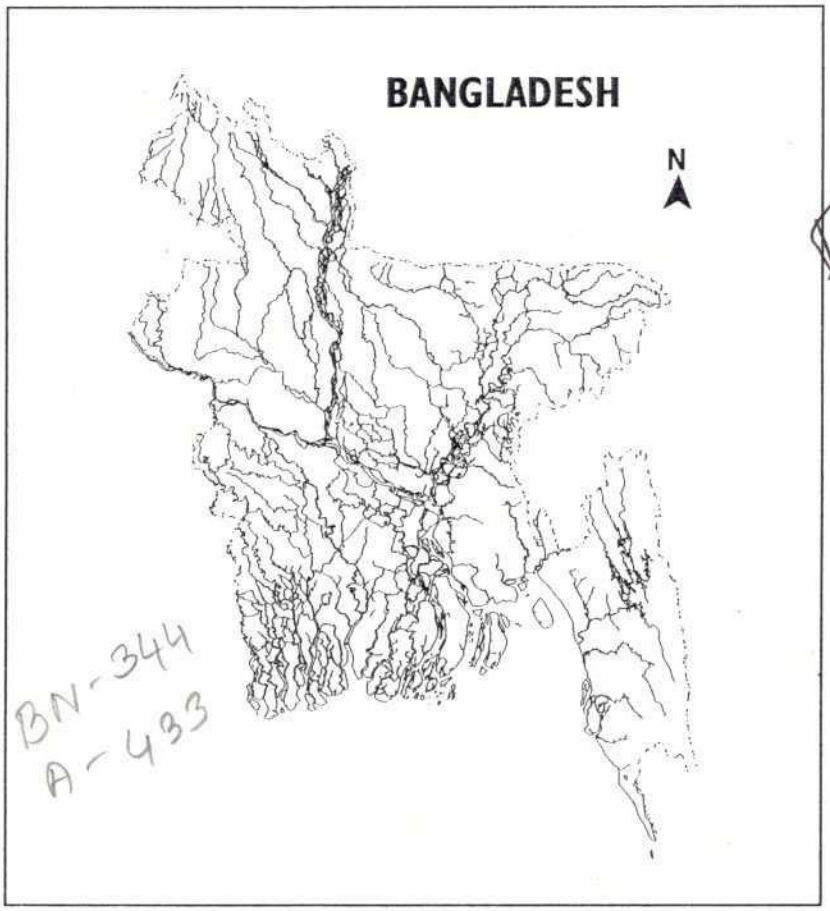
EXPANSION OF FLOOD FORECASTING AND WARNING SERVICES (FAP10)



Draft Inception Report

May 1995

Flood Plan Coordination Organisation
Ministry of Water Resources
Government of the People's Republic of Bangladesh

in cooperation with **Danida**

Consultants

Danish Hydraulic Institute

FLOOD FORECASTING AND WARNING SERVICES

DRAFT INCEPTION REPORT

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ACRONYMS AND ABBREVIATIONS

AIT	Asian Institute of Technology
ARC-VIEW	GIS software package
BGD/88/013	Title of previous Flood Forecasting Project
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
Danida	Danish International Development Assistance
DEM	Digital Elevation Model
DHI	Danish Hydraulic Institute
DMB	Disaster Management Bureau
ERD	External Resources Division
FAP	Flood Action Plan
FAP6	North East Regional Study Component of FAP
FAP10	Flood Forecasting and Warning Component of FAP
FAP11	Disaster Management Component of FAP
FAP19	Geographical Information System Component of FAP
FAP24	River Survey Component of FAP
FAP25	Flood Modelling and Management Component of FAP
FF	Flood Forecasting
FFWC	Flood Forecasting and Warning Centre
FMM	Flood Management Model
FPCO	Flood Plan Coordination Organization
GIS	Geographical Information System
GM	General Model
GM-FF	Dedicated Version of General Model for Flood Forecasting
GMX	General Model extended into India
GOB	Government of Bangladesh
MIKE11	River Modelling System Developed by DHI
MIWDFC	Ministry of Irrigation, Water Development and Flood Control
MOU	Memorandum of Understanding
NAM	Rainfall Runoff Model Developed by DHI
NCR	North Central Region
NCRM	North Central Regional Model
NERM	North East Regional Model
NGO	Non Government Organization
NWRM	North West Regional Model
SAARC	South Asian Association for Regional Cooperation
SPARSSO	Space Research and Remote Sensing Organization
SSB	Single Side Band (Radio)
SWMC	Surface Water Modelling Centre
TCO	Tele Communication Operator
TOR	Terms of Reference
TPO	Tele Printer Operator
UNDP	United Nation Development Program
UNICEF	United Nation International Children's Education Fund

WAPDA	Water and Power Development Agency
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

Introduction

The project "Expansion of Flood Forecasting and Warning Services" is a part of the Flood Action Plan undertaken as the FAP component 10. The project commenced in January 1995 and is planned to be carried out for a period of 3 years.

The overall objective of the project is to provide improved information on floods to aid national preparedness in flood disaster and to minimize flood impacts.

The performance of the Flood Forecasting and Warning Centre will be improved in the next 3 years project period and the services of the Centre will be expanded. More specifically, this will be done through the following activities:

- The number of forecast points on main and secondary rivers will be increased from 16 to 30
- Forecast Period will be expanded from 48 hours to 72 hours and the accuracy will be improved
- Forecasting of depth-area inundation will be introduced in 2-3 selected areas
- Forecasting of flashy rivers in the Eastern part of the country will be introduced on a pilot basis on 2 rivers
- Improved data communication system
- Improved facilities for hydrological and meteorological monitoring
- Improved dissemination system of flood warnings in close cooperation with the Disaster Management Bureau
- Development of a programme of public awareness on the availability and understanding of flood warnings
- Improvement of the institutional structure within Flood Forecasting and Warning Centre in order to implement a comprehensive Flood Operation Centre

A comprehensive training program will be provided to professional and technical staff and special courses offered to target groups throughout the project period

During the inception phase the plan for project implementation has been updated including a detailed work program.

Flood Forecasting and Warning Centre

The Flood Forecasting and Warning Centre (FFWC) of Bangladesh Water Development Board (BWDB) was established as a permanent entity in 1972 and is currently located on the 8th Floor of the WAPDA Building in Dhaka.

It was planned to shift the Centre to a new location within BWDB Hydrology, in Green Road. However at present the new office is not available. It is expected that a new office for FFWC will be made available in the new buildings in Green Road sometime after 2 years. Therefore it has been decided to stay in WAPDA building until that time. The office has now been modernized with an improved working environment.

The computer system at FFWC has been repaired and cleaned. A new Local Area Network covering the entire office has been installed.

At present 7 officers are working at the Flood Forecasting and Warning Centre. Two of the 7 officers will retire soon. There is a provision for 12 officers working at the Flood Forecasting and Warning Centre, with 5 positions lying vacant. To meet the project requirements to establish the expanded warning services it is extremely important to engage new young and bright engineers in the vacant positions.

Project Components

The project has been divided into 4 modules, out of which the first 3 modules are supported by Danida. Module 4 - Telemetry Development, is supported by the Japanese Government and is not included in the Danida-project. The activities of the first 3 modules along with a program of technology transfer are presented below:

Module 1

Coordination and monitoring

It is necessary to maintain the progress made in setting up the FFWC in BWDB to ensure that other activities and their output are integrated satisfactorily into the Flood Forecasting and Warning Services.

Communication and data transfer system

Having a good communication system is essential for the Flood Forecasting and Warning Centre. A lot of effort will therefore be used to strengthen and develop the communication system.

During the inception phase the wireless communication through radios has been analyzed. Further optimizing on the radios, the antennas and the frequencies can improve the communication. Improvement of the wireless network will continue in May and June 1995.

A strategy to improve the existing data transfer from India has been drawn up. As a first step, a contact has been initiated with the Ministry of Water Resource in India. Based on the response from India it is intended to visit the Flood Forecasting Centres in Patna and Guwahati and offer assistance to improve data transfer.

The data transfer link to Bangladesh Meteorological Department will be re-established by the end of 1996. In the meantime, the data transfer between BMD and FFWC will, be improved with a telephone and fax connection.

Remote Sensing

Bangladesh Meteorological Department will receive two new radars, one in Rangpur and one in Dhaka ready to be used at the end of 1996. The existing radar in Dhaka is outdated and will not be maintained by BMD. Therefore it has been decided not to use the old radar. It is recommended to upgrade the existing satellite receiving equipment at FFWC.

Module 2

Expansion of the flood forecasting system

This will be carried out through updated and improved modelling activities including the development of flooded area/depth forecasts in 2-3 selected areas.

A sub-contract has been signed with the Surface Water Modelling Centre to undertake the modelling activities. The sub-contract includes use of SWMC facilities, and the services of their local experts is the modelling work. Government Officers of Flood Forecasting and Warning Centre involved in the modelling activities will also work together with SWMC experts in SWMC.

The General Model used at FFWC will be further developed and expanded to include the major rivers in the North East Region and the North West Region. The North Central Region Flood Management Model will be further developed including capabilities for depth/area inundation forecasting.

Two rivers in the North East region have been selected for trial forecasting on flashy rivers, the Manu and the Surma. The rivers will be included in the modelling system.

Module 3

Development and improvement of forecast outputs, public and user awareness and dissemination

Special emphasis on development of appropriate warning systems at grass roots level will be given.

A workplan has been designed during the inception phase by a WMO consultant. The major part of this module has been subcontracted to WMO, which will implement the workplan. The implementation of this module will be carried out in close cooperation with the Disaster Management Bureau.

Training

In parallel with, and as an integrated part of the implementation of the above modules, a comprehensive training programme has been developed to ensure efficient operation and maintenance of the equipment and models forming part of the flood forecasting and warning system. The training programmes will include on-the-job training, local group training, individual overseas fellowships and study tours for senior executives.

The individual overseas training will be carried out through 4 predesigned courses for a total 20 persons to be held in Denmark and Thailand. The courses are.

- Advanced hydrological/hydraulic modelling
- Hydrological/hydraulic forecasting techniques
- System Management
- Disaster Management
- Wireless Communication/field measurements

Two study tours for human resource development are planned to Japan and Australia for 8 senior executives. The study tours will be carried out in connection with a Disaster Management course to be held at Asian Institute of Technology in Thailand.

Project Administration

The Principal Consultant will coordinate all project activities in close cooperation with the National Project Director. The Principal Consultant is responsible for the financial administration. The National Project Director will be consulted in major activities.

Budget

As approved by Danida and GoB, total Danida contribution is 17.67 million Danish Knoner and the total GOB contribution is Taka 487 lakh. Compared with the original budget some

minor modifications in the internal allocation have been made to accommodate the following changes:

- Approximately one fourth of the budget allocated for office setup in a new building in Green Road has been used to modernize the facilities in WAPDA building.

- Funds allocated to support the BMD will be used to improve the existing remote sensing facilities at the WAPDA building and to establish flood monuments in the field at the water level stations.

1. INTRODUCTION

1.1 Background

The Flood Forecasting and Warning Centre (FFWC) of Bangladesh Water Development Board (BWDB) was established as a permanent entity in 1972 and is currently located on the 8th Floor of the WAPDA Building in Dhaka. The jurisdiction of the Centre is all over Bangladesh in respect of water level and rainfall stations for forecasting purposes.

During the period 1981-1986 it received UNDP assistance. In 1988 a UNDP financed mission looked into a proposed 3-year continuation. A preliminary 8 month programme was agreed upon between the UNDP and the Government of Bangladesh in 1988 and in the period 1989-1992 the UNDP had an ad hoc type input to the project. The World Meteorological Organisation (WMO) executed these on behalf of the UNDP. Although the project started long before the initiation of the Flood Action Plan (FAP) the project has so far acted as a precursor to FAP 10.

A TOR for FAP 10 beyond 1992 was prepared and considered by the Technical Committee of the Flood Plan Coordination Organisation (FPCO) on 27th December 1992 and the modified TOR dated March 1993 was approved by this Committee on 9th June 1993. This approval has later been confirmed by the Ministry of Irrigation, Water Development and Flood Control (MIWDFC) and by the Economic Resource Division (ERD).

At a meeting in FPCO on 21st March 1993 with participation from BWDB, UNDP, the World Bank and the Danish Embassy, funding for an expansion of FAP 10 was discussed. Due to the close relationship between this project and the mathematical models developed at the Surface Water Modelling Centre (SWMC) and used under FAP 25: Flood Modelling and Management, both with Danish financial assistance, it was agreed that Danida would appraise the FAP 10 proposal for possible Danish technical and financial assistance. A project Proposal for FAP 10 in conformity with Danida guidelines for project preparation dated 22nd June 1993 was prepared by the Danish Embassy in Dhaka based on the earlier mentioned TOR for FAP 10 dated March 1993 prepared by FPCO of MIWDFC.

An appraisal team was fielded in Bangladesh during the period from 22nd November to 3rd December 1993. Based on the recommendations of the appraisal team and the Project Document prepared by Danida an agreement between the Governments of Denmark and Bangladesh was signed in late December 1994. The Danish Hydraulic Institute has been assigned to undertake the project activities in cooperation with FFWC. The project commenced on 17 January 1995 and is planned to be carried out for a period of 3 years. This Inception Report follows the approved Project Document.

1.2 Project Objectives and output

The overall objective of the project is to provide improved information to aid national preparedness for floods and to mitigate flood impacts.

The immediate objectives of the FAP 10 project are to support FFWC in order to improve performance with regard to increased mobilization of local resources and efficient utilisation of the resources available.

More specifically this is done through:

- Training provided to professional and technical staff
- Expanding the number of forecast points on main and secondary rivers
- Improvement of lead time and accuracy for real-time forecasts on main and secondary rivers
- Improvement of facilities for hydrological and meteorological monitoring, including data collection and use of radar facilities improved
- A fully comprehensive Flood Forecasting Centre established within BWDB

In line with the project objectives, the anticipated outputs from the current project are:

- Real-time flood forecasts at regional level and provision of local depth-area flood forecasts in 2-3 selected areas developed
- Forecast system for 2 flashy rivers in the east of the country established on a pilot basis
- Improved data exchange with countries in the Ganges - Brahmaputra - Meghna basins established, possibly through the framework of regional cooperation.
- A public awareness programme on the availability and understanding of flood warning and forecast information and the benefits to be derived from their use developed in conjunction with and in support of the Disaster Management Bureau
- Trained staff
- Improved institutional structure within FFWC to provide and maintain the necessary services established

1.3 Main Project Components

To meet the expected requirements both under the FAP and in a national context through the immediate objective and the outputs listed above, a major coordinated programme is required. The programme consists of three Modules which have been organised as follows. It should be noticed that module 4, development of telemetry system for real time data collection, is not included. Module 4 will be carried out in a separate project sponsored by the Japanese Government.

Module 1 - Coordination and Monitoring

The coordination and monitoring activities are designed to maintain the progress made in setting up the FFW in Bangladesh Water Development Board to ensure that the other activities and their output are satisfactorily integrated into the Flood Forecasting and Warning System, including accessing of external hydrometric information and containing the established links with other FAP components. Forecast of rainfall will be improved in close co-operation with BMD. BMD will receive a new radar in Dhaka from Japan. Reestablishing of the microwave link for fast data transfer from FFWC to BMD are included in the grant from Japan.

The inter-relation between sub-components/modules and the general support of technical developments, studies and training will be co-ordinated through a Team Leader/Principal Consultant working in direct co-operation with a national counterpart in BWDB.

Module 2 - Expansion of Model Application

This is related to modelling studies and applications to develop the range of forecast outputs. The activities under this module are being carried out in collaboration with the Surface Water Modelling Centre. The activities include:

- Continued development and refinement of the general model to improve lead time and accuracy of forecasts.

- In conjunction with SWMC and FAP Regional Studies, develop regional and secondary river flood forecasting models in relation to the identified requirements.

- As a preliminary to detailed model studies, use existing topographic and flood extent data to establish relations between local area flooding and danger level.

- Develop local area model giving depth/area flooding forecasts by interfacing MIKE11 with a GIS system. This will involve the facilities and outputs from FAP 19, as appropriate.

- Prepare adaption to real time flood forecasting of the flood management models prepared by FAP 25, commencing with pilot studies of selected flood prone areas.

- Extend the use of real time rainfall/run-off models to flashy rivers with catchments extending outside Bangladesh.

The model development programme will continue in close cooperation with the Surface Water Modelling Centre. Improvements and updates of the general model and the production of regional real time models will be carried out by the project and SWMC as information becomes available.

In developing models for depth-area-inundation and flood management, it will be necessary to integrate the hydrodynamic modelling with GIS facilities and terrain models available at SWMC.

The goal is to utilise models within Flood Forecasting and Warning Centre in real-time to produce the necessary forecast information as part of a broader flood management and preparedness programme.

A detailed description of the working program for this module is presented in Chapter 3.2.

Module 3 - Forecast and Warning Dissemination and Public Awareness

This component is concerned with the development and improvement of forecast outputs, public and user awareness and dissemination with special emphasis on development of appropriate warning systems at grass root level. The major part of module 3 has been subcontracted to WMO. TOR for the module includes:

- Increase the detail of forecasts and warnings with regard to locality, depth - area and timing.

- Introduction of a phased level of warnings to assist preparedness.

- In liaison with the appropriate bodies, prepare a range of forecasts for specific users, e.g. newspaper, radio and television.

- Liaise with FAP 11 to prepare systems for improved dissemination and response for forecasts and warnings, particularly at the "grass roots" level.

- Consolidate the dissemination of forecast and warning information at a national and regional level within BWDB and government organisations.

- Carry out evaluation of impact of forecast and warning information with existing

distribution users and sample groups across the spectrum of the community.

- Develop public awareness to flood warning information through publicity and education programmes.

- Develop awareness in government, NGO's and the private sector to use of warnings as part of flood preparedness.

The proposed work is linked with the programme for disaster preparedness to be undertaken by FAP 11. Actions during emergency situations will be undertaken through the Relief Ministry, but the need for improved flood forecast information and dissemination will be identified by FAP 10.

A detailed description of this module is presented in Appendix A.

Module 4 - Telemetry Development

Implementation of a pilot telemetry system granted by the Japanese Government has started. Setup of the telemetry system are in the pipeline and will be implemented afterwards.

Training Programme

In parallel with, and as an integral part of the implementation of the above modules, a comprehensive training programme will be organized to ensure efficient operation and maintenance of the equipment and models forming part of the flood forecasting and warning system. The training programme will include on-the-job training, local group training, individual overseas fellowships and study tours for senior executives.

1.4 Inception Report

This inception report describes the overall approach being followed and the resources required to achieve the project objectives. Chapter 2 presents the initial analysis carried out to assess the existing capabilities and the needs to fulfil the project objectives. Chapter 3 presents the programme for implementation of the project including a work programme. Chapter 4 presents the inputs to the project. Module 3 of the project is reported separately by WMO enclosed as Appendix A.

2. PROJECT ASSESSMENT AND NEEDS

2.1 Introduction

A number of factors needs to be considered in order to achieve the objectives of the project. This chapter presents an assessment of the factors involved and describes the project needs.

The chapter also presents results of activities carried out during the inception phase. Section 2.2 describes the setup and refurnishing of the Flood Forecasting and Warning Centre including repair and upgrading of the computer system. Section 2.3 describes the communication and data transfer system. The conditions of the wireless radios have been tested during the inception phase and some minor repairs of the antennas have been carried out. Investigations to get data directly transferred through a microwave connection from Bangladesh Meteorological Department are also included in this section. Section 2.4 contains a desk study with assessment on use of remote sensing for flood forecasting and section 2.5 contains a desk study with assessment of forecasting on flashy rivers. Section 2.6 describes the results of activities initiated under module 2 and section 2.7 presents the activities for module 3.

2.2 Flood Forecasting and Warning Centre

2.2.1 Office

Presently the Flood Forecasting and Warning Centre is located at the 8th floor of WAPDA building in the Centre of Dhaka. Government of Bangladesh had promised to provide a new office within the Hydrology Complex in Green Road for the Flood Forecasting and Warning Centre. However, at present the new office is not available. The new office is expected to be available only after 2 years.

A layout of the FFWC office in WAPDA building appears in Figure 2.1. In addition to this office, one room is available for the Flood Forecasting and Warning Centre on 9th floor. It has been decided to use approximately one fourth of the space on the 8th floor for telemetric equipment to be installed under the pilot telemetry system. Another space of approximately 50 square meter is needed to accommodate the people using the room allocated for the telemetric equipment. The FFWC was needed some significant refurnishing to create a good working environment.

During March and April the FFWC was refurnished and the Centre is now ready to be used for the 1995 monsoon. The office space is still limited and an application for more space has been submitted to the Government.

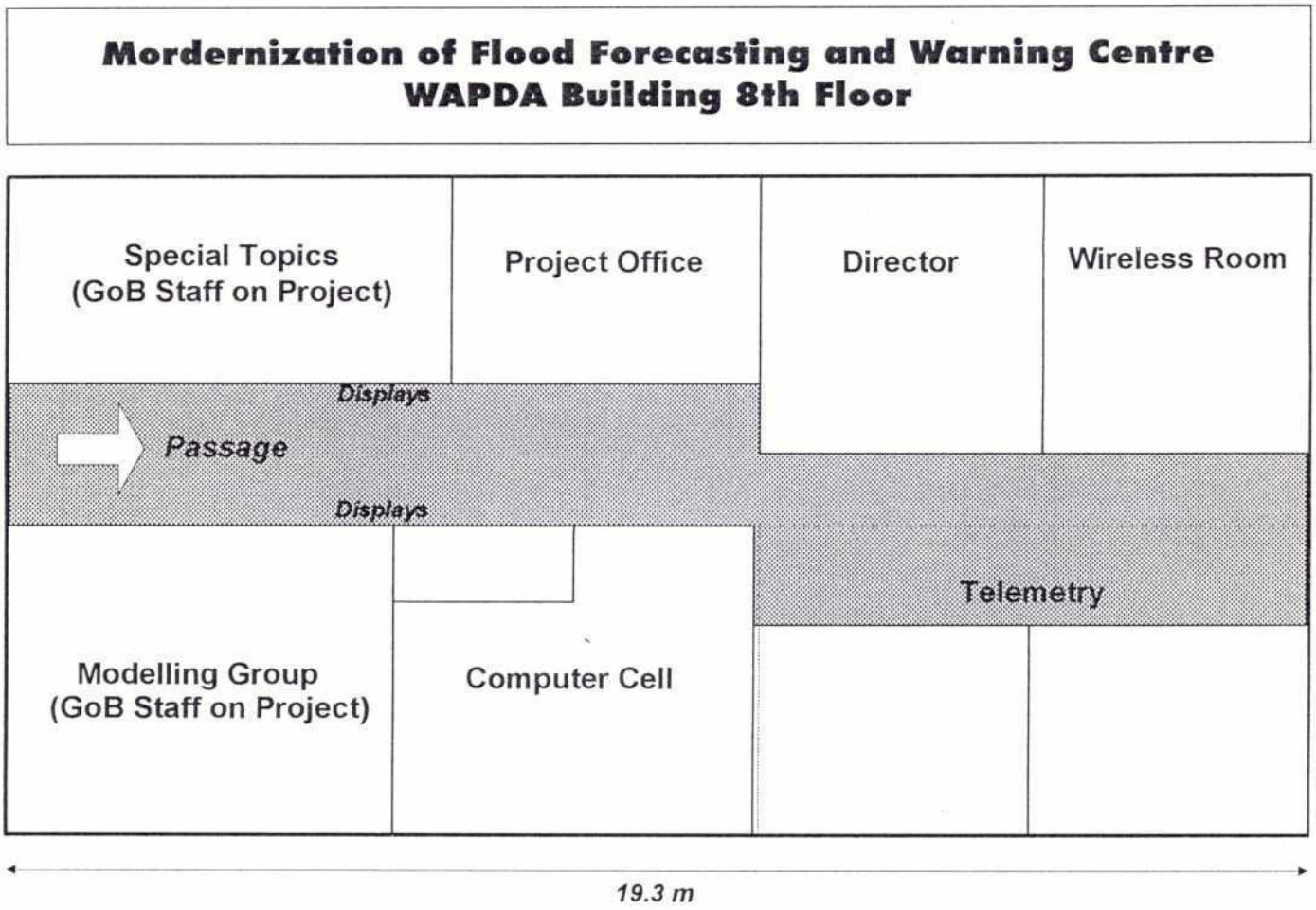


Figure 2.1 Layout of Flood Forecasting & Warning Centre

Figure 2.1. Layout of the FFWC.

2.2.2 Staffing

The total number of staff employed in the Flood Forecasting and Warning Centre is 30, out of which 7 officers are engaged in processing of field data, formulation of forecast and dissemination etc. and the rest in data receiving, bulletin distribution and including office work.

The officers at FFWC will be directly engaged in forecast formulation and dissemination. There is a provision to engage 12 officers at FFWC, however 5 of the positions are vacant at present.

In addition to staff working at FFWC, the Dhaka based Construction and Instrumental Division (C&I Div.), manned by two Instrumentation and one Construction Subdivisional Engineer are responsible for maintenance of the wireless communication system including data collection in the field. This division also has a shortage of technical staff.

To achieve the objectives of the project, implementing an expanded and fully comprehensive Flood Forecasting and Warning Centre, it is extremely important to engage new young and bright engineers in the vacant positions. These new engineers must have a good technical background.

The Government has been requested to assign more staff to FFWC.

2.2.3 Computer System

The computers used in the Flood Forecasting and Warning Centre have been hardly maintained from 1992-1995. In connection with the refurnishing of the Flood Forecasting Centre all computers have been cleaned and repaired. Fortunately, most of the computers have survided, the poor maintenance.

A small amount of money has been used to upgrade and repair the existing computers to be able to meet the requirements of the project. A new setup of the Local Area Network to all rooms in the FFWC has also been installed.

The Flood Forecasting and Warning Centre has now 3 PC's with 386 processor and 3 PC's with 486 processor ready to be used for the 1995 monsoon.

2.3 Communication and Data Transfer System

2.3.1 Wireless Radios

FFWC uses wireless radios to collect data from the field. At present 60 stations

report daily to the FFWC. A workshop to repair and maintain the radios is located in Green Road.

Modernization is needed for the present wireless communication system. During the inception phase the wireless communication problem has been analyzed.

The Flood Forecasting and Warning Centre has permission to use 6 frequencies for wireless communication: 3305, 4442, 4490, 5089, 8157 and 8188 khz. Normally 8157 khz frequency is used.

It was found that during the morning hours before 9.30 AM communications are not clear, specially on high frequencies. It is recommended to use low frequencies from 2500 - 3500 khz before 9 AM.

The Antenna on the roof on WAPDA building was found to be in a poor shape and after some repair communication has been improved. Further optimizing on the radios, the antennas and the frequencies will improve the communication. Improvement of the wireless communication system at FFWC and in the field will continue in May and June 1995. Faster data collection at the Flood Forecasting and Warning Centre through the wireless radios is very important for a good forecasting system.

2.3.2 Telemetric Network

Implementation of the pilot telemetric network, supported by the Japanese Government, has started. The pilot telemetric network will be installed before implementation of module 4. The pilot telemetric network is scheduled to be ready by November 1995. The network includes 9 automatic stations. Data will be transmitted to the Flood Forecasting and Warning Centre via the common microwave link. The telemetric network includes a new microwave link connecting the common national microwave network to the Flood Forecasting and Warning Centre.

The pilot network includes:

- Water level and rainfall data from Noonkhawa, Pankha and Amalshid
- Water level data from 6 stations around Dhaka : Nayerhat, Mirpur, Tongi, Narayanganj, Millbarak and Rekabi Bazar.
- Re-establishment of telemetric link from Sherpur, Dhalai, Manu, Shaistaganj and 2 rainfall gauging stations: Manu and Kamalganj.

These data will be used on an experimental basis during the 1996 and 1997 monsoons.

2.3.3 Data transfer from India

An important objective of the project is the improvement of the lead time and accuracy of real-time forecasts. This could be achieved simply and effectively by obtaining water level data within the Indian territory for the two major rivers, the Ganges and the Brahmaputra (Jamuna).

Present data transfer from India

At present there exists an agreement between India and Bangladesh which incudes following data:

Observed and forecasted water level are transmitted from New Delhi via the World Meteorological Organisation Satellite Services to Bangladesh Meteorological Department when the water level exceeds 1 m below danger level at the following locations.

- Dhubri and Goalpara on the Brahmaputra
- Farakka on the Ganges
- Silchar on the Barak
- Domohani on Teesta

Rainfall data in the Ganges and Brahmaputra basins are transmitted to Bangladesh when it exceeds 50 mm per day.

However, due to unknown reasons, the data are delayed by 10-15 hours before they are received in the Flood Forecasting and Warning Centre. In some cases the data are not received at all.

Use of Water Level data from India

Ideally, real-time water level data from the important boundary stations Dhubri and Farakka should be available at the time of forecast. To be of maximum benefit, these data should be received regularly during the monsoon. The FFWC already has the capability of forecasting from water level data inside India. The GMX model has extended boundaries on the Jamuna up to Dhubri and on the Ganges up to Farraka. These boundary data would improve lead times by several hours. In addition, forecasts for these upstream water levels are issued in India based on data even further upstream and could be used to increase the lead times considerably. This data is also received intermittently from the Patna Forecasting Centre. Therefore, substantial benefit would be obtained if these forecasts were routinely received. Water level data from India is often received too late to be used in forecasting. Delays of up to 15 hours could be seen in the FFWC records.

Consideration should also be given to extending the model even further up the Brahmaputra and Ganges rivers. Even if this is not feasible efforts should also be made to obtain water level data from upstream sites such as Patna on the Ganges and Guwahati on the Brahmaputra. This data could be used in a simplified forecasting approach such as site to site correlations to improve boundary forecasts. Clearly, if accuracy of water level forecasts can be improved at the boundary stations, then the accuracy of forecasts downstream will also improve.

Use of Rainfall data from India

The above-mentioned water levels provide quantitative data that can be readily incorporated in the present flood forecasting set-up. Complementary information can be obtained from rainfall measurements also within India. However these data would not be used directly in the model forecasts. Satellite information may be more useful in this context. Staff at the FFWC have received training in the use of satellite imagery for precipitation estimation. There is no doubt that such estimates depend on careful interpretation based on thorough training and experience. To evaluate the use of the satellite forecasts these estimates should be compared with measurements obtained within the Himalayan catchments and within Bangladesh. This should be performed routinely by obtaining rainfall measurements and comparing these to the satellite based estimates on the day following the forecast. This routine comparison would also give the forecasting team a feedback mechanism against which they can measure their own performance.

Rainfall data from within India would be of vital use in the flashy river systems in the north east region. Both historical and real-time data could be useful. In particular, the lead time for forecasting in this region would be improved considerably if reporting raingauge data from a station located within India, in either the Tripura or Meghalaya catchments, could be received in Bangladesh. Obtaining access to such a station may be more straightforward than obtaining discharge data.

Strategy to improve the data transfer

Improving the data transfer from India is extremely difficult. It is almost impossible to get a new agreement regarding data transfer.

A strategy improving the existing data transfer has therefore been drawn up.

It will be desirable receiving data regularly throughout the monsoon directly from the Flood Warning Centre's in Patna (Forecast on Ganges) and Goalpara (Forecast on Brahmaputra).

As a first step, a contact has been initiated with the Ministry of Water Resources in New Delhi, India regarding improved data transfer. Based on the response from

New Delhi the Flood Warning Centres in Patna and Guwahati will be visited and offered assistance to improve data transfer.

In addition, the Government of Bangladesh should through the Joint River Commission take necessary actions and press the Indian Government to improve data transfer.

2.3.4 Data transfer link to Bangladesh Meteorological Department

During the inception phase it has been investigated whether it is feasible to re-establish the direct data transfer link to BMD through a microwave link. Microwave transmission requires 'line off sight' between the stations. It has been found that direct data transmission was not possible between BMD and FFWC, because of high buildings between the two locations.

Investigation to include the Hydrology Complex in Green Road as a relay station has shown that direct data transmission between Green Road and BMD is possible. It was also found that direct data transfer was not possible between Green Road and FFWC, because of high buildings between Green Road and Motijheel.

It is therefore concluded that re-establishing of the data transfer between BMD and FFWC will be very costly and not possible within the limitation of the project budget.

However, it has been learnt that the Data transfer from BMD to FFWC will be re-established by the end of 1996 using a Microwave link under a separate project sponsored by the Japanese Government and signed in March 1995. A new radar will be installed in BMD under this project, along with a microwave link from BMD to the Flood Forecasting and Warning Centre including the required relay stations.

It has therefore been decided to improve the telephone and fax connection between FFWC to BMD until the new microwave link will be finalized.

2.4 Remote Sensing

Remote sensing data for flood forecasting consists mainly of radar and satellite imagery. The application of meteorological radar is discussed in section 2.4.1 and application of the satellite data in section 2.4.2.

2.4.1 Meteorological Radar

General remarks

There is no doubt that weather radars provide useful information for flood forecasting, however this information must be carefully interpreted. The most direct information that can be obtained from a radar is whether or not it is raining in a particular area at present. Quantitative precipitation estimation from radar images or now casting is still an area of active research and the best estimates are obtained when radar images are used in combination with rainfall gauges. Radar images can be related to rainfall intensity (Collier, 1989). The error of these estimates appear to range from 50%-300%. However accuracy improves as the period of time over which the estimation is made increases. The range in which hydrological computations can be carried out is limited to about 150 km under ordinary conditions and only 100 km for heavy rainfall (WMO, 1994).

The application of weather radar to flood forecasting could be used to :

1. Indicate where and how long rainfall producing clouds occur in the Himalayan catchments. This would be used in combination with satellite data;

2. Improve areal estimates of rainfall by using the radar image to interpolate between the rainfall stations. This would require calibration of the radar and some experience with the radar system before this could be carried out routinely;

3. Indicate when rainfall stops so that the occurrence of a peak and the following recession can be estimated; and

4. Provide an indication of flash flood producing rainfall, if the image can identify high intensity rainfall. Then, in combination with reporting rain gauges timely flash flood warnings could be issued.

Status of radar

At present there is no communication link between BMD and FFWC for the transfer of radar images. The earlier microwave link is now blocked by a high-rise building. The image was then received through a telephone line until hardware problems (see below) prevented this. Therefore in the last year no radar image has been received at FFWC.

The existing radar in Dhaka is outdated (as stated by BMD) and will not be supported from BMD. Therefore it has been decided not to use the old radar in Dhaka at the Flood Forecasting Centre.

Bangladesh Meteorological Department will receive two new radars, one in Rangpur and one in Dhaka as a Grant from the Japanese Government. The radar in Dhaka will replace the old outdated radar. The agreement was signed in March 1995. The new radars are expected to be operational by the end of 1996.

A second problem is the accuracy of coverage in the North-east region from a radar based in Dhaka. Ideally, a radar for flash flood warnings would be located in the north-east region. As the operating agency BMD will give a higher priority to the Dhaka location for meteorological observations. Practically, these images should be received at FFWC and the performance of the radar in predicting flash flood events should be quantitatively evaluated by comparing the results of a radar-based prediction to raingauge data in the north-east catchments. A related issue is the question of rainfall quantification. The most useful form of rainfall quantification would in fact be an experienced forecaster who can with experience relate the processed radar images and weather conditions to catchment rainfall conditions.

Recommendations

It is recommended to use the new radar from 1997 at Flood Forecasting and Warning Centre. In 1997, after BMD has received their new radar, training in radar application will be initiated in close cooperation with BMD.

2.4.2 Satellite Receiver

The FFWC has a present a satellite receiving station (SYSTEMS WEST) capable of automatically receiving NOAA-satellite and METEOR-satellite imagery and able to produce calibrated thermal infrared information for weather forecasts and precipitation estimation. Reception of METEOR-satellite data is not possible as the signal characteristics have changed. The FFWC staff have also received training in the application of these images to quantitative precipitation estimation (UNDP/WMO, 1991). In addition, GMS-satellite data has been received from SPARRSO through BMD, together with isobar charts and the official weather forecast also from BMD.

Status of satellite receiving station

At present the satellite receiving equipment is not functioning. The FFWC staff have suggested that this is a software problem. Furthermore, during the 1991 mission (UNDP/WMO, 1991) a number of recommendations were made regarding the updating and improvement of the satellite receiving station and data. It was recommended that updated software be purchased to allow reception of the METEOR-satellite, to show catchment and national boundaries, and to provide geometric correction for standard map projection. Furthermore, the lack of accuracy

in the internal computer clock leads to poor positioning of the map grid.

The application of remote sensing from meteorological satellites to flood forecasting could be used to:

1. Provide rainfall estimates in the Indian catchments that drain into Bangladesh. This information can be used in the same manner as the radar images but over a larger scale. The most useful and reliable information is the timing and duration of rainfall. This could be applied both in the main river catchments but also within the more flashy rivers.

2. Provide an estimate of the extent of flooding.

Recommendation

Both the computer hardware and software should be updated preferably before the onset of the next monsoon.

2.5 Forecasting systems for flashy rivers

Rapidly responding catchments in the north-east of Bangladesh are subject to frequent flooding, and often as in 1993 this may occur several times during the year. There is a urgent need for flash flood warnings, but this is a difficult task since the flash flood producing rainfall occurs outside the borders of Bangladesh in India. There are three issues that need to be addressed:

1. Can sufficient lead time be achieved to provide useful flash flood forecasts?
2. Where should pilot flash flood forecasts be carried out?
3. How should this forecast be disseminated and to whom?

Lead Time

Where such floods develop very rapidly, it may not be possible to implement conventional flood forecasting procedures developed for large rivers rapidly enough to be effective in providing forecasts with sufficient lead times. The use of radar and satellite imagery combined with raingauge data provide the best rainfall forecasts in the shortest possible time. Remote sensing, by radar or satellite, would indicate the potential for flash flood producing rainfall which with experience, especially if these were related to real-time raingauge data, would lead to accurate forecasts or warnings.

As an alternative to conventional forecasting, flash flood warning can be considered.

WMO 1994 suggest three alternative procedures; self-help forecast programmes, flash flood alarm systems and generalised watches and warnings, (WMO, 1994).

Two drawbacks are apparent with this scheme. One is that it relies on the judgement of one observer who, at critical times, may not be able to observe the rainfall at night or because of poor visibility. Secondly, the warning system is very expensive if this is to used at several sites and may be difficult to maintain under conditions in Bangladesh.

The first step is clearly to determine the lead times that can be expected at the forecast points on these flashy rivers. An analysis of the repeated flood events during 1993 should provide a good picture of this. Some study suggest that flash flood water level peaks can occur as little as 6-12 hours after rainfall. This needs to be convincingly documented, particularly as large floods peaks may move much more slowly if overbank spillage occurs. This is a common occurrence in the north-east catchments. Flash flood producing rainfall might occur during the evening, when there is no rainfall or water level data being collected. This timing of the peak should also be convincingly documented. A related issue is whether the catch in the valley raingauges in Bangladesh are correlated to runoff produced by storm rainfall further up the catchment.

Given these apparent short lead times a daily forecast may be inappropriate and instead some form of watch should be maintained. Two possibilities exist; a watch at the water level site by an observer or by automatic water level alarm or a telemetered water level gauge reporting to the forecast centre where a watch is maintained. Given a sufficiently large change in water level a warning could be issued. A similar approach could be adopted using a telemetered raingauge where given warning would be issued for a given rainfall intensity over a fixed time interval. The question of how to issue a warning or forecast is discussed below. At this stage, prediction of downstream water levels may not be necessary.

Location of flash flood forecasting pilot studies

It is proposed during FAP 10 to set-up a flash flood forecasting system using the MIKE11-FF package to forecast the river conditions. Several flashy rivers where forecasting may be appropriate are reviewed below. To be useful water level forecasts should be issued with sufficient lead-time to those who would receive direct benefit from these warnings. Figure 2.2, shows the flash flood prone areas.

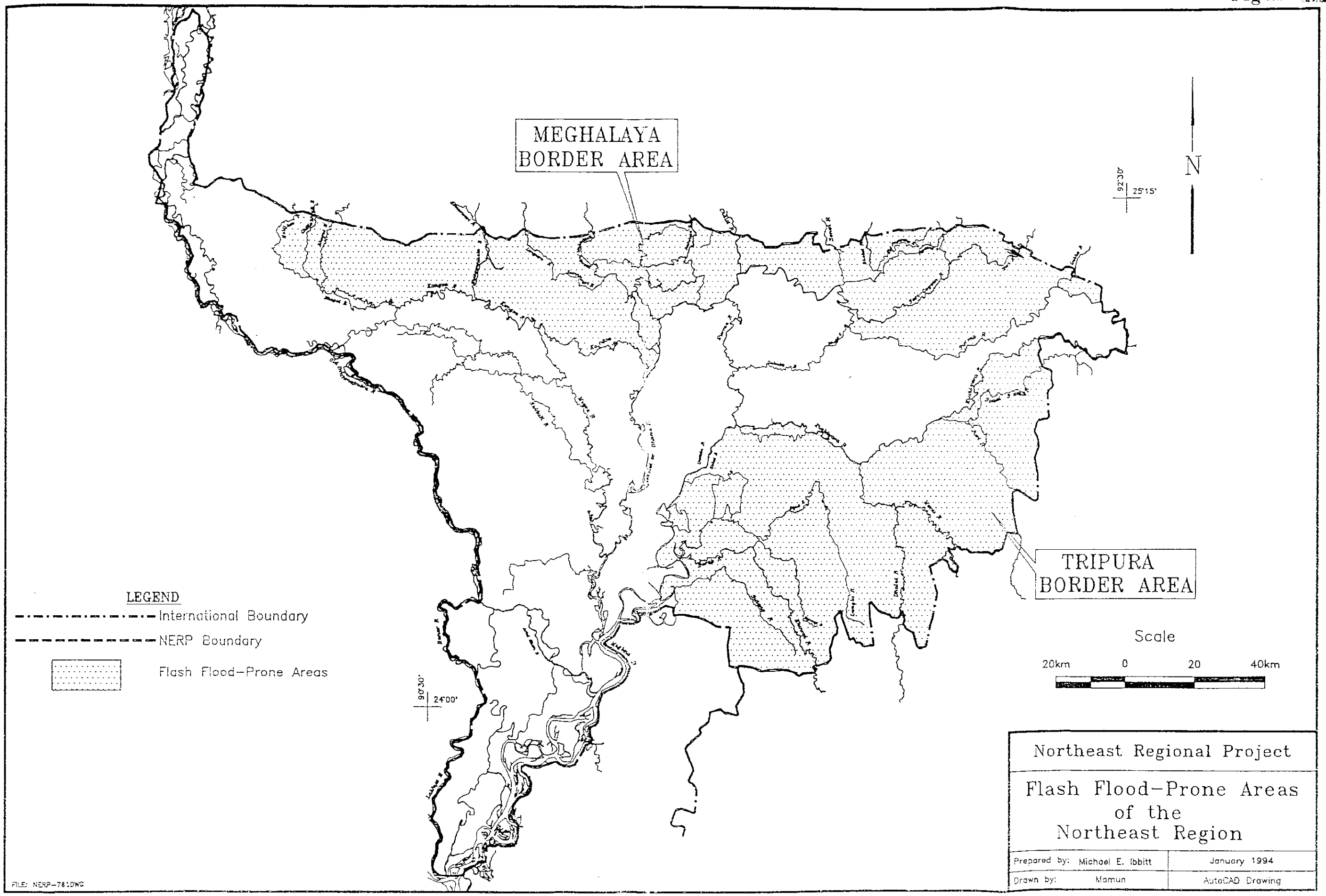
Following 11 river reaches have been identified where flash flooding could be expected to be severe :

River	Reach	Region
Bhogai	Border to Kangsha River	Meghalaya

Someswari	Border to Kangsha River	Meghalaya
Jadukta	Border to Surma River	Meghalaya
Dhalai(N)	Border to Piyain River	Meghalaya
Shari	Border to Sari-Gowain River	Meghalaya
Juri	Border to Dhaka-Sylhet Railway	Tripura
Manu	Border to Dhaka-Sylhet Railway	Tripura
Dhalai	Border to Dhaka-Sylhet Railway	Tripura
Karangi	Border to Dhaka-Sylhet Railway	Tripura
Surma	Border to Sunamganj	Tripura
Kushiyara	Border to Sherpur	Tripura

In all of these flashy catchments two problems recur. Firstly, the lack of rainfall measurements within the catchments and secondly, overbank spill upstream of the recording gauges which is not adequately quantified.

Figure 2.2


MEGHALAYA
BORDER AREA
TRIPURA
BORDER AREA
92°30'
25°15'
90°30'
24°00'
N
LEGEND
International Boundary
NERP Boundary
Flash Flood-Prone Areas
Scale
20km 0 20 40km
Northeast Regional Project
Flash Flood-Prone Areas of the Northeast Region
Prepared by: Michael E. Ibbitt
January 1994
Drawn by: Mamun
AutoCAD Drawing
FILE: NERP-78.DWG

Manu river

The Manu river is a likely candidate for flash flood forecasting. The Manu catchment is similar to other Tripura catchments such as the Khowai, Dhalai, and Juri. This catchment contains an important project, the Manu project. More detailed modelling work has already been carried on this river for these reason.

Modelling studies of the Manu river suggest that significant overbank spill occurs upstream of the highest discharge station, Manu Railway Bridge. The modelling studies indicate losses may be as large as 50% by overbank spill. Therefore, discharge and water level measurements upstream of the Manu Railway Bridge and embankments are desirable for flash flood forecasting.

Surma

The Surma river is also a likely candidate for flash flood forecasting. The upstream station at Amalshid close to the Border is included in the pilot telemetry network. Three important forecast points are located downstream: Kanairghat, Sylhet and Sunamganj and a fast flash flood warning system on Surma is therefore very important.

Alternative flashy rivers

Two other candidates are outflows from the Jadukhata and Someswari catchments (Figure 2.2). These are the largest catchments on the northern border in the Meghalaya region where rainfall is very high.

The optimal setup for flash flood forecasting would be a real-time reporting rainfall gauge located in India and a real-time reporting water level station close to the Indian border or within India. The minimum requirements would be a real-time reporting raingauge that is strongly correlated to the runoff and real-time water level measurements close to the border. More qualitative information from satellite and radar images would be useful especially for forecasting rainfall.

For flash flood forecasting, telemetered stations would provide the best chance of issuing a timely forecast. It would be useful to develop a model set-up on rivers where such stations are likely to be established.

Issuing of forecast

Forecasting of water levels in flashy river can be used to

1. predict the water levels which exceed embankment levels or warning

levels;
2. predict whether flash floods will continue i.e. whether or not the peak has passed or will continue to rise; and
3. predict inundated area and depth for assessing, for example, likely crop damage.

It must be recognised that because of the short rainfall response time, these forecasts will be difficult to make and therefore the risk of making a poor forecast is high; too many false warnings and these forecasts will be considered unreliable. Secondly, care should be taken as to whom the forecast should be presented. It would be best, perhaps, during the pilot work to target some specific users. For the Manu river it might be useful to contact the Manu project management. If they could be informed of the occurrence of a flash flood and when it would recede this may prove to be useful. Similarly, village of Jadukta/Maharam is one of the most dangerously exposed and frequently hit villages and would therefore derive a large benefit from timely forecasts. Furthermore, the river response appears to be a little slower. In other areas, crop damage during critical period in the growing cycle is important, however the benefit to be gained by forecasting should be examined critically.

Summary and recommended activities

It is recommended to implement flash flood forecasting on **Surma and Manu rivers.**

Flash flood forecasting or warning with realistic lead times requires water level data and/or rainfall data 24 hours a day. For flash flood forecasting, the most effective rivers are the Manu and Surma because of the possibility of setting up of a pilot telemetry system based on existing automatic stations. In particular, for flash flood forecasting to have reasonable chance of success, some form of nowcasting rainfall is essential. Even with real-time water level data, the time from forecast to the arrival of a flood wave may be very short. However, on the Surma a lead time up to 24 hours might be realistic with having a good data coverage. The Manu river is more difficult to forecast due to the nature of its faster response. It may prove impossible to carry out such forecasts unless a reporting raingauge is installed in the catchment in either Bangladesh or India.

The following activities are recommended

1. A desk study of the response times of the catchments most likely to be used for flash flood forecasting be carried out. This should examine the time that elapses from rainfall to the rise in upstream water level and the travel time of the flood wave to critical downstream sites. This study has already begun.

2. Field visit to the most likely flash forecasting or warning sites to investigate the requirements for a forecasting or warning system.

3. From the results of (1) it may become apparent which sites should be chosen for flash flood forecasting and under what conditions a conventional flood forecasting system is viable.

4. It is probable that only with raingauge data will it be possible to provide flash flood forecasts in time. Given such a gauge is established then a flood warning system may be as effective as a forecasting system. Thus by careful examination of historical data or even by modelling studies it should be possible to define a critical rainfall volume , e.g. 50 mm in the last 12 hours. At this stage a warning should be issued.

5. Subsequently a forecasting model could be used to provide more specific local information on whether embankment levels are exceeded and when levels will fall to acceptable levels. This last step should be geared to providing warning to specific areas where such information can provide maximum benefit such as a major village or farming area.

6. Improvement of the rainfall and boundary forecast using new techniques like neural network should also be considered.

Implementation of a flash flood forecasting system will require operational forecasting of flash flood from beginning of April each year.

In addition, the system would rely on the possibility of manning the FFWC on a 24 hour basis. This could only be implemented if the flash flood forecasts can prove its worth. Furthermore, the feasibility of such a 24 hour operation at FFWC should be investigated.

2.6 Module 2 - Expansion of Model Application

The work on Module 2 has start since February 1995 in cooperation with SWMC. The modelling activities will take place during the next two years.

Before the 1995 monsoon the General model used at the Flood Forecasting and Warning Centre will be updated with the latest SWMC version. The updating of the GM-FF has been finalized. The model will be tested on experimental basis in May before it can be used in real time from mid June at the FFWC. Section 3.2.1 gives a more detailed description of the activities required to develop GM-FF95 model.

The process to transfer the Flood Management Model developed under FAP 25 to a Flood Forecasting model has also started. The model will be used to forecast Water Level on operational basis and depth/area inundation on experimental basis

during the 1995 monsoon. Section 3.2.2 gives a more detailed description of the activities for this model development.

2.7 Module 3 - Forecast and Warning Dissemination and Public Awareness

During the inception phase a detailed work program has been prepared for Module 3. A WMO consultant was given the task to prepare a report to define the content and the work program for Module 3. The main objective was to assess the items in the Terms of Reference for Module 3 and develop a more detailed proposal to improve the flood forecasting and warning services. Section 3.3 gives a detailed description of the activities for Module 3 and Appendix A contains the WMO report.

3. PROJECT IMPLEMENTATION

3.1 Module 1 - Coordination and Monitoring

3.1.1 Coordination

Coordination and Monitoring will take place throughout the 3 year project period to maintain the progress made in setting up the Flood Forecasting and Warning Centre and to ensure that all project activities and their output are integrated satisfactorily into the Flood Forecasting and Warning Services.

Established links with other components in the Flood Action Plan will be maintained. The linkages with Disaster Management Bureau will be strengthened.

3.1.2 Development of the Communication System

Having a good communication system is essential for the flood forecasting and warning services. A lot of effort will therefore be used to strengthen and develop the communication system used by the Flood Forecasting and Warning Centre.

Wireless Radios

Improvement of the wireless radio system will take place during the 3 years project. A faster and more reliable data collection system will be developed.

Before the 1995 monsoon (May-June), radios and antennas will be checked. A special program for maintenance of radios and for improvement of quality of field data will be introduced during the same period.

It is planned to procure 10-20 new radios during the project period. The first 10 radios will be installed during October - November 1995. In addition, old and defective radios will be replaced with new radios.

Telemetric Network

Data from the pilot telemetric network will be used at the Flood Forecasting and Warning Centre on an experimental basis throughout the project period. It is also intended to integrate the telemetric data in the FFWC's database.

Data transfer from India

It appears to be very difficult to get a new agreement with India regarding data transfer. However, it should be possible to improve data transfer under the existing agreement.

It will be desirable to receive regular data throughout the monsoon directly from the Flood Warning Centres in Patna (Forecast on Ganges) and Goalpara (Forecast on Brahmaputra). This might be possible within the existing agreement.

As a first step to improve data transfer from India a contact has been initiated with Ministry of Water Resources in India regarding improved data transfer. After receiving a positive response the Flood Warning Centres in Patna and Goalpara will be visited by the project and offered assistance to improve data transfer to Bangladesh.

Data transfer from BMD

Bangladesh Meteorological Department will receive two new radars, one in Rangpur and one in Dhaka as a Grant from the Japanese Government. The radar in Dhaka will replace the old outdated radar. The agreement was signed in March 1995. The new radars are expected to be operational by the end of 1996. The Grant includes a new microwave connection from Bangladesh Meteorological Department to the Flood Forecasting and Warning Centre.

The new microwave connection from BMD to FFWC will ensure a good data transfer from BMD by the end of 1996.

Telephone and Fax connection between BMD and FFWC will be improved until the new micro wave connection has been established.

The existing radar in Dhaka is outdated (as stated by BMD) and will not be supported by BMD. Therefore it has been decided not to use the old radar in Dhaka at the Flood Forecasting Centre.

It is planned to use the new radar from 1997 at Flood Forecasting and Warning Centre. Training in radar application will be carried out in 1997.

Other Communications

The telephone and fax system will be upgraded at the Flood Forecasting and Warning Centre. The Flood Forecasting Bulletin will be distributed through fax to offices having a fax.

As a pilot project, data will be collected through cellular telephone around the greater Dhaka area.

3.1.3 Development of the Computer System

The Software and Hardware will be upgraded stepwise to fulfil the requirements for the expanded modelling and data handling.

A new setup of the Local Area Network to all rooms in the Flood Forecasting and Warning Centre has been installed in connection with the modernization of the Centre.

The Software will be updated to be able to meet the requirement from the modelling system, the increased amount of data from field, processing and presentation of data.

3.1.4 Supporting studies and development

The existing facilities for receiving satellite images directly at the Flood Forecasting and Warning Centre will be further developed. Part of the budget which will not be used for the radar will be used to upgrade the satellite equipment.

A study on a technology of applying satellite images in real time forecasting will be carried out in the beginning of 1996.

Supporting studies on radar technology applied in real time forecasting will be carried out, when the new radar has been installed in Bangladesh Meteorological Department.

Forecasting of flashy rivers will be studied during the project period. A pilot system capable to forecast floods in 2 flashy rivers will be developed during the project period.

Other supporting studies will take place throughout the project in order to improve the flood forecasting and warning services.

3.1.5 Establishment of Flood Monuments

Flood Markers/Monuments are planned to be established in selected forecast locations in the field. Danger Level and the 2-3 highest recorded Flood Levels will be marked on the flood monument.

3.1.6 Training Programs

To achieve the objective and outputs trained staff will be needed for efficient operation and maintenance of the flood forecasting and warning services. The training has been designed in the following fields :

1) Management of the computer system and local area network.
2) Advanced hydrodynamic modelling techniques for model development.
3) Hydrodynamic and hydrological modelling technique for new staff joining the Centre.
4) Flood forecasting techniques for new staff joining the Centre.
5) Meteorological and remote sensing applications in flood forecasting.
6) Operation and maintenance of hydrological radar system and its links to FFWC.
7) Interpretation and analysis of hydrological radar and satellite outputs.
8) Flood impact assessment and disaster preparedness.
9) Forecast preparation and presentation.
10) Public liaison and development of training and public education.
11) Training of field staff.

The project will support four types of trainings: On-the-job training, local group training, individual overseas fellowships, and human resource development, including study tours for senior executives. Training will be carried out in a number of training batches designed to fulfil the requirements of each group to be trained.

On-the-Job training and local group training

Daily On-the-job training will be carried out throughout the project period. The local officers will be involved in all aspects of the project.

Module 1 will support:

- dedicated training to the local system manager, who will participate in the setup of the computer system and the development of software
- local group training in computer technology at user level for all officers and wireless operators in FFWC
- dedicated training to the flood forecasting group in items 2, 3, 4, 5, and 7.

In module 2 the officers from the Flood Forecasting group will participate in the development of flood forecasting models at the Surface Water Modelling Centre together with the local consultants.

A special training program has been developed for the warning dissemination group in module 3 (see Appendix A).

Training of field staff

The Construction and Instrumentation Division under Surface Water Hydrology-II, maintains 60 SSB wireless radios in the field throughout Bangladesh. Through these wireless radios real time data are transmitted to FFWC. FFWC has also 4 TCO/TPO for receiving the data coming from the field.

At present only 39 wireless stations are operated by 39 TCO/TPO's. The remaining stations are being operated by the guards, who are not qualified.

To increase the efficiency of the operators, a training course will be held in Dhaka both for the TCO/TPO and the guards. To achieve the objective a 6 days training program will be implemented for the two groups as follows :

Training course for TCO/TPO's

i) Maintenance of Wireless radios.
ii) Light repair work and replacement of ordinary spare parts.
iii) Importance of real time data and timely transmission of the same to the FFWC.
iv) Other relevant subjects.

Training course for Guards

i) Maintenance of wireless radios.
ii) Receiving, collection and transition of data/messages.
iii) Other relevant subjects.

In addition to the training in Dhaka, a training program for maintenance of radios and for improvement of quality of field data will be introduced in the field.

Overseas training

The individual fellowships overseas should cover the requirements for trained manpower with regard to i) the maintenance of installations and equipment, ii) advanced hydrodynamic modelling techniques for model development, iii) hydrological modelling and forecasting for new staff joining and iv) disaster preparedness. Four individual training courses has been designed for overseas training:

Course 1:

Title	:	Advanced hydrological/hydraulic modelling
Dates	:	December 1995 - March 1996
Length	:	4 months
Participants	:	4
Place	:	DHI-Denmark
Description	:	The course will be conducted for staff from FFWC already capable of running flood forecasting models. The trainees will first receive updating of their existing modelling capabilities. Afterwards the training will concentrate on advanced hydrological and hydrodynamic modelling technique for model development including GIS-techniques. The National Project Director will visit DHI during the training course for 2 weeks. Within the 2 weeks period he will visit England to see the forecasting system of the National River Authority.

Course 2:

Title	:	Hydrological/hydraulic forecasting technique.
Dates	:	December 1996 - March 1997
Length	:	4 months
Participants	:	4
Place	:	DHI-Denmark
Description	:	The course will be conducted for the young officers from FFWC and will concentrate on item 3, 4, 5, 6 and 7.

Course 3:

Title	:	Wireless Communication/field measurements
Dates	:	November 1995
Length	:	1 month
Participants	:	2
Place	:	DHI-Denmark
Description	:	The course will be conducted for 2 young staff members of the C&I Division engaged by the Flood Forecasting and Warning Centre.

Course 4:

Title	:	Disaster Management
Dates	:	November 1995
Length	:	1 month
Participants	:	10

Place	:	AIT-Thailand
Description	:	The course will be conducted at the Asian Disaster Preparedness Centre at AIT Bangkok. The full spectrum of the disaster continuum from response, through recovery, rehabilitation, and development will be covered, with special emphasis on prevention, mitigation and preparedness. Over 25 resource persons will share their unique expertise with the participants in this course.

It should be arranged that all officers from FFWC participating in the overseas training courses (course 1-4) will be committed to work 5 years for the Flood Forecasting & Warning Centre after the completion of the project to ensure sustainibility of the Flood Forecasting and Warning Services.

Human resource development

The human resource development is proposed to include study tours, participation in regional seminars and workshops with regard to water resource management and flood forecasting and courses on supervision and appraisal.

Two study tours (one to Australia and one to Japan) have been planned for the participants in the disaster management course at AIT-Thailand. Each study tour will have a duration of approximately 10 days.

The first study tour will have 4 participants. The participants will visit the New South Wales Flood Warning Centre and other organisations related to water resources in Australia. Field Trips will also be arranged.

The second study tour, for 4 other participants in the AIT course, have been planned in Japan. The participants will visit National Warning Centres in Japan and other relevant organisations.

3.1.7 Work Programme module 1

Work Programme for module 1 including training activities is presented in Figure 3.1.

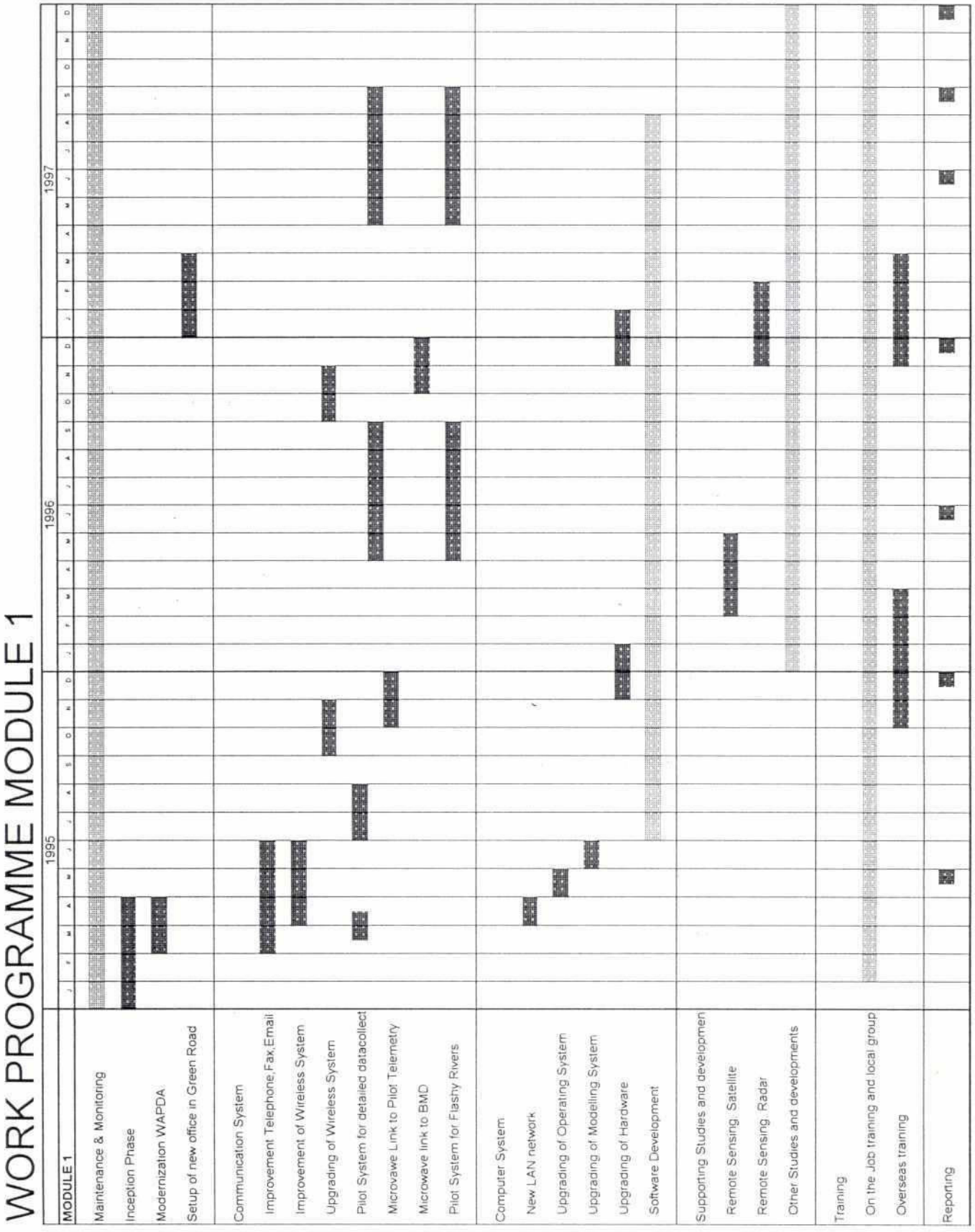


Figure 3.1. Work Programme Module 1.

3.2 Module 2 - Expansion of Model Application

Work on this module is being carried out in cooperation with the Surface Water Modelling Centre. A Memorandum of Understanding has been signed between the project and SWMC on the use of SWMC facilities and local experts. GOB engineers from FFWC are working with SWMC experts on model development.

In order to achieve the project objectives and outputs regarding the expansion of the flood forecasting services it has been decided to expand and further develop models from the Surface Water Modelling Centre.

The General model (GM) will be further developed and expanded with the major rivers in the North East Region and North West Region. A special setup of General Model for forecasting of flash floods in the North East Region will also be developed. The model will be used to forecast water levels.

The North Central Region Flood Management Model (NCR FMM) will be further developed to a flood forecasting model. The model will be used to forecast water levels and depth/area inundation.

3.2.1 Expansion of the General Model (GM-FF)

Introduction

The General Model (GM) has been used for flood forecasting in Bangladesh since 1990. In 1991, the GM-FF was extended into the North East to include the major rivers in that region, see Figure 3.2. The present setup of the model developed in 1992-93, has 16 forecasting stations. To improve the accuracy and applicability of the model, a plan of action has been drawn up, which will span a period of 18 months. The plan features a two stage approach, with an updated, but essentially unchanged model (GM-FF95) being brought into operation for the 1995 monsoon, and an extended and re-developed model (GM-FF96) being prepared thereafter for the start of the 1996 monsoon. The following sections describe the activities which are planned to bring these two models into operation.

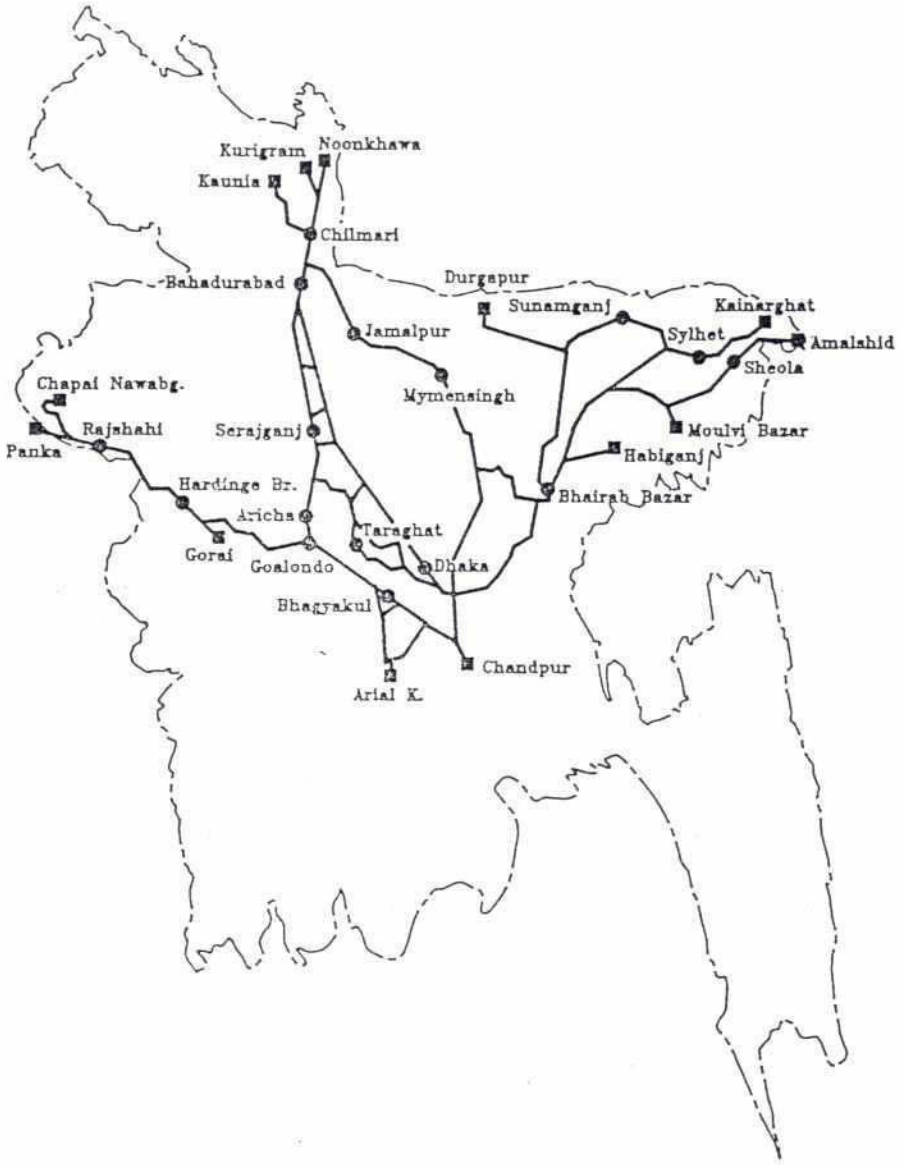


Figure 3.2. Existing GM-FF.

Establishment of GM-FF95

The model which will be used for forecasting in the 1995 monsoon will be based on the existing model, but updated with SWMC's latest version of their GM. SWMC last updated the GM in 1993 with the data of up to 1992. At present SWMC is validating the GM with 1993 and 1994 data. At the same time, several minor changes to the model setup are being made:

- Bench mark corrections identified by Finnmap, and listed by FAP24 will be applied to correct both observed water levels, and to adjust river cross sections where necessary.

- The volume of water spilling on the left bank of the Jamuna into the North Central Region will be reconciled with the simulated inflow to the North Central Region Model, and verified against available measurements.

- The model boundary on the Surma river in the north east will be moved upstream to Amalshid, to match the NERM schematization.

- The Ghior Khal, an important Jamuna left bank spill channel identified in the NCRM, will be added to the model setup.

- The model will be re-validated for the period 1986-1991 initially, and later with 1993-94 data after these have been processed. The 1993-94 data set includes many discharge measurements taken on the Jamuna by FAP24. These measurements will be helpful to check the volume of water spilling to the left bank.

The updating of the GM is being carried out jointly by SWMC and FAP10. After the update has been completed and the model verified, the model setup will be transferred to FFWC for use in forecasting in the 1995 monsoon.

Establishment of GM-FF96

Upon completion of the GM-FF95 model, work will immediately commence on the preparation of GM-FF96. This model will feature much more detailed descriptions of the river systems of the NW and NE regions through the partial adoption of the established regional models into GM-FF95. Improvements and developments to GM-FF95 which will be carried out in this period are described in the following.

Inclusion of Reduced NWRM into the GM-FF96

At present the only rivers of the North West region represented in the GM-FF are the Teesta and Dharla. The remaining river systems are represented in the model as

NAM catchments. To extend the coverage of flood forecasting stations it will be necessary to include more rivers in the model setup. It would not be feasible, nor desirable to include the entire NWRM into the GM-FF model. However, a "cut-down" version of the NWRM could be included, which comprises the major river systems in the North West.

At this stage it is planned to include the Atrai, Jamuneswari, Little Jamuna, Karatoya and Ghaghot systems into the GM-FF96. These rivers represent the major drainage paths of the North West Region. Adding these rivers to the GM-FF96 setup, the existing NWRM will be used as a basis. Smaller rivers and channels will be removed from the model setup. It will be necessary to reschematize the flood plains and the NAM catchment setup in order to take into account the reduced river coverage. Rivers removed from the model will need to be replaced either by extending the flood plains from adjacent rivers, or by adding flood channels with links to remaining rivers.

Extensive use will be made of the MIKE11-GIS package during the model reschematization process. The power of the GIS coupled with the newly available 500m grid DEM from FAP 19 means that redefinition of the flood plains and flood cells in the reduced model setup can be carried out quickly and efficiently. The GIS will also be used to redelineate the NAM catchments in the reduced model to cover those areas where river systems have been removed.

At present in the North West Region, 4 stations report in real time. In order to facilitate updating the model in the North West, an additional 4 real time stations have been proposed, including both boundary and forecast/update stations. These are shown in Table 3.1.

Table 3.1. North West Region: Existing and Proposed Real Time Stations

Station	River	Type	Status	Interval
Gaibhanda	Ghaghot	Boundary		3 hour
Badarganj	Jamuneswari	Boundary	New	1 hour
Bogra	Karatoya	Forecast		3 hour
Phulbari	Little Jamuna	Boundary	New	3 hour
Naogaon	Little Jamuna	Forecast		3 hour
Panchagarh	Karatoya	Boundary		1 hour
Mahavdepur	Atrai	Forecast	New	3 hour
Singra	Atrai	Forecast	New	3 hour

Inclusion of Reduced NERM into the GM-FF96

Rivers of the North East Region presently included in the GM-FF comprise the Surma, Kushiyara, Baulai, Manu, Kangsha, Khowai and Upper Meghna. It is proposed for the development of GM-FF96 to additionally include the Kangsha upstream of Jariajainjhal, the Sarigowain, Mogra-Dhanu, Jadukata and Jhalukhali rivers.

The addition of new rivers into GM-FF96 will follow the same procedure as for the NWRM, described above. The NERM will be used as a basis, with rivers other than those listed above removed. A large part of the existing NERM model setup comprises flood cells and flood channels, the present schematization of which depends on the existing river coverage. Therefore removal of some channels from the setup will require a major reschematization of the model. As with the NWRM, this process will be greatly facilitated by the MIKE11-GIS package and the 500m grid DEM available from FAP19.

As with the NWRM, the NAM setup will also need to be revised. Many of the rivers which will be removed from the setup will be flashy boundary rivers which in the NERM use discharge boundaries generated from rating curves using observed water level data. These inflows will need to be replaced by NAM catchments which extend across the border into India. A preliminary calibration of these catchments has already been carried out as part of the NERM development for FAP6. It is proposed that the existing calibration be adopted for use in the development of GM-FF96, with modifications as necessary.

Two of the largest boundary rivers, the Jadukata and Jhalukhali, are proposed to be added to the hydrodynamic model setup. Water levels at the boundaries of these

rivers vary rapidly between great extremes, and so constant monitoring of these water levels will be necessary. Table 3.2 shows the existing and proposed real time stations.

Table 3.2. North East Region: Existing and Proposed Real Time Stations

Station	River	Type	Status	Interval
Amalshid	Surma/Kushiy.	Boundary		1 hour
Sheola	Kushiyara	Forecast		3 hour
Sherpur	Kushiyara	Forecast	New	3 hour
Kaniaghat	Surma	Forecast		3 hour
Sylhet	Surma	Forecast		3 hour
Sunamganj	Surma	Forecast		3 hour
Markuli	Kushiyara	Forecast	New	3 hour
Durgapur	Kangsha	Boundary		1 hour
Habiganj	Khowai	Boundary		1 hour
Manu Rly Br	Manu	Boundary		1 hour
Moulvibazar	Manu	Forecast		1 hour
Lourergorh	Jadukata	Boundary	New	1 hour
Dulura	Jhalukhali	Boundary	New	1 hour
Lubhachara	Lubha	Boundary	New	1 hour

Forecasting on Flashy Rivers

Two rivers in the North East Region have been selected for forecasting trials on flashy rivers, the Manu and the Surma.

Manu River

The Manu river originates in the Indian state of Tripura. The river is important as it has been the focus of a flood control and irrigation development scheme known as the Manu River Project. The project comprises flood embankments on both sides of the river, a barrage on the river itself with associated headworks and irrigation canals. During the monsoon, the barrage gates are left fully open to allow the passage of floods. From November to March, they are closed to head up river water

for diversion into the irrigation canals.

Flash floods can occur at any time on the river during the monsoon, and often overtop the project embankments which are then breached. Public cuts are also made to allow drainage of the water from inside the project area back to the river after the floods have receded.

The main problem with forecasting on the Manu is associated with the be inadequate lead time. The present upstream boundary for the NERM is at Manu railway bridge. However, substantial spills occur upstream of this station into the Manu Project, and so the gauge does not capture the total flow. It would be preferable to move the real time station further upstream close to the Indian border. Failing this, a real time rainfall station could be installed on the border so that a NAM runoff could be used as input to the model.

Forecasts made for the Manu will be applicable only under an assumption that no breaching or overtopping of the embankments occurs. If breaches do occur, the behaviour of the flood wave will alter significantly, and this cannot be taken into account by the model unless the precise nature and timing of the breaches are known.

Surma River

Prospects for forecasting on the Surma river are much better than on the Manu. The upstream boundary of Amalshid on the Indian border will be upgraded to a real time station after the telemetric system (under module 4) has been established. This will allow a reasonable lead time for forecasting. The lead time could be improved even further if water level recordings or forecasts for the Barak River in India could be obtained.

The Surma rives flows past the important city of Sylhet, so forecasts on the river will be extremely useful. Flash floods on the Surma generally occur only during the pre-monsoon period. Later in the monsoon, the water level remain continually high due to backwater influences from the Meghna River downstream. The river is embanked along much of its upper course. The embankments have breached in the past e.g: in 1991. As with the Manu, the accuracy of forecasts in the case of embankment breaches will be reduced. Details of breaches should be obtained as soon as possible after they occur so that the model can be updated to reflect these phenomena.

Forecasting of Tidal Water Levels at Chandpur and Arial Khan

The downstream boundaries of the present GM-FF comprise a Q-h boundary on the Arial Khan, and a water level boundary at Chandpur on the Lower Meghna. Both

these stations are influenced by tides propagating up the rivers from the Bay of Bengal, yet these effects are not taken into account by the model. The diurnal tidal variation at Chandpur, even in the peak monsoon when the freshwater discharge is at its highest, is of the order of 1 metre. The tidal amplitude at the Arial Khan boundary would be similar. At present, the GM-FF uses a water level boundary at Chandpur with the tidal effects filtered out (therefore representing a mean water level). It will be investigated if the Arial Khan needs to be modelled with real time data to give a better description of the tidal effects.

In order to improve the accuracy of the model in this region, it will be necessary to include full tidal boundaries. To fully describe a tidal cycle (lasting approximately 6 hours) water levels need to be measured at a maximum interval of 30 minutes - 15 minutes is recommended. Arrangements will need to be implemented, suo that Chandpur reports in real time with 60 minute intervals or preferably 30 minute intervals.

Using tidal water level boundaries will also mean that some form of predicting the tide - for 72 hours maximum - will be required. Several approaches are possible, and these are outlined below:

- Tidal water level predictions are possible using standard commercial software packages, which use standard tidal constituent parameters prepared by the Admiralty of the Navy (so called "Admiralty Tables"), coupled perhaps with additional constituent parameters derived from a long term record of observed water levels. Experience in Bangladesh suggests that tidal predictions in the internal rivers using purely the Admiralty constituents are not accurate, without the addition of the local ("shallow water") constituents.

- For a 72 hour prediction of the tide, it may be sufficiently accurate to simply repeat the previous 72 hours data, shifted in time.

The long, continuous time records needed to carry out a tidal constituent analysis for the two stations are not available, and therefore a simple prediction based on the previous 72 hours data may be used. However, with the establishment of the real time stations, continuous data will be recorded so that after a sufficiently long record is obtained, a more detailed tidal analysis can be carried out which will permit a more accurate prediction of the tide.

Improvement of Forecast Lead Time

The most critical area in which the lead time of the present forecasts could be improved is that concerning the upstream boundaries. At present, only data from in-country boundary stations are used to prepare the forecasts. If the upstream model boundaries could be shifted further upstream, ie. into India, then the forecast lead time could be substantially increased. An extended GM-FF (named GMX) was

established during the course of the BGD/88/013 project, when the upstream model boundaries on the Ganges and Jamuna were located at Farakka and Dhubri respectively. It should be noticed that the GMX has been used in real time on an experimental basis in BGD/88/013 with promising results.

Forecasting with GMX or a similar model setup can only be carried out if real time data for Farakka and Dhubri are received in real time on a regular basis from India. During the course of the FAP 10, efforts will be made to assure that such data will be made available.

Area-Inundation Forecasting applying GM-FF96

The recent development of the MIKE11-GIS interface by FAP25 means that the results of MIKE11 simulations can now be displayed spatially as flood maps using GIS technology. FAP25 demonstrated the viability of linking MIKE11 simulations to a GIS via a "Flood Management Model" to produce flood maps indicating both the extent and depth of flooding at different times during the MIKE11 simulation. Flood depths are computed as the difference between simulated water levels and known land levels. A DEM covering the entire country (except Chittagong Hill Tracts) representing land levels on a 500 m grid has recently been digitized by FAP19.

MIKE11-GIS technology can be used together with GM-FF96 to augment the water level forecasts to produce area-inundation forecasts, using the FAP19 DEM. However, due to the coarseness of both the GM, and the underlying DEM, the computed depths should be seen as average values covering a given area, rather than actual measurable values. Discrepancies between simulated and actual extent and depths of flooding will be greater at low water levels (minor floods) as the uncertainties inherent in the DEM and simulated water levels are amplified. Only during extreme flood events (such as the 1988 flood) could the computed flood maps be regarded as depicting close to actual field situations. In such cases, the flood maps will have an instant visual impact, and will enable the progression of a major flood to be easily displayed.

3.2.2 Adaptation of North Central Region Flood Management Model to a FF-model

Introduction

This section describes briefly the existing North Central Region Flood Management Model developed by FAP 25 and its further development to a real time flood forecasting model with provision for depth/area inundation forecasting.

The new model will be used on an operational basis for real time forecasting of

water level at FFWC during the 1995 monsoon. The model will be ready for operational depth/area inundation forecasting for the 1996 monsoon. In the 1995 monsoon the depth area inundation forecasting will be carried out on experimental basis.

North Central Region Flood Management Model

The FAP25 NCR FMM is based on the NCRM developed by SWMC. For enhanced representation of the flood plains in the North Central Region, developed the SWMC NCRM model schematization was modified to a Quasi 2-D representation. The FAP25 NCR model is described in detail in (FAP 25, October 1994).

The extent of the FAP25 NCR model is, compared to the SWMC NCRM, limited to that part of the North Central Region which lies to the west of the Madhupur Tract. The basic schematization of the river network in the FAP25 NCR model closely follows that of the western part of the SWMC NCRM. The major difference is the inclusion of parts of the Jamuna, Ganges, Padma, Lower Meghna and Arial Khan in the setup. In addition, lateral discharge inflows were introduced to represent the contribution of the Teesta and Atrai. The boundaries of the major rivers were chosen at chainages corresponding to locations in the General Model, at which simulated discharges or water levels stations could be extracted.

Characteristic of the river system in large parts of the NCR model is that the river is separated from the flood plain by embankments and natural levees. In most places, the banks of the river are at a higher elevation than the adjacent floodplain. Also, the local rainfall on the floodplain can accumulate in depressions without immediately draining back into the river system.

FAP19 supplied the DEM for the western part of the NCR. The DEM is based on the BWDB 1953-67 4" and 8" to the mile contour maps. FAP25 primarily based the Quasi 2-D flood plain model schematization on topographic information extracted from this DEM.

In the model smaller flood plains were generally treated as flood cells. This approach assumes that floodwater are flowing in and out of the flood plain through links from the surrounding rivers.

In areas where the floodplain topography showed few constrictions to flow, the flood plains were treated as separate branches, behaving in a similar way to the river channels. This representation is typically encountered on the flood plains between Bangshi, Dhaleswari and Kaliganga.

Applying the FAP25 NCR model it is possible to simulate flood characteristics resulting from construction of embankments of different heights, which was not possible with earlier 1-D models.

The FAP25 study applied the developed NCR FMM for demonstration purposes primarily to demonstrate the capabilities of the MIKE11-GIS interface. The applications included among others the consequences of compartmentalization, embankment breach and depth/area inundation forecasting. The simulated water levels were presented as flood maps and as impact maps conveying the results in an extremely visual and easy to interpret manner.

North Central Region Flood Management Model, FF

FAP10 cannot directly apply the developed FAP25 NCR FMM for real time flood forecasting. The model schematization should be modified primarily to conform with the real time station network, secondarily to calibrate the real time update at forecast locations.

NAM Model:

The NAM model for the NCR compromises a total of 19 catchments covering the North Central Region. Six real time rainfall stations are available for generating mean areal rainfall. Besides the NCR catchments, river catchments along the boundary rivers are included, likewise is the runoff from the Atrai basin in the North West described by including catchments covering this area. The real time rainfall stations used for the FAP10 NCR FF are as follows (see Table 3.3) :

Table 3.3. Real Time Rainfall station in North Central Region.

STATION	REGION
Dewanganj	NCR
Jamalpur	NCR
Mymensingh	NCR
Serajganj	NCR
Tangail	NCR
Dhaka	NCR

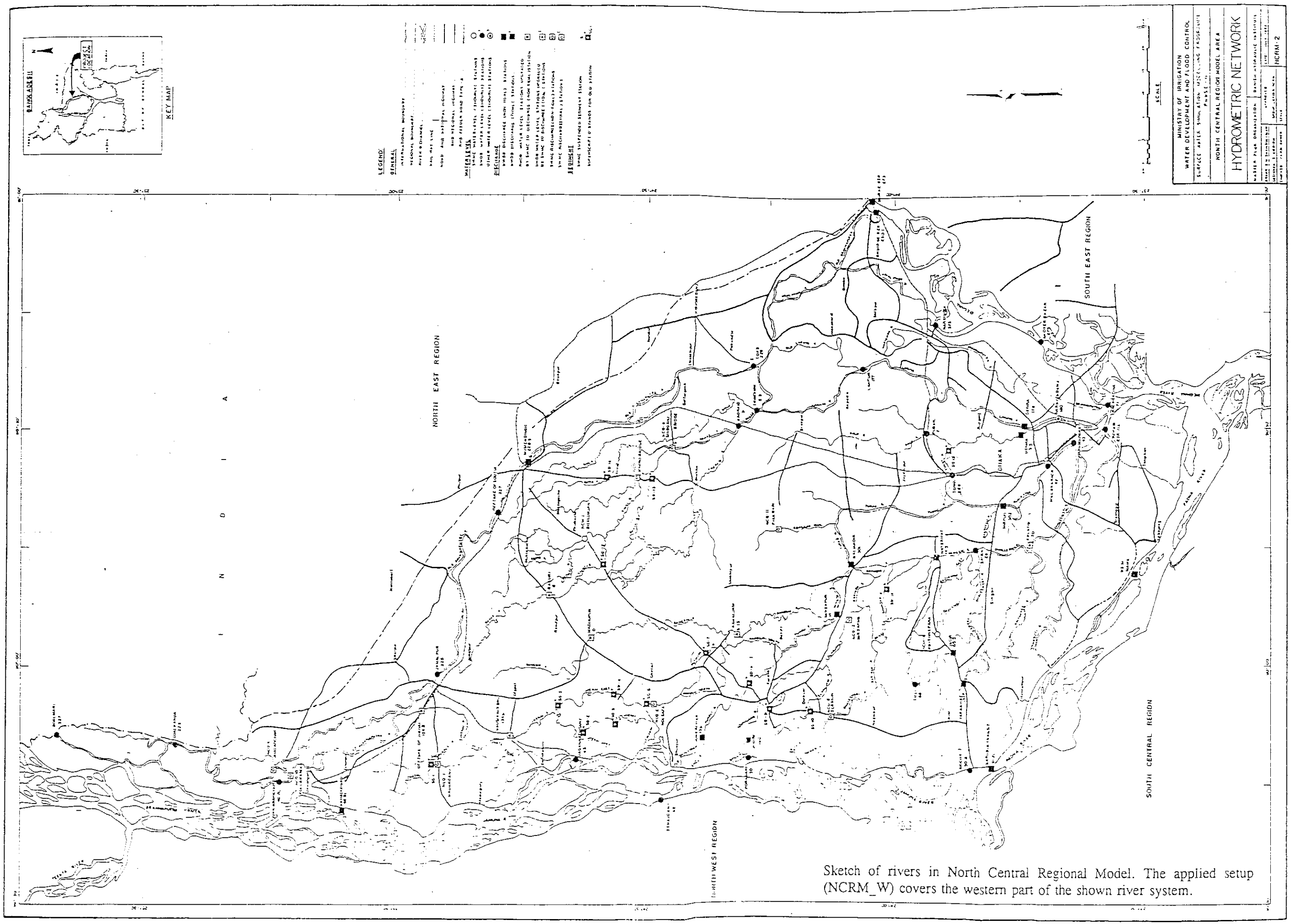
The lateral inflow generated by the NAM model is distributed locally to the schematized flood plains contributing to the flooding from local rainfall. The runoff generated by the major river catchments, being relatively small, is diverted directly into the river. The runoff from the NW Atrai basin drains to the Jamuna on the reach around the Atrai - Jamuna confluence.

Hydrodynamic Model:

The hydrodynamic NCR model compromises the rivers and flood plains of the western part of the North Central Region and the major boundary rivers controlling the flow into the North Central Region. The included river network is illustrated in figure 3.3 showing the model branch schematization. The boundary rivers are Jamuna, Ganges, Padma, Upper Meghna, Lower Meghna and Arial Khan. The schematization of the boundary rivers is the same as used in the General Model with spill channels and junctions placed accordingly. The open boundaries of the NCR model are found at real time stations. At inflow boundaries discharges were applied during the phase of initial calibration. Water level is, for the FF model, applied at all boundaries. Boundary conditions and real time forecast stations are listed in Table 3.4.

Table 3.4. Real time Water Level Stations in North Central Region.

Station	River	Type	Status	Interval
Noonkhawa	Jamuna	Boundary		1 hour
Chilmari	Jamuna	Update		3 hour
Bahadurabad	Jamuna	Update		3 hour
Serajganj	Jamuna	Update		3 hour
Aricha	Jamuna	Update		3 hour
Dharla	Kurigram	Boundary		3 hour
Teesta	Kaunia	Boundary		3 hour
Hardige Bridge	Ganges	Boundary		3 hour
Gorai Rly Br.	Ganges	Boundary		3 hour
Bhagyakul	Padma	Update		3 hour
Chandpur	Lower Meghna	Boundary		1 hour
Jamalpur	Old Brahm.	Update		3 hour
Mymensingh	Old Brahm.	Update		3 hour
Bhairab Bazar	Upper Meghna	Update		3 hour
Dhaka	Buriganga	Forecast		3 hour
Narayanganj	Lakhya	Forecast		3 hour
Rekabi Bazar	Dhaleswari	Update	New	1 hour
Nayerhat	Bangshi	Forecast	New	3 hour
Mirzapur	Bangshi	Forecast	New	3 hour
Tongi	Tongi Khal	Forecast	New	3 hour
Mirpur	Turag	Forecast	New	3 hour
Jagir	Dhaleswari	Forecast	New	3 hour
Taraghat	Kaliganga	Forecast		3 hour



Sketch of rivers in North Central Regional Model. The applied setup (NCRM_W) covers the western part of the shown river system.

Figure 3.3. River network in the North Central Region.

Depth/Area Inundation Forecasting with the model.

For real time Depth/Area Inundation Forecasting with the NCR FMM FF a focus area covering the area around Dhaka has been selected for experimental depth/area inundation forecasting. The area, shown in figure 3.2, covers approximately 2000 square km. This area has been selected as, covering the area encompassing the nation's capital, it has immediate interest and because FAP10 could readily apply the output of FAP25 with respect to flood plain model development and GIS.

Depth/area inundation forecasting will be performed with the newly developed MIKE11-GIS interface based on ARCView for PC operating as a full Windows application. The MIKE11-GIS interface includes:

- interpolation and generation of a Digital Elevation Model (DEM)
- display and analysis of DEM
- import of MIKE11 model description and model simulation data
- generation of Branch Route System
- animation of water levels in MIKE11 calculation points.
- interpolation and generation of flood maps
- display and analysis of flood maps

Defining and generating the DEM and the Branch Route System is usually only performed once for each area, inferring that the daily routines necessary for preparing four flood maps showing depth/area inundation today,after 24h,after 48h and after 72h reduces to:

- importing model simulation data from MIKE11
- generating four flood maps
- display and print

Difference flood maps showing eg. the change (increase/decrease) of flooding extent can also be produced. These comparative flood maps are useful for forecasting the change of flooding on a daily or eg. 72 hour basis.

The application of the NCR FMM FF for Depth/Area Inundation Forecasting during the 1995 monsoon will be conducted as an experimental study, where the results mainly will be applied to assess and define approaches toward important issues as:

- real time update of flood plain water levels
- validation of flood plain water levels using radar images, satellite images, ground truth data etc.

These fundamental topics need to be addressed and appreciated before depth/area inundation forecasting can be used on an operational basis.

3.2.3 Work Programme Module 2

Figure 3.4 shows an work program for the activities of Module 2.

3.3 Module 3 - Forecast and Warning Dissemination and Public Awareness

The major part of this module has been subcontracted to WMO. This section contains extract from the WMO report (see Appendix A) regarding the project implementation for Module 3.

The requirements from the TOR have been converted into detailed tasks and linked into groups of activities.

3.3.1 Group A - Strategic and Training Activities

Following activities are planned under this group

Interface with Disaster Management Bureau's Activities

The responsibilities of DMB and FFWC for dissemination of Flood Warnings will be will be worked out within the Draft Emergency Standing Orders. FFWC will develop Flood Warning Messages and make arrangements for dissemination through the media. The latest draft revision of Emergency Standing Orders will be reviewed for effect on tasks in the schedule. Input to future reviews of Emergency standing orders will be provided.

A Flood Warning Action Plan will be developed including a Operation Manual for FFWC. The action plan shall clearly state limits of responsibilities for dissemination of Flood Warnings by FFWC.

Flood Warning Development Plan

A long term development plan will be worked out including identification of all customers and customers locations, development and implementation activities, preparation of local action plans associated work loads & resource inputs which would be needed to complete implementation of a national wide Flood Warning Service.

A outline program will be developed of work to establish effective flood warning in all Thanas and Unions at risk of serious flooding.

WORK PROGRAMME MODULE 2

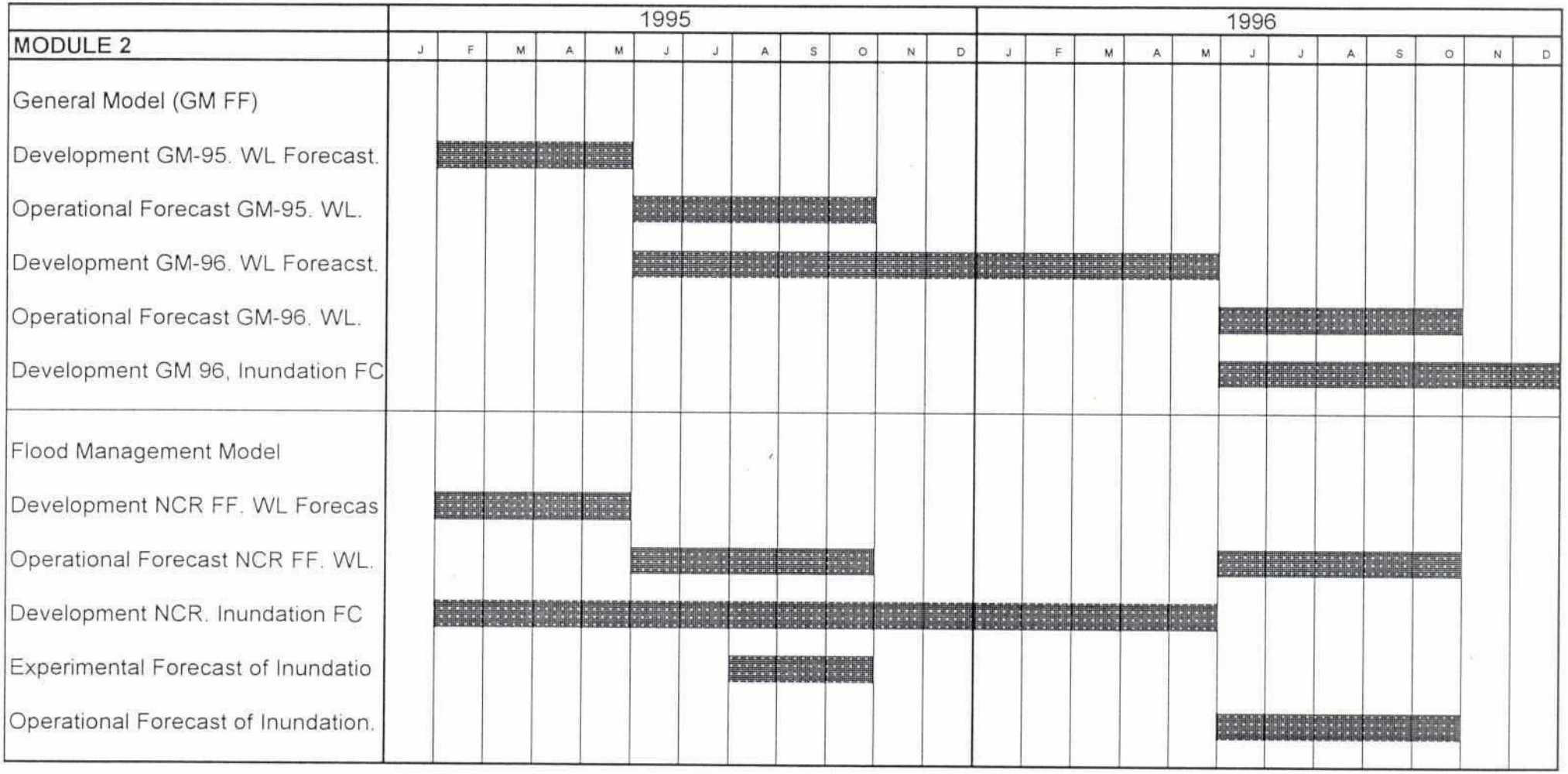


Figure 3.4. Work Programme Module 2.

Training and Manpower Development Activities

A basic training module will be developed on flood warnings to be used with Police, Fire and Rescue, Local Government Engineering Directorate, district agriculture staff and other groups.

Training exercises will be developed to be run by FFWC. The FFWC will be trained in warning dissemination and public awareness.

The training also includes contribution to workshops to be held by DMB, study tours and training of the FFWC staff in drafting an action plan.

3.3.2 Group B - Establishment of Principles and Development of Flood Warning Systems

Following activities are planned under this group:

Identification of Users and User needs

All Categories of situations requiring flood warnings will be identified. The studies will be concentrated on flood warning messages and dissemination procedures for main rivers. All end users of flood forecasts and flood warnings will be identified including their information requirements.

Establishment of Warning Criteria

This activity includes establishment of flood warning definitions and terminology, principles to apply to phasing of flood warnings, establishment of flood categories needing phasing and warning arrangements, establishment of a network of flood markers and identification of flood warnings to include specific action.

Establishment of Dissemination arrangements

This activity includes establishment of optimum time of day to release flood warnings, establishment of means for rapid transmission of flood warnings to media, exploration of use of local radio networks and broadcast in local dialects, an review of use of BWDB radio to transmit flood warnings, investigation of all other communication options available for flood warning dissemination, establishment of communication hardware needs at FFWC and development of hardware/software system to support message preparation and dissemination.

Development of Flood Warning Messages and Press Release Contents

These will be required for all phases of flood warnings messages and for all different types of applications. Standard proforma for press releases will also be developed.

Pilot Projects

This activity includes pilot projects for depth/area inundation warning schemes and flash flood warning schemes applying the general principles defined in other tasks to development arrangements in trial zones.

3.3.3 Group C - Public Awareness and Evaluation

Following activities are planned under this group:

Development of Public Awareness and Education

Education material describing flood warnings will be developed to be used in primary and secondary schools. Publicity material for communication and educational use will be developed in form of posters, maps, handout cards, videos etc.

Evaluation and Field Studies

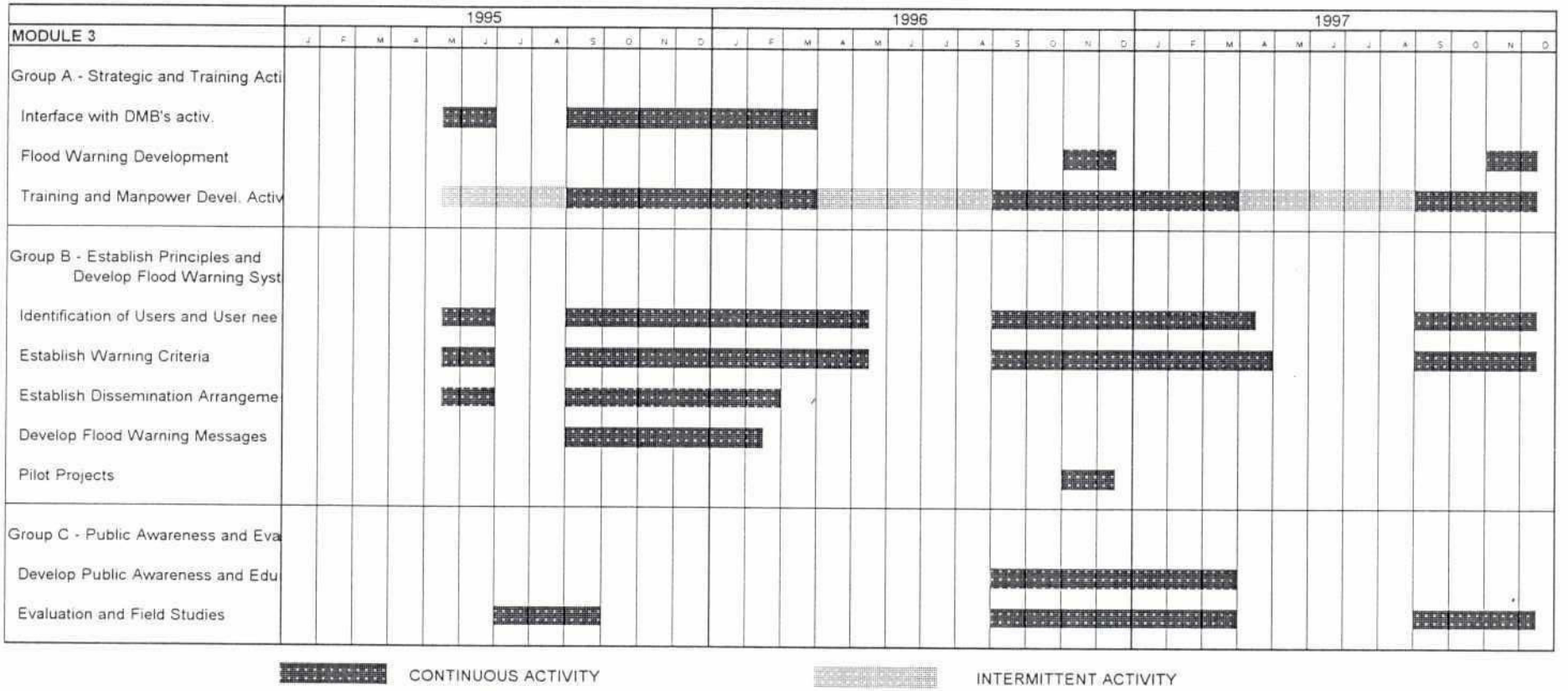
The Flood Response and Flood Proofing studies under the Flood Action Plan and relevant work in other countries will be reviewed. The activity includes development of a program of field evaluations. Lessons from the field evaluation will be incorporated into flood warning procedures and arrangement for feedback on extent of flooding will be established.

3.3.4 Work Program Module 3

The overall Work Program for module 3 is shown in Figure 3.5 (see also the detailed Work Program in Appendix A).

It should be noticed that a 3 years UNDP/UNICEF project "Support to Disaster Management" has been approved in February 1995. This might affect part of the Work Program for module 3. The working program will be updated by the WMO-consultant in June 1995.

WORK PROGRAMME MODULE 3



Note : Activities for 1997 is tentative.

Figure 3.5. Work Programme Module 3.

3.4 Reporting

Semi-Annual Progress Reports will be submitted by the project and will be commented upon by GOB and the Danida in Dhaka.

Annual joint Danida/GOB reviews will be undertaken preferably in connection with the annual consultation on the development assistance activities.

The annual joint Danida/GOB review after 2 years should focus on the sustainability of the project after completion, and on the training programme.

Special study reports will be published time to time. A draft Final Report will be submitted 2 months before the end of the project followed by the Final Report incorporating comments on the draft report.

4 PROJECT INPUT

4.1 Staffing

Expatriate Staff

The expatriate staff schedule for Module 1, Module 2 and Module 3 is presented Figure 4.1. Up to 30 April 1995, 9 man months of expatriate input have been used. Short Term Consultants will been included as per requirement in the Expatriate Staff schedule. Ten man month short term consultant input in 1996-97 has not been assigned. Table 4.1 shows the allocation of Expatriate Staff working for the project.

Table 4.1. Allocation of Expatriate Staff

Name	Title	Module	Period	Input(m/m)
Gregers Jørgensen	Principal Consultant	1	Jan95-Jan98	16
Guna Paudyal	Co-Principal Consultant	1	Jan95-Jan98	2
Nerqes Gavranovic	Computer System Expert & Forecasting Appl.Spec.	1,2,3	May95-Dec97	16.5
Morten Hvidberg	Short Term Expert	1	May95-Dec97	0.5
Henrik Muller	Short Term Expert	1,2	May95-Dec97	2.5
Michael Butts	Short Term Expert	1	Feb95-Dec97	0.5
Mogens Jønsson	Short Term Expert	1	Feb95-Dec97	1.5
Carl Henrik Andersen	Short Term Expert	1	Mar95-Dec97	1.5
Jesper Kjelds	Flood Forecasting Expert	2	Feb95-Dec96	5
Terry Van Kalkan	Flood Forecasting Expert	2	Feb95-Dec96	4
Peter Walch (WMO)	Disaster Man. Specialist	1,3	Feb95-Dec97	13
Morten Hvidberg Michael Butts Mogens Jønsson Carl Henrik Andersen Ejler Haubirk Henrik Sørensen	Short Term Experts (not yet assigned)	1	Jan96-Dec97	10
			Total man months	.73

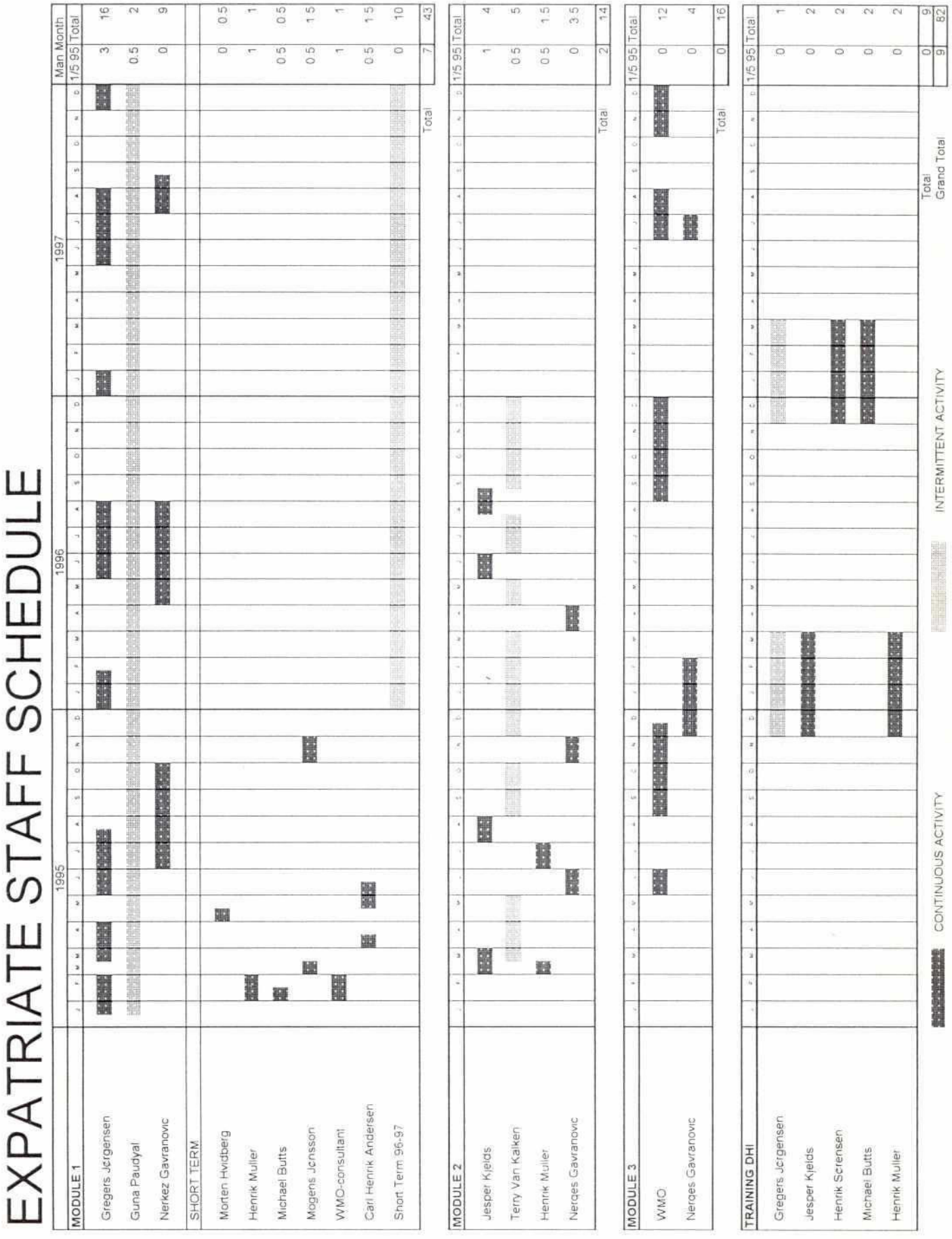


Figure 4.1. Expatriate Staff Schedule.

Local Staff

Local Consultants

Local Consultant (up to 24 man month) will be engaged in Module 1 when it is required.

The Surface Water Modelling Centre has engaged local consultants (48 man month) to be used in module 2. The engagement of the local consultants are in mutual agreement with the project. Any change in the staff of local consultants need to be confirmed by the project.

Local Consultants (30 man month) for module 3 will be appointed after June 1995 to work within the scope of the WMO contract.

Support staff

Project support staff include an office manager, a secretary, 3 drivers and other assistants.

4.2 Office Accommodation

In addition to the facilities at Flood Forecasting & Warning Centre the project has rented a small office to be used for project administration in DHI the resident office, House 19, Road 128, Gulshan.

4.3 Equipment

Re-installation of Data Transfer Link and repair of BMD radar system

Funds allocated to re-establish the data transfer link and to repair the BMD'radar system will be used to improve the existing remote sensing facilities at FFWC and to establish flood markers in the field at water level stations.

Vehicles

There is a provision for 3 vehicles on the project. Two Vehicle (1 Toyota Liteace Van and 1 Field Vehicle) has been purchased. A third car will be purchased in June 1995.

Radio transceivers and spares

Minor purchase of radio spares has taken place during the inception phase.

It is planned to purchase 2-5 radio transceivers including antennas before the monsoon. Additional 20 radio set will be purchased by the end of the year. The remaining budget for radio transceivers and spares will be used in 1996-1997.

Office equipment

The project has purchased 4 Pcs to be used at SWMC and for project administration. In addition approximately 15000 DKK has been used to repair and re-establish the computer system in FFWC.

The existing telephone and fax system at FFWC will be upgraded before the 1995 monsoon.

4.4 Budget

The total project budget and expenditures up to May 1995 is presented in Table 4.2. Compared with the original budget some minor modifications have been made to accommodate the following:

- Approximately one fourth of the budget allocated for office setup in a new building in the Green Road has been used to modernize the facilities in WAPDA building.

- Funds allocated to support the BMD will be used to improve the existing remote sensing facilities at the WAPDA building and to setup flood markers in the field.

Table 4.2. Budget and expenditures.

	Total Budget DKK	Total Budget Lakh Taka	Estimated Exp. 1995	Estimated Exp. 1996	Estimated Exp. 1997
1. Cost of Expatriate Consultants	6,978,181	488.47	2,500,000	2,524,242	1,953,939
1.1 Module 1	4,311,732	301.82	1,500,000	1,400,000	1,411,732
1.2 Module 2	1,124,242	78.70	600,000	524,242	0
1.3 Module 3	1,542,207	107.95	400,000	600,000	542,207
2. Cost of Local Consultant	1,360,680	95.25	540,000	570,320	250,360
2.1 Module 1	320,160	22.41	100,000	110,000	110,160
2.2 Module 2	640,320	44.82	320,000	320,320	0
2.3 Module 3	400,200	304.15	120,000	140,000	140,200
3. Travel Cost, Expatriate Consultants	1,664,680	116.53	630,000	550,000	484,680
3.1 International flight tickets	476,230	33.34	180,000	150,000	146,230
3.2 Accomendation and per Diem	1,188,450	83.19	450,000	400,000	338,450
4. Project Support	1,434,050	100.38	410,000	400,000	624,050
4.1 Admin, support staff	400,200	28.01	120,000	130,000	150,200
4.2 Office travel (BGD and region)	200,100	14.01	60,000	70,000	70,100
4.3 Reports: Printing cost etc.	146,740	10.27	40,000	40,000	66,740
4.4 Communication	53,360	3.74	30,000	10,000	13,360
4.5 O&M for equip, instal, vehicles	233,450	16.34	70,000	80,000	83,450
4.6 Office setup	266,800	18.68	70,000	10,000	186,800
4.7 Special data collection	133,400	9.34	20,000	60,000	53,400
5. Equipment	2,174,420	152.21	1,320,240	456,730	397,450
5.1 Reinstal. of Data Transfer Link	200,100	14.01	200,100	0	0
5.2 Computer sofware and magnat	333,500	23.35	200,000	60,000	73,500
5.3 Audio-visual equipment	126,730	8.87	50,000	76,730	0
5.4 Vehicles (2 Field and 1 Sedan)	280,140	19.61	280,140	0	0
5.5 Radio transceivers	800,400	56.03	400,000	200,000	200,400
5.6 Radio Spares	66,700	4.67	20,000	20,000	26,700
5.7 Office Equipment	233,450	16.34	120,000	50,000	63,450
5.8 Software Development License	133,400	9.34	50,000	50,000	33,400
6. Training	2,067,700	144.74	450,000	955,100	662,600
6.1 Local in service training	166,750	11.67	50,000	55,000	61,750
6.2 Human Resource Developmen	200,100	14.01	100,000	100,100	0
6.3 Overseas Training	1,700,850	119.06	300,000	800,000	600,850
TOTAL	15,679,711	1097.58	5,850,240	5,456,392	4,373,079
7. Contigensies (10% of total)	1,567,971	109.76	585,024	545,639	437,308
GRAND TOTAL	17,247,682	1207.34	6,435,264	6,002,031	4,810,387

Note : 1 DKK = 7 Taka

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APPENDIX A

WMO REPORT ON MODULE -3

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DANISH HYDRAULIC INSTITUTE

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

FLOOD ACTION PLAN 10

EXPANSION OF FLOOD FORECASTING
AND WARNING SERVICES

MODULE 3

DEVELOPMENT AND IMPROVEMENT OF FORECAST OUTPUTS, PUBLIC AND USER AWARENESS AND DISSEMINATION

prepared by

DR PETER D WALSH

for

WORLD METEOROLOGICAL ORGANIZATION

March 1995

TITLE: EXPANSION OF FLOOD FORECASTING AND WARNING SERVICES: Flood Action Plan 10 - Module 3

OBJECTIVE: Prepare Specification for Development of Forecast Output, Warning Dissemination, Public & User Awareness and Education

CONTENTS:

4. DEVELOPMENT OF OBJECTIVES AND PROPOSED WORK PROGRAMMES

- Introduction
- Review of Options
- Tasks:
  - Group A - Strategic and Training Activities
  - Group B - Establish Principles and Develop Flood Warning System
  - Group C - Public Awareness and Evaluation

ANNEXES

1. INTRODUCTION

Background

This report has been prepared at the request of WMO to define the content and work programme for Module 3 of Flood Action Plan 10 - Flood Forecasting and Warning [FAP-10(3)]. Work on FAP 10 is being undertaken by Danish Hydraulics Institute as lead contractor to Government of Bangladesh supported by DANIDA.

The author received a written brief - see Annex 1- on 27 January 1995 and visited Dhaka from 2 to 20 February. The report contributes to the Inception Phase of FAP 10 due for completion in April.

The primary activity has been to assess Items (a) - (h) in the Terms of Reference and develop more detailed proposals to improve Flood Warning in Bangladesh. Initially, this was perceived to be for the resources allocated to FAP-10(3), but it has been found necessary to extend the brief to consider in outline the need for longer-term development plans. Discussions have been held with Director Surface Water Hydrology II, Bangladesh Water Development Board, Director-General Bangladesh Meteorological Department, Director-General of the Disaster Management Bureau, DHI's Principal Consultant, with a number of other experts working on Flood Action Plan projects and with representatives of other Government and local organizations. A diary of meetings and visits held in Bangladesh appears in Annex 2.

Following this appraisal an early draft of the list of Tasks to be undertaken in the main phase of FAP-10(3) was discussed with Director of Hydrology II BWDB and the DHI Principal Consultant. The report was finalised following discussions with DHI in Copenhagen.

Work on Flood Action Plan projects has produced a wealth of valuable material, which has provided essential inputs and background material. A list of reports examined is given in Annex 3. Descriptions of flooding in Bangladesh appear in many of these reports and are not repeated. Examination of a wide range of reports has revealed a considerable amount of work relevant and related to flood warnings already complete or planned.

Summary

Present arrangements for dissemination of Flood Warnings are acknowledged to be inadequate in contrast to the strong flood forecasting capability, which has been developed in recent years. Effective Flood Warnings will contribute to the enhancement of a positive outlook of flood preparedness in Bangladesh, provided attention is also given to the sociological aspects of flooding. This requires further work to ensure that communities at risk will want to react to flood threats when a Flood Warning is issued and initiate preventive actions.

The 1989 Bangladesh Flood Policy Study [Ref (10)] emphasises the importance of improved flood warning and that this will increase in significance as potential flood losses rise with increased economic development of the country; it is one element of the Policy's Guiding Principles. The Policy Study proposed the involvement of local people in developing locally appropriate approaches and that the contents of warning messages and definitions of "Danger Levels" should be tested before widespread adoption. This review confirms that these principles remain valid and should underpin the development of Flood Warning arrangements. The proposed programme of work will develop and test both definitions and messages.

However, the plans for enhancement of Flood Warnings are still embryonic and the resources available in FAP-10(3) are small compared with the task which needs to be done nationwide. The detailed list of tasks, takes full account of earlier work, of current thinking and plans for disaster management and of recent developments in flood warning and emergency planning. A bibliography of additional relevant documents, which will contribute to the main programme of work, is supplied in Annex 4.

Whilst, particular and careful consideration has been given to identify activities in FAP-10(3) which can be achieved under the direct management of DHI and through FF & WC staff, it is important to stress that nation wide improved dissemination of flood warnings will take many years to implement. There would need to be a large programme of participative working and education to make a widespread impact on Flood Warning dissemination at "grass-roots" level.

The resources available for module 3 will jointly with BWDB & DMB only be able to:-

- Develop the principles and conceptual framework.
- Prepare documented procedures and awareness material.
- Implement the centrally managed core elements of the system.
- Develop and implement training of FF & WC staff.
- Initiate a limited number of small scale local pilot projects.

Flood Warnings and their dissemination are essential components of the strategic approach developed in The Flood Action Plan and in the national framework for disaster management being developed by the Disaster Management Bureau. These are linked activities and will require close cooperation between both Departments and with consultants supporting both BWDB and DMB to achieve maximum benefit. This would be facilitated by the establishment of a professional panel to advise, guide and support the development of Flood Warning arrangements.

Consideration should be given to the establishment of a Flood Warning technical sub-committee under the National Disaster Management Advisory Committee (see page 9 Ref(16)] which would be best able to undertake this role.

The development and widespread implementation of a nationwide flood warning scheme will require many years of effort, particularly at local level on work with community leaders.

The proposed work programme has been formulated to achieve a number of aims:-

1. Establish a basic foundation framework for Flood Warning dissemination which is consistent with institutional arrangements in Bangladesh.

2. Strengthen and build on present capabilities especially those for flood forecasting of main rivers.

3. Maps onto the community based framework inherent in the Flood Action Plan and identified by a number of sociological and anthropological studies.

4. Consistent with the emerging disaster management philosophy and criteria established under Disaster Management Bureau initiatives and the Draft Emergency Standing Orders. [Ref (16)]

5. Identifies the scope of and dovetails with further work programmes that will be required over a 10 year minimum period to implement Flood Warning nationwide.

Acknowledgements

The author has received invaluable assistance from all those he met in Bangladesh and essential information from the numerous reports produced in earlier studies; without these he would have been unable to complete this report. The author would like to thank them all for making his task easier and enjoyable.

2. APPRAISAL

Background

Separate Ministries have responsibility for water management and for disasters. The Ministry of Irrigation, Water Development and Flood Control overseas the Bangladesh Water Development Board (BWDB), of which the Flood Forecasting and Warning Centre (FF & WC) forms part of Surface Water Directorate II. The Ministry of Relief and Rehabilitation, in which the recently established Disaster Management Bureau (DMB) is located, covers natural disasters. The Bangladesh Meteorological Bureau (BMD) forms part of the Ministry of Defence. A number of other Ministries have interests which are particularly affected by rivers and floods. These include: Fisheries and Livestock; Agriculture; Ports, Shipping & Inland Water Transport; and Local Government, Rural Development and Co-operatives. However, as flooding affects so many aspects of life in Bangladesh all Ministries are likely to be involved with the consequences of major flooding.

Introduction

Considerable attention has been given in recent years to the development of a framework within Bangladesh for Disaster Management. In Bangladesh the term Disaster Management is now used [Ref (14)] in the wider context of planning for and responding to disasters; this is similar in concept to Emergency Planning as practiced in western countries. Flood Warnings, their dissemination and increasing public awareness are critical parts of planning for and the early response to imminent serious and widespread flooding.

The Government established the Disaster Management Bureau in 1992 with a wide brief in Disaster Management activities. These include [Ref(9)]:

> Enhancing capacity of Government and local-level authorities to warn people of imminent threats of cyclones and floods
>
> Ensuring the effective dissemination of appropriate warnings of floods and cyclones, through collaboration with BMD, BWDB, CPP, Radio, TV and local authorities.
>
> Activating and operating a national Emergency Operations Centre (EOC).

The programme of work proposed in Ref (9) would link with FAP10(3) in a number of ways. The main links are identified in Annex 8. It proposes that work be undertaken at various levels; that at local level will be initiated in 3 districts and extend to 15 over a three year period.

There would be considerable benefits if those Districts were chosen to link with FAP-10(3) developments.

Terminology

For Floods, this report makes a clear distinction between *"Forecasts"* as presently produced and issued (ie the model predictions) and *"Flood Warnings"*, which means those messages which are based on forecast information and will be developed during module 3.

It is strongly recommended that this terminology should be adopted and form part of the glossary being developed for disasters

The term "Danger Level" has an established meaning [Ref (12)] for official use:

> "Danger Level of a river is a level above which it is likely that the flood may cause damage to crops and homesteads.
> (In a river having no embankment, danger level is above annual average flood level. In an embanked river, danger level is fixed slightly below the design flood level of the embankment.) Danger level is defined for a particular measuring station for the area to its immediate vicinity"

The word "Danger" is also used in the cyclone warnings and is therefore associated in Bangladesh with a serious condition.

It is appropriate therefore to retain "Danger Level" for use in Flood Warning messages.

It is assumed throughout this report that the UNDP Hydrology study [Ref (17 & 18)] will not lead to any fundamental change in the meaning or physical significance of Danger Levels even if some absolute values are changed.

"Danger Level" is therefore used in this report to mean the physical level at which flooding becomes significant and a warning needs to be issued to the affected community.

Requirements for the Future

The overall requirements of the TOR is to enhance Flood Warnings for the future. To achieve this it will be necessary to:-

a) Establish FF & WC as the National Operational Flood Warning Centre for Bangladesh

b) Train and develop FF & WC staff in flood warning principles and operations

c) Extend the coverage of flood monitoring and forecasting

d) Establish the principle that ***Flood Warnings*** must have an urgency and significance similar to that attributed to ***Cyclone Warnings***.

e) Improve clarity and thereby understanding of Flood Warnings

f) Improve speed and dissemination coverage of Flood Warnings

g) Develop public awareness at grass-roots level.

Current forecasting arrangements and proposed enhancements

FF & WC has an established flood forecasting capability, based on the MIKE11 model, which produces daily forecasts with 24, 48 & 72 hour lead times for 16 forecast sites on the main river system. Forecasts of predicted 06.00 hours river levels are currently issued daily at 13.00 hours during the monsoon season for 24 & 48 hours ahead and it is planned to use the 72 hour forecasts operationally after further assessment of their accuracy. The FF & WC operates for 12 hours per day during the monsoon flood events. This would limit its ability to provide a flash flood forecast and warning service without a change to its working arrangements.

A further and major inhibition, particularly for flash flood rivers in north-east Bangladesh, is the lack of upstream rainfall and riverflow data on those catchments draining from India. The lack of upstream catchment flows and rainfall will seriously inhibit and may prevent successful flash flood warnings.

There is an urgent and pressing need to use every endeavour and facility available to WMO and within its data exchange framework to increase speeds of transmission of data for the R Ganges and to overcome the lack of data for north eastern catchments.

FF & WC produces comprehensive weekly, monthly and annual flood reports which are excellent source documents for ready reference and provide invaluable records of rainfall and river flows.

Effectiveness of Current Warning Arrangements

The routine production of daily forecasts is a well established activity which provides essential and appropriate input information for producing Flood Warnings. Although improvements to these forecast procedures are planned, these are not an essential pre-requisite to developing effective flood warning and dissemination procedures and practice. This can and should be developed using existing forecasts and then expanded to use improved and additional forecasts as these are developed.

A number of projects within the Flood Action Plan programme and earlier reviews of flood warning (eg Kachic [Ref (13)] & DANIDA [Ref (3)]) emphasise the need to develop improved dissemination arrangements and to target this dissemination particularly at the "grass roots" community level.

There are acknowledged deficiencies in the dissemination procedures which FAP10-(3) is targeted to address. The FF & WC is manned by highly and specially qualified staff whose expertise is in flood modelling and forecasting. It is important to ensure that their time is used productively in forecast and warning preparation (tasks which only they can perform) and not on extensive distribution and dissemination activities. Figure 2.1 outlines arrangements for issuing Flood Warnings (or in some cases Forecasts) that current resources - with enhanced hardware - should be able to support. FF & WC must also be able to depend upon communications arrangements similar to those in place for issuing cyclone warnings to ensure a rapid first step in the dissemination of warnings; it does not have the resources to achieve this. FAP-10 will enhance some of its communications capability with new hardware. Figure 2.2 [from Ref(14)] shows the wider dissemination arrangements. Superimposed are those elements that it is essential to enhance and upgrade.

In the FAP 23 workshop reports [Ref (8)] an example of dissemination taking 2-3 days to reach local farmers via Ministry, Upazila Agriculture Officer, Union Agricultural Adviser and contact farmers. These notes also state that surveys in urban areas revealed that most people received little or no flood warnings.

FAP-14 Flood Response Study [Refs (5 & 6)] examined seven flood risk zones using field studies and interviews with affected villagers. It found that Flood Warnings (Table 5.1 in ref (5)) were the most often suggested preparatory measure required in rural areas. In its conclusions FAP 14 states that there is a particular need for improved public flood warnings and that warnings and flood information are a high priority. FAP 6 [Ref (20)] also carried out field studies and found that eight out of nine villages surveyed wanted to receive Flood Warnings.

The most frequent source of information (Table 3.4 in ref (5)) on floods in rural areas was neighbours (84% for average floods/88% for severe floods) and the next most frequent was radio (51%/61%). Television accounted for only (10%/12%) and should not therefore be regarded as a primary information source in rural areas. It is reported in FAP 23 [ref (7)] that radio and TV are common sources of information in urban areas. Broadcasts on TV (using GIS & graphics) of the current status of flood warnings throughout the country could serve a valuable role in raising and enhancing awareness of flood warning arrangements within government, ministry staff and opinion makers.

A fundamental principle in issuing *"Flood Warnings"* should be that there is an real and urgent *"need to know"* (within timescales established for phased Flood Warnings). In other words Flood Warnings should only be issued for forecast floods exceeding Danger or other defined levels. This will add weight and significance to these announcements.

It is strongly recommended that public dissemination of detailed forecasts of levels that will not lead to serious flooding (ie when normal annual floods are predicted) should not be regularly broadcast or published in the media.

A number of the reports examined, comment that existing broadcasts which merely repeat the contents of the daily River Situation Summary [eg ref(12)] are not meaningful to the public since terms such as river stage and levels are not understood. Radio news bulletins were neither specific nor clear enough and listeners were unable to translate the forecast information into water levels for their own locality.

Forecast Statistical Statements and Summaries, possibly in modified form, should continue to be issued to Ministries and other organisations who need this information for their routine day-to-day activities.

Warning systems (as defined in ref (14)) are arrangements to ***rapidly*** disseminate information concerning an imminent disaster threat to officials, institutions, and the population at large in the areas at immediate risk. A warning system involves links to forecasting systems, the organizational and decision-making processes to decide on the issuing of particular warnings, and the communications facilities (radio and other) to broadcast the warnings. Overall effectiveness depends upon the prior education and training of officials and population concerning the meaning of warnings and the actions to be taken.

Effective warning arrangements require extensive pre-planning for all activities and the maximum amount of preparation of warning messages, dissemination arrangements etc. during the dry season. This is discussed further in Section 3.

The Cyclone Preparedness Programme (CPP) developed by Bangladesh Red Crescent Society supplements the broadcast of Cyclone Warnings issued by Bangladesh Meteorological Department. It has direct radio contact with both BMD and with 21,000 volunteers in local communities whose task is to warn and evacuate. In 1991 it is estimated that CPP assisted 350,000 people evacuate to shelters.

DMB and CPP both indicated that they could see value in a similar (but, appropriately structured for the different features of flooding) community and/or volunteer system to spread Flood Warnings at local community level. Although conflicting views exist elsewhere [see Ref (14)] this option should be fully appraised and systematically developed. It is understood that the Disaster Management Bureau plan to address this within the 3 year UNDP / UNESO project [Ref (9)] once approval to start is received.

The Terms of Reference for Module 3 (Annex 1) identify potential links with FAP 11 - Disaster Management. Proposals exist for a UNDP/UNESCO project "Support to Disaster Management" [Ref (9)] whose aims would achieve those of FAP 11. It has been established in this appraisal and is confirmed from the review of principles for effective flood warning in Section 3, that the development of systems and procedures that are integrated across many organisations is essential, but also a complex and time consuming activity.

However the resources available for FAP-10(3) are not sufficient to support a major participative initiative. Furthermore, at the time of writing it is not known when the UNDP/UNESCO project will commence. It should be possible within the resources available to develop the framework for a flood warning system, introduce simple revised dissemination procedures and develop standard warning messages. It will not be possible, even with the involvement of DMB, to implement effective procedures at local community level other than on a demonstration basis. Full implementation of an effective warning system will take very many years and needs to involve widespread education programmes as well as development of local flood markers.

Summary

- Good flood forecasting capabilities exist at FF & WC
- BWDB Flood reports provide valuable records of events

- Lack of data from India inhibits flash flood forecasting and effective flood warning

- Flood Warning dissemination needs strengthening
- Phased warnings will assist flood preparedness

- Surveys have shown that villagers value Flood Warnings
- Flood Warnings need to relate to local flood markers, showing recent (usually 1988) historic flood levels
- Flood markers are required in communities; these should use colour

- Warning messages need to be clear, simple and specific
- Daily Bulletins from FF & WC contain too much information to be used as warning messages
- TV can be used to increase awareness of flood warning arrangements within government and other sectors.
- Information needs to go to media on an exception basis
- Forecasts should not be issued to public & media on a daily basis

- Radio is a major source of information for rural communities and should be used to broadcast and regularly repeat Flood Warnings
- There is a need for local procedures to spread Flood Warning messages around affected communities

- FF & WC does not have equipment and resources to rapidly distribute Flood Warnings widely
- FF & WC will need to enhance its communications capability to issue even a limited number of Flood Warning messages rapidly
- FF & WC needs to be able to depend upon DMB to establish arrangements for widespread dissemination of Flood Warnings to local community officials.

FIGURE 2.1 DISSEMINATION OF FLOOD FORECASTS FROM FF & WC

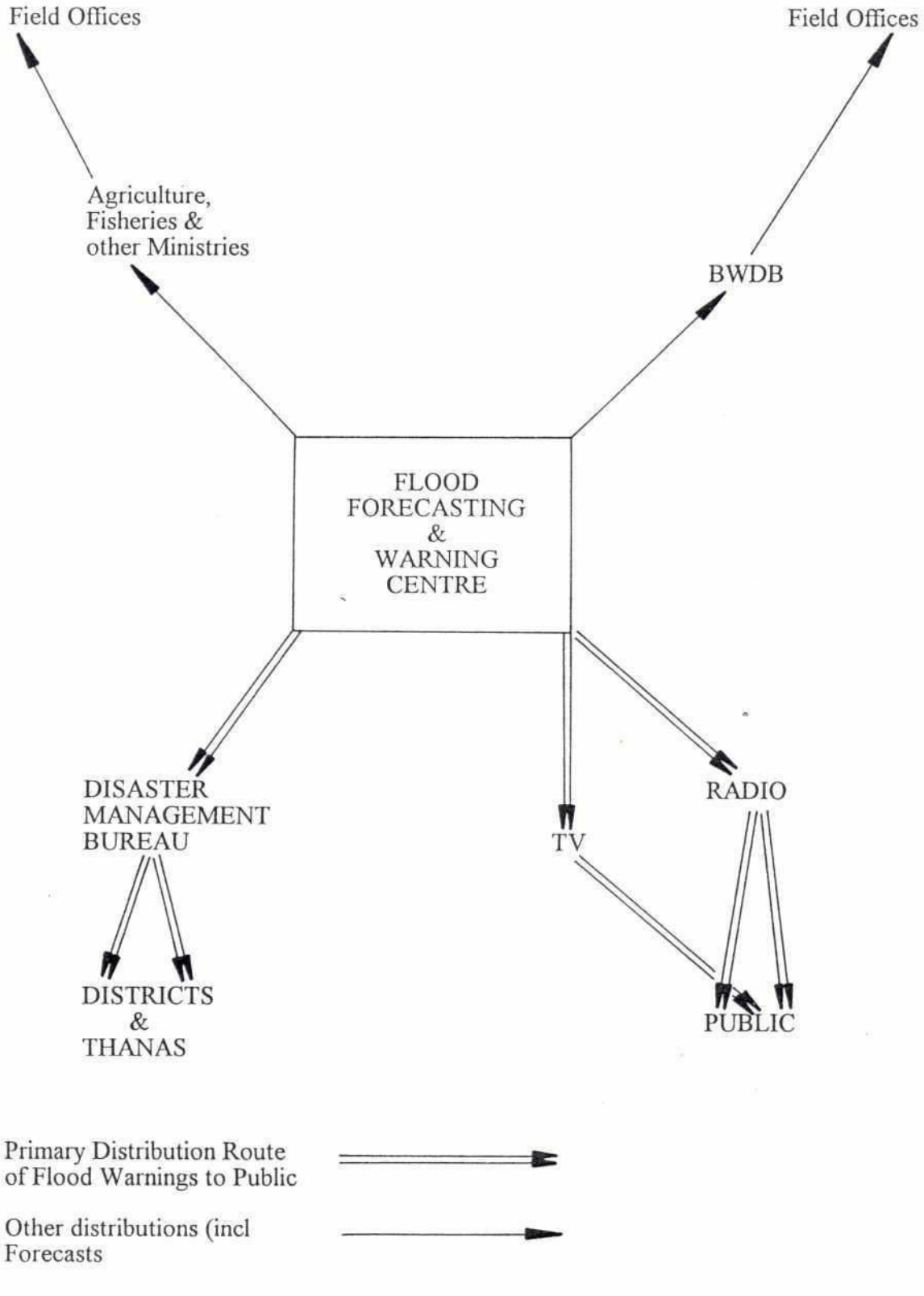
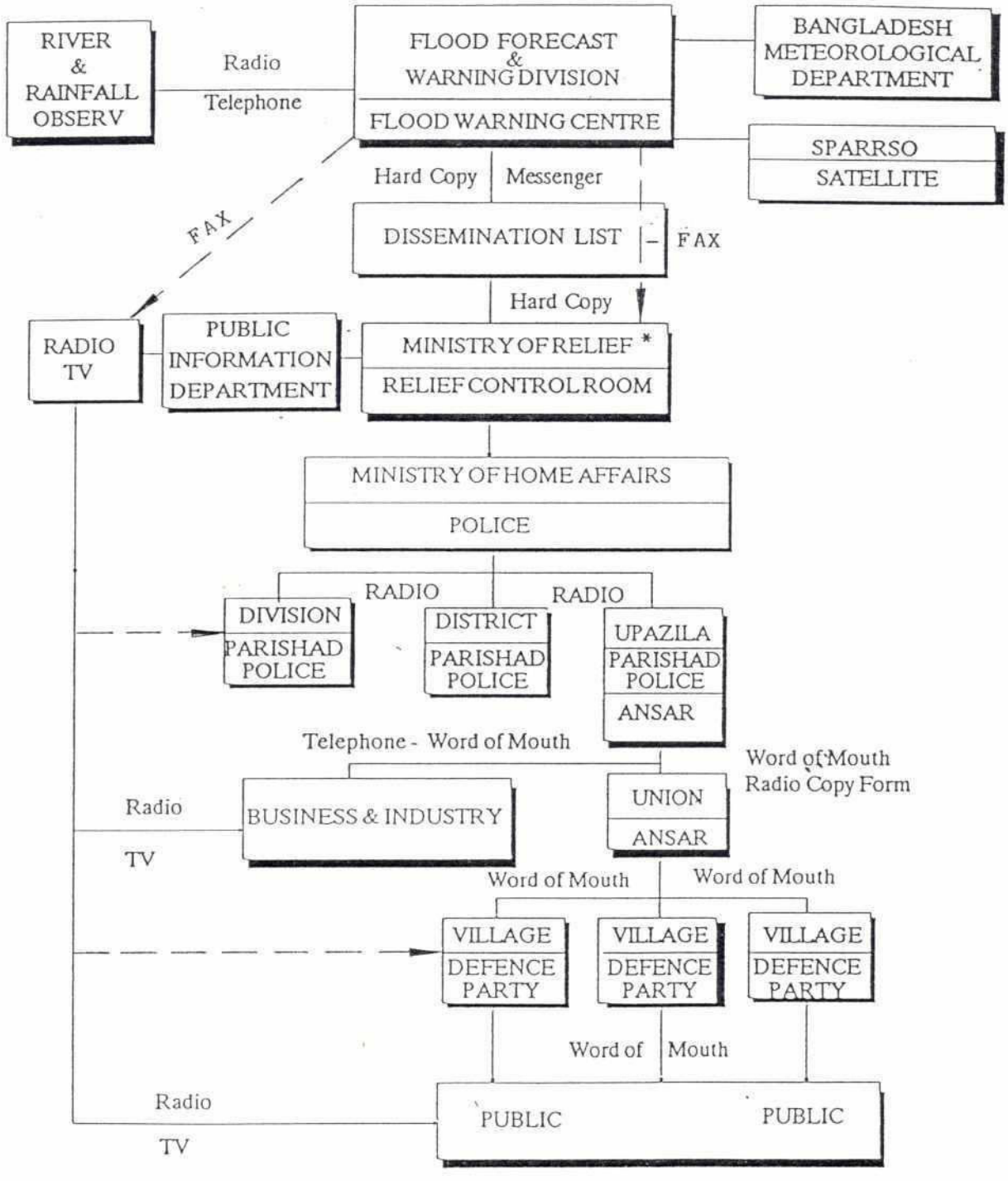


FIGURE 2.2

FLOOD FORECASTING AND WARNING DISSEMINATION SYSTEM

(Reproduced from Mott MacDonald International Limited - Ref 14)



* Disaster Management Bureau since 1992

Proposed initial enhancement to dissemination shown in Red

3. PRINCIPLES FOR EFFECTIVE FLOOD WARNING SYSTEMS

Introduction

Disaster Management and Emergency Planning have received increasing attention in recent years and there is a substantial body of research literature and application manuals. This section draws upon work particularly relevant to Flood Warning. It sets down the basic principles that should be applied to establish effective Flood Warning procedures and offers a methodology. An essential pre-requisite is the production of reliable forecasts; this is not discussed since good forecast systems already exist at FF & WC.

Some Basic Ideals

Effective emergency plans, of which arrangements for flood warning are one element depend upon:-

GOOD: COMMUNICATION - COORDINATION - COOPERATION

TIMELY & SIMPLE INFORMATION

Flood warning requires:

SIMPLE PROCEDURES

ROBUST SYSTEMS AT TIMES OF STRESS

QUICK & RELIABLE DISSEMINATION

MINIMUM OF TRANSMITTED INFORMATION

FIT WITH ORGANISATIONAL & ADMINISTRATIVE SYSTEMS

Planning

Scanlon [Ref (B2)] advocates a 9 stage process for developing emergency plans (including warning systems). For module 3 it is proposed that the following 9 steps should be used to achieve three aims:

i) act as a check list to ensure that there is a clear understanding of all the relevant issues.

ii) act as the basis for the detailed preparatory work on message writing and improved dissemination systems.

iii) initiate a process of regular review and update (Step 8)

'B' Series References are from the Bibliography in Annex 4

Plan Preparation

Step 1 **Identify Threats and Hazards**

- What form will flooding take?
- Who needs to be warned and of what severity of flood?

Step 2 **Establish Risks**

- What is the chance of flooding?
- How serious would be the consequences?
- What additional problems will occur during flooding that may interfere with dissemination process?

Step 3* **Prevention/Mitigation Options**

- Flood proofing and structural works
- Flood preparedness

Step 4 **Warning**

- Ensure warnings will be issued and acted upon
- Make them *specific* and *urgent*
- Establish alternative warning arrangements
- Establish back-up hardware and communications systems

Step 5* **Response**

Step 6 **Training and Education**

- Everybody must know their role
- Public need to understand threats

Step 7 **Testing**

- All plans should be tested
- Exercise dissemination chain before each flood season

Step 8 **Review & Update**

- Emergency preparedness must not stop
- Dissemination lists need updating (telephone numbers change!)

Step 9 **Involve Others/Neighbours**

- Emergencies do not recognise administrative or geographical boundaries
- Cooperation & coordination with other agencies is essential

Some of theses stages are already covered by current arrangements, in particular * items fall outside module 3.

Flood Warnings

Effective warning messages should contain 5 essential elements:-

Element 1 **Must be *specific* about the problem**

- Where is the flood?
- Which Unions will it affect?
- How big will it be?

Element 2 **Must be specific about what to do**

- Is it a preliminary warning?
- When should I prepare to evacuate?
- Where & when will I learn more?
- Will Danger Level be exceeded?
- Do I need to evacuate now?

Element 3 **Must be clear about who it is warning**

- Which areas will be flooded
- Where possible name the communities (Unions)

Element 4 **Must come from all possible channels**

- Do not rely on one communication channel
- But, do send the identical message via different routes

Element 5 **Must accord with past training, education and awareness**

- One reason to keep existing "Danger Levels"
- New public awareness and educational material should build on existing knowledge

The Australian Emergency Management Institute has prepared a 38 page manual "Flood Warning: An Australian Guide" [Ref (B6)] and a 4 page pamphlet "Guide-lines for Effective Warnings" [Ref (B5)]. (Copies of these have been handed to DHI, Dhaka.) They are based on the same general principles summarised in this section, but provide a more detailed methodology and discuss flood warning issues in more detail. They should form the basis for detailed work by the Flood Warning Systems Specialist and Journalist.

Warning Messages

It is important that these convey information in the form that is appropriate to those receiving them. This is usually contrary to the natural inclinations of the technical specialists who has devoted considerable efforts to develop and apply sophisticated mathematical models to produce forecasts. Civil Engineers/ Hydrologists are naturally and properly proud of this work and therefore want to publicise its excellence. However, when preparing Flood Warning messages it is vital to suppress this urge and to produce very simple and easy to comprehend messages.

Unless simple messages are used to convey the essential flood warning the detailed technical information, produced by the models, does not achieve its full value and is therefore wasted.

Design of Warning Messages

The 2 Australian Guides should be consulted for full details, in summary:-

Item 1 **A warning message provides advise on:**

- What is happening and where
- The impact on target recipients
- What they can do

Item 2 **A warning is required to**

- Initiate actions before a flood arrives
- Provide critical link between technical information sources and those at risk at "grass-roots"

Item 3 **A warning message must**

- Use language familiar to recipient
- Tell the recipients what they want to know (this may not be what the forecaster wants to tell them!)

Item 4 **A warning message should**

- Mean something to the target audience
- Persuade the recipients to take positive actions

Dissemination and Communication of Flood Warnings

Earlier stages in the process have establish reliable forecasts and converted these into easily understood messages. The final and often the most difficult task is to rapidly and reliably get the message to those at risk.

Dissemination can take 2 main forms:

General

- Dissemination to whole communities of a general "broad-brush" message, ie flooding is likely.
- Using a general distribution method, eg.
  - Radio broadcasts
  - TV broadcast
  - Notice-boards
  - Newspapers

Specific

- Targeted at particular communities at times of severe flood risk
- Using a targeted method of dissemination, eg.

  - Telephone
  - Fax & Telex
  - Radio (two-way) as for data collection
  - Loud-hailers & public address systems
  - Community leaders
  - Volunteer/ NGO personnel

General warnings are not usually adequate by themselves, but can serve to distribute the preliminary first phase warning. It is not usually recommended to use broadcast media as a primary source of warning messages since the messages may not be recognised as having official status. It will be important in Bangladesh to state the official source in all Flood Warning messages and to ensure that this is repeated in the broadcasts.

Specific warnings arrangements are more resource intensive;they have the important advantage of targeting and emphasising the severity of the warning and will be essential in Bangladesh in the long term. However, without the use of radio broadcasts it will not be possible to achieve a rapid and widespread dissemination of warnings across the countryside. As this can be achieved in the short-term, the use of radio broadcasts to disseminate official and formal flood warnings should be initiated without delay

Review and Development

There is a continuous circle of learning involved in the operation of flood warning systems, which also need progressive development. It is therefore essential to establish a framework within FF & WC that embraces this principle and also develops ownership of the system by the professional forecasting and warning staff. This should be extended to involve FF & WC staff in the implementation, during the dry season of systems, at the field level. This could involve both establishment of marker posts and training local authority staff, community leaders etc using the training packs to be developed in this module.

It is recommended that FAP-10(3) should fit within an annual cycle of activities. Figure 3 shows the annual "learning" cycle and Figure 3.2 an illustrative timetable of activities.

Summary

- Advanced preparation, regular review and revision of warning arrangements is essential
- Involve other agencies - coordinate & cooperate
- Assume that if something can go wrong then it will during a major flood event (but it may not happen, perhaps for many years)
- Use more than one method of dissemination
- Plans should be tested regularly, at least every year

- Staff require training in warning procedures
- Staff should train community leaders in dissemination principles
- Staff should be encouraged to develop ownership of procedures and to develop them during dry season.

- Establish who and what is to be warned
- Make message simple and specific
- Deliver messages to those at risk - communicate
- Use Journalist to draft simple messages
- Prepare messages in all appropriate dialects
- Use Teacher to prepare public educational and awareness display material
- Messages should go to media on an exception basis (ie as Flood Warnings) and not routinely as at present.

FIGURE 3.1 ANNUAL LEARNING CYCLE FOR FLOOD WARNING SYSTEMS

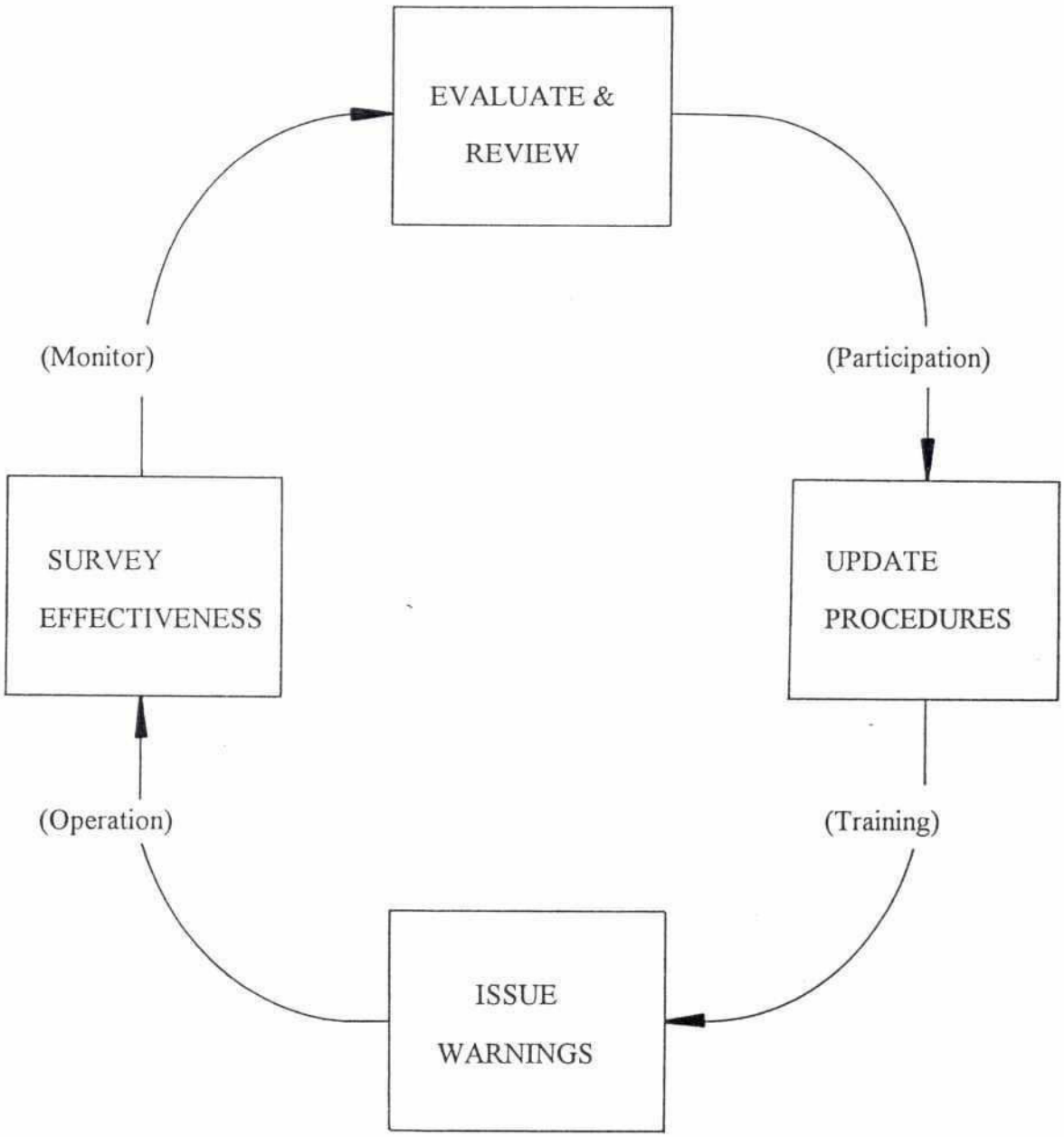
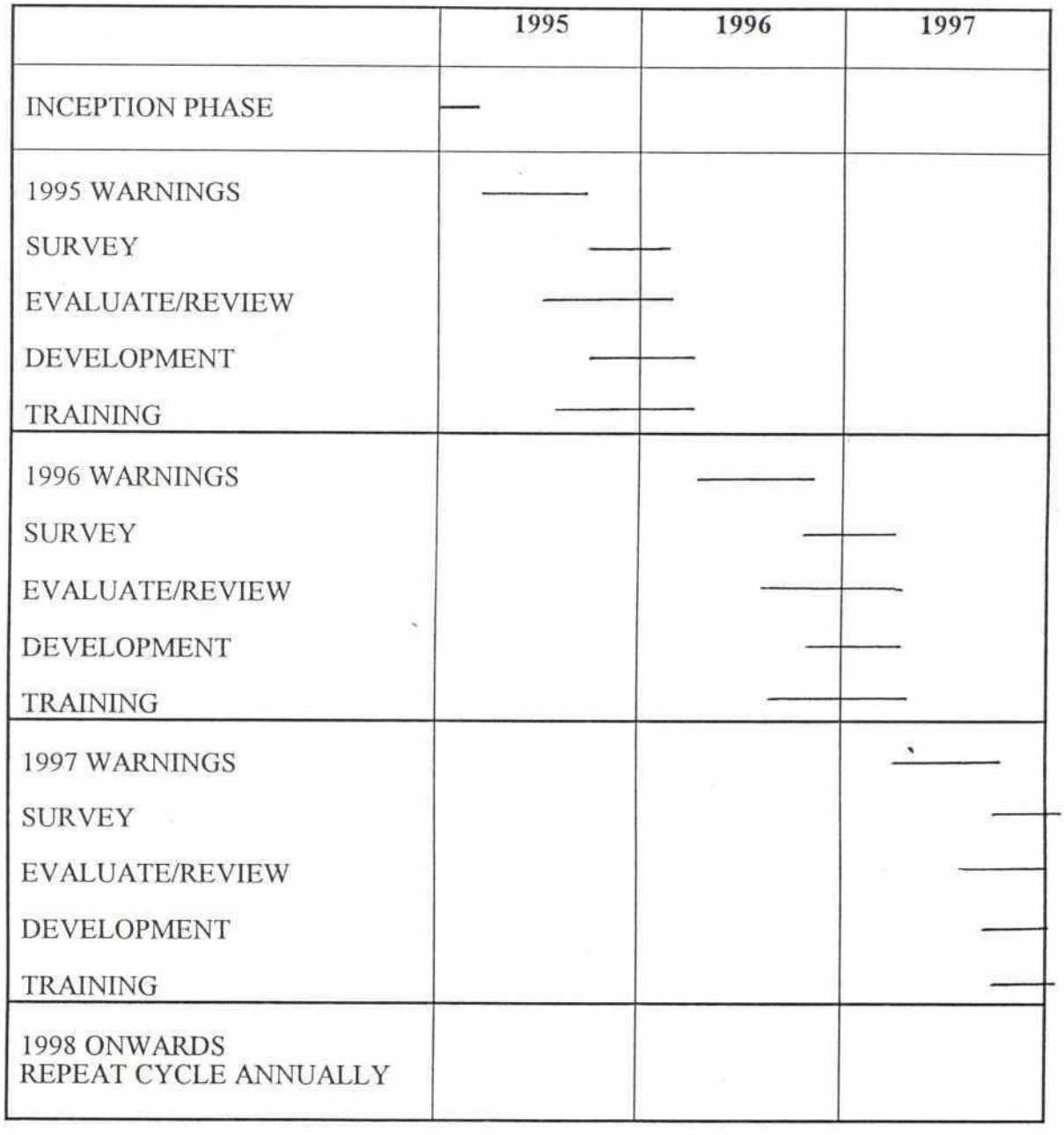


FIGURE 3.2 ILLUSTRATIVE TIMETABLE OF ACTIVITIES



4. DEVELOPMENT OF OBJECTIVES AND PROPOSED WORK PROGRAMME

Introduction

The Analysis section has identified a need to develop the core elements of a national flood warning scheme for Bangladesh in a form which integrates with the Disaster Management Bureau's Emergency Standing Orders and a community based approach for flood preparedness and warnings.

Review of Options

Decisions must be made on the scope of FAP-10(3) work in order to obtain maximum benefits and ensure both a successful outcome and a firm foundation for the future. The decisions on content of the work programme need to consider the following:-

- Resources exist for only a limited amount of work on each topic in TOR (Annex 1)
- Whether any TORs might be dropped without long-term detriment
- Need to develop principles and core systems
- Need to develop (at least in outline) a long term plan for nationwide implementation of Flood Warning
- Need for implementation of flood warning systems at "grass roots" level in demonstration (pilot) form as an minimum outcome
- UNDP disaster management project has still to be approved
- Amount of co-operation with UNDP project is difficult to estimate
- The contribution that new fields surveys can make to the 3 year programme

It has been concluded that:-

- There will be major long-term benefits from adopting the established principles for disaster management and emergency planning in the development of FAP-10(3).
- Training for FF & WC staff is a high priority
- FF & WC staff are a significant manpower resource that should contribute to development of flood warning systems outside the monsoon season
- There is an urgent and pressing need to establish the core procedures, warning message content and dissemination systems for a national Flood Warning Scheme
- Maximum benefit will be obtained from limited resources by reducing dependency on uncertain external links and inputs
- The work programme should be capable of completion without inputs from UNDP project
- The work programme should be able to link to UNDP project if it proceeds

- The pilot projects for flash flood warnings and development of an area inundation warning scheme should be carried out on an experimental basis. These pilot projects should be used to define a long term implementation plan for the next 10-15 years.

- Field surveys should be kept to the absolute minimum in order to devote resources to development of core procedures and their implementation.

The requirements from the TOR have been converted into detailed tasks based on the principle activities identified in Section 3, following the priorities established in this section and linked into groups requiring similar skills and activities.

The tasks described below have been designed to fit within the cooperative framework yet be capable of development and initial implementation where possible with minimum links. This approach should ensure a major benefit from the project through widespread enhanced flood warning dissemination to "grass-roots" communities using broadcast media to maximum effect. Demonstration projects will initiate the community involvement programme that will need to be continued over many years.

Tasks

Group A - Strategic and Training Activities

A1) Interface with Disaster Management Bureau's Activities

A1.1) Liaision with Disaster Management Bureau

In association with Director Surface Water Hydrology II, liaise with Disaster Management Bureau on roles allocated within Draft Emergency Standing Orders. Establish the respective responsibilities of DMB and FF & WC for the dissemination of Flood Warnings. Using Figure 2.1 as working assumption and develop procedures for dissemination.

As a minimum, Module 3 should develop Flood Warning messages and make arrangements for their dissemination through the media in order to ensure immediate improvements in dissemination

Obtain latest draft of revision to Emergency Standing Orders (currently being revised) and review effect on tasks in this schedule.

Provide input to any future reviews of Emergency Standing Orders.

A1.2) Develop Flood Warning Action Plan

Many of the tasks involved with development of the Action Plan will need to be performed in any event to develop enhanced Flood Warning arrangements and provide adequate documentation in form of a FF & WC Operations Manual. It is, therefore proposed that they be developed into an Action Plan to provide a basis for future development of operational procedures and for regular review and which would fit within the framework of Draft Emergency Standing Orders for Disasters.

Action Plan should clearly state limits of responsibility for dissemination of Flood warnings by FF & WC.

A2) Flood Warning Development Plan

A2.1) Prepare Outline Long-Term Development Plan

This review has identified the strategic elements required in a long term plan. Detailed work is required to identify all customers and customer locations, development and implementation activities, preparation of local action plans etc, and associated work loads & resource inputs which would be needed to complete implementation of a nation-wide Flood Warning service

Develop an outline programme of work to establish effective flood warning in all Thanas and Unions at risk of serious flooding.

Estimate resources required to undertake this over a 10 year period

A3) Training & Manpower Development Activities

A3.1) Develop basic training modules on Flood Warning

To be used with Police, Fire and Rescue, Local Government Engineering Board, District Agriculture staff and any other groups who would play a local role in disseminating Flood Warnings, other flood preparedness activities and flood responses.

A3.2) Develop pre -monsoon training exercises

These should be run by FF & WC staff before each and every flood season to practice dissemination and communication arrangements.

A3.3) FF & WC staff Human Resource Development and training:-

i) Impact assessment, flood awareness and disaster preparedness (incl. preparation of Action Plan)
ii) Forecast preparation, presentation and dissemination
ii) Public Liaison and development of training and public education

A3.4) Contribute to workshops held by DMB

FF & WC staff to work with DMB, representatives (inter-alia) of NGOs and community leaders to develop their joint roles in the development of and the dissemination arrangements for Flood Warnings at local level

A3.5) Arrange overseas study tour

Senior Staff to visit internationally recognised centre of excellence in Flood Warning.

A3.6) Train FF & WC staff in drafting of Action Plan

FF & WC staff will need to update Action Plan in future years.

Group B - Establish Principles and Develop Flood Warning System

B1) Identification of Users and User needs:-

B1.1) Identify all categories of situation requiring Flood Warnings

FF & WC has a defined distribution list based on Emergency Standing Orders For Flood, which includes:-

1. News agencies
2. Radio & TV
3. Public Information Department
4. Ministry of Relief & Rehabilitation
5. Concerned Government Officials
6. Concerned Water Development Board Officials
7. BWBD Field wireless stations, when Danger Level reached

Studies in FAP 14 identified the first seven classes of flood environment, (In addition there are floods caused by direct rainfall which cannot drain to the rivers):-

1. Main river
2. Secondary rivers
3. En-poldered villages (in saline S-West)
4. Chars
5. Haors/Beels
6. Flash floods catchments
7. Embankment breach flooding
8. Direct Rainfall

It is recommended that Module 3 studies concentrate on Flood Warning messages and dissemination procedures for main rivers and contribute to the development of pilot studies for flash floods and secondary rivers (in form of area-inundation predictions).

B1.2) Identify all end users of Forecasts

Mainly Government and official bodies, industry and some NGOs

B1.3) Identify all end users of Flood Warnings

Mainly media and & communities at risk.

B1.4) Establish information requirements of all end users

Use workshop or other forms of direct contact, with representative groups, to determine the information requirements of all end users of Forecasts and Flood Warnings.

It is suggested that these should be split into a limited number of user communities:-

E.G	1. Public Warnings	Simple statements
	2. Media (primarily Radio & TV)	Warnings & Report
	3. Ministries - high level overview	Summary of key information
	4. Technical Users (eg. LGEB, Shipping	Water levels and timings
	5. Local Authority & Community Groups	Integration at local level, use of marker posts etc.

B2) Establish Warning Criteria

B2.1) Establish Flood Warning definitions and terminology

These should become national standard terms and be used for all flood warning messages and announcements in all educational and supporting & explanatory leaflets, videos & broadcasts etc.

The 1988 flood level is well understood by those communities who were affected and should be consider for use as a local datum for use in warnings messages and publicity material etc.

B2.2) Decide principles to apply to Phasing of Flood Warning

It is suggested that the first trigger level is set at a level corresponding to 5-days before Danger Level at known maximum rate of rise. At this trigger FF & WC should increase its level of activity and advise Ministries and Districts that they should prepare for possible flood actions in next few days.

It is proposed that the second trigger level is based on a 72-hour forecast of a Danger Level. This would initiate a general (preliminary) Warning Message to the Media (also distributed to Ministries and Districts) advising that a "Flood Alert" (or other suitable term) has been initiated for named areas and that further announcements will be broadcast at hh.mm hours every day until further notice.

It is recommended that Flood Warnings should be issued whenever the 24 hour forecast predicts levels equal to or greater than the Danger Level

B2.3) Establish flood categories needing unique/different phasing and/or warning arrangements

eg flash floods need different phasing and/or warning arrangements. (Probably use workshop with Local Govt, NGOs etc).

B2.4) Establish network of Flood Markers

In communities these should correspond defined Flood Warning Levels (including depth/area inundation zones).

This will need to be done on a pilot basis, starting with communities close to flood forecasting sites. Sites should be chosen where possible to coincide with those selected by UNDP / UNESCO project - see cross references in Annex 8

(Do not use ft/metres above sea level datum in Flood Warning messages; these are only appropriate for dissemination to official technical users of forecasts)

Land surveys can be used to relate 1988 flood levels to flood level at nearest forecast station to provide a simple means of correlation to establish a reference level for use in warning procedures. More accurate information can be substituted from modelling studies when these are completed.

B2.5) Identify Flood Warnings to include specific action

These would usually be for specific locations and cover specific response actions such as evacuation. {Detailed implementation of this may need to follow as a later development}

B3) Establish Dissemination Arrangements

B3.1) Establish optimum time of day to release Flood Warnings

Time issue of messages to Radio & TV to reach maximum size of audience. Review forecast production timetable to guarantee delivery of Flood Warnings to meet media schedules.

B3.2) Establish means for rapid transmission of Flood Warnings to media

Establish jointly with Information Ministry and media representatives most effective and efficient means for rapid distribution of Flood Warning Messages to media.

B3.3) Explore use of local radio networks and broadcasts in local dialects

B3.4) Review use of BWDB radio network to transmit Flood Warnings

Wireless operators will need their own local "action plan" of steps they must take on receipt of a warning message to distribute it in their locality.

B3.5) Investigate all other communications options available for Flood Warning dissemination

In conjunction with DMB establish what other communications networks (eg Govt telephone system to Upazilas) could be used to disseminate Flood Warnings down to local levels and agree arrangements to utilise.

Review information collected in project BGD/91/021 [Annex E of Ref(14)] on communication systems

As in B3.4 local "action plans " will be needed by all who receive warning messages

B3.6) Establish communications hardware needs at FF & WC

Electronic means, such as PCs with fax software and modems, are essential to transmit hard-copy and to ensure effective and *prompt* dissemination of Flood Warnings. Voice should only be used as a last resort.
N.B. A variety of communications facilities should be available to provide back-up capability.

B3.7) Develop hardware/software systems to support message preparation and dissemination

Examine feasibility of software links to forecast system to automatically identify forecast levels exceeding trigger Flood Warning levels and initiate message preparation.

B4) Develop Flood Warning Message and Press Release Content

B4.1) Develop simple standard Flood Warning messages

These are required for all three phases of Flood Warnings and for all different types of application (eg may need to distinguish between flash and river floods). However the number of variants should be kept as small as possible.

Standard messages should be kept as word processor computer files (and as hardcopy pro-forma for back-up) and local details inserted at time of issue.

TV can simply show by means of coloured maps those areas for which warnings / no warnings are in force. Colours can be used to distinguish the different phases. As area inundation forecasts are developed further colours should be used to indicate forecast depth/severity of flooding.

B4.2) Develop standard pro-forma press releases

It is important to ensure that the media do not exaggerate, particularly at times when there are no flood risks. Therefore a series of press releases should be prepared for use during floods and those for use at other times that state simply that there are no flood risks.

For TV use coloured maps can be used to show "Warnings" and "No Warnings" currently in force

B5) Pilot Projects

B5.1) Depth/Area Inundation Warning Scheme

Apply general principles defined in other tasks to development of Flood Warning arrangements in trial zones for Depth/Area Inundation Pilot Flood Warning Scheme.

B5.2) Flash Flood Warning Scheme

Apply general principles defined in other tasks to development of Flood Warning arrangements in trial zones for Flash Flood Pilot Flood Warning Scheme.

Group C - Public Awareness and Evaluation

C1) Develop Public Awareness and Education Programmes

C1.1) Develop educational material describing Flood Warnings

This is for use in primary and secondary schools, in particular explaining the use of marker posts and how they are used to interpret Flood Warnings.

C1.2) Develop publicity material for community educational use

Develop display posters, display maps, handout cards (possibly enveloped in plastic), videos etc to publicize material developed for educational use.

C2) Evaluation and Field Studies

C2.1) Review Flood Response (FAP 14) and Flood Proofing (FAP 23) studies and relevant work in other countries

Prepare resume identifying sociological features of community response to Flood Warnings. Identify critical factors requiring attention in Bangladesh to ensure appropriate responses to Flood Warnings and in particular those which inhibit an effective response. (These will need to be the subject of follow-on studies the outcome of this should specify any further work identified)

C2.2) Develop programme of field evaluations

To be carried out in autumn of 1996 & 1977 to assess effectives of warnings issued in those years. If appropriate use field sites studied in FAP 14 to provide continuity and comparative data and consider working in conjunction with NGOs.

C2.3) Incorporate lessons from field evaluations into Flood Warning procedures

These should be applied the following year

C2.4) Establish arrangements for feedback on extent of flooding

To verify validity of Flood Warning Messages and enable updating of trigger levels and procedures after each flood season.

ANNEX 1- SCOPE OF MISSION & TERMS OF REFERENCE

The scope of the mission was specified in the WMO Purchase Order dated 23 January as follows:-

Assessment of the tasks (a) - (h) in Module 3, described in the terms of reference (see below)

Assessment of other relevant tasks to be carried out in Module 3

Discussions with relevant authorities and institutions

Preparation of specifications for tasks to be carried out during the 3-year project period and of an appropriate implementation schedule

Possible additional tasks to be decided in Dhaka

Terms of Reference

Specifications for Module 3 - Development of Forecast output, Public and user Awareness and dissemination

Background Information

General Project Information:

The FAP 10 project under the Flood Action Plan is a 3 year project starting from January 1995. The scope of work is described in detail in the Appraisal Report and the TAPP. The activities have been organised within three modules. The project starts with a 3 month inception phase.

Objectives of the Project:

The immediate objectives of the project are to improve the performance of the Flood Forecasting and Warning Centre with regard to increased mobilisation of local resources and efficient utilisation of resources available.

More specially this is done through:

- Training provided to professional and technical staff and special courses offered to the same target group throughout the project period
- Number of forecast points on main and secondary river increased
- Lead time and accuracy for real-time forecasts on main and secondary rivers improved
- Facilities for hydrological and meteorological monitoring, including data collection system and radar facilities improved
- A fully comprehensive flood operation centre established within Bangladesh Water Development Board

Outputs from the Project:

- Real time forecast at the regional level and provision of local depth-area flood forecasts in 2-3 selected areas developed
- Forecast system for 2 flashy rivers in the east of the country established on pilot basis
- Improved data exchange with countries in the Ganges - Brahmaputra - Meghna basins established, possible through the framework of the SAARC organisation
- Module 3 - A programme of public awareness of the availability and understanding of flood warning and forecast information and the benefits to be derived from their use developed in conjunction with and in support of DMB
- Trained staff
- Improved institutional structures within FFWC to provide and maintain the necessary services established

Description of Module 3

Development of forecast outputs, public and user awareness and dissemination. The module has the following tasks:

(a) Increase the detail of forecasts and warning with regard to locality, depth, area and timing

(b) Introduction to a phase level of warnings to assist preparedness

(c) In liaison with the appropriate bodies, prepare a range of forecasts for specific users, eg. newspaper, television

(d) Liaise with FAP11 to prepare systems for improved dissemination and response for forecasts and warnings, particularly at the "grass roots" level

(e) Consolidate the dissemination of forecast and warning information at a national and regional level within Bangladesh Water Development Board and government organisations

(f) Carry out evaluation of impact of forecast and warning information with existing distribution users and sample groups across the spectrum of the community

(g) Develop public awareness of flood warning information through publicity and education programmes

(h) Develop awareness in government, NGO's and the private sector to the use of warning as part of flood preparedness

The work proposed has links with the programme for disaster preparedness to be undertaken by FAP 11. The Relief Ministry will be supported by FAP11 in the development of preparedness programmes for cyclone and floods. Actions during emergency situations will be undertaken through the Relief Ministry, but the need for improved flood forecast information and dissemination will be identified by FAP 10. At present the Flood Forecasting and Warning Centre is responsible for the dissemination of daily bulletins and forecasts to a number of agencies. At times of emergency it has specific duties under the Emergency Standing Orders, and in particular stays in direct wireless contact with Bangladesh Meteorological Department personnel in the regions. There is a clear demarcation between the future roles of FAP 10 and FAP 11. FAP 10 will provide the forecast information in a number of forms according to the requirement of the targeted user. This will be distributed much as at present to government and other agencies at the national and regional level. The responsibility for widespread dissemination of flood warnings at critical times particularly to the lowest level users, will be through systems to be identified under FAP 11.

ANNEX 2 - PROGRAMME OF MEETINGS & VISITS by Dr Peter D Walsh

Thursday 2 February 1995

Arrival in Dhaka
Discussions with Mr G Jergensen (DHI)
Visit to Surface Water Modelling Centre & Annex
Discussion with Dr Guna N Paudyal

Friday 3 February 1995

Study reports

Saturday 4 February 1995

Meeting with Mr Alam Miah, Director, Surface Water Hydrology II
Discussions with Mr G Jergensen
Study reports

Sunday 5 February 1995

Study reports

Monday 6 February 1995

Demonstration of STORM Weather Radar Display to DHI & SWMM.
Meeting with Dr Khan Chowdhury, Director Bangladesh Meteorological Department and Permanent Representative WMO.
Discussions with Mr G Jergensen

Tuesday 7 February 1995

Visit to Flood Forecasting and Warning Centre, WAPDA Building
Meet Mr K B Khan and technical staff

Field Visit to River Ganges (Padma) at Bhagyakul, River Measuring & Flood Forecasting Station, Climatological Compound and Hydrology Training Centre with Mr G Jergensen, Mr M Butts and Mr Noorullah.

Wednesday 8 February 1995

Meeting with Mr Michael Gillham, Mott MacDonald International to discuss Disaster Management studies and proposals

Thursday 9 February 1995

Review and assessment
Report Drafting

Friday 10 February 1995

Appraisal and development of Options
Report Drafting

Saturday 11 February 1995

Discussions with DHI on options
Report drafting

Sunday 12 February

Meeting with Mr Emad Hassain, Bangladesh Red Crescent Society to discuss Cyclone Preparedness Programme and role of volunteers in dissemination of cyclone warnings.
Discussion with DHI on options
Report drafting

Monday 13 February

Report drafting and review

Tuesday 14 February

Meeting with Mr Akramul Islam, Director-General, Disaster Management Bureau, Ministry Relief.
Exchange of ideas with Mr Alam Miah and Mr Gregers Jergensen
Report drafting and review

Wednesday 15 February

Report drafting and review

Thursday 16 February

Discussion with Mr G Jergensen
Informal discussions with Mr J I M Dempster, Team Leader - International Team of Consultants for 1989 UNDP Study [Ref (10)]

Friday 17 February

Rest day

Saturday 18 February

Meeting to discuss Draft Report with Mr Alam Miah and Dr Guna N Paudyal

Sunday 19 February

Revision of Report

Monday 20 February

Depart from Dhaka

ANNEX 3 - DOCUMENTS CONSULTED

1. Emergency Standing Orders for Flood, Government of the People's Republic of Bangladesh, Relief and Rehabilitation Division, Ministry of Food, February 1984

2. Standing Orders for Cyclone, Government of the People's Republic of Bangladesh, Ministry of Relief and Rehabilitation, November 1985.

3. Appraisal report: Expansion of Flood Forecasting and Warning Services (FAP 10), Danida, Ministry of Foreign Affairs, Copenhagen, March 1994

4. Technical Assistant Project Proforma: Expansion of Flood Forecasting and Warning Services (FAP 10), Ministry of Irrigation, Water Development and Flood Control, June 1994

5. Draft Final Report and Appendices, Flood Response Study (FAP 14), ISPAN, Sept 1992

6. Briefing Notes - Flood Response Study Conference (FAP 14), ISPAN, Feb 1992

7. Issues Report, Flood Proofing Study (FAP 23), (Revised Draft), ISPAN, Dec 1992

8. Briefing Notes (Preliminary - for discussion only) - Flood Proofing Workshop (FAP23), ISPAN, Sept 1991

9. Project Document: Support to Disaster Management (BGD/92/002/A/01/99), UNDP/UNICEF, Dec 1994

10. Bangladesh Flood Policy Study, Final Report, Government of the People's Republic of Bangladesh & UNDP, May 1989

11. Annual Flood Report: 1993, Flood Forecasting & Warning Division, Directorate of Surface Water Hydrology-2, Bangladesh Water Development Board, March 1994

12. Rainfall and River Situation Summary as on 20th September 1994, Flood Forecasting & Warning Division, Directorate of Surface Water Hydrology-2, Bangladesh Water Development Board, 1994

13. Improvement of Flood Forecasting and Warning, Public Awareness for Flood Preparedness (Project BGD/88/013), Mission Report, A.S. Kachic, WMO Consultant, March 1992

14. Assistance to Ministry of Relief in Monitoring and Coordination of Cyclone Rehabilitation (BGD/91/021), Inception Report, Mott MacDonald International Ltd, June 1992

15. Disaster Preparedness for Bangladesh, Floods and other Natural Calamities. A K M Kafiluddin, Published by Md Salauddin & Taslim Jahan, Kalabagan, Dhaka, 1991

16. Draft Standing Orders for Disasters, Government of the People's Republic of Bangladesh, Ministry of Relief Disaster Management Bureau, February 1994.

17. Revision of Flood Danger Levels in Bangladesh, Terms of Reference Flood Frequency Analysis, June 1994

18. Revision of Flood Danger Levels in Bangladesh, Defining the Approach and Initial Tasks, Project UNDP/UNDDSMS BGD/88/054, October 1993

19. Nutritional Surveillance Project Cyclone Preparedness Study; How Ready Were We? Results from the HKI/UNDP Post-Cyclone Study, Helen Keller International, October 1994, Dhaka

20. Flood Action Plan: North East Regional Water Management Project (FAP6) Improved Flood Warning Concept Paper, Shawinigan Lavalin (1991) Inc. Northwest Hydraulic Consultants, Draft Final January 1994

21. Technology of Prediction and Warning System for Floods, Paper presented to International Workshop on "Hazard Assessment and Mitigation with a Focus on Floods and their Consequences", Mohammed Alam Miah, Dhaka, 1990

ANNEX 4 - BIBLIOGRAPHY AND SOURCES OF INFORMATION ON FLOOD WARNING, EMERGENCY PLANNING & DISASTER MANAGEMENT

The reports listed contain additional information and guidance on flood warning that will be relevant during the programme of work for module 3. It is not an exhaustive list of flood warning and emergency planning literature, but contains major sources of published UK, European Community, and Australian research and applications on Flood Warnings.

Many Flood Action Plan reports listed in Annex 3 contain extensive lists of references, which the specialist consultants should consult. (Eg. Social Scientist is recommended to review FAP-14 & FAP-23 references and consult Helen Keller International's Monthly Reports & Newsletters)

Organisations specialising in Disaster Management, Emergency Planning and Flood Warning include:

Flood Hazard Research Centre, University of Middlesex, Enfield, London, EN3 4SF, United Kingdom

Australian Emergency Management Institute, Mt Macedon, Victoria 3441, Australia

Emergency Planning College, The Hawkhills, Easingwold, York, YO6 3EG, United Kingdom

Cranfield Disaster Preparedness Centre, Shrivenham, United Kingdom

Asian Disaster Preparedness Centre, Bangkok, Thailand

Bibliography

The first two items are essential inputs to Module 3
*** Items - copies available at DHI, Dhaka**

B1)* Guide-lines for Effective Warning, 1993, Produced at Workshop "Towards Improved Severe Weather and Flood Warning Effectiveness", Bureau of Meteorology & Australian Emergency Management Institute

B2)* Flood Warning: An Australian Guide, 1991, Produced following Workshop at Australian Emergency Management Institute.

B3) Scanlon, J., 1992. Disaster Preparedness: Some Myths and Misconceptions, Emergency Planning College, York, United Kingdom
[This is a very readable short book with an extensive list of disaster/emergency references and is recommended reading for this study]

B4)* Guide to Management Techniques in Emergency Planning (Workshop 1993), Emergency Planning Society, United Kingdom.

B5) Thompson, P.M, and Penning -Rowsell, E.C., 1991. Socio-Economic Impacts of Floods and Flood Protection: A Bangladesh Case Study, Paper presented to Conference on 'Disaster: Vulnerability and Response, Developing Areas Research Group of the Institute of British Geographers and the Royal Geographical Society, Flood Hazard Research Centre, United Kingdom

B6) Crises in a Complex Society, Easingwold Papers No 7, Emergency Planning College, York, United Kingdom

B7) A digest of some well-known Disasters, Easingwold Papers No 8, Emergency Planning College, York, United Kingdom

B8) Bangladesh Disaster Preparedness: Assessment for the League of Red Cross and Red Crescent Societies Geneva, CDR Resources Group, 1991, United Kingdom

B9) Handmer, J.W.,(Ed), Flood hazard management: British and international perspectives, Geo Books, Norwich, UK, 1987

B10) Parker, D.J. and Handmer, J.W.,(Eds), Hazard management and emergency planning: Perspectives on Britain, James and James, London, 1992

B11) Starosolsky, O., and Melder, O.M.,(Eds), Hydrology of Disasters, James and James, London, 1989

B12) EUROflood Project Inception Report, Coordinator: Flood Hazard Research Centre, London, December 1992

B13) Anderson, William A (1965) "Some Observations on a Disaster Subculture: The Organisational Response of Cincinnati, Ohio, to the 1964 Flood" Columbus: Disaster Research Centre.

B14) Drabek, Thomas E (1986) Human Responses to Disaster An Inventory of Sociological Findings, New York: Springer-Verlag New York Inc.

ANNEX 5- DRAFT JOB DESCRIPTIONS

Flood Warning Systems Specialist (Expatriate)

This specialist is expected to have a degree and professional qualification in an appropriate discipline such as hydrology or river-engineering related subjects. Management experience and/or a postgraduate management qualification would be desirable. A minimum of 15 years experience and relevant operational background are equally important. He/she should have extensive experience of a major river flood warning application and have been particularly involved with either public awareness studies and/or emergency planning activities. Some experience of work in developing countries would be an advantage.

The main duties/tasks are:

- (It is assumed that FF & WC staff will support these tasks with local inputs, especially in the application and development of procedures and systems to multiple sites)
- Supervise development of a Flood Warning Action Plan for FF & WC of BWDB, working in association with Disaster Management Bureau.
- Liaise with Disaster Management Bureau and forecast users within BWBD to improve operational response.
- Liaise with other government departments, NGOs and the private sector to ascertain their forecast requirements
- Review and develop the Flood Warning systems of FF & WC to incorporate outputs from improved forecasting techniques.
- Lead review and development of Flood Warning messages
- Train and advise FF & WC staff in the production of warning messages, and of forecast bulletins and flood reports, particularly for media information.
- Lead development of dissemination requirements by FF & WC staff, particularly at a local level, for warning and emergency situations working closely with Disaster Management Bureau.
- Develop and carry out training programmes for FF & WC staff in all aspects of Flood Warning within remit of Module 3.
- Advise on and assist in development of publicity material, working closely with journalist on developing clear, concise and simple messages.
- Advise on and assist in development, working closely with educational specialist, of publicity and educational material, particularly visual, for public awareness programmes
- Develop in outline long-term Flood Warning Development Plan to implement nationwide systems and procedures developed by Module 3.

Technical/Systems Development Expert (Expatriate)

He/she must have extensive experience in flood modelling and in the development of computer software particularly using GIS/graphical display techniques and preferably in communications to remote sites.

The main duties/tasks are:

- Develop software for graphical displays of forecasts for flood inundation areas for use in Flood Warning TV broadcasts.
- Liaise with Bangladesh TV (BTV) on arrangements for transmission of images from FF & WC.
- Establish communications links with BTV
- Develop software to generate Flood Warning messages for rapid transmission by fax (or other means) to recipients.
- Establish hardware needs for message preparation and graphical displays
- Install hardware and software, prepare documentation for system and train FF & WC staff
- Establish procedures to ensure quality control of both the developed software and systems to generate warnings

Lead Social Scientist (Local Consultant)

He/she must have a post graduate degree, preferably a Ph.D. in Social Science and have extensive experience in designing, undertaking and supervising rural socio-economic surveys in developing countries, preferably Bangladesh. He/she should ideally also have experience of disaster preparedness.

The main duties/tasks are:

- Review existing survey work on flood responsiveness for Bangladesh flood-plains
- Identify issues which inhibit a positive response to the Flood Warnings and prepare recommendations on how Flood Warning arrangements might be further developed to ensure their effectiveness.
- Develop appropriate survey methodologies to assess success of Flood warning dissemination to all recipients and to assess the responsiveness of communities to flood warnings and flood events
- Undertake and supervise field surveys.

- Analysis of survey findings and prepare recommendations to incorporate conclusions into flood warning arrangements
- Contribute to the development of flood warning messages, dissemination arrangements and flood awareness programmes

Social Scientist (Local Consultant)

He/she should have a post graduate qualification in Social Sciences with a minimum of 10 years experience in undertaking, designing and supervising social surveys in rural Bangladesh.

- Assist in developing appropriate survey methodologies to assess success of Flood warning dissemination
- Undertake field surveys.
- Analyse results of surveys and produce recommendations
- Assist in development of flood warning procedures and systems

Journalist (Local)

He/she should have an appropriate degree and should preferably be fluent in a number of the dialects in common use in Bangladesh with a minimum of 10 years experience in radio or newspaper journalism.

The main duties/tasks (in association with Flood Warning Specialist) are:

- Prepare simple Flood Warning statements for broadcast use, covering all phases of warnings and flood types.
- Prepare range of simple press releases describing main features of a range of flood situations, including the "all-clear". (This might be done by reference to weekly flood reports from 1988 floods)
- Assist in preparation of display material (posters etc)
- Assist in development of TV display material
- Arrange or translate Statements into all appropriate dialects

Educational Specialist (Local)

He/she should be a qualified teacher, preferably of geography or at primary level, with 5-10 years experience in a rural flood prone community.

The main duties/tasks (in association with Flood Warning Specialist) are:

- Develop education material to explain Flood Warning system and messages
- Develop, in association with Journalist, display material for use in flood risk areas
- Arrange or translate material into all appropriate dialects
- Contribute to development of flood warning messages

ANNEX 6 - PROPOSED RESOURCE ALLOCATION (Man-Months)

Tasks	Flood Warning Expert	Lead Social Scientist	Social Scientist	Journalist	Teacher	FF & WC Staff
Group A - Strategic and Training Activities						
A1) Interface with Disaster Management Bureau's Activities	2	2				6
A1.1 Liaison with Disaster Management Bureau						
A1.2 Develop Flood Warning Action Plan						
A2) Flood Warning Development Plan						
A2.1 Prepare Outline Long Term Development Plan						
A3) Training and Manpower Development Activities	4	2				18
A3.1 Develop basic training modules on Flood Warning						
A3.2 Develop pre-monsoon training exercises						
A3.3 FF & WC Human Resource Development and training						
A3.4 Contribute to workshops held by DMB						
A3.5 Arrange overseas study tour						
A3.6 Train FF & WC staff in drafting of Action Plan						
Group B - Establish Principles and Develop Flood Warning System						
B1) Identification of Users and User needs:-	1	2				6
B1.1 Identify all categories of situation requiring Flood Warnings						
B1.2 Identify all end users of Forecasts						
B1.3 Identify all end users of Flood Warnings						
B1.4 Establish the information requirements of all end users						

Tasks	Flood Warning Expert	Lead Social Scientist	Social Scientist	Journalist	Teacher	FF & WC Staff
B2) <u>Establish Warning Criteria</u>	1	1				12
B2.1 Establish Flood Warning definitions and terminology						
B2.2 Decide principles to apply to Phasing of Flood Warning						
B2.3 Establish flood categories needing unique/different phasing and/or warning arrangements						
B2.4 Establish network of Flood Markers						
B2.5 Identify Flood Warnings to include specific actions						
B3) <u>Establish Dissemination Arrangements</u>	1	1		1		6
B3.1 Establish optimum time of day to release Flood Warnings						
B3.2 Establish means for rapid transmission of Flood Warning to media						
B3.3 Explore use of local radio networks and broadcasts in local dialects						
B3.4 Review use of BWDB radio network to transmit Flood Warnings						
B3.5 Investigate all other communications options available for Flood Warning dissemination						
B3.6 Establish communications hardware needs at FF & WC }						
B3.7 Develop hardware/software systems to support message preparation and dissemination }	3½*					
B4) <u>Develop Flood Warning Message and Press Release Content</u>	½			4		
B4.1 Develop simple standard Flood Warning messages						
B4.2 Develop standard pro-forma press releases						
B5) <u>Pilot Projects</u>						
B5.1 Depth/Area Inundation Warning Scheme	1					
B5.2 Flash Flood Warning Scheme						

Dec

Tasks	Flood Warning Expert	Lead Social Scientist	Social Scientist	Journalist	Teacher	FF & WC Staff
Group C - Public Awareness and Evaluation						
C1) Develop Public Awareness and Education Programmes	½			1	6	
C1.1 Develop educational material describing Flood Warnings C1.2 Develop publicity material for community educational use.						
C2) Evaluation and Field Studies	½	3	7			
C2.1 Review Flood Response (FAP 14) and Flood Proofing (FAP 23) studies and relevant work in other countries C2.2 Develop programme of field evaluations C2.3 Incorporate lessons from field evaluations into procedures C2.4 Establish arrangements for feedback on extent of flooding						
TOTAL MAN MONTHS	12½ + 4½*	11	7	6	6	48

*** DHI for Hardware/Software issues**

ANNEX 7 - OUTLINE TIMETABLE

Tasks	Resource	1995			1996				1997			
		Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Group A - Strategic and Training Activities												
A1) Interface with Disaster Management Bureau's Activities												
A1.1 Liaison with Disaster Management Bureau	FWS	—	—	—	#							
A1.2 Develop Flood Warning Action Plan	FWS + FF + WC		—	—	—							
A2) Flood Warning Development Plan												
A2.1 Prepare Outline Long Term Development Plan	FWS								.....			—
A3) Training and Manpower Development Activities												
A3.1 Develop basic training modules on Flood Warning	FWS + LSS							—	—			
A3.2 Develop pre-monsoon training exercises	FWS + FF + WC							—	—			
A3.3 FF & WC Human Resource Development and training	FWS		—	—	—			—	—			—
A3.4 Contribute to workshops held by DMB	FNS/LSS/FF + WC	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
A3.5 Arrange overseas study tour	FWS			—								
A3.6 Train FF & WC staff in drafting of Action Plan	FWS		—	—								
Group B - Establish Principles and Develop Flood Warning System												
B1) Identification of Users and User needs:-												
B1.1 Identify all categories of situation requiring Flood Warnings	FWS + FF + WC	—										
B1.2 Identify all end users of Forecasts	FWS + FF + WC	—										
B1.3 Identify all end users of Flood Warnings	FWS + FF + WC	—										
B1.4 Establish the information requirements of all end users	FF + WC		—	—	—			—	—			- - -

Tasks		Resource	1995			1996				1997			
			Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
B2)	**Establish Warning Criteria**												
B2.1	Establish Flood Warning definitions and terminology	FWS											
B2.2	Decide principles to apply to Phasing of Flood Warning	FWS											
B2.3	Establish flood categories needing unique/different phasing and/or warning arrangements	FWS											
B2.4	Establish network of Flood Markers	FF + WC											
B2.5	Identify Flood Warnings to include specific actions (eg. evacuate)	FWS											
B3)	**Establish Dissemination Arrangements**												
B3.1	Establish optimum time of day to release Flood Warnings	FWS											
B3.2	Establish means for rapid distribution of Flood Warning to media	FWS + DHI											
B3.3	Explore use of local radio networks and broadcasts in local dialects	FWS + J											
B3.4	Review use of BWDB radio network to transmit Flood Warnings	FWS + DHI											
B3.5	Investigate all other communications options available for Flood Warning dissemination	FWS + DHI											
B3.6	Establish communications hardware needs at FF & WC	DHI											
B3.7	Develop hardware/software systems to support message preparation and dissemination	DHI											
B4)	**Develop Flood Warning Message and Press Release Content**												
B4.1	Develop simple standard Flood Warning messages	J											
B4.2	Develop standard pro-forma press releases	J											
B5)	**Pilot Projects**												
B5.1	Depth/Area Inundation Warning Scheme	FWS											
B5.2	Flash Flood Warning Scheme	FWS											

Tasks	Resource	1995			1996				1997			
		Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Group C - Public Awareness and Evaluation												
C1) Develop Public Awareness and Education Programmes												
C1.1 Develop educational material describing Flood Warnings	T											
C1.2 Develop publicity material for community educational use.	T + J											
C2) Evaluation and Field Studies												
C2.1 Review Flood Response (FAP 14) and Flood Proofing (FAP 23) studies and relevant work in other countries	LSS											
C2.2 Develop programme of field evaluations	LSS + SS											
C2.3 Incorporate lessons from field evaluations into procedures	LSS											
C2.4 Establish arrangements for feedback on extent of flooding	LSS											
Flood Warning Specialist in Dhaka (months)		1½		3	2			2	2			2

Then as required

* DHI to decide

ANNEX 8 - LINKS TO UNDP / UNICEF PROJECT: BGD/92/002/A/01/99 " SUPPORT TO DISASTER MANAGEMENT"

There will need to be links between FAP-10(3) and the UNDP project. Many activities are relavent to a greater or lesser extent and this list should be reviewed as both projects progress. Those activities, identified in Section C3 of Ref (9), which would have *major* links with Module 3 work are listed below:-

	UNDP /UNESCO Project	**FAP-10 Module 3**
Activity	1.1.ii & iii	C1
	1.3.i & ii	C1
	2.1.iii	B3.7 (GIS)
	2.1.v	A1
	2.3.i	A1.1 & A1.2
	2.4.i	A1.2
	2.7.ii & iii	B3.4, B3.5 & B3.6
	3.2.i, 11, & iii	A2.1 & A2.4
	3.4.i, ii, & iii	A2.4 & (B2.4)
	3.5.i & ii	A2.1 & (C1.2)
	3.6.iv	A1.1 as interface
	4.1.ii	C2 & A2.4
	4.2.i	B2.4
	4.3.i	C2.1
	4.3.v	A1.1 as interface
	6.2.i	A1.1 as interface

N.B. Activities 3.6.i, 4.3.v & 6.2.i link with many activities in Module 3.