the Day Curve but that the curve should be re-calibrated to take account of local conditions (USACE 1994). IWR also suggest a 0.3 to 0.6 in shift in the stage damage curve to account for actions taken when the mitigation time is greater, although the rational for this shift is not fully explained. The report further suggests that "the simplest way to adjust the stage-damage curve is to assume some percentage reduction in damages at each stage. The extent of the assumed reduction in damages can be based on *inter alia* explicit knowledge of the flood plain community and professional judgment.

FHRC methods: Methods proposed for benefit evaluation are similar to those by Day and IWR. Based on an analysis of historical flood damage and simulation, Chatterton and Farrell (1997) concluded that "... eventual depth of water in a building is an important factor for influencing the effectiveness of flood warning. The damage -reducing effects of flood warning are likely to be greater for higher rather than low flood stages." They proposed a relationship in which damage reduction is a function of both depth and mitigation time. An example is shown of damage reduction estimates for residential structures and contents in Figure 2-5. If this result is combined

with the depth-damage relationship of Figure 2-6, the damage reduction for different flood depths and warning times can be computed.

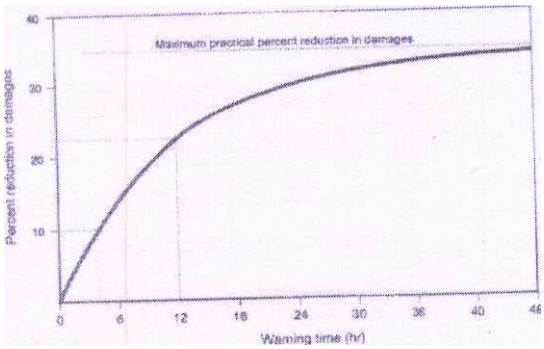


Figure 2-5: Day curve (Day 1970)

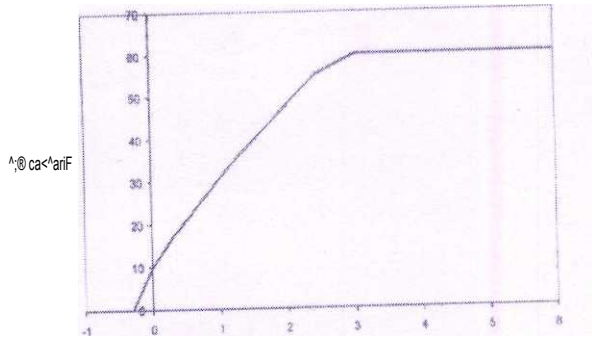


Figure 2-7: Residential content depth-damage relationship (USACE 1991)

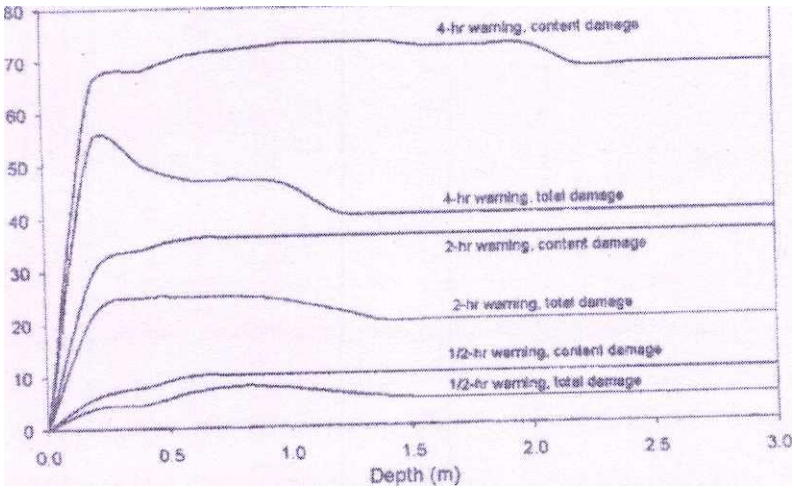


Figure 2-6: Damage-reduction estimates for residential structures: (Chatterton and Farrell 1977)

Carsell et al (2005) observed that the damage reduction predicted by the Day curve and other methods were `optimistic', as they presumed that, when notified, property owners would act rationally and efficiently. Actually, property owner's (or tenant's) reaction to flood varies with several factors including whether they were properly notified at the time of emergency. Unless these factors are accounted for, the benefit computed will overestimate the true benefit. Carsell proposed to introduce a term to indicate the efficiency of flood warnings, although the authors recognized that the assessment of the efficiency term was subjective in the current state of development.

FHRC reviewed flood response in the United Kingdom and suggested that actual flood damage avoided Da can be computed as:

$$Da=DP\ RPaP,Pe \qquad (2)$$

Where, DP is maximum potential flood damage avoided with a fully effective system; R is reliability of the flood warning system; Pa is the fraction of residents available to respond to a warning; P, is the fraction of households who respond to a warning or others who will do so for them; and Pe is the fraction of households who respond effectively. Each of these factors range from 0 to 1 representing the efficiency of the system components (Parker 1991)

Sorensen and Mileti (1988) presented another quantitative assessment of the efficiency of flood warning. Their assessment considers the fraction of people that could possible be warned in a given time and the fraction of people that will evacuate when ordered or advised to do so. Their research suggests that the number of people who will receive the warning increases as warning lead-time increases, as shown in the Table 2-1

Drabek (2000) published a review of factors that influence response to warning. He noted that few comparative studies, such as those by Sorensen and Mileti and FHRC have been completed even though there is a need for more quantitative information on the effect of early warning systems. However, qualitative research is available that describes the many factors that influence how the public responds to warning.

Table 2-1: Fraction of Public Warned with different Mitigation Times (t)

Mitigation time	**Equation**
0.8 h (50 min) or less	Fraction warned= 0.8183 t
0.8 to 3 h	Fraction warned= 0.5958 t . '.
3 to 7 h	Fraction warned= 0.6663 t

Source: Sorensen and Mileti (1988)

In Bangladesh, there are very few in-depth flood damage assessment studies. With a few exceptions (Thompson and Tod 1998 and Islam 2005), flood damage research has been limited to assessment of agricultural losses. Most of the available literature (for example Sen, 1981; Paul, 1984; Montgomery, 1985; Murshid, 1987) deals with the post-flood damage assessment and no study was found regarding the probable savings or benefits from implementing flood early warning systems. There is shortfall in data on actual damages during floods, especially in the non-agricultural sector, and there has been no systematic study to collect flood damage data. This

situation led the FAP Study on the Impact of Flood Control Schemes (FAP-12 Study, 1992) to conclude:

> `-there is a serious lack of reliable data on flood damages, particularly to property and infrastructure, but also to agriculture, from which to estimate flood protection benefits. Research is needed to provide a comprehensive data set and methodology which could be applied consistently across FCD / I project appraisals in Bangladesh---' (FAP-12 1992:4-10)

Unfortunately, the situation has not changed in the years since the FAP-12 Study, and there is still a lack of reliable information on flood damages. With these limitations, there is a need for this EWS Study to develop an effective formulation for assessing the savings from an early warning system for floods in Bangladesh.

2.7 Key Findings of the Literature Review

FFWC's system for preparing flood forecasts and warnings is well established and produces reasonable forecasts, especially for the central region of the country. Their system has evolved to incorporate new technologies that increase the accuracy and reliability of flood forecasts. There are innovations and improvements being made to flood forecasting world wide, and FFWC have kept pace with some of these technological advancements to improve the delivery of more accurate and reliable forecasts and warnings and prepare information that is more useful to end users.

Dissemination of flood warnings is much less developed, and works only at national level. Dissemination has only recently received more attention through a number of research projects linking the flood forecasts and warnings provided by FFWC to the flood-warning needs of floodplain communities.

The response element of the Flood EWS is neglected and is scarcely mentioned in the literature. The exception is the coastal zone where cyclone-induced storm surges result in the loss of a large number of lives. After the devastating cyclone in 1991, government and donors responded by funding the construction of cyclone shelters throughout the coastal zone to avoid the loss of life in future cyclones. The dissemination system for cyclone warnings was also further developed in the coastal zone so that communities receive a warning with adequate time to move to the shelter.

As communities become more vulnerable as a consequence of changing climate, higher seasonal variability and more frequent extreme meteorological events, there is a need to update and improve the Flood EWS so that all elements of the Flood EWS provide useful flood warnings to all potential users.

*2.7.1 Technology **and Tools***

- The setting of Bangladesh on a low-lying coastal delta with the outfall of three major rivers requires a robust flood forecasting and warning system to handle the complex river network.
- The accuracy of forecasts is good in the Central Region but there are deficiencies in forecasts in other regions.
- The data collection and transmission system needs to be updated and upgraded to ensure the quality and usefulness of the data
- Routine update and upgrade of the flood forecast models are required to ensure accuracy of the forecasts
- Improving the upstream boundary condition of the model requires the installation of 23 automatic water and rainfall monitoring stations
- Satellite rainfall data should be made available to FFWC throughout the GBM catchment
- Flash Flood forecasting should be taken up on a priority basis
- Numerical weather modelling needs to be further developed
- Flood forecasting system should be extended to provide flood warnings for infrastructure managers
- Modern Doppler radar systems should be installed to measure rainfall in the Northeast and over the Indian catchments.
- Lead Time of Forecasts can be improved significantly with addition of data from weather/climate models and also from river basin models.
- Cyclone-induced storm surge and coastal flood forecasting should operationalised
- Data on tropical depression weather systems is required to forecast high tides in coastal areas
- Flood forecasting for major cities should be developed
- Expansion of forecast coverage and detailed local level forecasting requires that DEM should be updated

- Storm water drainage and sewerage system management should be integrated with flood prevention in the flood prone urban areas of the country, especially for Dhaka Metropolitan Area.

2.7.2 Dissemination

- EMIN system successfully developed to disseminate flood warnings to communities.
- Local institutions are able to disseminate flood warnings
- Forecasting lead-time should extended so that forecasts are more useful to end users
- Warning messages should be easily understood by potential users
- Household and community level flood preparedness and contingency planning should be promoted
- Information on safety level of Major River structures should be included in warning message
- Community awareness on flood response and flood fighting should be developed
- Lack of coordination and insufficient communication about flood warnings at upazila and union levels
- Dissemination can be expanded to other areas following the EMIN approach initially and later from the expanded flood forecast model of the whole country.
- The scope for DMIC to disseminate flood warnings should be investigated.
- Flood warnings should be prepared for infrastructure managers so they can become more pro-active in reducing flood damage to infrastructure

2.7.3 Institutions and Legal Aspects

- BWDB Hydrologic Services needs to be improved and strengthened
- BWDB staff should be trained to translate flood forecasting information for infrastructure managers to facilitate planning and implementation of emergency actions during floods
- Infrastructure managers should be trained the utilisation of flood forecasting information to facilitate planning and implementation of emergency actions during floods
- A national land use policy should be prepared for coordinated development planning considering the floods.

- Lack of clarity about the role and responsibilities of government staff during floods
- DMB is set up to respond to disasters once they happen rather than to promote disaster awareness
- Systematic studies are required to assess household flood damages in rural and urban areas.
- Planning all aspects of flood risk management should take account of gender issues
- FFWC's institutional status should be raised to the Circle Level to provide increased autonomy for better control and utilisation of resources
- Funding for all FFWC activities not certain after closure of CSFFWS Project.
- To address the high turnover of FFWC staff, BWDB's incentive structure for promotion and remuneration should be reviewed to ensure that there is professionally and financially rewarding pathways for FFWC's technical staff.
- Mechanism for continuous monitoring and routine feedback should be established for the forecasting and warning system.

Chapter 3

State of Flood Forecasting and Warning Services in Bangladesh

3.1 Flood Forecasting and Warning Centre

3.1.1 Introduction

Flood Forecasting in Bangladesh is the responsibility of the Flood Forecasting and Warning Center (FFWC) of Bangladesh Water Development Board (BWDB). This center was established in 1972 and is fully operative in the flood season, from I` April to 31" October, as directed by the Standing Orders for Disaster (SOD) of the Government of Bangladesh.

The objectives of flood forecasting and warning are to enable and persuade people and organizations to be prepared for the flood and take action to increase safety and reduce damage. Its goal is to alert the `combat' agencies to enhance their preparedness and to motivate vulnerable communities to undertake protective measures.

The Bangladesh Water and Flood Management Strategy has given particular emphasis to the development of flood forecasting and warning services. Flood Forecasting Warning and Response System (FFWRS) integrates flood forecasting, assessment of flood impact, the dissemination of warning messages and response by both the agencies involved in flood mitigation and by the public in the threatened communities.

A principal diagram illustrating the operation of the Centre is given in Figure 3-1. The basis of all flood forecasting is measurements of rainfall and water level which are used to interpret the present flood situation and generate flood forecasts. The measurements upon which the flood monitoring and forecasting depend comprise:

- a real time hydrological monitoring system covering Bangladesh
- a data exchange agreement with India through which FFWC obtains additional rainfall and water levels measurements from outside its national borders
- meteorological data from Bangladesh Meteorological Department (BMD); and
- Satellite and radar images.

The hydrological data collected through the monitoring are used as input to a numerical model which forms a core component of the forecasting system. The results of the model computations are used as the basis for the preparation of a range of flood warning products, including warning bulletins and inundation maps. FFWC disseminates these through a variety of media, including email, fax and the Internet via its own dedicated web site (www.ffivc.gov.bd).

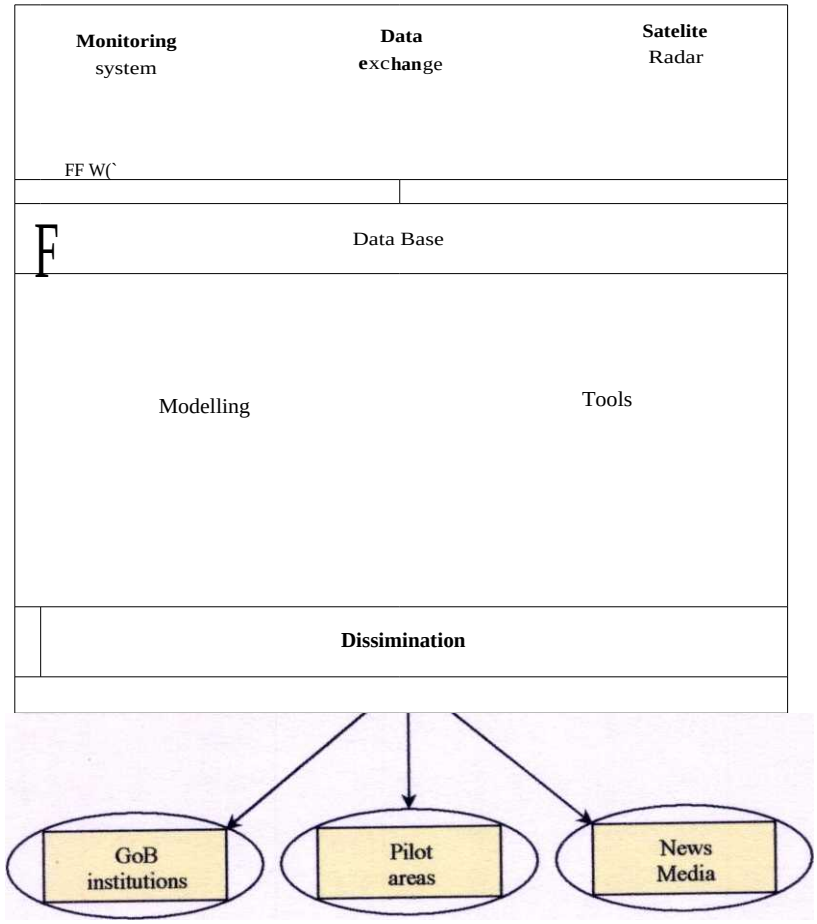


Figure 3-1 Operational Work **Structure** of FFWC. **Source**: ***FFWC, BWDB***

3.1.2 Location

The Flood Forecasting and Warning Centre (FFWC) **is located on the 8**ℎ floor of the WAPDA **building in** Motijeel, **the commercial** hub of the **capital Dhaka**. The Centre houses **the main computer modeling**, pilot telemetry **system and radio transmission rooms, as well as** offices for the Executive **Engineer** and the Centre staff.

3.1.3 Institutional Position and Responsibilities

The Flood Forecasting and Warning Centre of the Bangladesh Water Development Board (BWDB) were established in 1972. The FFWC is a division of the Directorate of Surface Water Hydrology-II, which is under the control of the Chief Engineer, Hydrology. Closely associated with FFWC is the Construction and Instrumentation (C&I) division, which also falls under Processing and Flood Forecasting Circle.

Together, FFWC and C&I exclusively undertake the transmission and processing of data for flood forecasting and warning services. The telecommunication/ radio operators are attached to the Instrumentation Sub-division II, which is also responsible for maintaining the communication equipment and the gauging equipment. Reception, processing, forecasting, and dissemination **are all** undertaken by FFWC. The role and responsibilities of Flood Forecasting and Warning Center briefly explained in Standing Orders on Disasters (SOD) of the Government (Annexure-1).

3.2 Development of Flood Forecast

Forecasting of river levels in Bangladesh is undertaken by FFWC between June and October each year. This period corresponds to the main monsoon season in the country. Forecasts are issued for 52 stations covering almost all flood prone areas of the country. In the pre-monsoon **season**, typically from April to June, serious flooding can occur due to flash flooding in the north **east region**. During this period a specially developed flash flood forecast model of the north east **region is** utilized to produce local forecasts for this region.

The FFWC flood forecasting system is highly automated and based around the Flood Watch software product developed by DHI. The original Flood Watch system was developed during the previous project *"Expansion of Flood Forecasting and Warning Services"*, which ended in 2000. In the present project, the software has been updated and further customized to provide a user friendly tool to aid the flood forecasting operations. Flood Watch is a based on the Arc-View Geographical Information System (GIS), which allows for highly visual map based displays of flood **status** and extent. Flood Watch includes a range of functions to ease the tasks of data preparation, modelling and results processing. These include:

- Map based displays of observed and forecast flood levels and rainfall
- Data entry forms and quality assurance
- Plotting of observed and forecast data
- Automated tidal boundary estimation
- Data conversion for model input
- Automation of model simulations and results extraction
- Generation of bulletins of current and forecast flood levels
- Flood inundation mapping
- Thana status mapping

Flood Watch has been set up in a way that the user follows a number of logical and sequential steps, mirroring the actions that would logically be undertaken to develop the flood forecast manually, but providing a high degree of automation in each step.

The sequence of operations in the development of a flood forecast at FFWC can be summarized as shown in Table 3-1

Table 3-1: Development of Flood Forecast at FFWC

BWDB **gauge** data	Data from BWDB gauges located within Bangladesh is received
	via radio and mobile phone
Additional gauge	Additional data, mainly relating to rainfall and boundary river
data	conditions are collated from a range of national and international
	sources
Remote sensing data	Satellite and radar imagery are collated and analyzed
Data entry and	The collated data are processed and prepared for use in the forecast
processing	model using Flood Watch.
Boundary data	Estimates for rainfall and water level boundaries for the models are
estimation	prepared in Flood watch
Modelling	The MIKE 11 forecasting model is run by Flood watch to generate
	water level forecasts
Post-Processing	The model results are extracted by Flood Watch and used to
	develop warning bulletins as well as maps of flood inundation
	extents and warning status in each Thana.
Dissemination	The model forecasts are published to FFWC's web site and
	distributed to subscribers via email, fax and hard copy.

Further details of each task in the operation sequence are provided in the following.

3.2.1 BWDB Gauge Data

The real time monitoring system consists partly of stations in the well-defined hydro-meteorological network set up by Surface Water Hydrology of BWDB. The monitoring at all stations takes place every year from 1 April to 31 October. The monitoring continues in the major rivers during the dry season also.

Water levels data are collected from a total of 75 stations and rainfall from 58 stations by SSB radio and mobile phone.

Rainfall are measured by manual readings once every 24 hours at 6.00 am each morning, whilst water levels are measured typically at 3 hourly intervals, 5 times day, between 6.00 am and 6.00 pm. Water levels at coastal boundary stations are subjected to tidal fluctuations and

measurements are obtained at hourly intervals, 24 hours a day. The increased frequency of measurements at these stations is required in order to forecast the tidal water level variation at these boundary points. The measurements are transmitted by either radio or mobile phone FFWC, who receive all measurements between 9.00-10.00 AM. Once the data have been entered into the database, Flood Watch provides a means to obtain a rapid overview of the current flood situation. This is illustrated in Figure-3-2, which shows the flood status on Aug 2009.

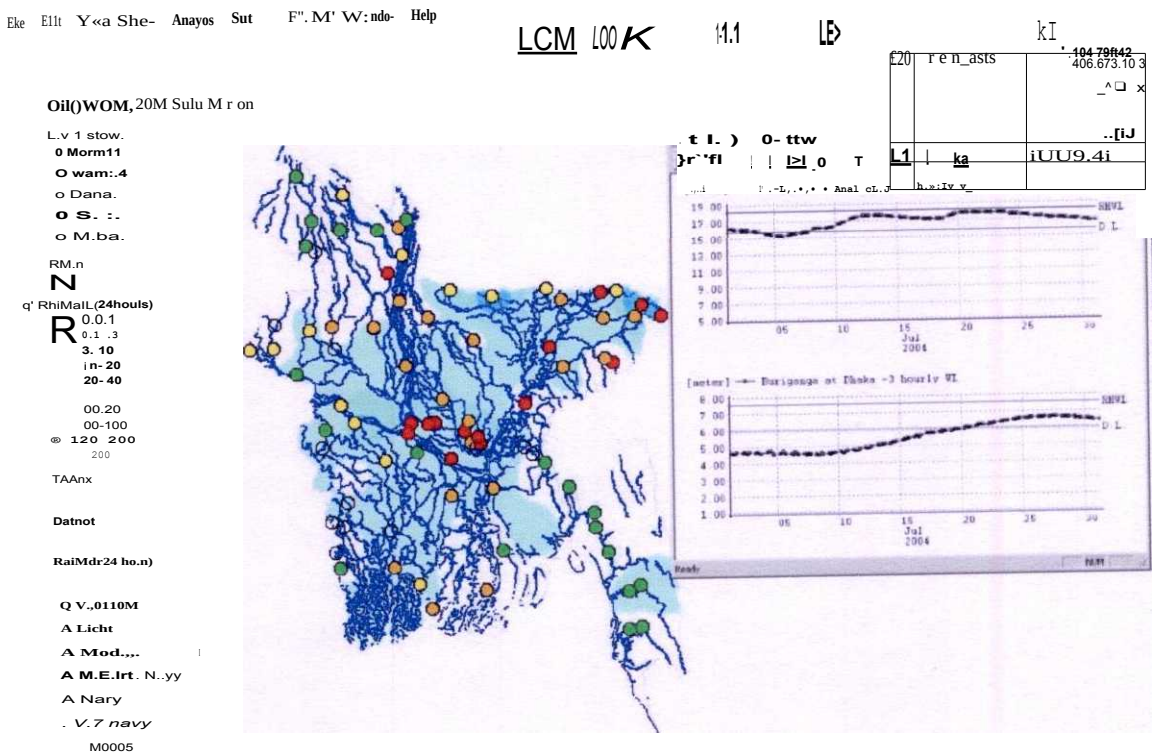


Figure 3-2 Flood Watch screen display during the Aug 2009. *source:* Fwvic *website*

3.2.2 Additional Gauge Data

Apart from the real time data network within Bangladesh, water level and rainfall data are available through a number of official and unofficial channels.

Indian Data Available via the Joint Rivers Commission (JRC) agreement with India. The JRC of Bangladesh is the National Governmental body handling issues relating to shared waters of the Ganges, Brahmaputra and Meghna river basins.

Central Water Commission (CWC) of India presently provide water level data for 17 stations covering 12 of the largest cross border rivers, including the Ganges and Brahmaputra through

e-mail to FFWC. The data is made available only when water levels exceed pre-determined danger levels at each station, and hence the record is discontinuous.

Rainfall measurements are made available at 9 stations, distributed amongst the Brahmaputra and Ganges basins, as well as a number of smaller flash-flood prone catchments close to the Bangladesh border. Like the water level measurements, the rainfall records are not continuous as data is generally transmitted only when the recorded daily measurement exceeds 50mm.

The Indian Meteorological Department (IMD) publishes observed rainfall measurements for a number of stations on their web sites. Of particular interest is the data published by the North East India Regional office at Guahati, which publishes recorded rainfall measurements in the main flash flood generating catchments of the north east region.

3.2.3 Remote Sensing Data

Satellite data are captured via BWDB's own satellite tracking installation, as well as through the internet from a variety of secondary sources. The BWDB data can be processed to provide information on cloud cover extent and temperature, the latter is an indication of likely rainfall intensity. Secondary satellite image sources include those from SPAARSO and IMD. SPAARSO provide satellite cloud cover information which is delivered by fax to FFWC daily. IMD publishes on their web site processed images obtained from the Kalpana-1 geo-stationary weather satellite image on 3hr interval.

Rainfall radar images are provided by BMD via microwave link to FFWC for each of the country's radar sites at Dhaka, Khepupara, Cox's Bazaar and Rangpur. Together these radar sites cover most of the country, but crucially do not cover all of the north east region catchments, which experience the highest and most intense rainfall in the model area. Calibration of the radar images against actual rainfall intensities has not been carried out to date, and therefore this data, along with satellite images, are used qualitatively to estimate rainfall intensity as a basis for the forecasting model.

3.2.4 Flood ***model run and forecast generation***

Present flood forecasting in Bangladesh is carried out using MIKE 11 Flood Forecasting Modelling System. This system software was developed by by DHI-Water & Environment. The model MIKE 11 has three components: a) NAM model, a rainfall run-off model, b) Flood Routing Model, based on St. Venant's continuity equation and c) Flood forecasting updating procedure.

The rainfall-runoff module simulates the rainfall-runoff processes occurring on the catchment scale inside the Bangladesh. The hydrodynamic module simulates the water level and discharges in the river network. The flood forecasting module is used to correct the model up

to the time of forecast and is used during real-time flood forecasting. Flood Watch, which **integrates time series database with MIKE 11 modelling system**, **is used for real-time flood forecasting**. Flood Watch is **developed and works within the** ArcView GIS **under** Windows environment.

Another software MIKE 11 **GIS is also utilized** to produce **flood or inundation map from** the model simulation. The flood forecasting model of **Bangladesh is extended up to the tidal** boundary **stations Daulatkhan**, **Dasmunia. Patherghata**. **Rayenda and Mongla**. The model **spreads** over **most of the flood-prone areas of** the country **and covers** approximately 80% of **Bangladesh**. FFWC maintains a website (http://Nvww.ffwc.gov.bd) **providing** the forecast **information in graphical and tabular format** compared with **the earlier major floods and flood map**. Figure 3-3 shows 52 forecast **locations.**

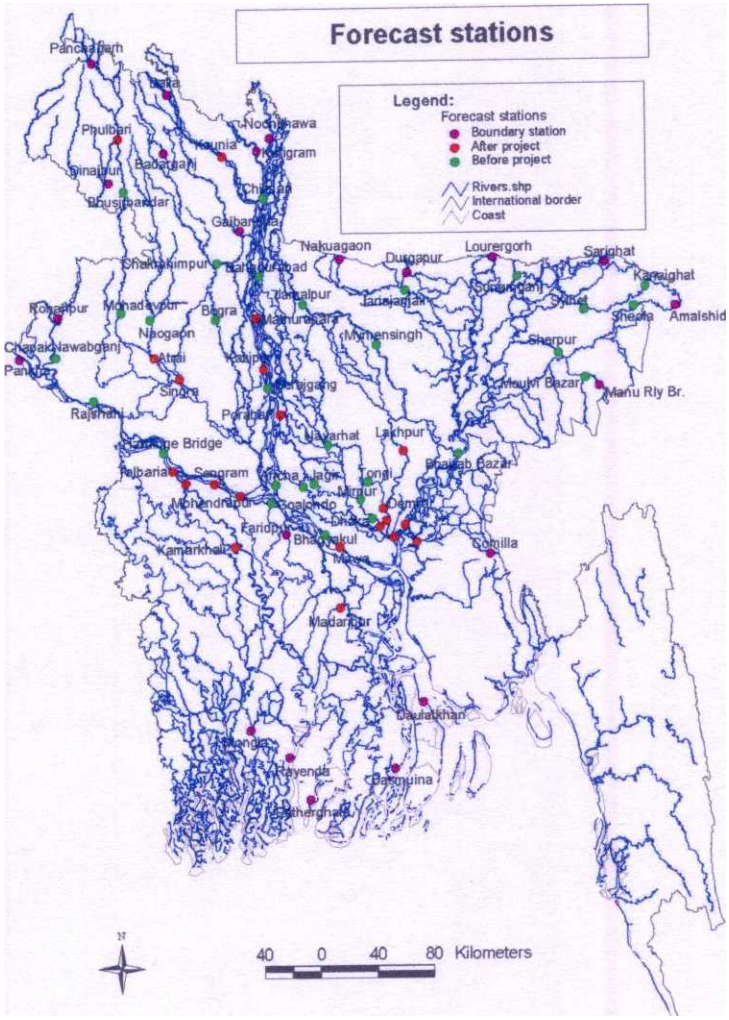


Figure3-3: showing the forecast **stations**, sonee: FFWC

The model simulations for both models are automated within Flood Watch, which prepares the necessary data for the model. The MIKE 11 **model includes automatic updating routines which use the real time water level measurements to correct for deviations between the model simulations and observations**. **The forecast simulations cover a period of 10 days (7 days hindcast and 3 days forecast**), **taking less than 30 minutes to execute.**

A schematic diagram in figure: **3-4 shows featuring** Flood **Forecasting and Warning Procedure**

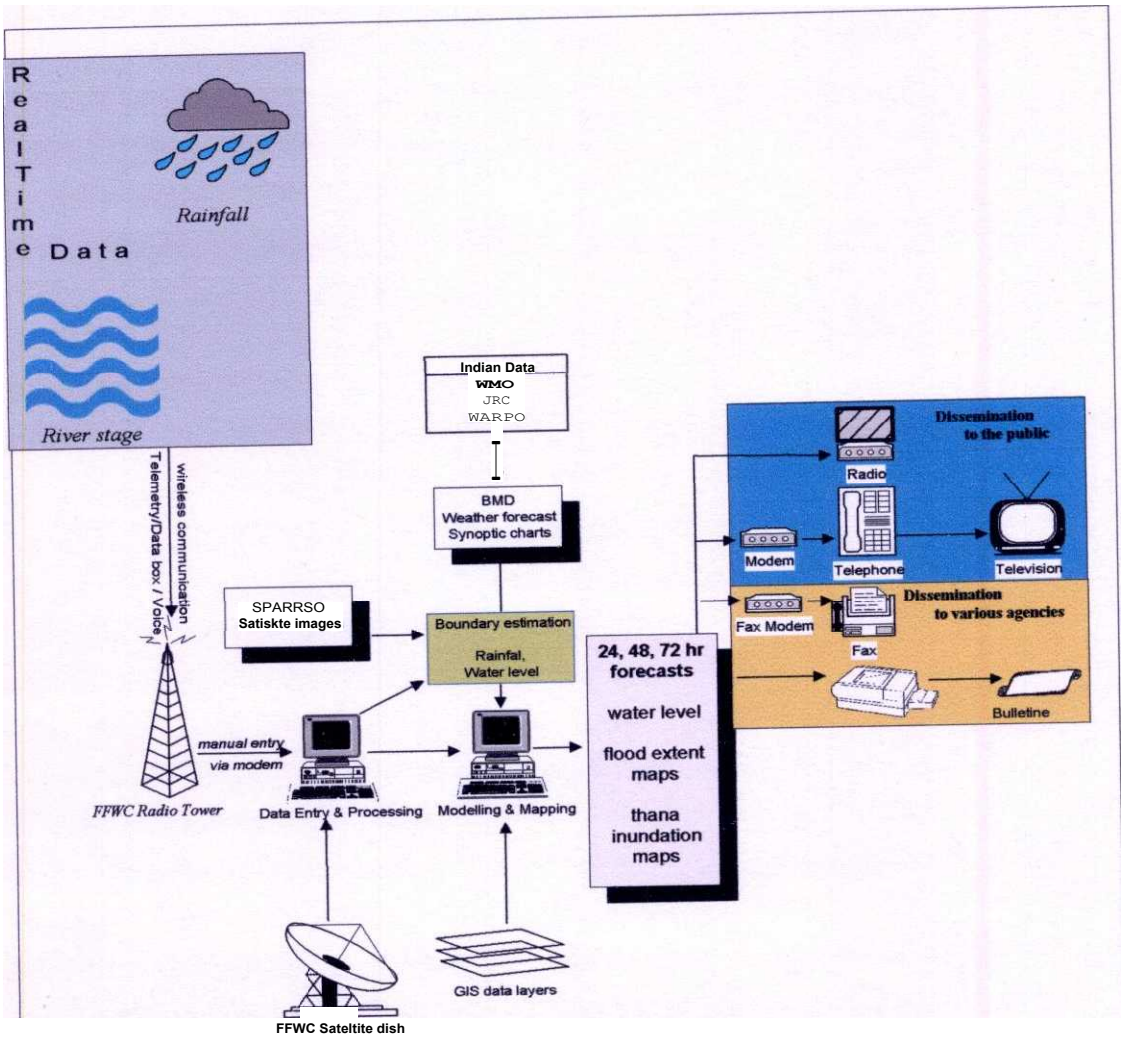


Figure 3-4: Flood **Forecasting and Warning Procedure.** ***Source****: FFWC. BWDB*

3.2.5 Flood ***Warning Products***

Once the forecast simulation is complete, a range of post processing tools built into Flood Watch are used to extract and process the results for incorporation into forecast bulletins and web pages. These tools are semi-automated, requiring limited user intervention. The main post-processing tasks comprise:

Bulletins - these comprise tabular summaries of both existing (observed) and forecast conditions for each of the main river systems in the country. These are produced in digital

form and are saved in Word document format for dissemination as hardcopy, fax and for internet upload. An example of bulletins with observed and forecasted values shown in figure 3-5.

FLOOD FORECASTING MODEL - FF2004:

Data available **up to** 25-07-2004

River	Station	D.L. (meter)	1 0600 1 (meter)	1 0600 1 (meter)	today 1 0600 1 (cm)	24-hrsl Fore- cast (cm)	24-hrsl 1+ rise I- fall I- 1 0600 1 (meter)	48-hrsl Fare- cast I(neter)	48-hrsl 1• rise I- fall I- 1 0600 1 (cm)	48-hrsl I+ abovel I- belowl 1 0600 1 (cm)
			25-07	126-07	126-07	1 26-07	1 27-07	1 27-07	1 27-07	
Water Level in [m]										
Brahmaputra	Chilmari	24.00	24.00	23.67	-33	33	23.33	34	67	
Jamuna	Bahadurabad	19.50	19.79	19.50	-29	0	19.27	-23	-23	
Jamuna	Mathurapara	-	17.73	17.42	-31		17.16	-26		
Januna	Kazipur	16.46	115.35	15.13	-22	-133	114.93	-20	-153	
Jamuna	Serajganj	13.75	114.70	14.45	-25	70	114.18	-27	I+ 43	
Jamuna	Porabari	12.27	112.10	11.92	-18	-35	111.72	-20	-S5	
Jamuna	Aricha	9.40	110.28	10.14	-14	I• 74	9.96	-18	I• 56	
Old Brahmaputra	**Janalpur**	**17.00**	17.43	17.23	-20)	+ 23	17.02	-21	+	**2**
Old Brahnaputra	**Mymensingh**	**12.50**	**113.06**	**13.06**	**0**	**+ 56**	12.99	-7	+	49
Bangshi	**Hayerhat**	**7.32**	**7.89**	**7.99**	•	**10 • 67**	**8.07 + 81 • 75**			
Old Dhalesari	Jagir	**8.23**	**9.49**	9.51	+	2 • 128	9.53 +	**21 • 130**		
Dhaleswari	**Kalagachia**	**4.88**	**6.72**	6.77	+	51 + 189	6.79 +	2		191
Kaliganga	**Taraghat**	**8.38**	**9.92**	9.94	•	21 • 156	**9.94**		**01 • 156**	
Tongi Khal	**Tongi**	**6.08**	**6.76**	6.85	•	91 + 77	**6.92 +**	•	7	• 84
Turag	**Mirpur**	**5.94**	**7.11**	7.20	+	91 + 126	**7.26 +**	•	6	+132
Buriganga	**Dhaka (Kill Barrack)**	**6.00**	**6.58**	6.66	+	**81 + 66**	6.70 +	•	4	• 70
Buriganga	**Dhaka (Hariharpara)**	**5.79**	-	**6.89**		• 110	6.94 +		51 + 115	
Balu	**Demra**	**5.03**	**6.91**	7.00	+	91 • 197	**7.07 +**	•	**71 • 204**	
Lakhya	**Lakhpur**	**5.79**	**7.45**	7.54	•	91 + 175	7.61 +		71 + 182	
Lakhya	**Hara9anganI**	**5.50**	**6.72**	**6.82**	+	**101 + 132**	6.89 +	•	71 • 139	

Observations - 25Jul-2004

RIUER SITUATION AS ON 25-07-2004 AT 06:00 HOURS

SL	RIUER	STATION **HAKE**	**RHWL** (n)	D.L. (n)	W A T E R L E U E L 24-07-2004	25-07-**2004**	**+ Rise Above** - Fall **in cm**	D.L. **in cm**
	BRAHMAPUTRA BASIN							
1	**DHARLA**	**KURICRAM**	27.52	26.50	26.82	26.51	-31	1
2	TEESTA	DALIA	52.97	52.25	51.79	51.83	+ 4	
3	TEESTA	**KAUHIA**	**30**.52	30.**00**	**28**.25	28.24	-1	
4	JAMUNESWARI	**BADARGAHJ**	32.92	32.16	31.34	30.62	-72	
5	**CHACOT**	**GAIBAHDHA**	22.81	21.70	22.65	22.40	-25	• 70
6	**KARATOA**	**CHAKRAHIMPUR**	21.41	20.15	**20.33**	**20**.57	• 24	• 42
7	**KARATOA**	BOGRA	17.45	16.32	-	-	-	-
8	**BRAHMAPUTRA**	**HOOHKHAWA**	28.10	27.89	26.62	26.33	-29	
9	BRAHMAPUTRA	CHILMARI	**25.06**	24.00	24.25	24.00	-25	
10	**JAMUNA**	**BAHADURABAD**	20.62	19.50	19.95	19.79	-16	• 29
11	JAMUNA	SERAJGANJ	15.12	13.75	14.81	14.70	-11	• 95
12	JAMUNA	**ARICHA**	10.76	9.**40**	**10**.31	10.**28**	**-3**	+ 88
13	**OLD BRAHMAPUTRA**	**JAMALPUR**	18.00	17.00	17.54	17.43	-11	. 113
14	**OLD BRAHMAPUTRA**	**MVMEHSINGH**	13.71	12.50	13.01	13.06	• 5	+ 53
15	**BURIGANCA**	**DHAKA**	7.58	6.00	6.47	6.58	+ 11	+ 58
16	**BALD**	**DEMRA**	7.13	5.03	6.**83**	**6.91**	+ 8	+108
17	LAKHYA	NARAVANCAHJ	6.93	5.50	6.66	6.72	+ 6	+122
18	TURAC	MIRPUR	**8.35**	**5.94**	6.98	7.11	• 13	+117
19	TONCI KHAL	TONGI	7.84	6.**08**	**6.64**	**6**.76	+ 12	• 68
20	KALICANCA	TARACHAT	10.21	8.38	9.88	9.92	• 4	+154
21	DHALESWARI	**JAGIR**	**9**.73	8.23	9.42	9.49	• 7	+126
22	**DHALESWARI**	**REKABI BAZAR**	7.66	5.18	6.45	6.51	+ 6	+133
23	**BAHSHI**	**NAVARHAT**	8.39	7.32	7.67	7.89	+ 22	• 57

Figure 3-5 Example **of Observation** (**top) and Forecast bulletins** produced by FFWC

Flood Maps - The simulated water levels in the rivers are used together with a digital elevation model (DEM) of the country to compute the expected extent and depth of flood inundation. The flood maps are produced by MIKE 11 GIS, a standard flood mapping package for MIKE 11 developed by DHI. As well as the country-wide flood map, local flood map products are developed for the Greater Dhaka area.

Upazila Status - A map showing the degree of inundation in each Thana is produced based on the results of the flood mapping above. The Upazilas are color coded depending on the expected percentage area of inundation, providing a highly visual "'snapshot" of the flooding status on a countrywide.

Flood Watch automates the assembly of much of the required flood warning products that are disseminated through a variety of mediums. The main products produced by the Centre are:

- Rainfall Observation Bulletin
- River Situation Bulletin
- River Forecast Bulletin
- Flood Inundation Maps
- Thana Status Map
- Plots of water levels and flows for Internet upload

Bulletins are mainly produced using FloodWatch, but are manually enhanced to provide information in more descriptive terms. This is particularly the case for the two observation (rainfall and water level) bulletins. The river bulletins provide an overview of each river system in the country, and provide absolute water levels at each observation/forecast station, as well as the observed and predicted rise or fall of water level in the next 24, 48 and 72 hours. An example of flood map and thana status map is shown in *Figure 3-5.*

The bulletins are converted to Word documents for dissemination by various means (email, web, fax etc). The flood maps are stored in digital image (.jpg) format compatible with common web browsers.

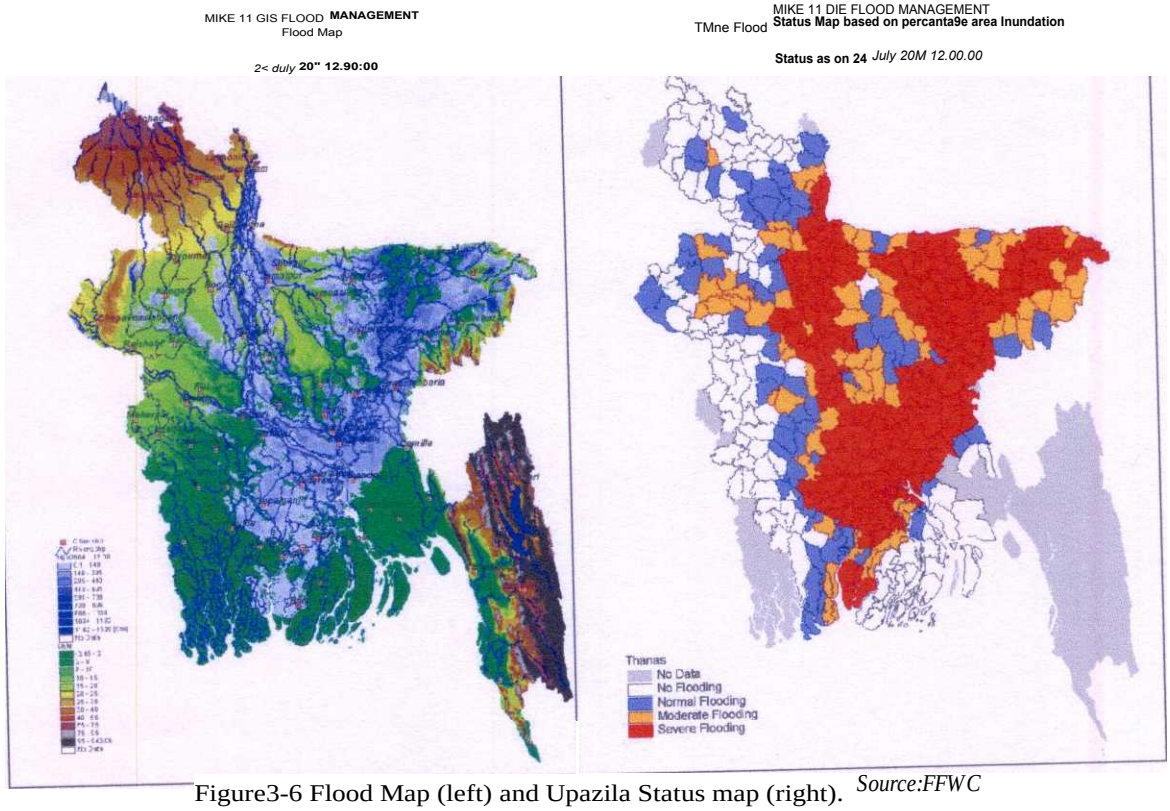


Figure3-6 Flood Map (left) and Upazila Status map (right). *Source:FFWC*

3.2.6 Flood Warning Message

A flood warning message is a notice of impending flood threat issued to the public by the competent authority so that people and organizations can undertake necessary precautions or protective behavior or help towards their achievement. Flood forecast model MIKE-11 generate forecasts of river stages at 50 locations with a lead time of 24, 48 & 72 hours in numerical values such as the Jamuna at Serajganj will rise 10 cm by next 24hr. and will flow 30 cm above danger level. These sorts of numerical river level forecasts then converted to flood warning message in English language which briefly explain present situation draw a qualitative future scenario of impending flood to the flood victims, stakeholders and to the authority. So that people, disaster managers and organizations can undertake necessary precautions and measures. The warning message is macro level flood information which mostly covers district level and sometimes upto upazila level but never covers community level. An example of flood warning message on July 27 2007 is shown below:

- *Flood situation in the district of Serajganj is deteriorating and is likely to deteriorate further. More areas in the districts of Patina and Tangail are also likely to inundate by next 2/3 days.*
- *The Meghna at Bhairab Bazar continued rising and may cross danger level by next 48/72 hrs. Inundation of low lying areas in the districts ofNarshingdi, Brahmanbaria and Narayanganj are likely to start by next 2/3 days.*
- *Small rivers surrounding Dhaka and Narayanganj continued rising and are likely to approach danger levels by next 2/3 days.*

3.2.7 Dissemination Routes

FFWC disseminate flood warning products through a range of different mediums as shown in Table 3-2. Email and Internet are the main effective dissemination routes of FFWC. Traditional methods of hard copy and fax still covers VVIP recipient group. FFWC's dissemination routes covers up to upazila level which got the excess to telecommunication facilities.

Table 3-2 Flood Warning **Product Dissemination Routes**

Dissemination Medium	FFWC **Product**	**Recipient Group**
Hard Copy (hand delivered),	Bulletins	President's Secretariat, Prime Minister's office, government ministries, BWDB high officials, government or anizations
Fax and Email	**Bulletins**	Different control rooms, Secretaries of different ministries
Email	Bulletins	NGO's, embassies, international donor and aid or anisatioits, news media
Internet	Bulletins, plots, flood map, Thana status	General public, international and anybody.

3.3 Performance of Existing Warning System

3.3.1 Warning Message

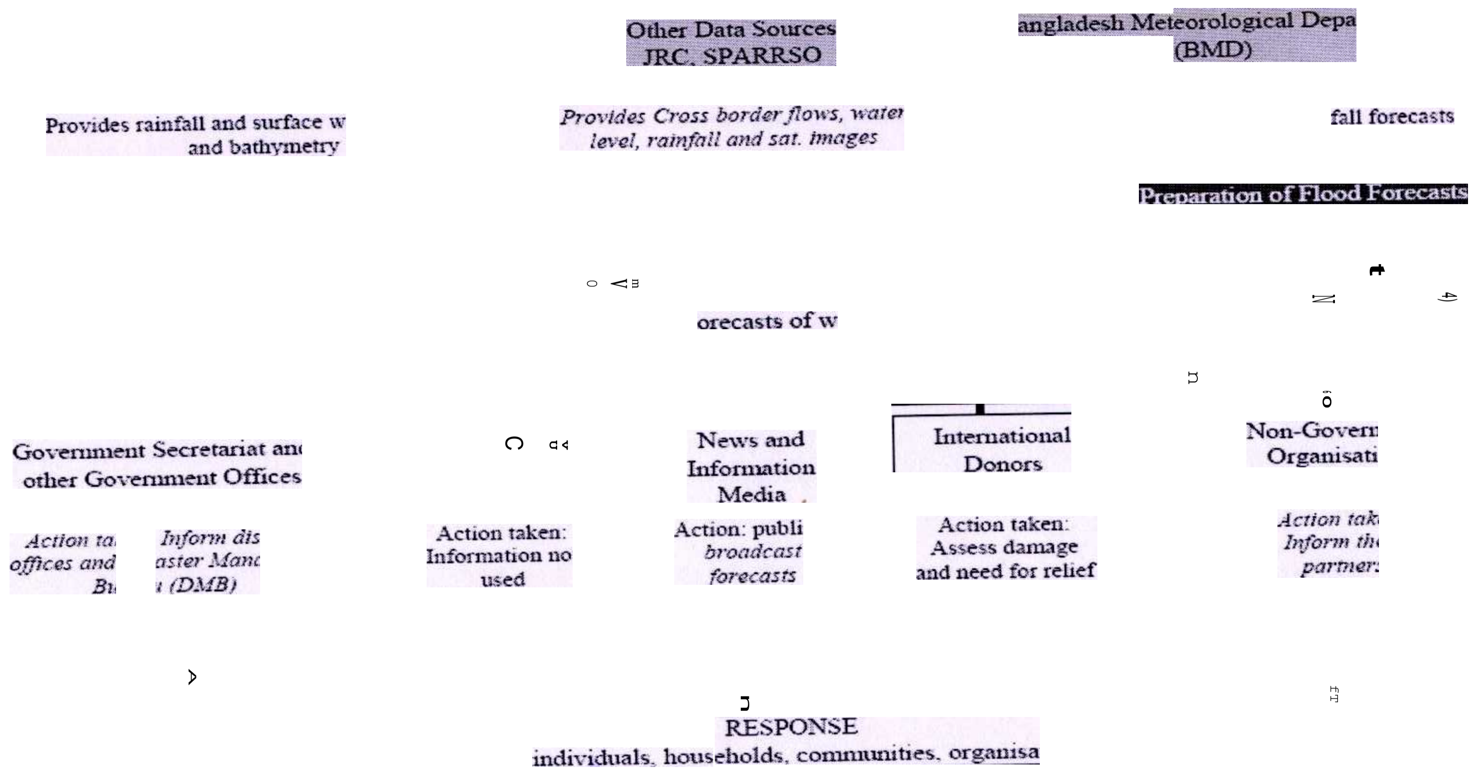
Flood warning is expected to "translate" a physical observation (e.g.: surpassed water level, or "flood threshold") into a stimulus triggering a specific response, possibly pre-formatted (individual or collective disaster response). Since a so-called "zero risk" situation cannot be obtained, nor reached, one of the major functions of flood warning therefore is to care for existing "residual risk". This is the risk that theoretically remains after all other flood mitigation and control measures (structural and non-structural) have been taken. In that sense, flood warning is expected to enable society to provide a timely disaster response.

A user-based approach in forecast and warning design aims at matching information users and information needs. Traditionally, the forecasts produced by FFWC are mainly targeted to central and district level decision makers. When floods are approaching severe conditions, warning messages are produced for the use by common people affected by floods. The traditional forecasts and warning message did not fully correspond to the needs of the stakeholders. Due to its nature, presentation, delay or any other characteristics, it is not well adapted to the local needs. Furthermore, on the basis of information such as a danger level in the river, many people are unable by themselves to take adequate steps of protection against flooding.

It is recognized that credibility of the warning message is a product of the discipline of the forecasting organization, and effectiveness of a flood warning system increases if it succeeds in maintaining a continuous dialogue between warning users and authorities.

It is therefore, strongly recommended that FFWC redefines the danger levels and area specific warning messages contain local danger levels.

The existing early warning system is shown in Figure 3-7.



Other Data Sources
JRC, SPARRSO
angladesh Meteorological Depa
(BMD)
Provides rainfall and surface w
and bathymetry
Provides Cross border flows, water
level, rainfall and sat. images
fall forecasts
Preparation of Flood Forecasts
orecasts of w
Government Secretariat anc
other Government Offices
Action ta
offices and
Bu
Inform dis
aster Manc
(DMB)
Action taken:
Information no
used
News and
Information
Media
Action: publi
broadcast
forecasts
International
Donors
Action taken:
Assess damage
and need for relief
Non-Govern
Organisati
Action tak
Inform th
partner
RESPONSE
individuals, households, communities, organisa

3.3.2 Dissemination

The flood forecast bulletins and the flood warnings are disseminated to the stakeholders as stated in SOD over 100 listed recipients. They include all the concerned offices of the government of Bangladesh (from the office of the President, Prime Minister, and Ministry of Disaster Management and Relief down to the deputy commissioners of each District), electronic and print media, selected foreign missions located in Dhaka, and some bi-lateral donors, as well as national and international GOs.

As per the standing order issued by the Ministry of Disaster Management and Relief, the responsibility of disseminating flood warnings down to the local level lies with Disaster Management Committees at the district and Upazila levels. The performance of the present flood warning dissemination system is serving well to disaster managers, government high officials, policy maker, NGO's, print and electronic media, and international bodies. In fact, present system essentially based on internet and telecommunication system and those have access to internet, FAX and phone are getting flood information in time but the grassroots level and the flood victims those do not have access to all modern telecommunication facilities are not receiving flood early warnings at time of need. The summarized performance of flood early warning dissemination is shown in Table 3-3.

Table 3-3: **Existing Dissemination** Performance of FFWC

Stakeholders	Performance	Remarks
National level: Policy Makers, Disaster Managers, Development Partners, Foreign Missions, NGO,s	Excellent	E-mail, Web browsing: Have access to Telecommunication facilities
Radio, Television, Print & Electronic Media	Excellent	Direct communication &Have access to Telecommunication facilities
National level: Policy Makers, Disaster Managers, Development Partners, Foreign Missions, NGO,s	Excellent	E-mail, Web browsing: Have access to Telecommunication facilities
Radio, Television, Print & Electronic Media	Excellent	**Direct communication &Have access to Telecommunication facilities**
District Disaster Management Committee (DDMC)	Good	Those have FAX **and Internet facilities**
Upazila Disaster Management Committee (UzDMC)	Fair	**Only those have FAX and Internet facilities**
Community level especially the flood victims and grassroots level people	Poor	FFWC **do not shoulder the responsibility to reach community level.**

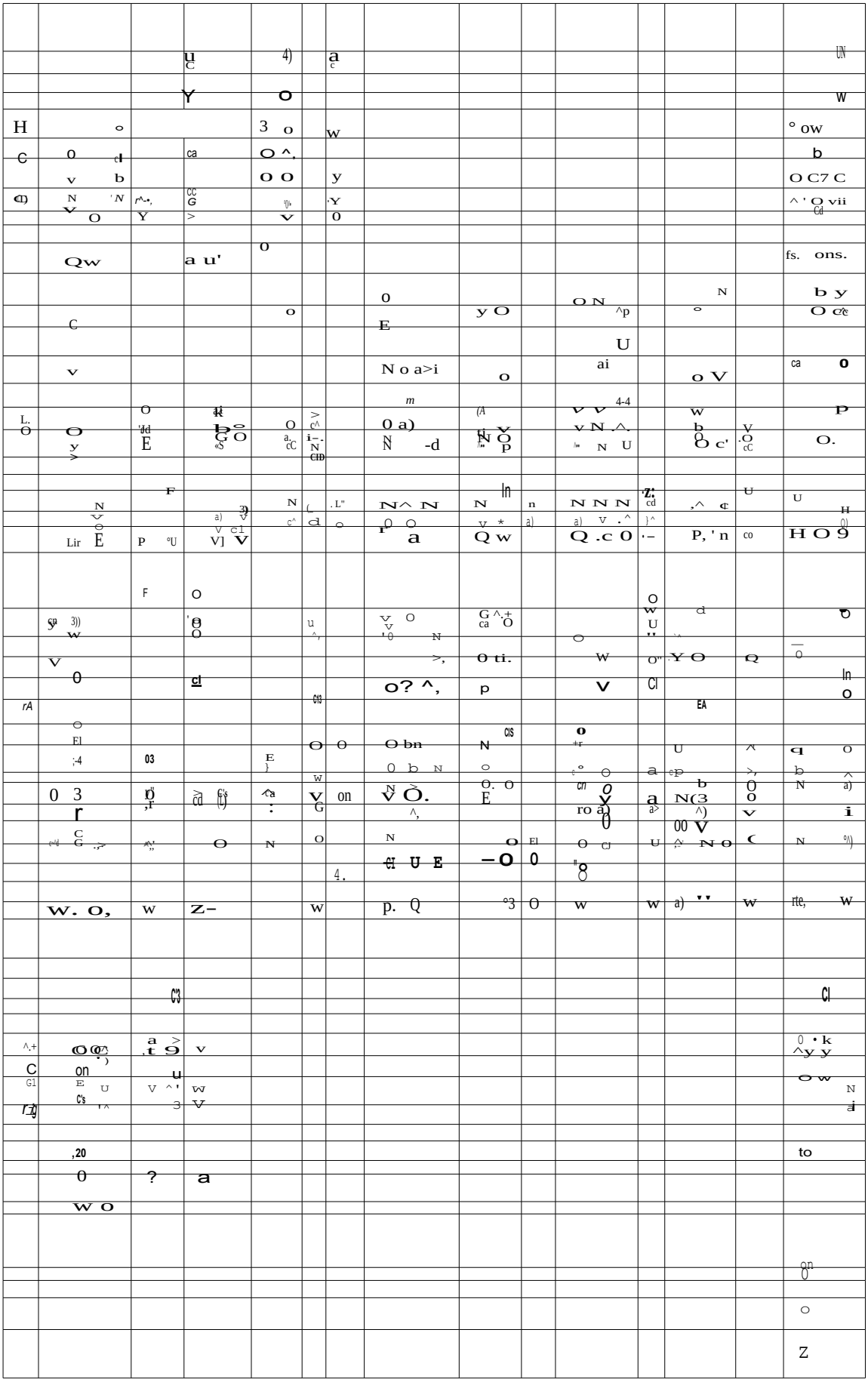
Source: FFWC, BWDB

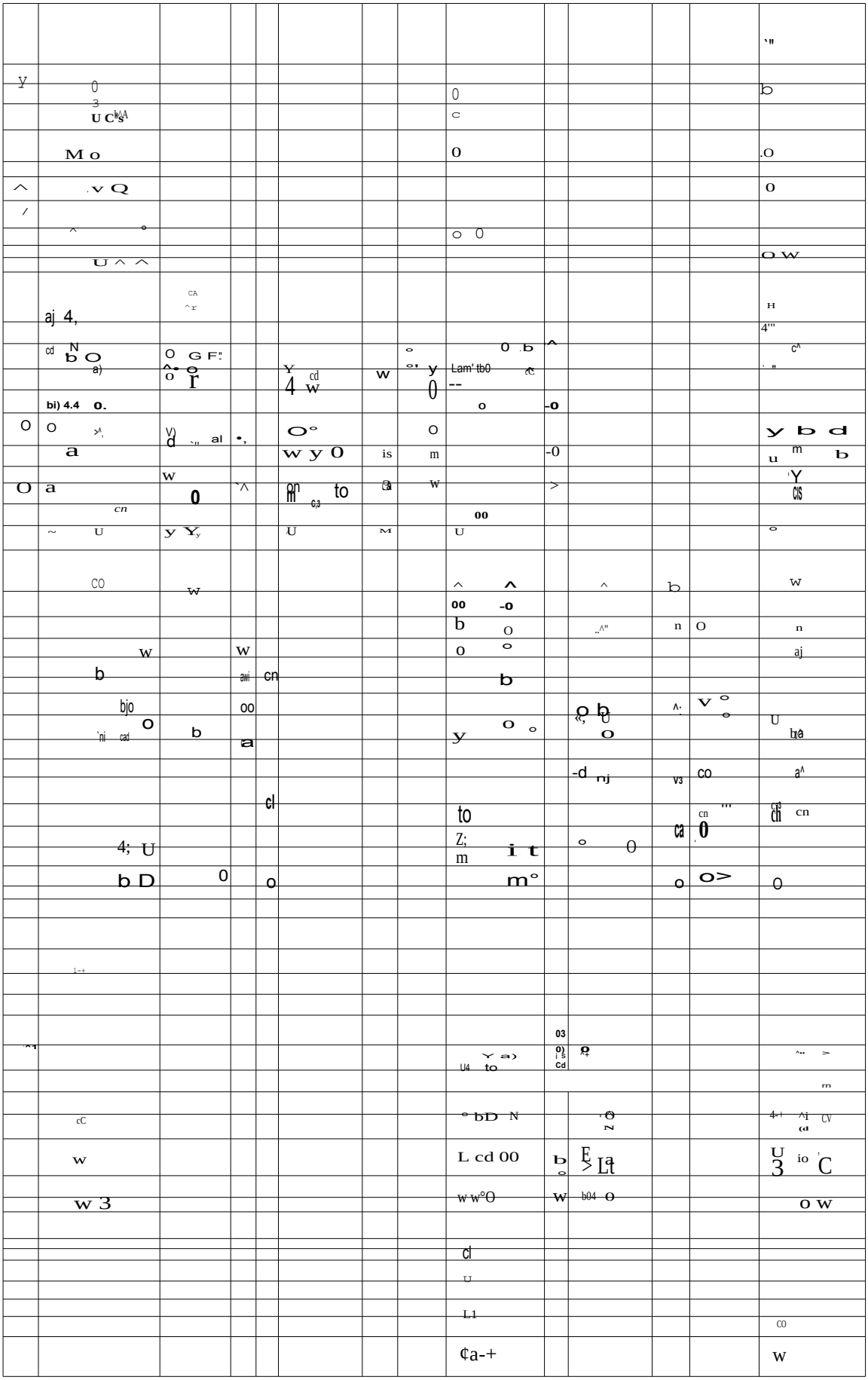
SOWT Analysis of FFWC

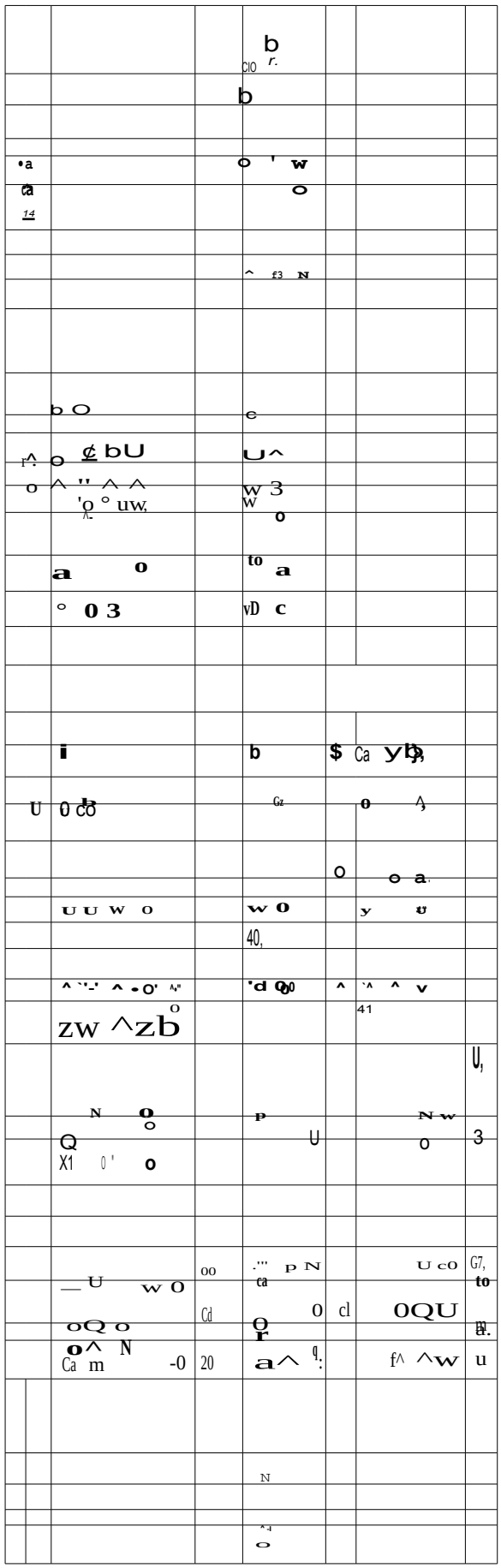
A SWOT (Strength, Weakness, Opportunity and Threats) analysis of FFWC is prepared based on discussions with Flood Forecas (FFWC (BWDB), and other information provided by FFWC. The results of the SWOT analysis are shown below:

Table 3-4: SWOT Analysis of FFWC

[illegible]	[illegible]







Chapter 4

Study Area and Methodology

4.1 Purpose of the Study

The Purpose of the study was to:

- Check whether the present flood warning message fulfilling the need of the community?
- **Is the existing warning message** understandable to the flood affected community and meeting their need?
- Whether the present mode of dissemination gratifying the want of the flood affected community?

4.2 Methodology

The methodology **for this study was mainly based on key informant's interview**, **consultation** with **Union disaster management committee** (UDMC), **institutional focus group discussions and secondary data collected from different organizations**. **The research was a quasi-experimental one involving cross-sectional** study, **discussion with involved authorities, content analysis**, and key **informants interviews etc.**

The methodology included:

- **Analysis of existing Flood Warning Message** issued by FFWC
- **Examining existing procedure of warning message dissemination**
- **Reconnaissance** Survey **& Consultation with** UDMC & **Stakeholders**
- **Questionnaire Preparation for key-informant interview**
- **Key informant interview**, **consultation with** UDMC **and institutional focus group discussion**
- **Design** of User friendly **Flood Warning Message and dissemination procedure.**

The researcher engaged the stakeholders in the following manner:

- Key informants of different profession and group of the study area were interviewed.
- Consultation meetings with UDMC were carried out at Union Parishad office.

- Upazila level concerned institutional focus group discussions were arranged at different institutions.

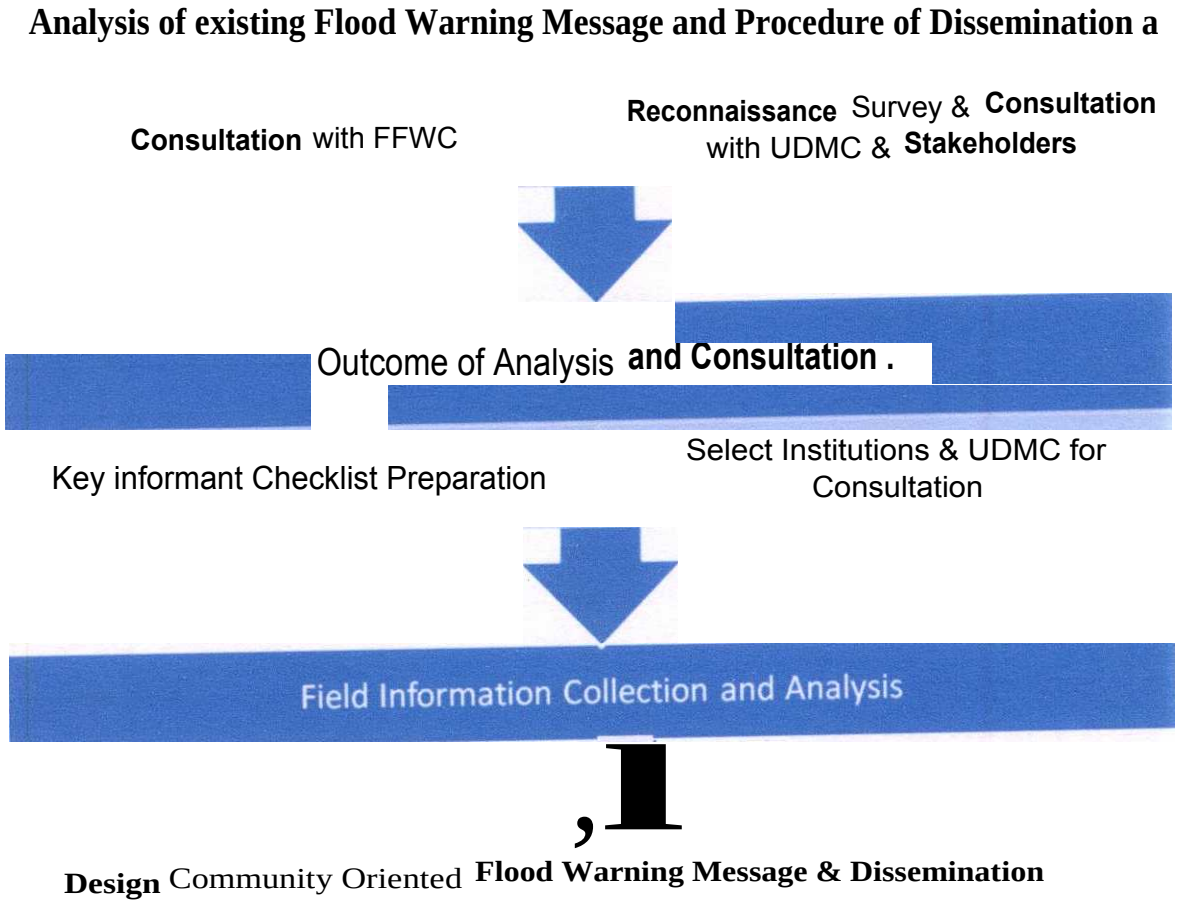
For Key informant's interview, a qualitative questionnaire was used and key informant's selection was based on age, profession, education, gender and length of stay at study area. Discussions with Union disaster management committee (UDMC) were carried out at union parishad office using participatory approaches through guided checklists. Institutional Level Focus Group Discussions (IFGD) were carried out at different concerned institutions office to capture the local level institutional preferences and recommendations for designing and dissemination of user friendly flood warning message.

Parameters were included in the key informant questionnaire:

The following parameters were included in the key informant questionnaire to have an idea for flood warning message design and dissemination at community level. Community's preferences and flood hazard specificity considered in developing the questionnaire. The major parameters of the key informant questionnaire are as follows:

- ✓ General demographic information (age, occupation, literacy etc.);
- ✓ Flood warning perceptions (understanding, reliance, reaction etc);
- ✓ Flood warning availability (receiving, frequency, lead-time, efficiency);
- ✓ Sources of flood warning (existing and preferred);
- ✓ Sharing, accuracy, trust and validation of flood warning information;
- ✓ Flood warning dissemination (mode, area coverage, quality, efficiency);
- ✓ Flood warning message content quality and understandability;
- ✓ Preferred dissemination modes;
- ✓ Suggestions to improve flood early warning message and dissemination procedure

Methodology followed



4.3 Description of the Area

The central region of Bangladesh is highly vulnerable to floods caused by over bank flow from the Brahmaputra-**Jamuna** river. Daulatpur is one of the most vulnerable areas, and floods result in significant damage to crops and livelihoods as happened in 1988, 1998 and 2004. The study area is situated in a flood prone zone on the left bank of the Jamuna River which is designated by CARE Bangladesh as "medium vulnerable to flood" (CARE. 1999).

Daulatpur is located at 23°57'40"N 89°50'30"E / 23.9611°N 89.8417°E / 23.9611; 89.8417. It has 26,720 units of house hold and total area 216.24 km2. It has [updatela population of 156,860. Males constitute are 50.23% of the population, and females 49.76%. Daulatpur has an average literacy rate of 38.35% (7+ years). It has 8 Unions, 172 Mauzas/Mahallas, and 170 villages. 80% of the population engaged in agriculture and the rest are in service **and small** business *(source:* ***upazi& &a cot office).***

The agriculture land area about 180 sq km2 is particularly vulnerable to flooding as much of the land is low lying. Floods and erosion damage crops, infrastructure, culture fisheries and homesteads. Floods in Daulatpur are influenced by flows in three rivers; the Jamuna, Kaliganga, and Dhaleswari. Location of study area shown in figure 4-1.

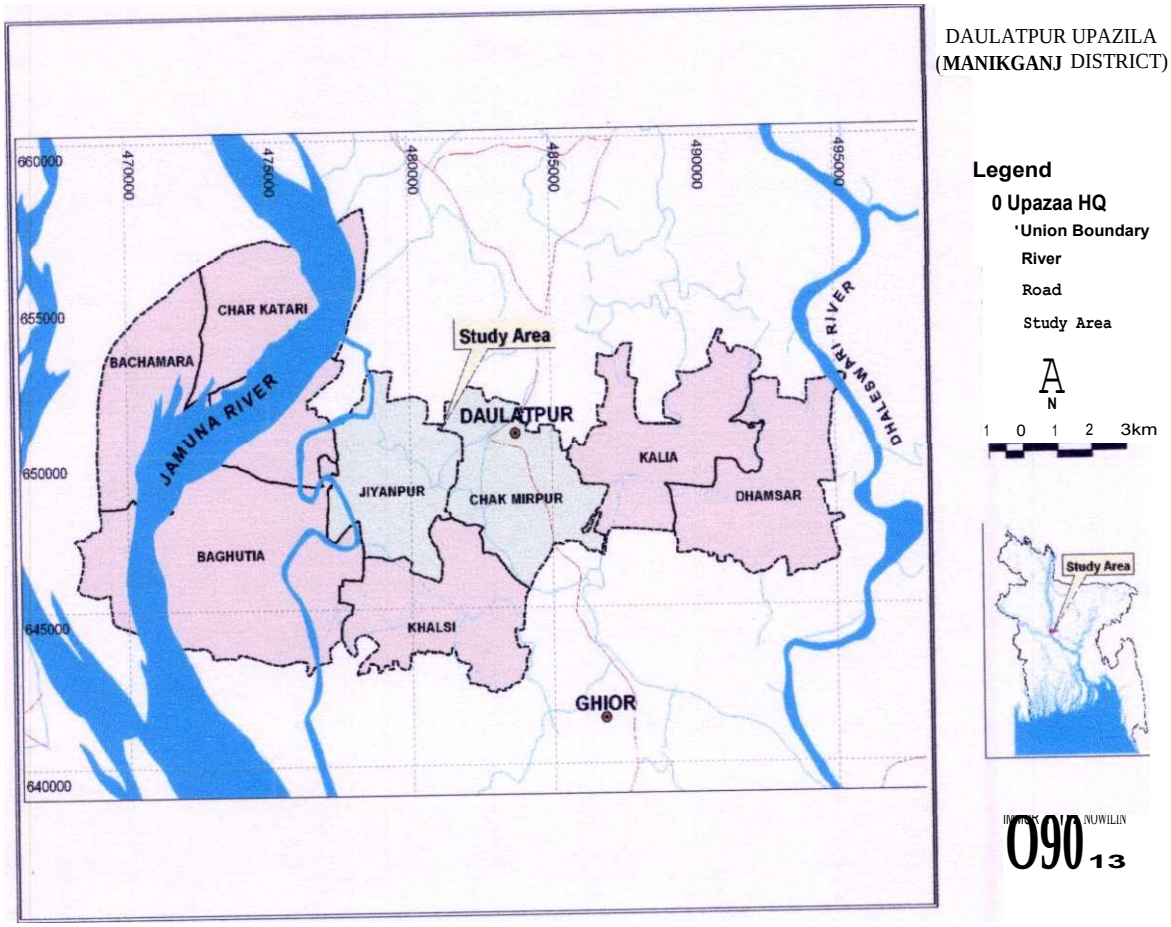


Figure 4-1: Location of Study Area. *Source: IWM*

4.3.1 Selection Method

The selection of a flood prone study area followed a systematic approach after identifying a set of criteria (Table 4-1). Information **against** the criteria was checked in the field with local stakeholders and interested projects **to ensure** collaboration.

Table 4-1: Selection criteria for study area

"` riteria	Status of study area
Hazard	
Medium-high flood risk.	Based on the vulnerability map produced by
	FFWC, Daulatpur *Upazila* is "medium vulnerable
	to flood.
The area partly goes under water during	About 60 percent of the area is inundated during
normal flood years.	normal flood condition based on CEGIS' flood
	monitoring study report.
The agricultural practices of the area are	Though the major crop of the area is dry season
influenced by the uncertainties of flooding.	rice, the farmers also practice wet season rice
	including *TAman* and *B.Aman.*
Protection	
The area is not protected with flood control	No flood control infrastructure exists along the
structures.	Jamuna River in Daulatpur.
Interest of Other Agencies	
Government and NGOs have particular	Flood Forecasting and Warning Centre has interest
interest in the area.	in the area. Daulatpur *Thana* is included in the
	CARE disaster management program.
Other relevant projects have interest in the	Environmental Monitoring Information Network
area.	(EMIN) project, under planning at the time of
	study area selection, expressed interest in working
	there; meetings with cellular telephone company
	(Grameen Phone) indicated that the area was
	targeted for full cellular coverage within a year.
Availability of Information	
Flood related information on the area is available to develop the methodology.	Yes.
Access for researchers to conduct study.	Limited access as roads and bridges damaged in
	1998 flood; access by boat in flood season is
	adequate.

4.3.2 Types of Vulnerability:

Flood, river erosion and poor communications are multiple vulnerabilities of the people of Daulatpur. Biodiversity is declining as aquatic vegetation and reeds are less and wild birds are fewer. People used macha (a platform made by bamboo) to lift their assets above floor level in the homestead compound. Due to lack of work when there are floods, about 15-20% of households migrate to Dhaka and other distance place for earning. Some households take loans from Mohajon or NGOs. Female members have no savings but they sell vegetable, eggs, etc. in family crisis period. Some households sell fixed assets, mortgage assets, sell agricultural products in advance and also reduce family member's food consumption.

When there is a flood, a major concern is the availability of a safe (dry) place to live. Thus, at the warning phase people would like to know by how much the water level will rise and how fast it will rise. People are reluctant to move away from their homesteads to take shelter elsewhere, for several reasons including personal security, safety, protection of their assets, etc. They will even try to make temporary shelter within the homestead compound instead of moving to another place. If they have to move out, information is needed on the availability of public shelter and how they can travel to the shelter.

4.3.3 Flooding Condition

Floods in Daulatpur are caused by high water levels in the Jamuna River, and flood waters spilling from the Jamuna through the Dhaleswari and Kaliganga rivers into the area. In addition, flooding occurs when rainfall is intense and drainage is congested due to high river water levels. Normal flooding has little adverse effect on rice production in Manikganj but the long durations of the 1988, 1998, 2004 & 2007 floods led to major production shortfall.

Initially, the 2007 floods caused only relatively minor damage to standing crops but, as floodwaters persisted into September, the flooding destroyed seedlings of the main monsoon season Aman rice crop. In addition, because of using river water instead of tube well water for domestic uses, diarrhea and other waterborne diseases were rampant. The damage to physical infrastructure (roads, embankments, bridges, and culverts) was greater in 1998 than in 1998. When required to leave their homestead due to floods, the first choice of is to move to relatives, if this is not possible, the second choice is to move to a nearby public place such as school or shelter. Livestock are usually taken to a road embankment. Elderly people find evacuation very difficult. Usually one or more family members will remain behind to protect their property.

4.3.4 Flood Damage in 2004 & 2007:

In addition to the losses to crops, 80 percent of the households suffered damage or destruction of assets, which reduced their household wealth as well as future productive capacity. Many households had no access to safe drinking water. 70% of the Aus crop was damaged and agricultural laborers lost an employment opportunity when the flood destroyed the crop. The damages statement shown below table is from secondary data and information from Union parishad.

-2: Extent of damages

4V		Damages in 2007
Content	**Damages** in 2004 Chak Mirpur & Jiyanpur Union	hak Mirpur & iyanpur Union
Homestead Structure	25%	21%
Household Possessions	50%	38%
Liquid **assets** (Tree, **outside property**)	25%	18%
Livestock and poultry	30%	22%
Agriculture (Crops, **tools etc**)	95%	72%
Fishery	30%	28%
Water Supply and Sanitation	17%	18%
verage Damage Value for Household Content Tk/household)	7,500	5,500
verage Damage Value for **Agriculture** Tk/household)	6,200	4,800
Average Damage Value for Fishery (Tk/houschold)	2,500	2,800

c,,,.-.-0- FFWC of **RWDR** and LGED

4.3.5 Communications

Daulatpur Upazila is connected with the district headquarters by road and waterways. The basic means of transport available are bus, boat, and rickshaw. The Upazila headquarters is connected with most of the union parishads by kutcha roads. Country boats play a vital role in the rainy season. Land and mobile phone communication exists in Daulatpur Upazila as well as eight post offices and one telegraph office.

4.3.6 *Baseline Condition of Flood Information*

The baseline condition of the project areas was investigated for different stakeholders revealing the following:

- ✓ Pre flood condition:
  - No flood warnings were issued or received at community level.
    Local people used their indigenous knowledge for their flood preparation.
- ✓ During flood condition:
  - Limited national flood information/warnings were received through radio, television, and
    newspapers, but no area specific forecasts were available.
  - Adjustments and coping initiatives were taken based on indigenous knowledge.
- ✓ Post flood condition:
  - No post flood information was collected or made available to the communities

4.4 Soclo-Economic Description : *(Source: Upazila statistical office & UP office)*

Human assets:

Total **population** at Chak Mirpur **and Jiyanpur** Union 65,606; male 50.02%, female 49.98%

Main occupations Agriculture 41.71%, agricultural **labor** 26.17%, wage labor 2.91%, fishing **10%, cattle farming 1.1%, commerce** 9.7%, service 4.61%, transport 1.39%

Social assets:

Good relationship with UP Chairman and members. Local influential and rich man has strong command on community. Friends and relatives play vital role in any crisis situation and extend their helping hands. Female has no strong voice in the community and in decision making process. Female are partially attached with NGO activities. A good number of NGO's are working in both the unions.

Natural assets:

Land use Cultivable land 2,695 hectares, fallow land 42 hectares; single crop 25%, double crop 65%, triple crop 10%. Cultivable land under irrigation 35%. Both the unions are covered by green trees of fruits, fire wood and also timber.

Physical assets:

18 % of households with tile/corrugated iron (CI) sheets roof

15% of households with straw/bamboo roof

75% of **households** with **tin roof**

80 % of household having hand tube well water as sources and 5% having river /beel water sources

Financial assets:

They **have marginal savings and most of the time takes loan from** NGO's and Mohajon. Try to pay **installments** weekly **or as per agreement. Female members have no savings** but they **sale vegetable**, **eggs and lessen some family financial crisis.**

4.5 Key **Informants Interview**

Seven key informants were selected and interviewed from Chak Mirpur and Jiyanpur Union for information/data collection for the study. Key informant selection was based on age, profession, education, gender and length of stay at study area. A list of key informants and of their details summarized in Table 4-3 below.

Tah1P d-'t• T it of kPv infnrmants

Sl No	Name	Father's/husband Name	Age	Education	Profession	Duration of Stay	Remarks
01	Mr. M.M Saha'ahan	Late Badar Uddin Mrida	55 yrs.	B.A	Teacher	14 Yrs.	Cont: 01714499545, Seems non-biased.
02	Mrs. Delwara Khatun	Md. Abu Zafor	49 yrs.	B.A	Teacher & Social Worker	25 yrs.	Cent: 01710288212, Excellent Cooperation
03	Md. Abul Hossain	Late Syed All	45 s.	SSC	Imam	Local	Good understanding on flood warning
04	Mr. Soin Uddin	Ufaz Uddin	45 yrs.	viii	Farmer	Local	Poor knowledge on flood forecasting
05	Md. Khabir Uddin	Late Altaf Uddin	55 yrs.	SSC	Service	30 yrs.	Cent: 01716487675 Superior communicative skill
06	Mr. Ujjal Miah	Md. babul Miah	30 rs.	vii	Business	Local	
07	Mr. Nimai Chandra	Late Profullah Chandra	51 yrs	SSC	UP secretary	Local	UP activity biased

Key informant information collection checklist was prepared according to the objective of the research study (Attached as Appendix-2A). The field information was carried out during Dec. 05 to Dec. 09 2009.

4.6 Consultation with UDMC

Two consultation meeting were arranged in two union parishad offices (Chak Mirpur & Jiyanpur). A brief checklist was prepared for consultation meeting emphasized on: *flood warning perception, availability of flood warning message, understandability, accuracy/trust,*

use, fulfilling ***need and dissemination.***

On December 06 2009 first UDMC **consultation meeting was arranged at Jiyanpur union parishad** office and **the second one was arrange** on Dec 09 2009 **at 6 no**. **Chak Rahimpur union parishad** office **premises**. **Location**, **venue and list of attendance as follows:**

UDMC consultation	**List of Participants**	**Designation**
meeting **Jyianpur Union** Date: 06/12/09	1. Md. Shamsul Haque	Chairman of UP
	2. Md Rahman Sheik	Member, UP
	3. Mrs. Azizunnesa	School Teacher, Member
	4. Md. Akram Uddin	UDMC
	5. Md. Abdul Baset	**Imam**, Member UDMC
		Secretary, UP
6 No. Chak Rahimpur Union Date: 09/12/09	1. Azizul Haque Montu	Chairman of UP
	2. Md. Abdul Latif	Member, UP
	3. Mrs. Paru Rani Fouzder	Member, UP
	4. Billal Uddin Akand	Member UDMC

Check **list used** for UDMC consultation **meeting attached** as Appendix-2B and formation of UDMC **and it role according** to SOD as Appendix-3.

UDMC **consultation meeting at** UNO office & Union Parishad office

4.7 Institutional Focus Group Discussion

Three Institutional Focus Group Discussion (IFGD) were set at Manikganj Water Development sub-division office, Daulatpur Upazila Project Implementation (PIO) office and Daulatpur Govt. Primary school office. A concise checklist was prepared for IFGD emphasized on: *flood warning perception*, *availability offlood* warning *message*, *understandability, and accuracy/trust*, *use, fulfilling need, functioning of UDMC and* *dissemination system*.

IFGD at BWT)B sub-**division** office, **Manikganj**

Location **and list** of attendance **as in three** IFGD as follows:

Institutional Focus Group Discussion	**List of Participants**	**Designation**
Date: 09/12/09 Manikganj Water Development sub-division office (Daulatpur Upazila under **their jurisdiction**)	1. Md. Shamsul Haque 2. Md. Rahman Sheik 3. Mrs. Azizunnesa 4. Md. Akram Uddin 5. Md. Abdul Baset	Chairman of UP Member, UP School Teacher, Member UDMC Imam, Member UDMC Secretary, UP
Date: 09/12/09 Daulatpur Upazila Project Implementation (PIO) off ice	1. Azizul Haque Montu 2. Md. Abdul Latif 3. Mrs. Paru Rani Fouzder 4. Billal Uddin Akand	Chairman of UP Member. UP Member, UP Member UDMC
Date: 07/12/09 Daulatpur Govt. Primary school office.	1. Mr. M.M. Sahajahan 2. Mrs. Sapna Rata 3. Md. A.K. Azad 4. Mrs. Ramija Khatun	Head Master Teacher Statistical officer Peon

Check **list used for Institutional Focus Group Discussion** (IFGD**) attached** as Appendix-2C

IFGD at Daulatpur PIO office

IFGD at Daulatpur Primary School

4.8 Confines of following Methodology

A good number of NGO's are working in the study area from long past and the people and the institutions are seemed to be albeit annoyed with this sort of study. Problems encountered in following methodology are summarized below:

- The researcher noticed that the key informants are always focusing on his own domain. Sometimes too negative, occasionally too positive and always an intention to blame institutions and government systems.
- It was difficult for the researcher to get key informants appointment more the 30 minutes though the check list requires about 1 hour time to collect full information.
- The field information collection time was in winter season (December) but the research topics was on "Flood Warning and Dissemination" that's why informants has to re-call their memory and sometimes it was *Fun* to them as the researcher working on flood in winter season.
- UDMC and institutions were reluctant in providing information to a student for his research purpose. They are more enthusiastic with survey/study from where they will get project/ financial benefit.
- The concerned institutions officials are busy with their normal activities and it was very intricate for the researcher to arrange meeting where the officials do not find any significance. The researcher has to postpone two IFGD and one UDMC meeting.

Chapter 5
Results and Findings

5.1 Flood Warning Message

5.1.1 Communities Perception of Flood Warning Message

Flood warning is expected to "translate" a physical observation (e.g.: surpassed water level, or "flood threshold") into a stimulus triggering a specific response, possibly pre-formatted (individual or collective disaster response). Since a so-called "zero risk" situation cannot be obtained, nor reached, one of the major functions of flood warning therefore is to care for existing "residual risk". This **is the risk that theoretically remains after all other flood mitigation and control measures (structural and non-structural) have been taken. In that sense, flood warning is expected to enable society to provide a timely disaster response.**

The summation up views of the key informants on Flood Warning Message and its Understandability are summarized in Table 5-1.

-1: Summarized views of the key informants

Topic/Item	Views/**Response**
Flood Warning Message:	• The flood warning messages are not generally available to them until they collect it for their own interest.
Availability	• Farmers did not get any type of flood information from the upazila or union parishad.
	• Depends on severity of flood; during severe flood they used to get flood warning messages.
	• During flood time they get it from different source but are not aware of FFWC as the mandated government office to prove flood warning message.
Trust	• In general they have trust on flood warning message but conclude with the comments that "everything depends on almighty Allah".
Use & Sharing	• They use flood warning message for different purposes.
	• Suggested disaster managers and government officials to use flood warning message for relief and rescue.
	• Always share with family members, sometimes with friends and relatives and rare with UDMC.
Benefit	• Removing household property, cattle and poultry
	• Taking precaution

	• Moving to a safe place • Saving crops (harvesting)
Accuracy	• Flood warning message seems accurate
	• They are not aware of accuracy
	• They never calculate accuracy
Understandability	• Farmers did not understand the existing formal warnings and they could not relate the information within their local
	• They did not understand the language and meaning of national media on flood-related issues.
	• They could not relate the national warnings within their local context.

The synopsis of both the UDMC consultation **meetings on flood** warning **message** is briefly **sum up** in Table 5-2.

TQUIG J-L. Surnrtariz**ed result of UDMC consultation meetings**

Topic/Item	Views/**Response**
Observation of Flood Warning	• Advance flood warning possible
	• NGO's are working in this field and we can understand the technique of flood forecasting
	• Everything under sole control of almighty Allah but yet man can forecast accurately for few days not more.
	• Flood warning is good if you can provide it accurately
Availability	• We get it from Upazila project implementation office (PIO) office
	• We are concerned about it and got it from radio, TV and newspaper
	• We UDMC committee arrange meeting on flood so we have to be aware of flood warning.
	• Upazila office and NGO's are our main source of flood warning message.
Understandability	• NGO peoples have trained us and now we understand well.
	• Flood warning board will be better for understandability
	• Bangla language is preferable for flood warning message
	• Whether flood water will increase/decrease is important for us
Trust	• We work on it and we believe.
	• Now people have believe on it
	• Last few years flood forecast were accurate so we have a good trust on it

	• We have to trust it as we are part of government.
Accuracy	• Sometimes flood forecast accuracy good and sometimes bad.
	• Overall accuracy acceptable
Use	• Flood warning messages are useful for us
	• When flood water starts rising we have to arrange UDMC
	meeting.
	• We are peoples representatives, we have to collect warning
	message and serve the people accordingly
	• Removing household property, cattle and poultry
	• Save lives and property
Fulfilling Need	• Fairly fulfills our needs but more lead-time expected.
	• Failed to meet the need of farmers as they require medium to
	long range forecast
	• It would be better if forecasts are provided at the stating of
	monsoon season
Remarks	• Flood warnings are beneficial to all
	• We UDMC need fund to work for the distress people during
	flood time
	• More relief and rehabilitation works require during and after
	flood disaster
	• UDMC needs to be more empowered financially to deal with
	flood

The synopsis of three Institutional Focus Group Discussion (IFGD) on flood warning message is briefly sum up in Table 5-3.

hole J-J: ... of inetitntinnnl Focus Group Discussions

Topic/Item	Views/**Response**
Observation of Flood Warning	• We are aware of flood warning system and with the help of modem technology flood warning is possible
	• Flood forecasting and warning center of BWDB is providing flood warning message during flood time
	• Flood warning is possible for short lead-time, long lead-time is not possible
	• **Institutions** dealing with maintenance of infra-structures will be more benefited from flood warning.

Availability	• We are not receiving any flood warning mtormation airecuy
	from FFWC
	• Now we have internet connection (installed by CDMP Psase-1)
	and we will get it regularly
	• We collect it for our own interest depending on flood severity
	• We used to get message from Radio, TV and Newspaper
Understandability	• Not enough understandable, relation between centimeter and
	inch preferable
	• Warning message in Bangla will be more clearly understandable
	• The basic need of the people is to know weather the flood water
	will rise or fall
	• Now people are more aware and can understand flood warning
	message
	• More awareness campaign required.
Trust	• Flood warning message trust worthy, we have trust on it
	• As a government office we are part of it and we have to trust it
	• Flood warning message based on science and technology and it
	seems fairly correct to us.
	• Previous warning messages were correct and we have a good
	trust on it.
Accuracy	• Overall accuracy within acceptable limit
	• Flood water is coming from upstream (India, Nepal & China) so
	accuracy depends on flood information from neighboring
	countries
Use	• We use it, specially for repair and maintenance flood warning
	message has a great role
	• We do not have any idea of using by general people
	• Fund required during flood time to use flood warning message
	• We use it in maintenance of local infra-structures
	• Intelligent people use it but lazy and foolish one does not care
	about it.
Fulfilling Need	• We need more lead-time of warning message then it will fulfill
	our need
	• 15 days lead-time required for farmers
	• 3 days lead time is enough for institutional preparation

	• **Our needs are not fulfilling fully, elaborate warning message with more lead-time required.** • **We are not aware of fulfilling the need of general people**
Functioning *of UDMC*	• UDMC **only works during severe flood**
	• We are **not aware** of UDMC's activities, they **never function well**
	• **More interested for relief works**
	• **Functioning** of UDMC largely **depends on** the role of UP **chairman**
Remarks	• **Flood warning message should be in Bangla**
	• **More lead-time required for our preparation**
	• UDMC's role is very **important and** they **needs to be strengthen** further.
	• **Some** NGO's **are functioning well**
	• **More awareness campaign and coordination among all agencies needed.**

5.1.2 Communities Expected Flood Warning Message

Summing up the communities expectation, a typical local flood warning message preferred by the community is presented in the box below:

Typical ***community prepared local flood warning*** ***message***

An urgent & important flood warning message. We have received information from flood forecasting and warning center & the Union parishd office and observed the trend of rise of water <River/Khal Name> near <Important Location> flood water has started entering through the low lying areas. The <Village road name> will go under water by next 2/3 days. Heavy rainfall as forecasted by meteorological department will deteriorate the situation in the next 2/3 days. Overall flood situation is alarming and flood water is likely to exceed <recent year flood record> flood level.

We request you to:

- Please follow FFWC's flood warning message
- Harvest your crops
- Please plan for evacuation if required
- Prepare Macha/Raise your house plinth level if possible
- Evacuate your cattle and poultry to safe place
- Keep chira, muri and other dry food for the family
- Always drink boiled water or water purified by alum
- Keep saline, medications, etc., ready

message. However, a user-based approach in forecast and warning design aims at matching information users and information needs. Traditionally, the forecasts produced by FFWC are mainly targeted to central and district level decision makers. When floods are approaching severe conditions, warning messages are produced for the use by common people affected by floods. Due to its nature, presentation, delay or any other characteristics, it is not well adapted to the local needs. Furthermore, on the basis of information such as a danger level in the river, many people are unable by themselves to take adequate steps of protection against flooding. Therefore, the study has focused mainly on information needs at community level. Expected added-value of this contribution therefore is twofold:

1. The objective is to explain why flood warnings are issued to the public. This usually triggers a complex social process. Clear understanding of this process is a key to a satisfactory design of both technical and "social" warning characteristics (such as: lead time, target audience, dissemination channel, message form and content).
2. How participatory processes and community involvement in particular, offer useful approaches and tools for a community-based, demand-driven (user-based) design of locally efficient flood warning systems?

It is recognized that credibility of the warning message is a product of the discipline of the forecasting organization, and effectiveness of a flood warning system increases if it succeeds in maintaining a continuous dialogue between warning users and authorities.

The following general guidelines and characteristics of flood forecasts and warning messages are suggested from the study.

- Forecasts should be made area specific; at least Upazila and, if possible, Union specific forecasts should be provided by FFWC. Upazila authorities should arrange interpretation of FFWC forecast in relation to its' unions.
- FFWC forecast message should speak about extent of rise or fall on the existing level of water and the extent of rise/fall of water should be mentioned in inch/feet in addition to cm/m.
- **The warning messages should be translated into local languages.**
- **Each** of the **flood-prone Upazilas should have a reference pillar**, with **a scale on it, in the open water** body **nearest to the Upazila complex.** FFWC should **forecast for the concerned** Upazila **in relation to its reference pillar that has connection** with the **nearest permanent gauge station** of FFWC.
- **The visualization of the flood situation on a national / regional map showing the area endangered** by likely **flood could be developed** and widely **disseminated nationally in**

the media. This type of information, if updated every day and nationally circulated through TV and newspapers, may fulfill the requirement in terms of flood warning. The field survey indicated that many people received information about floods from radio and TV or through indirect media such as market, mouth to mouth etc.

- In order to be effective in implementing mitigation measures, the flood forecasts and warnings should have one week's lead time.

Content **of flood forecast and warning**: Advance flood-warning messages should contain information on: type of flooding, time of flooding, level of flooding, severity of flooding, duration of flooding and areas to be inundated by the flood. It is also learnt that the flood warnings are useful only if they are associated with information related to possibility to evacuation to safe places and suggestions on how to handle the situation, if it is a disastrous one.

Accuracy **of forecasts and warnings**: Correct information on flood situation should be disseminated. Many respondents reported that sometimes they received a general radio message- "Flood is coming". But many times, the flood did not occur as per the forecast. This reduces the confidence of people.

Forecast lead time: Ideally, flood warnings at the Upazila/Union level should be available at least 5-7 days in advance in order to alert people including those living in the remote areas. This would allow them enough time to move to safety along with their essential goods, livestock, etc. Most significantly, farmers will get opportunity to take necessary steps for planting/harvesting of crops. However, in case of emergencies during severe floods situations should be handled as quickly as possible.

In summary, it is concluded that the forecast and warning messages are designed best by involving and consulting the users. Model flood warning messages depending on severity of flood has designed in **section 5**.4 negotiating community need/expectation and ability of FFWC and is expected to serve a multifaceted objective.

5.2 Dissemination

Flood warning dissemination at community level is a challenge to both flood forecasting authorities and flood prone communities. The whole process of dissemination can be addressed by three main considerations:

- Production and dissemination of warning
- Getting the warning to the people
- Measuring warning efficiency (feedback and impact assessment)

Flood warning production and dissemination can be described as a series of successive, interrelated technical and organizational actions. The classical approach considers the "warning chain" as a succession of interconnected elements. It is believed that this chain can be conceptualized as a complex socio-technical system, mixing scientific, technical, organizational and social factors with this in view to eventually producing the warning decision. Any flood warning system is subject to failure. A few threats are: limited availability of data, technical limits of modelling complex hydro-meteorological systems, limited communication networks, lack of organizational procedures for information exchange, coexisting different professional "cultures" and "languages" among warning practitioners, misunderstanding of warning by receivers, lack of interaction with grassroots level for real-time information exchange, etc.

5.2.1 Communities Perception on Flood Warning Dissemination

For a flood warning dissemination system to be effective, the community should be prepared. They should understand the meaning and relevance of warnings, how they relate to their lives, and what responses are appropriate according to the magnitude and characteristics of the flood that has been predicted.

The summation up views of the key informants on Flood Warning Dissemination is summarized in Table 5-4.

Table D-4: Summarized views on warnin dissemination

/Item	Views/Response
Dissemination:	• Existing mode of dissemination is not functioning well
Existing	• Dissemination source/responsibility is not clearly identified
	• Who is mandated for dissemination at grassroots level?
	• No dissemination system exists in community level
	• FFWC disseminate up to upazila level then is a gap from upazlia to community.
	• We collect information from different source and sometimes create confusion of reliability.
Prepared	• Community involvement suggested
	• UDMC should play key role in dissemination from Upazila to community level

	• UDMC could be dependable and sustainable institution of
	disseminating flood warning message
	• Different institutions in the community like Schools,
	Madrashas, social organizations; NGO's can be involved for
	community level dissemination.
	• Imams of Mosque at each community would be a preferable
	dissemination agent
Remarks	• NGO's involvement in dissemination is highly discouraged.
	They function well as long as project/money is available and
	their activities are biased and commercial.
	• For sustainability and to ensure accountability, permanent
	institutions already exits in the community need to be
	involved in dissemination of flood warning at community
	level.

The synopsis of both the UDMC consultation meetings on flood warning dissemination is briefly sum up in Table 5-5.

Summarized result of UDMC consultation **meetings**

Topic/**Item**	Views/**Response**
Present	• Present dissemination system functioning well, we UDMC is
Dissemination	working hard to disseminate at community level
	• Sometimes we are not getting information from Upazila right at
	time
	• We get flood warning information from NGO's
	• When flood starts people used to watch TV, read newspaper to get
	flood information and warnings.
	• Clear responsibilities are not defined for dissemination from
	upazila level to community level
	• Present dissemination needs to be strengthening further.
Prepared	• Flood warning information should reach to UDMC directly
Dissemination	• We are the grassroots level government institution and elected by
System	
	the community but unfortunately our strength is unused in
	manifold. We can serve well at community level.
Remarks	• Flood warning dissemination is not enough, what to do and how to
	do should be clearly identified from Upazila administration.
	• Presently dissemination is everybody's business means nobody's

business. Responsibilities of dissemination should be clearly identified.

- Fund is required for UDMC for dissemination of warning message.
- Imams of Mosques can be used effectively for warning dissemination. Still Imams has a good face value to the community.
- Parallel to warning dissemination, more relief and rehabilitation is required.
- Coordination and cooperation is required among all agencies.

The synopsis of three **Institutional Focus** Group Discussion (IFGD) on flood warning **message dissemination** is briefly sum up in Table 5-6.

Table 5-6: **Summarized** views **of Institutional** Focus Group Discussions

Topic/**Item**	Views/**Response**
Present Dissemination	• Present system is not functioning well. We remain busy with our own responsibilities and nobody send it to us directly. Sometimes we collect it for our own interest.
	• During flood time we browse FFWC website and receive flood information
	• Nobody send it to us rather we collect it.
	• Improvement required in present dissemination system.
Prepared Dissemination System	• Flood information should reach at all institutions at Upazila level directly.
	• Relevant institutions needs to be equipped with computer and internet facilities so that they can get flood warning directly
	• FFWC can develop system to send SMS to concerned Upazila level officials directly
	• UDMC's network can be effectively used for dissemination from Upazila to community level.
	• Different institutions at community level can disseminate warning message.
	• A clear cut responsibility, accountability and monitoring system required at Upazila level for dissemination at community level.
Remarks	• If FFWC can reach Upazila level successfully then the institutions working at Upazila will be able to disseminate at community

level.

- Dissemination system needs to be enhanced
- Broadcast in radio, Television should be more elaborate regarding flood warning message
- Warning message should be in Bangla for clear understanding.
- UDMC needs to be strengthen
- Flood warning message in not enough, officials have to go for action to reduce damage and sufferings.
- Coordination and cooperation required at all level
- Lump sum allocation for UDMC is essential for this service.

5.2.2 Communities Expected Flood ***Warning Dissemination***

Summing up the communities anticipation, a typical local flood warning message ideal for the community is presented in Figure 5-1.

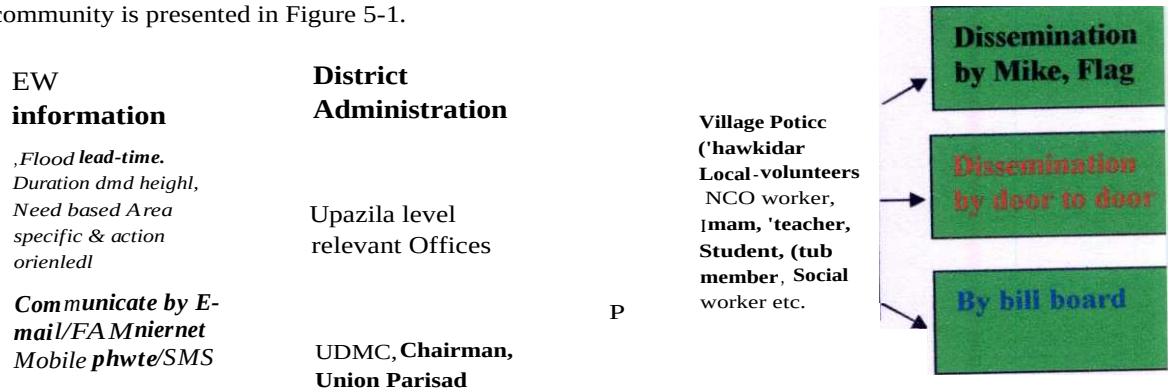


Figure 5-1: **Communities demanded flood warning dissemination process**

5.2.3 *Flood* ***Warning Dissemination****: a socio technical process*

Dissemination of a flood warning can be described as a socio-technical process involving different disciplines, stakeholders, and decision-making levels, degrees of uncertainty, scales and territories. The three main components are: a) a communication system, b) a decision

process, and c) a warning process. The key elements and "dimensions" of a flood warning dissemination system are:

- Technical dimension: data collection; forecast generation; warning dissemination
- Communication dimension: receiving warning information; understanding the message; valuing the information;
- Action dimension: knowledge of action to be taken; time constraints; decision-making capacity to act.

Flood warning can be seen as a social construct, since the warning message usually serves as a starting point for individuals and groups to make decisions and take protective actions when confronting the flood threat.

Before they make their decision, receivers usually process the warning message according to a series a phases that Fitzpatrick and Mileti (1994) describe as follows:

1) hear the warning;
2) understand the message;
3) believe the message content;
4) personalize the information (the receiver recognises that he/she is in danger); and
5) decide and respond (action-taking in front of the flood: protection, evacuation, and search for additional information).

Yet, there exist a series of factors affecting the efficiency of this process as shown in Table5-7 (adapted mainly from Fitzpatrick and Mileti, 1994; Affeltranger and Bogardi, 2000).

Table5-7 Factors affecting the efficiency of flood warning dissemination process

Processing phase	**Affecting factors (examples)**
1 - Receiving	a) Technical factors: weak communication networks for dissemination and reception; unequipped remote areas
	b) Individual factors: weak attention; "selective" listening; lack of education.
-Understanding	a) Unknown language (local dialect)
	b) Message discourse: too technical; lacking references to receiver's environment
	c) Technical misunderstanding of the event involved (danger level)
	d) False interpretation of threat intensity (under- or overestimated)
3 - Credibility	a) Socio-political factors: challenging legitimacy and credibility between information sources (authorities, relief forces, relatives, community members and leaders, media); public distrust towards authorities and institutions; group behavior

	b)	Individual factors: contradiction between warning content and personal observation at local level; worldviews; personality
4 - Personalization	a)	Reduced appropriation of the threat (for oneself, one's family, one's community); affective relationship to the hazard
	b)	Misunderstanding of the geographical distribution of threat and disaster impacts
5 - Decision & Action	a)	Unawareness of individual safety instructions (escape routes, location of shelters, self-protective behavior)
	b)	Unawareness of authorities' disaster management measures; lacking dispositions to save inhabitants' belongings and cattle; unprotected houses and plots of land
	c)	Empirically built "coping mechanisms", that reveal unfit to the disaster situation at hand (e.g.: different flooding characteristics and patterns)

In addition to the above-mentioned factors likely to affect the "technical" efficiency of flood warning dissemination, a series of parameters that are found to co-vary with the eventual efficiency of a given warning (usefulness to warning recipient to make decisions and take actions when confronting the threat) are presented in Table 5-8. Fitzpatrick and Mileti (1994) break down these parameters into two categories: "sender determinants", and "receiver/situational determinants". These factors interact with risk perception, and influence behavior of people receiving the flood warning.

Table 5-8 Parameters interacting with dissemination process

Sender determinants	Receiver/ **Situational determinants**
a) Source of the **warning information**	a) Visibility of risk at local level
b) Consistency of the warning **message**	b) Inscription of warning receiver in social networks and information flows
c) Accuracy of the **message**	c) Socio-demo graphic characteristics of warning receiver
Clarity of the emergency information	d) Socio-economic characteristics of warning receiver
Certainty level of the message	e) Receiver's psychological dispositions
Quantity of information carried	f) Receiver's memory of risk
Guidance and instructions (safety)	g) Risk tradeoffs and "competing vulnerabilities"
Frequency of warning updates	
Location (geographical) of information	
Dissemination channel of the warning	

Of the many problems related to an effective dissemination of flood warning to the users at grassroots level, the most difficult is the means of communication to and within flood affected communities. Relay of warning messages to Upazila levels have been achieved satisfactorily but the problem remains from Upazila level to community level.

In summary, it is concluded that the forecast and warning messages are like cooked food and has to be serve before hungry people right at time. Effective dissemination is *"serving"* and deserves great care. Negotiating with community need/expectation and available information channel also ability of FFWC, a model flood warning dissemination procedure has designed **in section** 5.5 and is expected to serve at community level well.

5.3 Institutional Analysis

In Bangladesh, a number of national and local level agencies are involved in generating and disseminating flood-related information. However, there still exists the need for more comprehensive and adequate information to be produced and delivered at the right time to the people and agencies needing the information. The agencies currently operating in flood monitoring, prediction, and mitigation are both national and local.

At the national level, FFWC is responsible for producing forecast related information and for disseminating it to national and local level agencies. FFWC receives information from other organizations such as BWDB, BMD, SPARRSO, and WMO. The forecast information is distributed first to the prime minister's secretariat, then to the president's secretariat. By the end of each day, FFWC disseminates the forecast information through fax, radio, television, and their website to other relevant agencies at the national and local levels.

The relevant local level organizations can be divided into three tiers. At the topmost tier are the district level offices of organizations including BWDB, DMB, BMD, BIWTA, LGED, BARC, DAE, and the office of the deputy commission. The responsibility of the district level offices is to disseminate the forecast information and to take part in post-flood relief activities. DMB assumes responsibility for disseminating flood information with assistance from other organizations. There is little dissemination of monitoring or base information through these institutions.

At the next tier is the upazila administration, including upazila staff of LGED and local NGOs. Dissemination of flood information as well as activities relating to flood preparedness and post-flood relief and rehabilitation at this level are carried out under the leadership of the Upazila Nirbahi officer. The NGOs play a role in disseminating information to vulnerable people through their own networks.

The bottom tier of local level organizations are the union parishads (local government comprising of elected councils with a chairman and 12 ward members) that have an important role in the dissemination process. Local NGOs and other local level organizations also have an important role to play at this level.

In August 1999, the Disaster Management Bureau, Ministry of Food and Disaster Management of the Government of Bangladesh prepared standing orders on disaster. These standing orders clearly identify and distribute the roles and responsibilities of different organizations. The purposes of the standing orders are:

1. To reduce the loss of life and property.
2. To alleviate the suffering of people affected by natural disasters.
3. To provide guidelines to different departments at the national, divisional, district, upazila and union level government, and non-government agencies for actions to be taken at different stages of a disaster, e.g., before, during, and after the disaster.
4. To clearly spell out what is to be done, when and by whom, at different stages of the disaster.

5.3.1 Role of Agencies

The standing orders on disaster states that the following council and committees will be responsible for policy formulation and coordination of disaster management at the national level:

- National Disaster Management Council (NDMC)
- Inter-Ministerial Disaster Management Coordination Committee (IMDMCC)
- National Disaster Management Advisory Committee (NDMAC)

The NDMC headed by the Prime Minister, and IMDMCC, chaired by the minister-in-charge of the Ministry of Food and Disaster Management, are to ensure coordination regarding disaster management activities at the national level. Coordination at the field level is to be carried out by respective district, upazila, and union disaster management committees headed by the deputy commissioner, the UNO, and the chairman of the union parishad respectively. The institutional arrangement for disaster management is shown in Figure 5-2.

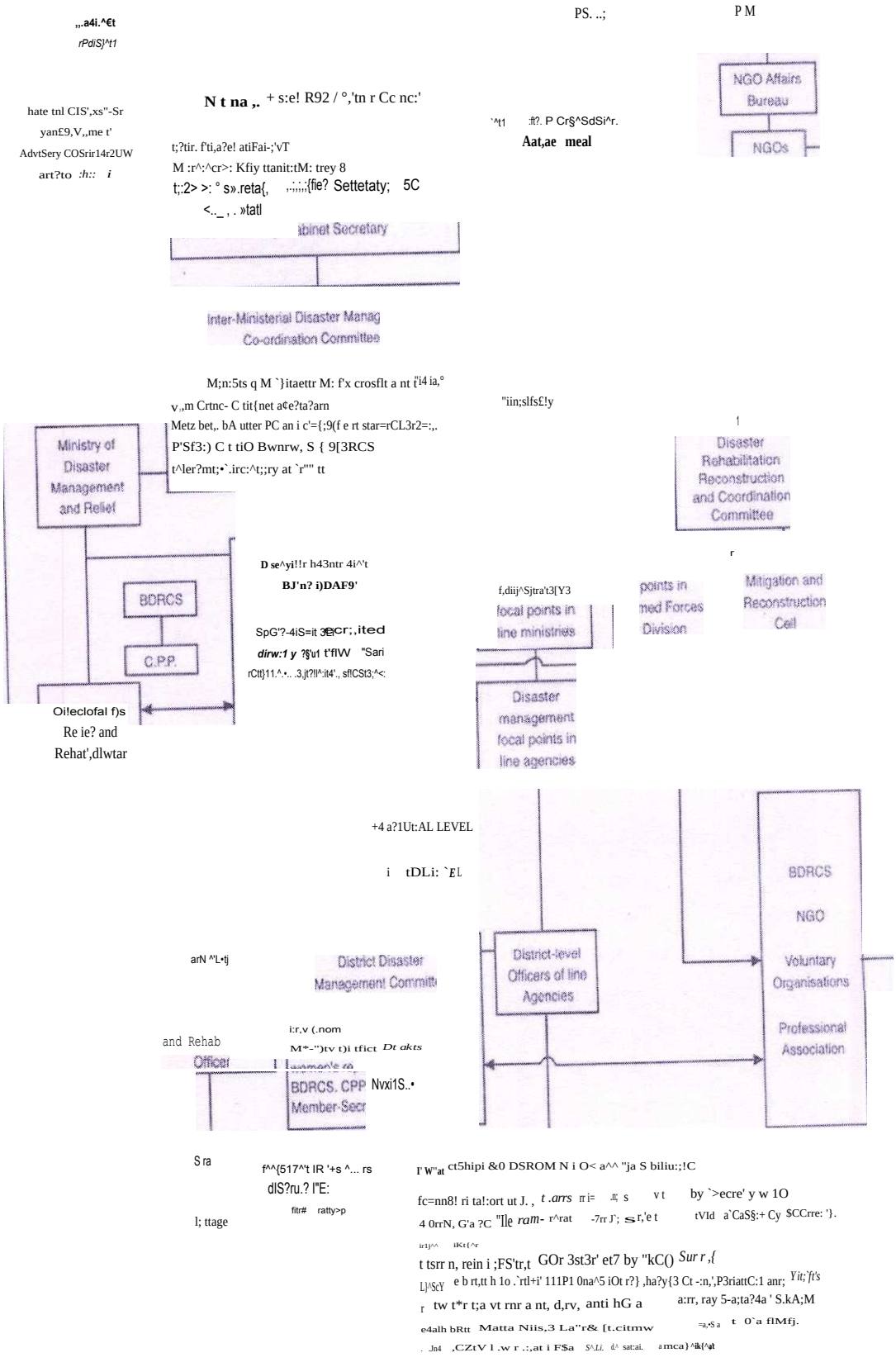


Figure 5-**2: Institutional arrangement** for disaster **management** in Bangladesh (Rahman, 2006)

According to the Standing Orders, 23 ministries are closely involved with disaster management, including the ministries of: Disaster Management and Relief; Water Resources; Information, Health and Family Welfare; Food, Agriculture; Fisheries and Livestock; Civil Aviation and Tourism; Defense, Home Affairs; Communications; Shipping; Housing and Public Works; Social Welfare; Local Government Rural Development and Cooperatives; Foreign Affairs; Finance; Industries; Education; Commerce; Post and Telecommunication; Power Energy and Mineral Resources; and Environment and Forests. Each ministry has its own action plans and responsibilities regarding disaster management. The standing order also describes the duties of other ministries as well. The roles of the key agencies closely related to flood management are summarized in Annexure-3.

Notably the Disaster Management Bureau is to "establish and coordinate all activities related to flood forecasting and warning dissemination". BWDB is to "ensure an efficient flood forecasting and warning system." The mass communication department is to "keep the people of the disaster prone areas informed through different publicity media about their duties at these stages," and the meteorological department is to "ensure full time effectiveness of the quickest channel of communication for disseminating weather warnings to all concerned".

Some of the institutions that can be potentially involved with flood warning dissemination have some intrinsic limitations and shown in Error! **Reference source not found..**

BWDB: Have a communication system up to the district level but there is no formal staff and office below districts, except in projects. Deployment of any additional staff, dedicated to flood warning dissemination, would not be cost effective as the activities are not year-round.

NGO: Have communication means that can quickly disseminate message downward but have little coverage and moreover, communication means of all the NGOs are not homogeneous. NGOs operate on a project to project basis and are heavily dependent on external financial supports.

Local Government **Institutions** (LGI): Have a wide network (office and people) all over the country in Districts, Thana, and Union. But they are not mandated for flood warning dissemination and have no quick inter-communication means between District, Thana and Union.

DMB: Have a set up at national level that becomes active once a disaster has been declared. They communicate through the general administration using the services of the Police (wireless) for interaction in the management of a disaster. At District, Thana and Union levels a committee may be formed as per the Government Standing Order but there is no mandate for activation before a disaster.

Table 5-9 Strength, weakness and sustainability of institutions affiliated to flood warning

	Strength	Weakness	Sustainability
Institutions			
BWDB	Strong technical capacity, mandated for flood forecasting	No grassroots office Limited mandate for dissemination	Yes
NGO	Interested, motivated	Institutionally heterogeneous, need financial support	No
LGI	Good coverage	No quick means of communication, need financial and materials assistance, need mandate	Yes
DMB	Can use the quick means of communication	Becomes active only when a disaster (flood or cyclone) has been declared.	Yes

5.3.2 Institutional Arrangement

a) Source to district: Flood Forecasting and Warning Centre (FFWC) is mainly responsible to disseminate flood warning message to the people. FFWC disseminate the flood warning message to Prime Minister Office, all ministries, disaster management bureau, district commissioners' office and mass medias everyday though email, fax, telephone. Due to the accessibility of the mentioned communication tools (phone, fax, website, **e-mail), it is** possible to ensure warning message for different level agencies.

The role of District Disaster Management Committee (UDMC) is very important in dissemination of flood warning message to the community. But the reality is different. For lack of operating skill and proper maintenance, mentioned communication tools become useless during flood. Though FFWC has a well-designed website with update information on flood, it is also not accessible for the same reason. As a key organization of the government, DMB still do not play the important role in terms of ensuring the warning dissemination.

Most of the time in emergency, on behalf of DDMC, District Relief and Rehabilitation Officer (DRRO) sends the warning message to the upazilas in a asymmetrical manner.

b) District to Upazila: As FFWC do not send the flood warning message to the upazila level directly those do not have internet or FAX facilities, DDMC is the nearest source for those upazila for getting the warning message. Though it is not mentioned in the SOD; as the key representative of UzDMC, usually Upazila Nirbahi Officer (UNO) or Project Implementation Officer (PIO) plays vital role in getting and disseminating warning message at local level. But unfortunately it was found through pilot testing that some of the positions of UNO and PIO are vacant. In that case, some local government officials from another place act as replacement. Some of the government agencies especially Department of Agricultural Extension (DAE), Ansar VDP, Department of health also get warning message irregularly from their respective district level line agencies. Considering the effectiveness of the communication, it was found that telephone and cell phone are the best tools. Some of the upazilas have fax and e-mail facilities but due to lack of maintenance and skill, those are not accessible for emergency communication.

c) Upazila to Union: UzDMC is the nearest source for union level as well as Union Disaster Management Committee (UDMC) for getting flood warning message. Though it is not mentioned in the SOD; as the key representative of UDMC, usually Chairman or Secretary of the Union Parishad plays vital role in getting and disseminating warning message at community level. But it is also found through the pilot study that the Chairman and Secretary of Union Parishad are always busy with other development activities. So most of the time they cannot not pay their full attention to disseminate the warning message during flood. At the union level cell phone is the most effective communication tool for warning dissemination.

d) Union to Community and household: Dissemination of flood warning message from Union to community and household level is the most challenging. Addressing the challenge, ward members of the Union Prishad are identified as the key persons for getting and disseminating warning message to the warning dissemination groups, community and household as well. At the same time, change religious leaders as Imam of the mosques, teachers of the educational institutions, field level government officials, NGO workers, representatives of the local market committees are identified and used as agents for disseminating the warning message at community level. Every member of the union pan shad do not have the cell phone access. Even If they have any, due to network problem dissemination flow of warning messages is disrupted. Some extent, they feel that the cell phone calling charge is an extra burden for them. It is also found that the performance of the

local agents is enthusiastic. Without any financial benefit they are always ready to act. Mosques, temples, educational institutions, local hat-bazar are identified and used as most effective warning dissemination places. Microphone of the mosque, handmade mike and drum/ Cl sheet biting are successfully adopted as communication tools for disseminating flood early warning at community level.

5.4 Design Model Flood Warning Message

A negotiation between communities demanded flood warning **message** format and ability of FFWC as well as advancement of science in this field was obvious. A compromised model flood warning **message** hereby designed considering the technical ability of flood forecasting and warning center. Flood warning **messages** are largely depends on **intensities** of flood and classification. Broadly flood categories classified as:

- Medium Flood
- Severe flood
- Widespread and very severe flood

5.4.1 Model Message for Medium Flood

FLOOD WARNING FOR IMMEDIATE BROADCAST

This Flood Warning is issued by Flood Forecasting and Warning Centre Telephone (02) 9553118; 9550755, FAX: 9557386, E-mail: ffwc@ffwc.gov.bd, Web-site: www.ffwc.gov.bd, WAPDA building, 8th floor, Motijheel C/A, Dhaka-1000.

DISASTER MANAGEMENT BUREAU should IMMEDIATELY transmit this message to DISTRICTS.

BANGLADESH RADIO and TV should broadcast this Flood Warning IMMEDIATELY after every news bulletin.

A Warning of General Flooding for <list of districts> was issued at <time> on <day> <date>

The BWDB Flood Forecasting & Warning Centre reports that the River(s) <rver names> are rising and flowing Close to or above Danger Level.

River levels will continue to rise and areas of all Upazilas in particular <upazila names > Will Experience general flooding. This will affect low lying villages and may cause some property damage and disruption to local communications.

Flood water will inundate low lying areas during the next 24 hours. Damage to crops and culture fisheries are expected.

You should listen to the radio for further information. This information will be updated following the next news bulletin.

A Warning of General Flooding has been issued for <list of districts>.

5.4.2 Model Message for Severe Flood

FLOOD WARNING FOR IMMEDIATE BROADCAST

This Flood Warning is issued by Flood Forecasting and Warning Centre
Telephone (02) 9553118; 9550755, FAX: 9557386, E-mail: ffwc@ffwc.gov.bd, Web-site: www ffwc.gov.bd. WAPDA building, 8th floor, Motijheel C/A, Dhaka-1000.

DISASTER MANAGEMENT BUREAU should IMMEDIATELY transmit this **message to** DISTRICTS.

BANGLADESH RADIO and TV should broadcast this Flood Warning IMMEDIATEY after every news bulletin.

A Warning of Severe Flooding for <list of districts> was issued at <time> on <day> <date>

The BWDB Flood Forecasting & Warning Centre reports that the River(s) <river names> are flowing well above Danger Level.

FFWC forecasts predict that river levels will increase further over the next <...> hours. Severe Flooding will inundate large areas of all these districts during the next <...> hours.

Flooding will occur in many rural areas and may affect some towns. Damage to property is expected Roads railways, embankments and bridges are likely to be submerged and damaged.

You* should *remain alert and listen to the radio bulletins for further information. This information will be updated following the next* news *bulletin.

A Warning of Severe Flooding has been issued for <list of districts>.

For any further clarification, please contact immediate to Flood Forecasting and Warning Center's Flood Information Control (FIC) room.

5.4.3 *Model Message for Widespread and Very Severe Flood*

FLOOD WARNING FOR IMMEDIATE BROADCAST

This Flood Warning is issued by Flood Forecasting and Warning Centre
Telephone (02) 9553118; 9550755, FAX: 9557386, E-mail: ffwc@ffwc.gov.bd, Web-site: www.ffwc.gov.bd , WAPDA building, 8th floor, Motijheel C/A, Dhaka-1000.

DISASTER MANAGEMENT BUREAU should IMMEDIATELY transmit this message to DISTRICTS.

BANGLADESH RADIO and TV should broadcast this Flood Warning IMMEDIATEY after every news bulletin.

A Warning of Widespread and Very Severe Flooding for <list of districts> Was issued at <time> on <day> <date>.

The BWDB Flood Forecasting & Warning Centre forecasts that river levels will increase over the next <...> hours and will be close to highest recorded levels. There will be Catastrophic Flooding inundation **large areas** of all these districts during the next <...> hours.

Flooding in rural areas will worsen and will sfread into many areas of the towns and cities. Water levels are expected to remain high for many days.

Serious damage to property will occur and all communications will be seriously disrupted. Further damage to roads, railways embankments, bridges and other structures will occur. Watch and take care of flood embankments.

You should remain alert and listen *to radio bulletins for further information. This information will be updated following the next* news *bulletin.*

A Warning of Widespread and Very Severe Flooding has been issued for <list of districts>.

For any further clarification, please contact immediate to Flood Forecasting and Warning Center's Flood Information Control (FIC) room.

5.5 Design Model Flood Warning Dissemination

Of the many problems related to an effective dissemination of flood warning to the users at grassroots level in Bangladesh, the most difficult is the means of communication to and within flood affected communities. Relay of warning messages to Upazila levels (those have access to internet &FAX) have been achieved satisfactorily. The process of dissemination is clearly a combination of mandates of Government agencies and committees established by the Government and the availability of proper communication facilities at different levels. A simple dissemination flow diagram from Source to Community level shown in Figure 5-3.

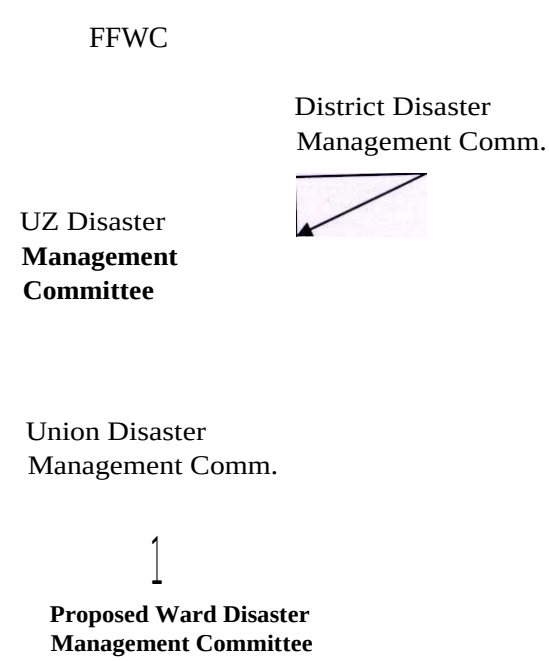


Figure 5-3: Simple Dissemination flow diagram from Source to Community level

Some specific suggestions are listed below which will ensure flow of dissemination from source (FFWC) to community level.

1. **The existing disaster management committees at local levels (District, Upazila and Union) under the co-ordination of DMB should be strengthened and equipped with**

communication facilities (Fax, E-mail). BWDB technical staff should assist in the interpretation of the warning messages for wider distribution.

2. FFWC should communicate the message to DMB and DMB will disseminate it to Upazila Public Information Officer (PIO). PIO will disseminate the message to the end users.

3. There has been a rapid diffusion of radio and television throughout the country. This reveals the possibility of electronic media for dissemination of flood forecasts and warning messages. People are also becoming increasingly aware of this potential media. During flood time a daily radio/television broadcast of 5 minutes on flood may be arranged covering 1) Flood forecasts & Warning messages from FFWC; and 2) Dos and Don'ts in pre flood situation, during flood and in post flood situation. This would be one of the most suitable methods of dissemination of flood forecasts and warning messages in general.

4. The Internet is a reliable and cost effective means of communication. Upazila specific flood forecasts and warning messages could be downloaded at the Upazilas by the Upazila Nirbahi Officer (UNO)/Upazila Disaster Management Committee (UzDMC) from the FFWC web site. It is expected that each UNO office will have an Internet connection soon.

5. For effective implementation of any improved dissemination method, responsibilities should be delegated very specifically and should be mandated through governmental circular or ordinance.

6. UDMC will disseminate the forecast and warning message through committee members, Chowkiders, volunteers, etc. using loudspeaker, words of mouth, siren, inter-personal contact, etc.

7. The Upazila is the main the main gateway of the whole process of flood information dissemination to lower levels. Hence, the Upazila offices should be strengthened and their mandates should be made clear. Institutions from Upazila down to Ward are well-established formal public institutions that are meant for public services and trusted by the people.

8. Except at the ward level, disaster management committees are well established at all levels. It is suggested to establish Ward Disaster Management Committee (WDMC) in all the wards of a Union. Structure of proposed Ward Disaster Management

Committee. A Ward is more reasonably sized and well defined than a traditional village; each ward comprises a number of villages. Small villages may not have any elected Union Parishad (UP) representative, but each ward has at least one elected UP member. As regards to spreading the flood warning at the Ward level, it is suggested to use public loudspeakers and other local means such as:

- Public Loudspeakers - (i) broadcasts from local mosques by Imams; (ii) from mobile boats and vans; and (iii) from the high towers.

  Drum Beating - Drum beating at public places to draw the attention of people about the incidence of flood.

- Hoisting of Red Flags - Hoisting of red flags at most visible places of the community to convey visually the flood warning messages to the villagers. This could only be used during daytime.

- Erecting flood markers posts: Flood marker posts with explanation of colors should be erected at market places and at major village centers.

- Red Light Focusing - To keep the visual communication undisrupted even during night time, focusing by high-power red light is suggested. This will be something supplementary to the red flag when the flag will not be visible from remote places.

9. Local NGOs and other community based organizations should be encouraged to include flood warning dissemination as one of their core activities (during flood season) at Union levels.

10. In order to facilitate effective communication and interpretation of flood forecasts and warnings, it is suggested to create BWDB's Flood Cells at all flood prone districts.

Chapter 6
Recommendations and Conclusion

6.1 Findings and Recommendations

The findings and recommendations from the study are summarized below.

- Flood warning message should be made for specific areas; at least Upazila specific warnings should be provided by FFWC, and the UzDMC should arrange interpretation of FFWC warning in relation to its Unions with the assistance of available BWDB officials.
- One of the key findings from the study is that effectiveness of flood warnings would increase manifold if the warning messages accompany information regarding possible damages to house, property and crops; flood shelters; availability of relief materials; health and drinking water conditions; post flood rehabilitation etc.
- FFWC warning messages should include the information on the expected rise or fall of the existing water level and should be communicated in feet and inches in addition to m/cm. Each of the flood-prone Upazila should have a reference pillar, with a scale on it, in the open water body preferably nearest to the Upazila complex.
- Deterministic forecast lead-time should be increased to 5 days from existing 3 days. Ten days lead-time for qualitative forecast is most desirable.
- PIO at the Upazila and the Secretary of the Union Parishad must be trained in interpreting flood warnings to their local contexts and dialect.
- Awareness programs on flood forecasting and warning services for people of the flood-prone areas have to be arranged. Small meetings / brief training courses / focused seminars could be organized in this regard.
- The Upazila **headquarters should be the focal point of communication and dissemination of flood warning message.**
- Present Disaster Management Committees at Upazila and Union levels have to be strengthened, so that those could successfully construct and transmit the warning messages issued from FFWC. In this regard proper co-ordination and collaboration between FFWC and DMB has to be ensured.

- Communication facilities should strengthen for transmitting the flood warnings from FFWC to the Upazila. Flood warnings are to be transmitted from the FFWC to Upazila by 12 noon as UP office does not function well after 2 p.m.
- During flood time a daily radio and Television broadcast of 5 minutes (preferably just before prime news) on flood situation suggested. The program likely to cover 1) Flood forecasts and warning messages from FFWC; and; 2) Dos and Don'ts in pre flood situation, during flood and in post flood situations.
- During the threats of severe flooding, the PIO should have the authority to requisition the services of the Ansars / Chowkidars of UPs to carry urgent warnings to their respective areas.
- **Each and every community has at least a Mosque equipped with Mike** /Loud **speaker and peoples of that community used to come 5 times in a day for praying. Imams**/**Muazzins of local mosques with motivational training and small incentive can be used** very effectively **for flood warning dissemination at community level.**
- **Disciplined organization like Answer**, **Police, village police and community police should be integrated with the dissemination process.**
- **Dissemination of flood warning through cell phone voice service should be introduced by integrating the cell phone companies.**
- **A minimum funding supports should be provided** to the UDMC **as the operational costs.**
- **Manuals and handbooks should be prepared for flood warnings and dissemination.**
- A chapter/sub-chapter on flood disaster management should be included in national curriculum of science/social science/natural science subject at secondary school level.
- SOD should be revised by incorporating specific flood warning framework and responsibilities.
- For effective implementation of any step towards improved dissemination of flood warnings, responsibilities have to be delegated very specifically and should be mandated through governmental circular or ordinance.

6.2 Concluding Remarks

Designing appropriate flood warning message that effectively match recipients' needs of information when confronting the flood, requires not only accurate mapping of users, but also a clear understanding of social practices dedicated to protection and to relief. The following steps are suggested as a general methodology for community based design of flood warning:

1. Understand flooding patterns and flood-related social practice (including "culture of risk")
2. Map priority areas, target groups and valuable (economically and culturally) assets
3. Identify representative resource persons/organizations to be involved in the process
4. Agree on goals, method and outputs; build consensus on project planning
5. Identify existing threats, risk priorities and risk tradeoffs, if any
6. Identify reasons (technical, social and cultural) to weak efficiency of warning
7. Develop participatory design and testing of warning options; monitor implementation
8. Maintain communication and iteration (feedback with users) during the process
9. Sharing the consensus: involve the rest of the community and develop social ownership
10. Institutionalize feedback procedures and ensure sustainability/maintenance of the system

It is clear that national and local authorities (including BWDB and DMB) responsible for timely flood forecasting, warning and disaster management would largely benefit from a proactive, pre-flood assessment of the "social" relevance and usefulness/efficiency, of their flood warning strategy. Such a commitment

a) ¡mproves the characteristics of warning content, form, and dissemination features
b) helps authorities to win social support, sense of ownership, and increased visibility of their action
c) contributes to public awareness of risk, preparedness and eventually autonomy when confronting the flood.

The findings from the study provide an overview of what may look like an integrated initiative for improving social efficiency of the flood warning. Yet, it would be most welcome that any large-scale initiative be preceded by a series of demonstration projects, possibly relying on networks and know-how already available in the society.

set-up.

One common request among stakeholders is that the Disaster Management Bureau (DMB) should play a key role in the dissemination of flood warning to community level, as it is done during the cyclone disasters. FFWC and DMB co-operate regularly at official levels; flood bulletins are sent to DMB on a priority basis. However, DMB's mandate is such that it becomes active only after a flood situation has been declared as a disaster, at which time they tend to focus on organisation and monitoring of relief works. Only once the flood situation becomes catastrophic (severe flooding) does the DMB start to communicate with the affected people using the wireless network (of Police) from central to Upazila and Union levels.

Disaster Management Bureau (DMB) through its CDMP phase-I project is being implementing components 5a and 5b (Strengthening Early Warning Capabilities). Under these components some recommendable progress has achieved.

CDMP phase-2 will replace phase-I at early next year (2010). Hopefully activities taken under components 5a and 5b in phase-1 will be more focused and continue. It will be an immense boost up in flood warning dissemination at community levels.

It is recommended that the existing co-operation between BWDB and DMB be strengthened to create a working relationship in order to implement an operational flood warning dissemination system at community level through the flood season. It is expected that the Comprehensive Disaster Management Project (CDMP) phase-2 under DMB will emphasis on this issue as it did in its phase-1 activities.

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Based on the Standing orders on disaste', Luc ^^^N^=^=^••^^
flood or disaster are as follows.

Disaster Management Bureau

- Work as advisor of the government on all matters relating to disaster management and maintain liaison with all related organizations.
- Undertake various activities for creating awareness and reducing risks during disaster.
- Assist in the preparation and implementation of a framework for an Action Plan on disaster management at District, Upazila, and Union levels.
- Impart training to all related government and non-government employees and disaster management committee members.
- Establish an Emergency Operations Centre (EOC) with improved communication facilities and operate it 24 hours.
- Establish and coordinate all activities related to flood forecasting and warning dissemination.
- Monitor progress of rescue, relief and rehabilitation operations, identify the problems and needs and to draw the attention of the proper authority.

Directorate of Relief and Rehabilitation

- Ensure stock, security, **and maintenance** of adequate **materials** in disaster-prone areas.
- Open a Control Room in the Department and maintain link with the EOC of the Ministry.
- Inform the Ministry about relief preparedness in affected areas
- **Ensure** quick dispatch of relief materials **and grants** to affected areas.

Bangladesh Water Development Board

- Ensure an efficient Flood Forecasting and Warning system.
- Operate a "Flood Information Centre" from April to November every year.
- Collect, during the monsoon period, weather forecasts and water level of all principal rivers originating from different places in Bangladesh and India.
- Quickly assess the loss and damage and prepare required plans for repair and reconstruction work on priority basis.
- Ensure the restoration of infrastructure, logistics, and installations in shortest possible time for domestic, industrial and export use. Projects connected with agriculture, fisheries and industrial rehabilitation will be given top priority.
- Render assistance and cooperation in the rehabilitation programs of the civil administration and other agencies.

respect.

Bangladesh Television

- Establish contact with Meteorological Department and ensure proper functioning of telephone and teleprinter.
- Telecast special programs as authorized by the Meteorological Department and the Ministry of Disaster Management and Relief for information and action of the public.
- Telecast special precautionary **signals** of the Meteorological Department along with their meanings.
- Bangladesh Television must telecast on receipt of warning signal No. 4 along with explanation given by Meteorological Department every one hour and continue such telecast if advised by the Ministry of Disaster Management and Relief without any interval even after normal broadcasting hours. As soon as signal No. 3 is hoisted, Bangladesh Television will establish contact with the Ministry on a full-time basis for non-stop broadcast beyond normal broadcasting time.
- Dhaka Television shall telecast all announcements issued by the Ministry of Disaster Management and Relief and the Meteorological Department
- Announce instruction relating to precautionary measures issued by the Ministry of Disaster Management and Relief and the Meteorological Department.
- Telecast programs to keep the morale of the affected people high and short and long term programs regarding rehabilitation

Mass Communication Department

- To increase public awareness about disaster preparedness and response activities through video, cinema, films, slides, booklets etc.
- Take technical advice on the above subjects from the Disaster Management Bureau.
- Keep the people of the disaster prone areas informed through different publicity media about their duties at these stages.
- After the disaster, conduct publicity work in affected area with a view to keeping mental spirit of the people high and advise people of epidemic, self reliance in reconstruction work, general security, agricultural rehabilitation, etc.

***Directorate** of Health*

- Prepare medical team; arrange supply of medicine and other emergency goods.
- Operate the Control Room round the clock (24 hrs).

- Maintain a full-time liaison with the EOC of the Ministry of Disaster Management and Relief.
- Ensure appropriate preparedness planning of the three services in respect of the security of the people, establishment, equipment, installation materials, and transport in the cyclone/flood prone areas before the cyclone/flood season starts.
- Keep the appropriate units of Army, Navy and Air force in readiness for conducting rescue, evacuation, and relief operations as per requisition.

Meteorological Department

- Keep ever-careful watch over weather conditions, and ensure improvement of cyclone forecast procedures and supply of information on regular basis.
- Ensure full time effectiveness of the quickest channel of communication for disseminating weather warnings to all concerned.
- Issue as soon as possible the alert warning signals of cyclone, at least 36 hours ahead of formation of depression in the Bay of Bengal.
- Publicize warning **signals** for Cyclone at each of the following specified stages:

(a)	Warning	24 hours before
(b)	Danger	At least 18 hours before
(c)	Great Danger	At least 10 hours before

- The same warning signals are to be repeated to the EOC at the Ministry of Disaster Management and Relief, Control Room of the Disaster Management Bureau, the Directorate of Relief and Rehabilitation, the Cyclone Preparedness Programme and the Bangladesh Red Crescent Society.

Union Disaster Management Committees

Normal Times:

i. Arrange training and workshops on regular basis on disaster **issues** and keep the Disaster Management Bureau informed.

ii. Prepare a Disaster Action Plan with a view to enabling local people, Union authority and local organization to take up security arrangement in the perspective of imminent danger related warnings or occurrence of disaster.

iii. Take steps for quickest and effective publicity of forecasts/warnings relating to cyclone and floods, and informs people about their responsibilities of saving their lives and properties from disaster.

During Disaster

i. Organize emergency rescue work by using locally available facilities in times of need and if directed assist others in rescue work.

ii. Collect statistics of loss incurred in disaster in the light of guidelines of Disaster Management Bureau and Upazila Authority and send the same to UzDMC/Upazila authority.

iii. Take steps for distribution of articles for rehabilitation received locally or from the Relief and Rehabilitation Directorate and any other source following guidelines from the Disaster Management Bureau and UzDMC/Upazila authority.

Upazila Disaster Management Committee

Normal Times

i. To ensure increased alertness, disaster risk reduction and informing about ways of sure and effective survival.

ii. To arrange training and workshop on disaster related issues regularly by keeping the Disaster Management Bureau informed.

iii. To prepare a Disaster Action Plan in the light of warning signals for impending disaster, keeping in view whether Upazila authority and local organizations are prepared to meet the disaster effectively and efficiently

iv. To hold mobilization drills in cooperation with District and Union authority for intermittent publicity of information and warning signal/forecasts and of matters related to evacuation, rescue and primary relief operations in the interior of the Upazila.

v. To raise public awareness at the village level by wide publicity of disaster forecasts.

During Disaster

i. To operate an emergency operation centre (Information Centre and Control Room) for coordination of activities related to evacuation, rescue, and relief at Upazila level.

it. To prepare plans carefully for rehabilitation work at local level including possible arrangements for risk minimization.

iii. To allocate and distribute relief based on actual needs.

iv. To supervise the distribution work of relief and rehabilitation and to maintain its accounts and send the same to district authority and other relief donors.

v. To be responsible for coordination among different offices at Upazila level.

ii. To disseminate forecasts ana warnings u u►saNwi , aiiu ii, — -- 1—▮ them.

iii. To prepare a District Disaster Action Plan with a view to keep the District authority and local organizations well prepared to meet disaster effectively and efficiently in the light of warning signals about imminent disaster and the occurrence of disaster

During Disaster

i. To operate an Emergency Operations Centre (Information Centre and Control Room) for maintaining coordination of activities at all places in the interior of the district in respect of evacuation, rescue, relief, and primary rehabilitation work.

ii. If necessary, to operate rescue work with the facilities locally available and to coordinate mobilization of rescue teams for rescue operations in severely affected Upazilas.

iii. To collect, verify and supply statistics relating to loss according to instructions issued by the Disaster Management Bureau and other national authorities.

iv. To prepare plans for rehabilitation work carefully based on priority measures for risk reduction at District level.

v. To allocate and distribute relief to Upazilas on a realistic basis according to necessity.

vi. To supervise distribution of relief and rehabilitation activities and maintain their account and send the same to national authority and other relief donor organizations.

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Constitution and Responsibilities of Union, Thana and District Disaster Management Committee

1.	Constitution of Union Disaster Management Committee			
	(i)	Chairman, Union Parishad	-	Chairman
	(ii)	Members, Union Parishad	-	Member
	(iii)	Teachers Representative	-	Member
	(iv)	Government Employee at Union level	-	Member
	(v)	Women Representative	-	Member
	(vi)	Cyclone Preparedness Programme (CPP) Representative	-	Member
	(vii)	Bangladesh Red Crescent Society's Representative	-	Member
	(viii)	NGO's Representative	-	Member
	(ix)	Union Parishad Secretary	-	Member-Secretary

In the light of local situation and special circumstances, the Chairman of the Committee can co-opt more members.

The committee will meet once in every two months. During disaster the Committee will meet once daily, and after some improvement in situation, twice in every week.

2. The **responsibilities of Union Disaster Management Committee are mentioned below:**

2.1 Normal Times

- Ensure that local people are kept informed regarding taking practical measures for the reduction of risk personally or unitedly and also about wide publicity regarding the reduction of risk at community level and the methods of keeping alive.

Arrange training and workshops on regular basis on disaster **issues** and keep the Disaster Management Bureau informed.

Prepare a Disaster Action Plan with a view to enabling local people, Union authority and local organisation to take up security arrangement in the perspective of imminent danger related warnings or occurrence of disaster including the issues already mentioned under this paragraph.

Take steps for quickest and effective publicity of forecasts/warnings relating to cyclone and floods and also inform people about their responsibilities of saving their lives and properties from disaster.

Determine specific safe centre/shelter where the population of certain areas will go at the time of need and assign responsibilities to different persons for various services at the shelter/centre.

communication with Thana Headquarters and local arrangement for rehabilitation of severely affected families.

Arrangement for rehearsals or drills on the dissemination of warning signals/forecasts, evacuation, rescue and primary relief operations.

2.2 During Disaster

Organize emergency rescue work by **using** locally available facilities in times of need and if directed **assist** others in rescue work.

Collect statistics of loss incurred in disaster in the light of guidelines of Disaster Management Bureau and Thana Authority and send the same to TDMC/Thana authority.

Take steps **for distribution of articles for rehabilitation received** locally **or from Relief and Rehabilitation Directorate and any other source following the guidelines from Disaster Management Bureau and** TDMC**/Thana authority.**

Send accounts of material received to Thana authority or donor agency.

2.3	In addition to above follow Standing Orders on disaster management related issues and instant orders of appropriate authority.			
3.	**Thana Disaster Management Committee**			
	(i)	Thana Nirbahi Officer	-	Chairman
	(ii)	Chairman of Union Parishad	-	Member
	(iii)	Officials of concerned department of Thana leve	-	Member
	(iv)	Women's Representative	-	Member
	(v)	Representative of Thana central Cooperative Society	-	Member
	(vi)	Representative of Cyclone Preparedness Programmes (CPP)	-	Member

The local members of Parliament will be Advisers to the Committee.

The Chairman of the Committee may co-opt any other member, if necessary, in the light of local situation and special conditions.

This Committee will sit in a meeting once in every two months. During disaster, meeting will be held once daily and after some improvement in the situation twice in every week.

4. The **Responsibilities of Thana Disaster Management Committee**

4.1 **Normal Times**

To constitute a broadly representative Union Disaster Management Committee and its activation, give necessary advice and ensure receipt of information and benefit drawn from training facilities.

To ensure increased alertness, disaster risk reduction and informing about ways of sure and effective survival.

To ensure whether the risk of disaster and possibility of its reduction has been fully considered in preparation and implementation of development plans at local level.

To arrange training and workshop on disaster related issues regularly by keeping the Disaster Management Bureau informed.

To prepare a Disaster Action Plan in the light of warning signals for impending disaster including the issues below keeping in view whether Thana **authority and local organizations are prepared to meet the disaster** effectively **and efficiently:**

To take steps for speedy and effective dissemination of the forecasts of cyclone and flood to all officials of the Thana, relevant persons/organisations and the persons responsible in this respect at Union level.

- To select specific shelters/safe centres for evacuation of population of Thana Headquarters in

To help Union Disaster Management Committee **in initial emergency relief and rescue work, establish communication between unions and District headquarters , and to prepare contingent plans comprising arrangements for its maintenance /restoration.**

To hold mobilization drills in cooperation with district and Union authority for intermittent publicity of information and warning signal/forecasts and of matters related to evacuation, rescue and primary relief operations in the interior of the Thana.

To raise public **awareness at village** level by wide publicity of disaster forecasts.

4.2 During Disaster

To operate emergency operation centre (Information Centre and Control Room) for coordination of activities related to evacuation, rescue and relief at Thana level.

If necessary to operate rescue work by using the services available locally and to coordinate the relief operations undertaken by others, if made responsible for it.

To collect and verify statistics regarding loss due to disaster from Thana and union level officials according to directives from Disaster Management Bureau and District authority. To identify needs and priorities by conducting study and information analysis by officials or any other competent persons.

To supply report/statistics to district authority about loss, requirement and available resources for relief and rehabilitation work.

To prepare plans carefully for rehabilitation work at local level including possible arrangements for risk minimization.

To allocate and distribute on the basis of actual needs, the materials received from local source or Relief Directorate/other sources for rescue, relief and rehabilitation work according to the **directives of Disaster Management Bureau and** District authority.

4.4	In addition, to follow Standing Orders **on Disaster** and comply instant orders of appropriate authority.		
5.	**District Disaster Management Committee**		
(i)	Deputy Commissioner	-	Chairman
(ii)	Officials of Concerned		
	Department at District level	-	Member
(iii)	District Executive Officers	-	Member
(iv)	Women's Representative	-	Member
(v)	District Representative of		
	Bangladesh Red Crescent Society	-	Member
(vi)	Representative of Cyclone		
	Preparedness Programmes (CPP)	-	Member
(vii)	NGO's Representative	-	Member
(viii)	District Relief & Rehabilitation Officer	-	Member-Secretary
(ix)	Representative of Armed Forces		
	(During disaster time)	-	Member

All the **MPs of the District will be advisers to the Committee.**

The chairman of the Committee can co-opt more members in the light of the local situation and special circumstances.

The Committee will meet at least four times a year. During the disaster period, meetings should be held once daily and after some improvement of situation, at least twice a week.

6. Responsibilities of District Disaster Management Committee

6.1 Normal Times

To constitute a broadly representative Thana Disaster Management Committee with its activation, ensure receipt of directives and information and draw benefit from available training facilities.

considered while preparing and implementing development programmes at District level.

To disseminate forecasts and warnings regarding disaster and to make the people conscious about them.

To prepare a District Disaster Action Plan including the following issues with a view to keep the District authority and local organizations well prepared so as to meet the disaster effectively and efficiently in the light of warning signals about imminent disaster and the occurrence of disaster:

To ensure speedy and effective publicity of cyclone and flood related forecasts and warnings among all officials of the District, relevant persons/organizations and the persons of Thana level responsible in this respect.

To select if necessary the specific shelter/safe centre for evacuation of people from District Headquarters and allocation of responsibility to different persons for rendering various services at these places.

- When necessary, to ensure supply of water which can be filled in cans at shelter/safe centre located at District Headquarters and arrange other necessary services and ensure same type of facilities and services to shelter/centre at Union level in communication with Thana Disaster Management Committee.

- **To make contact with the Thana Headquarters, National Emergency Operations** Centre (EOC) **and Disaster Management Bureau for helping Thana Disaster Management Committee in rescue work, emergency relief work and preparation of contingency plans for essential services in the interior** of the **District along with their maintenance and re-installations.**

To arrange mobilization drills intermittently for publicity of the warning signals/forecasts and matters related to evacuation, rescue and operation of emergency relief work in cooperation with Disaster Management Bureau and Thana authority.

If necessary, to operate rescue work with the facilities locally available and to coordinate mobilization of rescue teams for rescue operations in severely affected Thanas.

To collect and verify statistics relating to loss according to instructions issued by Disaster Management Bureau and other national authorities from Thana officials and Thana Disaster Management Committee and to determine priority and requirement through emergency survey by officials or any other competent persons.

To supply information relating to loss, needs, available resources and priority needs for relief and rehabilitation work to the EOC at the Ministry of Disaster Management and Relief and the Control Room of Disaster Management Bureau.

To prepare plans for rehabilitation work carefully based on priority **measures** for risk reduction at District level.

To allocate and distribute to Thanas the materials, received from local source or Relief Directorate/any other sources on realistic basis according to necessity as per directives issued from Disaster Management Bureau and District authority.

To supervise distribution of materials under relief and rehabilitation activities and maintain their account and send the same to national authority and other relief donor organizations.

6.3 To **perform responsibility of overall coordination among various departments at district level.**

6.4 In addition, to follow the Standing Orders on Disaster and comply with instant orders of appropriate authority.

Appendix - 4

Proposed Ward **Disaster Management** Committee (WDMC)

1.	UP Member of the Ward	-	Chairman
2.	Govt. **service** holder/ Teacher	-	Member
3.	Student representative (SSC & above)	-	Member
4.	Imam of Mosque	-	Member
5.	Woman representative	-	Member
6.	Farmer representative	-	Member
7.	VDP representative	-	Member
8.	Landless representative	-	Member
9.	Chowkider/ Dafader	-	Member
10.	NGO/Cooperative group **leader**	-	Member
11.	Local elite/ Matubbar	-	Member