BANGLADESH
ACTION PLAN FOR FLOOD CONTROL

FAP 10

EXPANSION OF FLOOD FORECASTING AND WARNING SERVICES

DRAFT TERMS OF REFERENCE
(TOR)

FLOOD PLAN CO-ORDINATION ORGANISATION
MINISTRY OF IRRIGATION, WATER DEVELOPMENT
AND FLOOD CONTROL

March 1993

Terms of Reference
for
Expansion of Flood Forecasting
and Warning Services
with reference to the
Action Plan for Flood Control in Bangladesh

1.0 BACKGROUND

1.1 Preamble on the Action Plan

The disastrous floods which affected Bangladesh in 1987 and 1988 raised considerable international interest in helping the country find a long term solution to the flooding problem. A number of studies were undertaken, and in June 1989 the Government of Bangladesh requested the World Bank to co-ordinate a five-year Action Plan for Flood Control in Bangladesh. The role of the bank in co-ordinating international efforts to assist Bangladesh in flood control was endorsed in the Communique of the G7 economic summit meeting held in Paris in July 1989. The Action Plan was endorsed by a meeting of donors held in London in December 1989.

The Action Plan consists of project oriented studies in all the country's main regions, supporting activities to improve project design and execution and non-structural measures. For each of the plan components, comprising surveys, studies or pilot projects, one or more donors originally expressed interest in providing finance. The various actions are to be implemented by these donors in close co-operation with the Government of Bangladesh and under the co-ordination of the World Bank, as described in the Action Plan. The Government of Bangladesh has established the Flood Plan Co-ordination Organisation (FPCO) to co-ordinate Action Plan projects in Bangladesh. The development of flood warning services under FAP 10 is seen as a key non-structural measure which will make a significant contribution to flood preparedness and hence to the national economy.

1.2 The Physical Problem

The whole of Bangladesh is subject to a vigorous monsoon climate which produces a rainy season lasting from May to September. Annual average rainfalls range from 1200 mm to over 6000 mm, and about 80% of this falls within the wet season. With the exception of the south-east of the country, the rest of Bangladesh occupies active delta and flood plain zones developed at the downstream end of major catchments which drain vast areas of the northern and north-eastern Indian sub-continent, along with the eastern Himalaya and parts of the Tibetan Plateau. The principal rivers concerned are the Brahmaputra, the Ganges and the Meghna - over 90% of their combined catchment areas lie outside Bangladesh.

Flooding to a lesser or greater extent is an annual phenomenon - in the more extreme years well over one third of the country may be affected by floods. There are three principal causes of flooding:

- floods on the major rivers, generated over their contributing catchments inside and outside the country;
- rainfed floods, caused by localised heavy rainfall over several days, exacerbated when the levels of major rivers are high, thus impeding drainage;
- floods generated in the hilly areas to the northwest and northeast of the country, which experience extremely heavy rainfalls. These are termed flash floods.

Coastal areas are affected by tidal flooding, storm surges and cyclonic storms, but these have only limited relevance to this project.

The impact of flooding is made more serious due to the rapidly increasing population placing more and more people onto marginal land exposed to flood risk. Severe floods have a major impact on communication and commercial infrastructure, but even under average conditions, considerable damage is caused to agriculture and rural housing.

1.3 Rationale

Flood forecasting and warning was identified as a key component of the Flood Action Plan which could exert major benefits on numerous aspects of national life, with considerable potential for improving the national economy. As such it is recognised as a highly cost effective, non-structural measure.

The management of water, and in particular, control of floods are essential to the future of Bangladesh. On the one hand FAP will concentrate on the development of structural controls such as embankments and drainage systems, but it has been clearly recognised that non structural measures like forecasting and preparedness are highly important and also complement physical design. Early development of these can help both the population and the productive sectors of the economy to cope with floods until major structures are in place. Forecasting and preparedness will continue to be essential for management and maintenance of protective structures during and after construction.

1.4 Previous and present Project Activities

The Flood Forecasting and Warning Centre (FF&WC) of BWDB was established as a permanent entity in 1972 located at 8th floor WAPDA Building,Dhaka.The jurisdiction of the centre is all over

Bangladesh in respect of the water level and rainfall representative stations for forecasting purposes. It received UNDP assistance through Project BGD/76/006 between 1981 and 1986, and also Project BGD/88/013 which commenced in July 1989 and continued till November 1992 with short break from August 1990 to December 1990. Both projects were executed on behalf of UNDP by the World Meteorological Organisation (WMO). The latter project was started as a precursor to FAP 10, but as it has extended far beyond its original schedule, it has effectively functioned as a FAP component.

During the period from July 1989 to November 1992 the project has resulted in the following facilities.

- A wireless network has been upgraded from 50 Nos. to 60 Nos. and monitoring stations have been increased, water level from 35 Nos. to 47 Nos. and rainfall from 34 Nos. to 46 Nos.(Fig 1,2 & 3).

- Forecast with 48 hours lead time with th help of new model (MIKE-11 FF) has been established and disseminated to concerned authorities as described in project management chapter. The forecast lead time for 72 hours has also been formulated and is in trial use.

- Improvement of Hydrometric network.

- A micro-computer system for receiving and analysing weather information from NOAA Polar orbiting satellites.

- A micro computer based Local Area Network (LAN) for operation of flood forecasting models, the centre's data base and the production of forecast outputs.

- Installation of new data base system UNIX operating system.

- Teleprinter, facsimile and land line links for receipt of data including water level and rainfall information from India primarily through BMD storm warning centre.

- Reconnaisance survey for nationwide Telemetry System.

- Support for nationwide data acquisition and dissemination system.

- Overseas training and local training.

Summary of the achievement of outputs is enclosed as Appendix-A.

At the same time as BGD/88/013 was progressing, implementation of the Pilot Telemetry System project was expected. This is funded as part of a debt relief grant from the government of Japan and implemented directly by BWDB through international tender.The system has been designed to link 9 river level and rainfall stations to a monitoring centre at FF&WC. Three stations are to be located at the entry points into Bangladesh of Meghna, Brahmaputra and Ganges rivers. The remaining points are located immediately upstream of Dhaka. The design has been completed, but no contractor has been appointed.The contract will be awarded soon.

The present facilities provide a sound basis from which the future development of national flood forecasting requirements should be made. In its present state the centre is able to produce daily forecasts at 16 points on the main river system as illustrated in Fig.4 using the MIKE 11-FF model. Forecasts are made for advanced periods of 24, 48 and 72 hours and are issued daily as part of the River Situation Report. There is also daily production of a Bulletin which records rainfall and river level over the preceding 3 days at each station in the observation network.

2. Project Management

2.1 Institutional Framework

The FF&WC at present is a division of the Directorate of Surface Water Hydrology - 2, which is under the control of the Chief Engineer, Hydrology of BWDB. Field operations are supported by the Construction and Instrumentation Division. The responsibility for the day to day operations of FF&WC within BWDB is expected to continue in this format and thus BWDB remains the most appropriate implementing agency. As the project is a component of the Flood Action Plan, the Flood Plan Co-ordination Organisation (FPCO) will have a role to review and guide progress.

The flood forecasting operations have been dependent on a working arrangement with BMD for receipt of various items of meteorological information, e.g radar pictures, synoptic charts,etc., and this will continue. During the monsoon period FF&WC also receives daily satellite imagery from the western Pacific geostationary satellite (GMS-Japan), which is monitored by SPARRSO (Space Research and Remote Sensing Organisation) in Dhaka. Once the river situation and forecast has been prepared, it is disseminated to the following (complying Standing Orders for Flood)

(1) News Agencies
(2) Radio & TV
(3) Public Information Department
(4) Ministry of Relief & Rehabilitation
(5) Concerned Government Officials

(6) Concerned Water Development Board's Officials
(7) Field Wireless Stations (to inform Water Development Board's Officials, when the river crosses danger level at that point)

Detailed dissemination list is enclosed as Annex-1. The forecast and warning is also transmitted to the wireless stations at forecast points as shown in Fig. 5.

The functional body is expected to be the recently established Disaster Co-ordination and Monitoring Unit (DCMU), which itself will be developed through FPCO by FAP 11. FF&WC will extend their existing responsibility for distribution of information, and will take on a special role to assist DCMU in interpretation of information. FAP 11 and DCMU will identify and develop pathways for distribution of forecast and warning information which will be an input from FAP 10. The identification of the needs for forecast information from the field will be a joint responsibility of the project and DCMU for which close co-operation will be required with the large number of government agencies with responsibility for disaster management under the Emergency Standing Orders for Flood and NGO's with relief programmes.

The project is basically organised as a series of interconnected modules based on specific activities. Donor or a number of separate donors may be involved.

2.2 Project Contributions Under the Flood Action Plan

Now that the flood forecasting and warning system (FAP 10) is established in an initial form, it should develop its interactive role with other FAP components. This role is important in the overall advance FAP will make to sustainable national development. The expansion of flood forecasting facilities requires a combination of technical and operational developments, to be paralleled with improving and broadening the scope of information and dissemination to meet the requirements of users and the public in general.

The nucleus of FF&WC will now be developed to provide greater detail of information at a local level, with increased forecast lead time and better public dissemination. The needs for the future are :-

(a) Improve and expand the capabilities of the FF&WC so that it will function as a proper "operations centre";

(b) Extend the coverage of flood monitoring and forecasting to a larger proportion of the country with depth/area inundation;

(c) Improve the dissemination of forecast outputs and develop public awareness at the grass-root level.

The principal interactions with individual FAP components are explained below and illustrated in Fig. 6.

FAP 11. Disaster Preparedness. There is a clear demarcation between the role of DCMU in the dissemination of information and the implementation of flood preparedness and response actions, and that of FF&WC which will provide the forecast information. At certain stage of disseminated forecast FAP-11/DMB (Disaster Management Bureau) will arrange the necessary high level co-ordination committee meetings , call meetings of focal points. However, FF&WC will have the responsibility to develop its range of forecast outputs and existing dissemination lines to meet requirements, in particular for mass understanding. FAP-11 will provide their Forecast/Warning input requirements to FAP-10.

FAP 19. Application of Geographical Information Systems. This will provide vital information to link between the river system models and topographical information necessary to develop depth-area inundation models. Model development and the appropriate adaptation of MIKE11-FF will take place through the FAP 10 project. The provision of information from the GIS will be prepared by FAP 19, who will also advise and assist with the necessary software facilities. The initial stages of the development of depth area models under FAP 10 will take place on a pilot level where link with the programme of FAP 20 could be beneficial.

FAP 24. River Survey Programme. This is expected to provide improved information on river hydrology and morphology, which will be complementary to the development of river forecast models.

FAP 25. Flood Hydrology Study and Flood Management. The flood management component started in October 1992. Initially as planning exercise, it is envisaged that the models could be used for specific real time functions. The flood management model will be adapted by FAP-25 from the MIKE11 general model and GIS information from FAP 19. Once developed will be handed over to FAP-10 for real time operation. Recalibration with updating data will be made by FAP-10.

Future Dissemiantion

The dissemination of flood forecasting & warning will be done on the basis of "The Emergency Standing Orders for Flood". FAP-10 shall maintain close liaison with FAP-11/DMB/DCMU.

3.0 SCOPE OF WORK

3.1 Objective

The overall objective is to provide improved information to aid national preparedness for floods as a major contribution to the non-structural measures aimed at mitigating flood impacts. The mitigation of flood impacts will be achieved by progressive development of flood forecast and warning capabilities to increase accuracy and timeliness and extending their coverage to more localised areas. This requires a number of technical developments incorporating new equipment such as Telemetry etc. The technical developments will have to be matched by a greater ranges of forecast outputs to serve the needs of the Government and the public. This project will keep good liaise with FAP-25. Flood management and modelling and FAP-11 - Disaster preparedness as had been discussed in Art. 2.2.

The outputs envisaged in the present TOR Expansion of Flood Forecasting and Warning Services have been prepared on the above light without any duplication with other FAP Components. The radar component has been dropped in this TOR as per minutes of the 13th meeting of the Flood Action Plan Technical Committee held on December 27, 1992 in the Conference Room of the Ministry of Irrigation, Water Development and Flood Control (MIWDFC), Bangladesh Secretariat, Dhaka.

3.2 Outputs

- The setting up of a fully comprehensive flood operations centre within BWDB.
- Increased numbers 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 development of telemetry and existing radar facilities.
- The establishment of improved data exchange with countries in the Ganges - Brahmaputra - Meghna basins.
- Development of real-time forecasts at the regional level and provision of local depth-area flood forecasts.
- Development of a forecast system for flashy rivers, mostly in the east of the country.

- Provision of more detailed forecast information and a range of forecasts targeting different users.

- In conjunction with and in support of FAP 11, increase public awareness of the availability and understanding of flood warning information and the benefits to be derived from their use.

- Improved institutional structure within FF&WC to provide and maintain the necessary services.

3.3 Description of Activities

- Provision of specialist services by international and local consultants in support of the project programme.

- Procurement and installation of additional wireless sets for observation network.

- Design, procurement and installation of additional automatic telemetry facilities.

- Reinstallation and upgrading of a micro-wave (UHF) link between BMD and FF&WC to provide multi-channel data transfer facilities for radar imagery, catchment rainfall estimates and meteorological data.

- Continued development of modelling applications, in particular for regional and localised warnings.

- Liaison with FAP 25 in the development of flood management models and their operation in real time by FF&WC.

- Development of more comprehensive and effective warning and forecast outputs linked to an improved dissemination system to be set up by Relief Ministry.

- Procurement of vehicles and office equipment to support operations.

- Provision of maintenance service and spares for computer, telemetry systems and existing radar.

- Phased software and hardware developments for the computer LAN.

4.0 TERMS OF REFERENCE

4.1 Introduction

As FF&WC has developed a sound basis, it is important to build on this and not to devolve responsibilities to other centres. The existing facilities can be expanded to a limited extent without a major assistance programme. Some degree of diversification of forecast outputs could be developed, the subjective application of river level forecasts to local area impacts, and improving awareness within the BWDB structure at regional and local level. However, staffing levels and availability of funding would soon become very restrictive. To meet the expected needs under both FAP and in the national context through the overall objective and the outputs listed above, a major co-ordinated programme is required. The programme will consist of a number of sub-components/modules which have been organised as follows.

Sub-Component/Module 1. Co-ordination and monitoring to maintain the progress made in setting up the FF&WC in BWDB to ensure that the other activities and their outputs are integrated satisfactorily into the FFW system including the accessing of external hydrometric information and containing the established links with other FAP components.

Sub-Component/Module 2. Expansion of Flood Forecasting System through updated and improved modelling activities including the development of flooded area/depth forecast in conjunction with FAP-19 and FAP-25.

Sub-Component/Module 3. Development and improvement of forecast outputs, public and user awareness and dissemination with special emphasis on development of appropriate warning systems at grass root levels.

Sub-Component/Module 4. Installation and development of Telemetry system to upgrade data collection and improve forecast accuracy and lead time.

The separation of the whole project into sub-components/modules is also seen as facilitating multi-donor support, possibly through sub-contracts. There are clear distinctions between technical and socially oriented requirements which should allow close

identification with individual donor programmes. The project programme to link the implementation of the various modules will be carried out as a Technical Assistance arrangement by consultants or an international implementing agency.

4.2 Coordination and monitoring to maintain the progress made in setting FF&WC and Increased access to hydro-meteorological forecast information from external sources. (Sub-Component/ Module 1)

- Coordination and monitoring to maintain the progress.
- Liaise with FAP components and different organisation.
- Upgrading or the replacement of the data link between BMD and FF&WC to a high level of reliability to provide FF&WC with visual and processed data from the radar system and data through GTS system from India.
- Development of necessary software and terminal hardware facilities for improved data handling from the storm warning centre (SWC) computer system to FF&WC database.
- Liaison with BMD over provision of improved forecast information for both long and short term rainfall forecasts.
- Development of the use of the weather satellite receiver system to provide more detailed information on local and regional weather behaviour.
- Maintain liaison with SPARRSO and FAP 19 to advise on remote sensing potentials and utilisation in flood forecasting operations.

The inter relation between the sub-components/modules and the general support of technical developments, studies and training will be co-ordinated through a full time Team Leader/Chief Technical Adviser working in direct co-operation with a national counterpart in BWDB. Other staff having a number of short term inputs specialist consultants will provide overall co-ordination as shown in Fig.7 and illustrated in Art. 7.

The BMD has recently acquired a microwave data link with the World Weather Watch GTS regional centre in New Delhi. This allows rapid transfer of meteorological and flood data to the BMD database. The former microwave link between BMD and FF&WC is to be re-established to allow transfer of information which is currently done by teleprinter under manual operation. The data handling facilities in the BMD database will require software development to allow

automatic data screening and selection, and transmission to the FF&WC database. Modems have already been provided under BGD/88/013, and these will need to be properly interfaced with both systems.

4.3 Modelling studies and applications to develop the range of forecasts produced. (Sub-Component/Module 2)

- Continued development and refinement of the general model MIKE11-FF 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 models giving depth - area flooding forecasts by interfacing MIKE11 models with terrain models and GIS data. This will involve the facilities and outputs from FAP 19, as appropriate.

- Prepare adaptations 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 programme for model development will continue in close co-ordination with the Surface Water Modelling Centre and other components of FAP. 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. Under the Project BGD/88/013, updating and recalibration of the models takes place prior to the monsoon season to incorporate the latest updates in the general model by SWMC.

In developing models for depth-area-inundation and for flood management, close co-ordination with FAP 19 and FAP 25 will be necessary to incorporate hydrodynamic modelling with GIS facilities and terrain models. In the early stages of the project, the area inundation and the management models will be developed at a pilot level. In view of the detail of data expected to be available through the work on FAP 3A and FAP 20, the pilot level work could concentrate on the Jamalpur and Tangail areas. The aim must be to

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quickly apply the findings at the pilot level to specific flood prone areas. Another target will be to apply areal flooding estimates in direct relation to the present "danger level" reference points.

The goal is to utilise the models within the FF&WC operations centre in real time to produce the necessary forecast information as part of a broader flood management and preparedness programme.

4.4 Development of forecast outputs, public and user awareness and dissemination. (Sub-Component/Module 3)

- 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. newspapers, 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 educational programmes.

- Develop awareness in government, NGO's and the private sector to the use of warnings 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 FAP 11 in the development of preparedness programmes for cyclones and floods. Actions during emergency situations will be undertak through the Relief Ministry, but the need for improved flood forecast information and dissemination will be identified by FAP 10. At present FF&WC is responsible for the dissemination of daily bulletins and forecasts to the agencies listed in Annex 1. At times of emergency it has specific duties under the Emergency Standing Orders, and in particular stays in

direct wireless contact with BMD 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.

4.5 Development of the telemetry system to upgrade data collection and improve forecast accuracy and lead time. (Sub-Component/Module 4)

- Ensure full integration of the Pilot Telemetry System with existing flood forecasting activities and evaluation of the performance of the system.

- Design, procurement and installation of extended telemetry system to more stations about 40 to support localised forecast requirements.

- Phased replacement of wireless links at key river stations with automatic telemetry stations;

- Expansion of the existing wireless observation network to meet the needs of regional forecast models.

- Integration of all telemetry inputs to the routines of the Operation Centre, with automatic links to database and models.

It must be noted that this part of the project plan is highly dependent on the performance of the Pilot Telemetry Scheme. The cost estimates to support the activities under the above terms of reference are based primarily on the provision of about 40 field Telemetry stations as illustrated in Fig. 8 as well as in Appendix-B.

Telemetry is required to support local area and flash flood forecasting where frequent monitoring and short-term updating are essential. It also has greater flexibility for accessing information than wireless stations which are not always continuously manned. The expansion of telemetry has to allow for additional telecommunications facilities and modification to the central control system, though it is assumed that the major capital costs for these will have occurred under the installation of the pilot system.

4.6 Training

Training will be carried out in an on-the-job manner as well as by courses, study tours and attachments overseas. It is important that a wide spectrum of staff receive exposure to operations and techniques in other flood forecasting undertakings. As this is a long term project, the programme should be flexible and developed progressively. A provisional break down of training location and notional costs is given in Annex 3. It is anticipated that the main training topic requirements will be for:-

- operation of the telemetry system and its linkage to the existing flood forecasting and data processing facilities;
- maintenance of telemetry installations and equipment;
- system management for UNIX based computer local area network;
- advanced hydrodynamic modelling techniques for model developments;
- hydrodynamic and hydrological modelling for new staff joining:
- hydrological forecasting for new staff joining;
- meteorological and remote sensing applications in flood forecasting and maintenance of micro-wave link between BMD and FFWC and analysis of synoptic charts of BMD;
- operation and maintenance of the hydrological radar system and its links to FF&WC;
- interpretation and analysis of hydrological radar and satellite outputs for flood forecasting purposes;
- impact assessment and disaster preparedness;
- forecast preparation and presentation;
- public liaison and development of training and public eduction.

5.0 REPORTING

- Inception Report. To be submitted 3 months after the commencement of the project. This will review the TOR, revise these if appropriate and provide a detailed work plan to meet the project outputs.

- Quarterly Reports (Progress). After the inception report, the consultants will submit quarterly reports showing the progress of activities and the project budget delivery.

- Annual Interim Report. At the end of years 1 and 2 of the project, the consultants will submit 50 copies of an interim report, covering all aspects of the study completed to date. It will also contain discussion on the coming year's programme and review options for long term development.

- Draft Final Report. The consultant will submit 50 copies of the draft final report for review by GoB 3 months before the end of the project. All comments should be presented for discussion within 1 month.

- Final Report. Following finalisation of comments and their discussion and amendment, the Draft Report will be revised and improved as necessary. The Final Report will be submitted in 50 copies at the end of the project.

- Working Papers. These will be submitted at suitable intervals on specific topics within the project to provide a forum for discussion and information exchange, particularly amongst the components of FAP.

6.0 PROJECT DURATION AND SCHEDULE

The project is planned to continue to the end of 1995 in line with the time frame initially proposed for the first phase of FAP. Assuming a start date closely following the end of Project BGD/88/013, this gives a project duration of about 3 years. This assumption has been used in drawing up the bar charts for the proposed work plan and staffing inputs. (Fig. 9 and 10).

The periodic upgrading of the general flood forecast model is an activity that can be carried out by FF&WC staff in conjunction with SWMC, and is expected to take place throughout the project. Other specific studies will have to commence early in the project. The work for local depth/area forecasting can start with the existing general information on flood depth at given return periods as produced by MPO and a thorough review of the local "danger level" criteria. The aim to link river forecasts models with land elevation models for area forecasting must be progressively developed with the activities of FAP 19, commencing at the pilot level and then proceeding to specific flood prone localities. Flood management is another area where real time forecast application are envisaged. Some liaison with FAP 25 will be required from early in the project as their programme develops. Once flood management models are defined, then FAP 10 will

concentrate on developing these to real time operation for eventual incorporation into the Flood Forecast Centre operations.

If the recommendations under BGD/88/013 for increase of FF&WC staff levels and the relocation to the Hydrology Centre site are implemented before the start of FAP 10, then the restoration of the data link with BMD must be an early priority. This will be linked with the upgrade of the BMD microvax computer and the development of the interfaces with the FF&WC computer network. Once this is established, there can be progressive growth in the accessing of forecast information from BMD.

The expansion and upgrading of forecast information provided will be a continuous process th[illegible]ghout the project. It can start immediately, even without external project support with the implementation of some recommendations made under BGD/88/013. These largely concern reformatting of published information and the introduction of a more phased process of alert and warning. Once in place, this will allow the commencement of a long term programme for the development of public awareness as to the use and understanding of forecast information. Training is envisaged for BWDB, government and other recipients, as well as general publicity and can be undertaken in each year of the project. During the latter stages of the project when more local forecast information is anticipated the training and awareness programme will be extensive.

The telemetry expansion is the only module for which an early start is not anticipated, as it awaits the construction of the pilot telemetry system, the programme for which is under execution at the moment. The system is expected to be in place by the end of 1993. FAP 10 will then review the performance and plan for future development in a year or two, to be followed by procurement with the aim of having the extended system constructed, fully operational and integrated with the activities of the centre in year three.

7.0 STAFFING [illegible]D OTHER STUDY INPUTS

The project activities are arranged under five main modules, which will largely run concurrently, rather than being sequentially dependent. The inter-relation between the modules and the general support of technical developments, studies and training will be co-ordinated through a full time Team Leader/Chief Technical Adviser working in direct co-operation with a national counterpart in BWDB. Other staff having a number of short-term inputs and specialist consultants will provide overall co-ordination as in Figure 5.

The project will require the services of a number of suitably qualified expatriate specialists, through an internationally recognised consultancy firm or an appropriate implementing agency. In addition to inputs connected with the specific activities identified as modules, the following general staff inputs are required.

- Team Leader/CTA	32 m/m
- Computer Systems Specialist	11 m/m
- Hydrologist	8 m/m
- Short-term Consultants	21 m/m

Annex 4 contains job descriptions and TOR for the key posts, but the duties of the general project staff and the staff inputs for the various modules are described briefly below.

The **Team Leader** will be responsible throughout for management and co-ordination of all activities under the international project inputs. He will liaise with and directly advise the counterpart agency to support and expand the activities of the FF&WC, the point of contact being the National Project Director. The Team Leader will also be the focal point for co-ordination with other government agencies involved in the project and the activities of the Flood Action Plan.

The **Computer Systems Specialist** has to ensure that the facilities provided by the Pilot Telemetry System allows direct access of data to the LAN for model and database operations under UNIX. The specialist will also advise and co-ordinate developments to the LAN to support expansion of models and database, including integration of other data sources and facilities, e.g. GIS, inter computer communications with BMD.

A **Hydrologist** is required to provide specialist technical co-ordination between the various project activities and to guide the work undertaken by supporting studies. He/she will also carry out review of results and operations and concentrate on research and planning concerns, particularly the application of model results to operational requirements. As the extent of this work is difficult to ascertain until the project is under way, the time of the specialist has been limited, but further support for this activity is allowed under ad-hoc consultancies.

Short-term Consultants. There will be the need for a number of short term specialist inputs to support the programme, and these should be particularly linked to training. The fields to be covered are:

- remote sensing,
- flood management and damage/risk assessment,
- hydrology and hydrometeorology,
- media/public awareness,
- institutions and organisational planning,

- sociological/public participation matters.

Staffing inputs in the various project modules would have a certain degree of flexibility as these are anticipated to be implemented as sub-contracts. Indicative staff inputs and their duration are given below.

Sub-Component/Module 1 - Co-ordination, monitoring, supporting studies and accessing of external hydrometric information. The specialist staff inputs required for this module will cover the design and physical installation of the BMD and FF&WC data link and the modification of software required for data handling and transfer. The communications link will require services from a **Telecommunications Specialist** totalling 6 man months over the project, which allows for the initial design and installation and maintenance supervision in each year after construction. Software modifications to the BMD data handling facilities will be handled by a short term ad-hoc consultancy. As a short term solution for the operation of the existing radar for hydrological purposes, the proposal of Chinese team regarding the spares like magnetron for about five years and development of software to receive the hydra data will be considered after taking permission of EEC. The existing radar facilities are explained in **Annex-2.**

Sub-Component/Module 2 - Development of Flood Forecasting Models. The use of the MIKE11 model for flood forecasting is directly linked with the model development programme of the Flood Action Plan, which is in turn linked to the programmme of the Surface Water Modelling Centre with DHI as consultants. SWMC will provide the regular upgrades of the general and regional models. The specialised development of flood forecasting models will be carried out within the project with the assistance of **Hydraulic Modelling Specialists.** To carry out new model development and to continue the improvement and expansion of existing models, the sub-contract will include regular staff inputs over the whole project totalling 22 man months.

Sub-Component/Module 3 - Improvement of Outputs and Public Awareness. The development of the range of forecast outputs produced by FF&WC will require the services of a **Forecast Applications Specialist.** These inputs will take place at various time throughout the project and total 15 man months. It is highly important to identify the needs of various groups to relate forecasts to preparedness. As this will require detailed evaluation at local levels, it is proposed that this module should include inputs by a **Socio-economist** expatriate consultant who has experience of the impact of flood warning programmes in other countries. The input will be 8 man months. The activities of this module will be supported by a multi disciplinary team of local consultants to identify requirements and encourage public

participation over a broad spectrum of society and to evaluate feed-back.

Sub-Component/Module 4 - Telemetry Development. One Telemetry Specialist will be required to ensure that the Pilot Telemetry System is fully integrated with the other functions of FF&WC. At the time of installation he will have a short input to ascertain the system capabilities. Once the system is established and operating under monsoon conditions, he will review performance and assist in the planning and implementation of further telemetry developments. (11 man months).

Cost:

Sl. No.	Sub-Component/ Module	Man month	Cost in million	Total cost in million
1.	Co-ordination, monitoring & supporting studies	78	US$ 1.127	US$ 2.061
2.	Expansion of model application	22	US$ 0.396	US$ 0.396
3.	Development of forecasts & public awareness	23	US$ 0.322	US$ 0.391
4.	Telemetry system	11	US$ 0.154	US$ 3.254

8.0 RESPONSIBILITIES OF THE GOVERNMENT

8.1 Freedom from Taxation and Duties

The Government/Executing Agency shall bear the cost of any taxes, duties, fees, levies and other impositions under the laws and

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regulations in effect in Bangladesh on the consultant and expatriate personnel in respect of:

- any payments made to the consultants or their staff, other than Bangladeshi nationals, in connection with the carrying out of the services;

- any materials, equipment and supplies brought into Bangladesh for the purpose of carrying out the services and which after having been brought to the country will be subsequently withdrawn therefrom;

- any equipment imported for the purpose of carrying out the services and paid out from the funds provided by the Government and which is treated as the property of the Government.

Provided that:

a) The consultant and his expatriate personnel shall follow the usual customs procedure of the Government in importing property into Bangladesh; and

b) If the consultant or any of the expatriate personnel does not withdraw, but disposes of any property in Bangladesh upon which customs duties and taxes have been exempted, the consultant shall bear such customs duties and taxes in conformity with the regulations of the Government.

8.2 Other Privileges and Exemptions

The Government shall:

- provide the expatriate personnel with work permits and such other documents as shall be necessary to enable them to perform the services, including privileges specified in the Government of the Peoples' Republic of Bangladesh notification no. /RO 88-L-85/906/CUS, dated 13 February 1985 and /RO 89-/85/907/CUS, dated 13 February 1985, (circular of 1988 is to be incorporated);

- arrange for the personnel and his authorised dependents to be provided promptly with all the necessary entry and exit visas, residence permits, work permits, exchange permit and travel documents required for their stay in Bangladesh;

- facilitate clearance through customs of any property required for the services and of the personal effects of the expatriate personnel and the prompt issue to the consultants expatriate personnel of Customs Pass Books;

- issue to officials, agents and representatives of the Government all such instructions as may be necessary or appropriate for the prompt and effective implementation of the services;

- exempt the consultants and the personnel for the services from any requirement to register or obtain any permit to practice their profession or to establish himself higher individually or as a corporate entity according to the laws of Bangladesh;

- arrange for duties and taxes on the imported equipment, vehicles and other materials relating to the project which will be retained in Bangladesh to be paid by the implementing agency in Bangladesh.

8.3 Services, Facilities and Equipment

- The Government shall provide assistance to collect pertinent data, maps and information available for the performance of the services under the contract.

- The Government shall, if available, provide accommodation in Government Rest Houses at the usual rate.

- Indemnify, save and hold harmless the consultant and its personnel from and against all claims, demands or suits that may be brought against the consultant and its personnel arising directly from the performance of the services, provided that such claims, demands or suits are not the result of negligence or willful acts of the consultant and its personnel.

9.0 RESPONSIBILITIES OF THE CONSULTANT

9.1 General Responsibilities

The consultant shall carry out the services as detailed in "Scope and Terms of Reference" in the best interest of the Government for the successful realisation of the programme with all reasonable care, skill and diligence, with sound engineering, professional, administrative and financial practices, and shall be responsible to the Executive Agency (FPCO) for the discharge of the responsibilities

The consultant shall during the execution of the services appoint and designate a team leader to represent the consultant in Bangladesh in all matters relating to the services.

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The consultant shall be responsible for the professional and technical competence of its employees and the personnel's behaviour and shall use its best efforts to select and employ for work in Bangladesh only those persons who in its judgement will be he best and most likely to perform satisfactorily the terms of their employment.

The consultant shall keep accurate and systematic records and accounts in respect of the services in such form and detail as is customary in the profession and shall be sufficient to accurately establish the costs and expenditures incurred for the services.

Except with the prior approval of the Government/Executive Agency, the Consultant shall not at any time communicate to any persons or entity not connected with the services, any confidential information disclosed to them for the purpose of the services or disclosed by them in the course of the services, nor shall the consultant or the consultant's personnel make public any information relating to the services.

The consultant shall be responsible in respect of life, health, accident, travel and other insurance which may be necessary for the consultant's personnel for the purposes of the services.

All existing rules and regulations of the Government of Bangladesh related to the classification, custody and issue of restricted map, aerial photograph and other related data shall be maintained.

9.2 Information

The consultant shall furnish the Executing Agency with such information relating to the services and the project as the Executing Agency may from time to time reasonably request.

9.3 Assignments, Sub-contractors

Except with the prior written approval of the Government, the consultant shall not assign or transfer the contract or any part thereof, nor engage any independent consultant or sub-contractors to perform any part of the services, other than nominated personnel listed in the contract.

The approval of the Executing Agency to the assignment of any part of the contract or to the engagement by the consultant of independent consultants or sub-contractors to perform any part of the services shall not relieve the consultant of any of his obligations under the contract.

9.4 Prohibition on Conflicting Activity

No member of the personnel assigned to the project shall engage, directly or indirectly either in his name or through the consultant, in any other business or professional activities in Bangladesh during the performance of his duties or assignment under the contract.

9.5 Laws and Regulations of Bangladesh

The contract shall be deemed to be a Bangladesh contract and shall accordingly be governed by and construed according to the laws for the time being in force in Bangladesh.

The consultant shall respect and abide by all applicable laws and regulations in Bangladesh and shall use his best efforts to ensure that the consultant's personnel and their dependents while in Bangladesh, and the local employees of the consultant shall respect and abide by all the laws and regulations of Bangladesh.

9.6 Ownership of Drawings, Data and Reports

All reports and relevant data such as maps, drawings, plans, statistics and supporting records or materials compiled or prepared in the course of the services shall be the absolute property of the Government. The consultant agrees to deliver all these materials to the Executive Agency upon completion or termination of the services.

9.7 Reports and Communication

All reports, communications, recommendations and general correspondence from the consultant to the Executive Agency under the contract shall be in the English language.

9.8 Notice of Delay

In the event when the consultant delay in obtaining the required services or facilities set forth in the contract for the conduct of the services, or the occurrence of an event or condition that might delay or prevent completion of the services in accordance with the time schedule, the consultant shall promptly notify the Government of such delay, indicating what steps are being taken or suggested by the consultant to meet the situation, and may request an appropriate extension of time for the completion of the services.

2 (1

9.9 Co-operation

The consultant shall co-operate fully with the Government in performance of the services for which the Government shall provide the data and facilities asset forth in the contract.

10.0 COST ESTIMATES

The cost estimate for the project is made up of a foreign exchange component of almost US$ 6.102 million and a local currency contribution by the Government of Bangladesh of Taka 732.00 lakh. Commitments from donor countries are required to provide the foreign exchange for the budget summarised below. All figures are in US dollars.

Sub-component/Module 1

Project Personnel			
Team Leader	32 m/m	@ 13,000	416,000
Comp. System Expert	11 m/m	@ 15,000	165,000
Hydrologist	8 m/m	@ 15,000	120,000
Short-term Consultants	21 m/m	@ 16,000	336,000
Sub-total	72 m/m		1,037,000
Project Support			
Administrative support staff	L.S.	20,000 pa	60,000
Official Travel			25,000
Mission costs (Evaluation and monitoring)			50,000
Reports			22,000
Communications			8,000
O & M			33,000
Miscellaneous/sundry			45,000
Sub-total			243,000
Re-installation of Data Transfer Link			
Equipment and installation			145,000
Expert services, 6 m/m @ 15,000			90,000
Software & magnetron for the existing radar system			50,000
Sub-total			285,000

Sub-contracts

1. Sub-component/Module 2	
Expansion of model application	
Expert Services, 22 m/m @ 18,000 Sub-total	396,000
2. Sub-Component/Module 3	
Forecast Development	
Audio-visual equipment	19,000
Specialist Services, 23 m/m @ 14,000	322,000
Local Consultants	50,000
Sub-total	391,000
3. Sub-Component/Module 4	
Telemetry Development	
Equipment: field, base station & telecoms installations, LS	3,000,000
Spares	100,000
Specialist Services, 11 m/m @ 14,000	154,000
Sub-total	3,254,000

Equipment	
Vehicles; 2 field @15,000; 1 sedan @ 12,000	42,000
Radio Transceivers; 40 @ 3,000	120,000
Radio spares	8,000
Office Equipment	10,000
Computer spares/replacements and additions	35,000
Software developments/licenses	20,000
Sub-total	235,000
Training	
Local in-service training	16,000
Study Tours	25,000
Overseas training	220,000
Sub-total	261,000
TOTAL	6,102,000

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The break-down of the local currency component is as follows.

		Taka in lakh
Equipment (CDST)		450.00
Vehicles		16.00
O & M during execution		50.00
Land		3.00
Buildings and construction		30.00
Installation of equipment		70.00
	Sub-total	619.00
Vat (@ 15% of sub-total)		93.00
Miscellaneous		20.00
	TOTAL	732.00

FIG-1

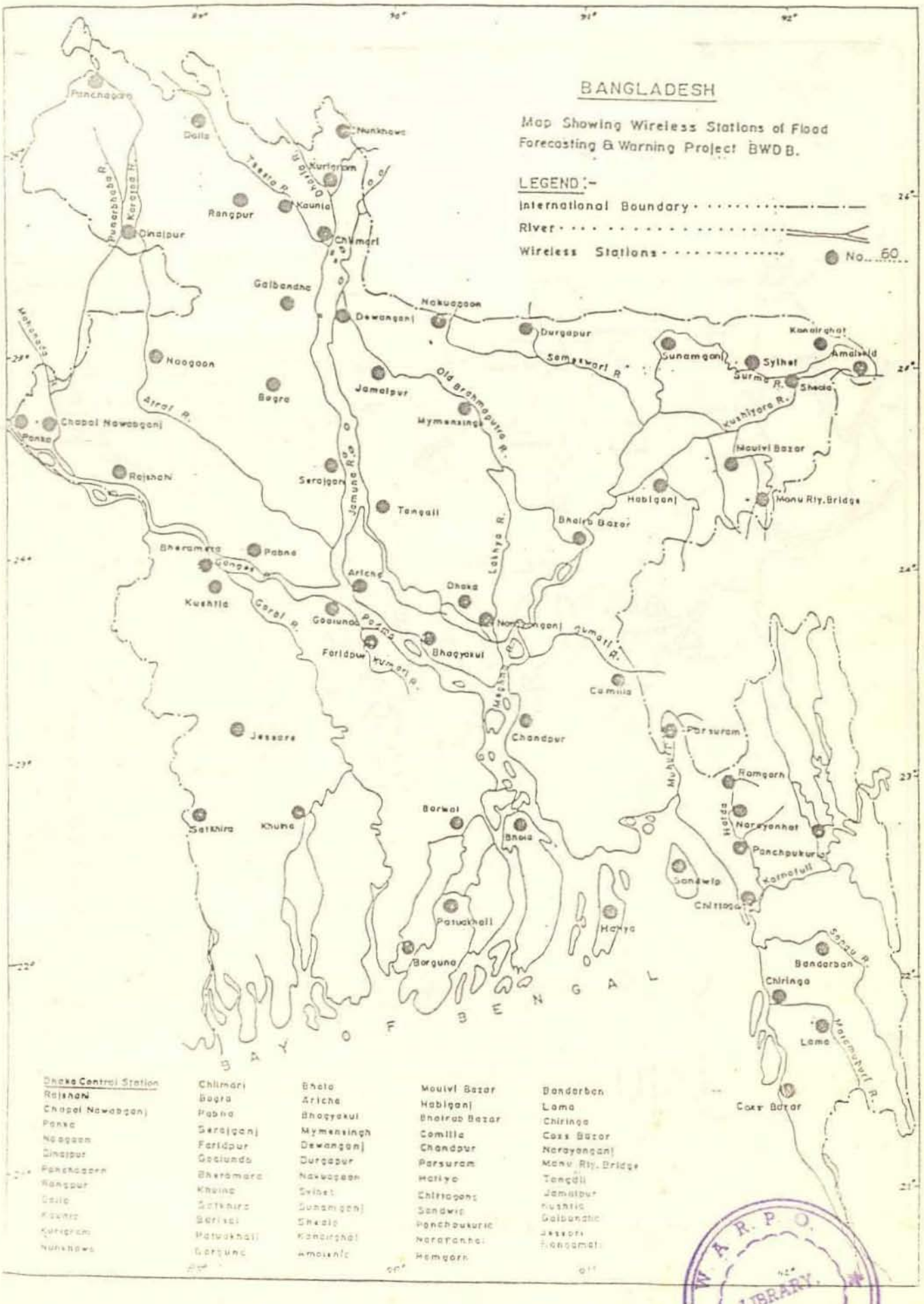
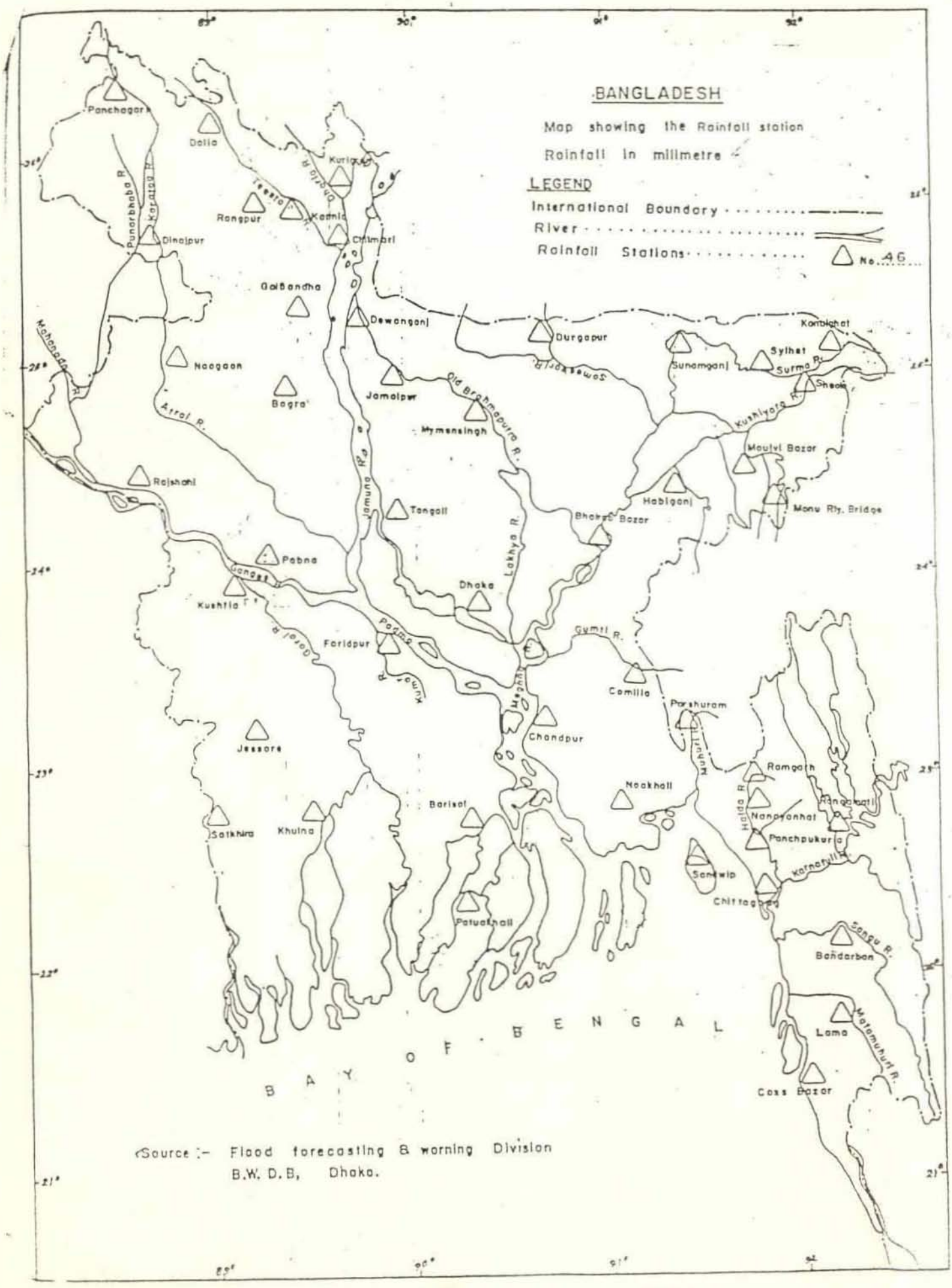


FIG – 2



Source :- Flood forecasting & warning Division
B.W.D.B, Dhaka.

FIG-3

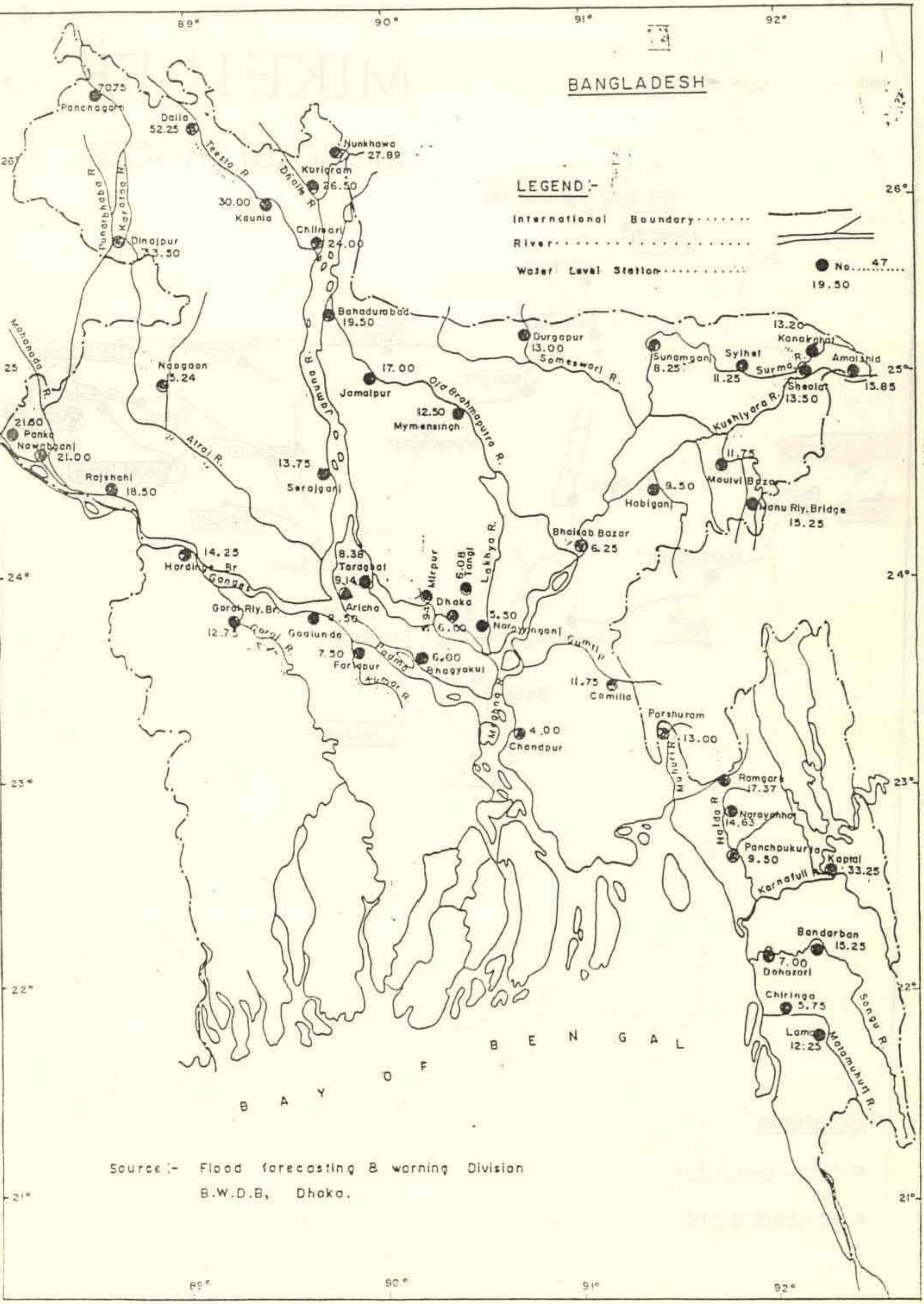
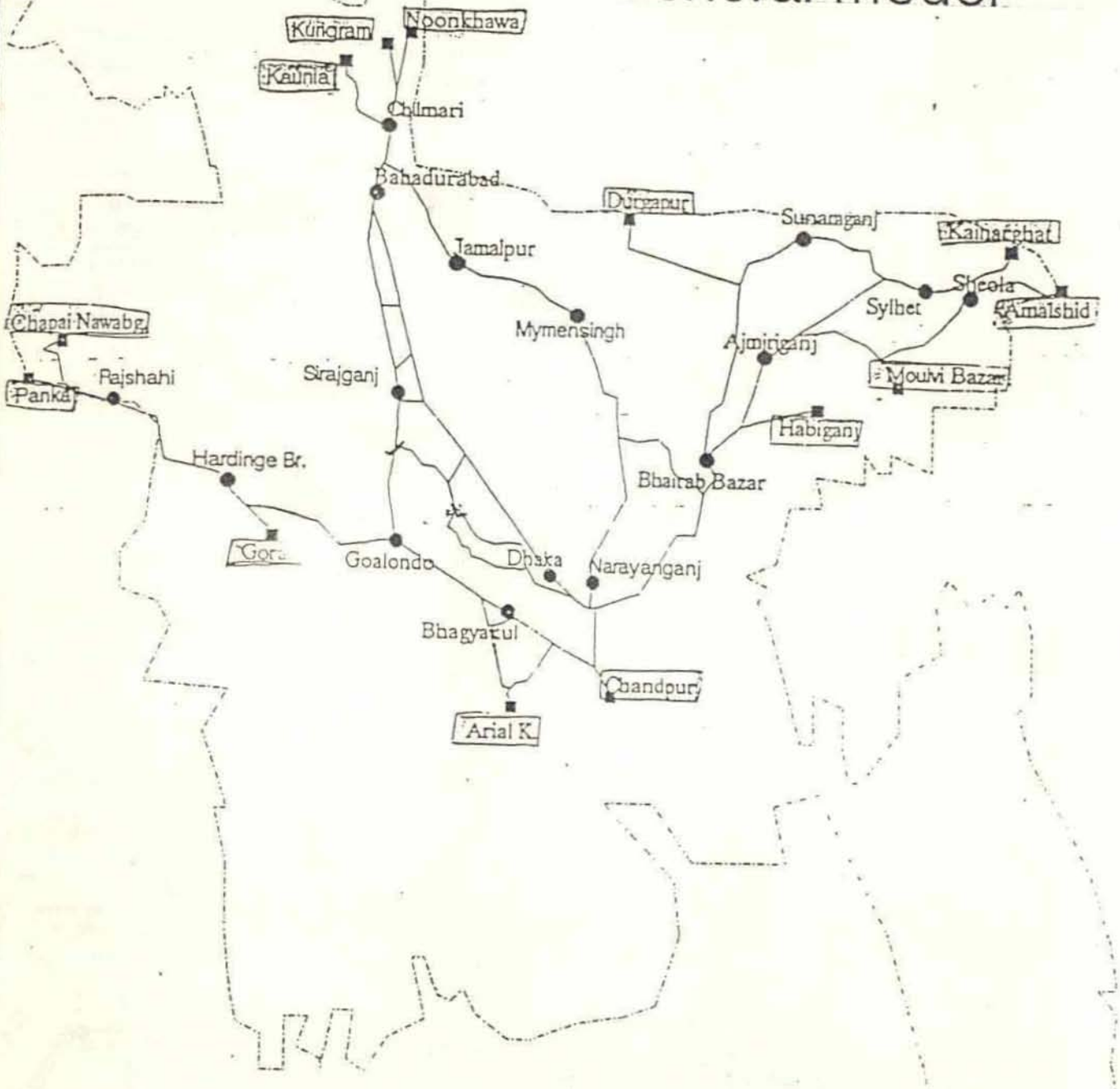

BANGLADESH
LEGEND :-
International Boundary
River
Water Level Station
No. 47
19.50
BAY OF BENGAL
Panchagarh 70.75
Dalia 52.25
Nunkhawa 27.89
Kurigram 26.50
Kaunia 30.00
Chilmari 24.00
Dinajpur 33.50
Bahadurabad 19.50
Durgapur 13.00
Sunamganj 8.25
Sylhet 11.25
Kanairghat 13.20
Amalshid 15.85
Sheola 13.50
Jamalpur 17.00
Mymensingh 12.50
Naogaon 15.24
Panka 21.80
Nawabganj 21.00
Rajshahi 18.50
Serajganj 13.75
Moulvi Bazar 11.75
Hobiganj 9.50
Manu Rly. Bridge 15.25
Bhairab Bazar 6.25
Hardinge Br 14.25
Taraghat 8.38
Aricha 9.14
Mirpur
Tongi 6.08
Dhaka 6.00
Narayanganj 5.50
Gorai Rly. Br. 12.75
Goalundo 8.50
Faridpur 7.50
Bhagyakul 6.00
Comilla 11.75
Parshuram 13.00
Chandpur 4.00
Ramgarh 17.37
Narayanhat 14.63
Panchpukuria 9.50
Kaptai 33.25
Bandarban 15.25
Dohazari 7.00
Chiringa 5.75
Lama 12.25
Teesta R.
Dharla R.
Punarbhaba R.
Karatoa R.
Mahananda R.
Atrai R.
Jamuna R.
Old Brahmaputra R.
Lakhya R.
Someswari R.
Surma R.
Kushiyara R.
Ganges
Gorai R.
Padma
Kumar R.
Meghna R.
Gumti R.
Muhuri R.
Halda R.
Karnafuli R.
Sangu R.
Matamuhuri R.
89° 90° 91° 92°
26° 25° 24° 23° 22° 21°
Source :- Flood forecasting & warning Division
B.W.D.B, Dhaka.

FIG – 4

MIKE11-FF

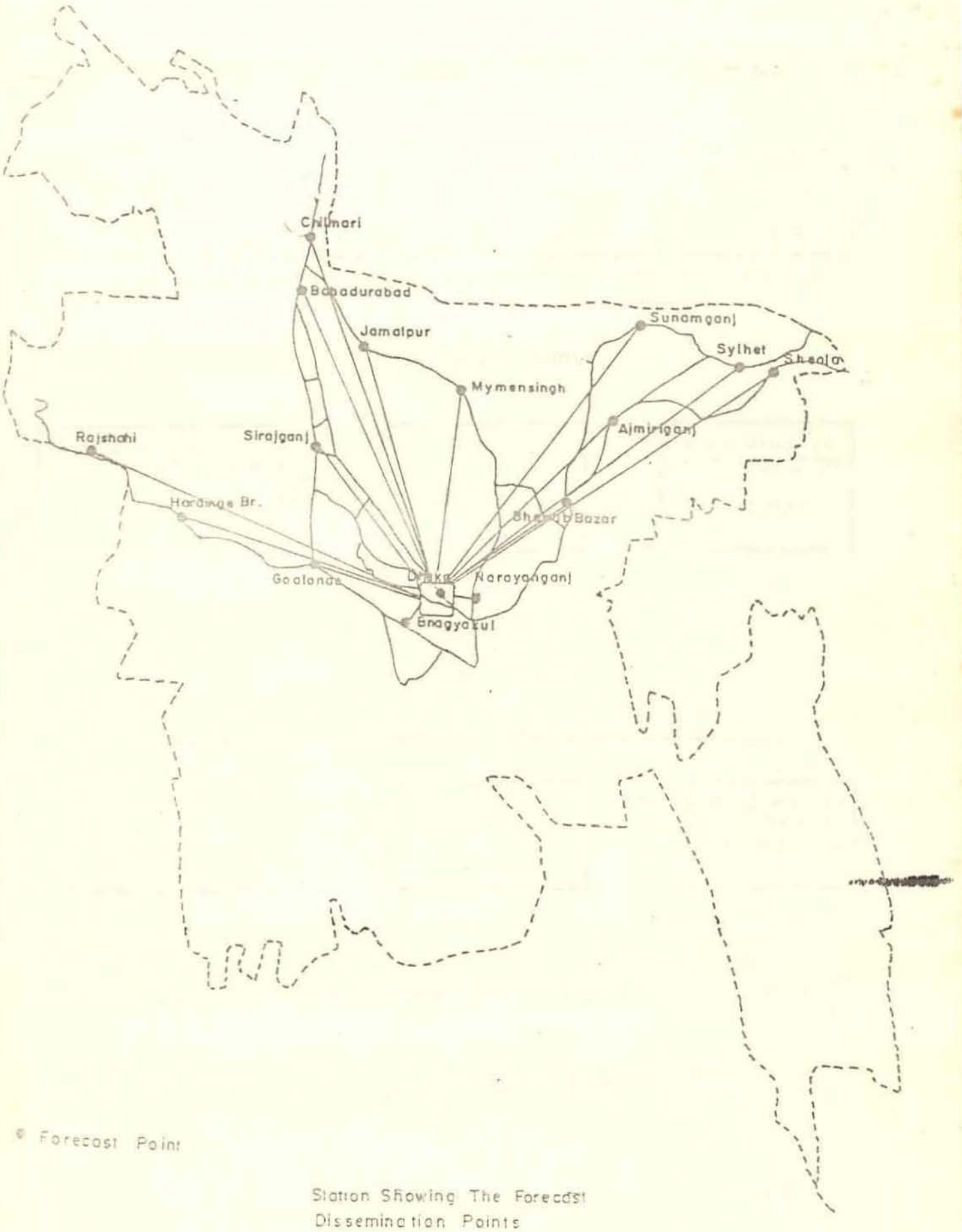
General model



Signatures

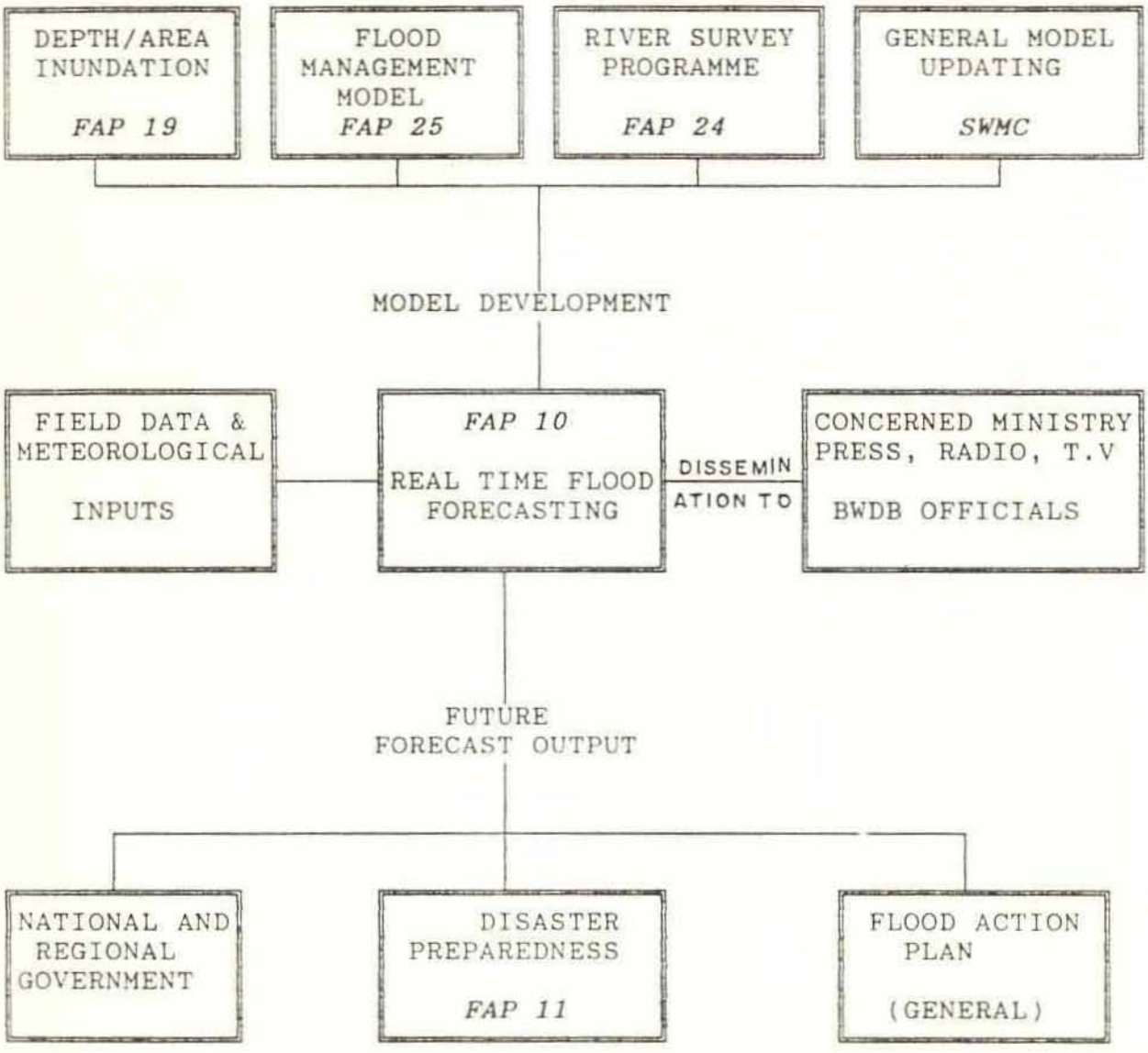
- Model boundary
- Forecast point

FIG-5



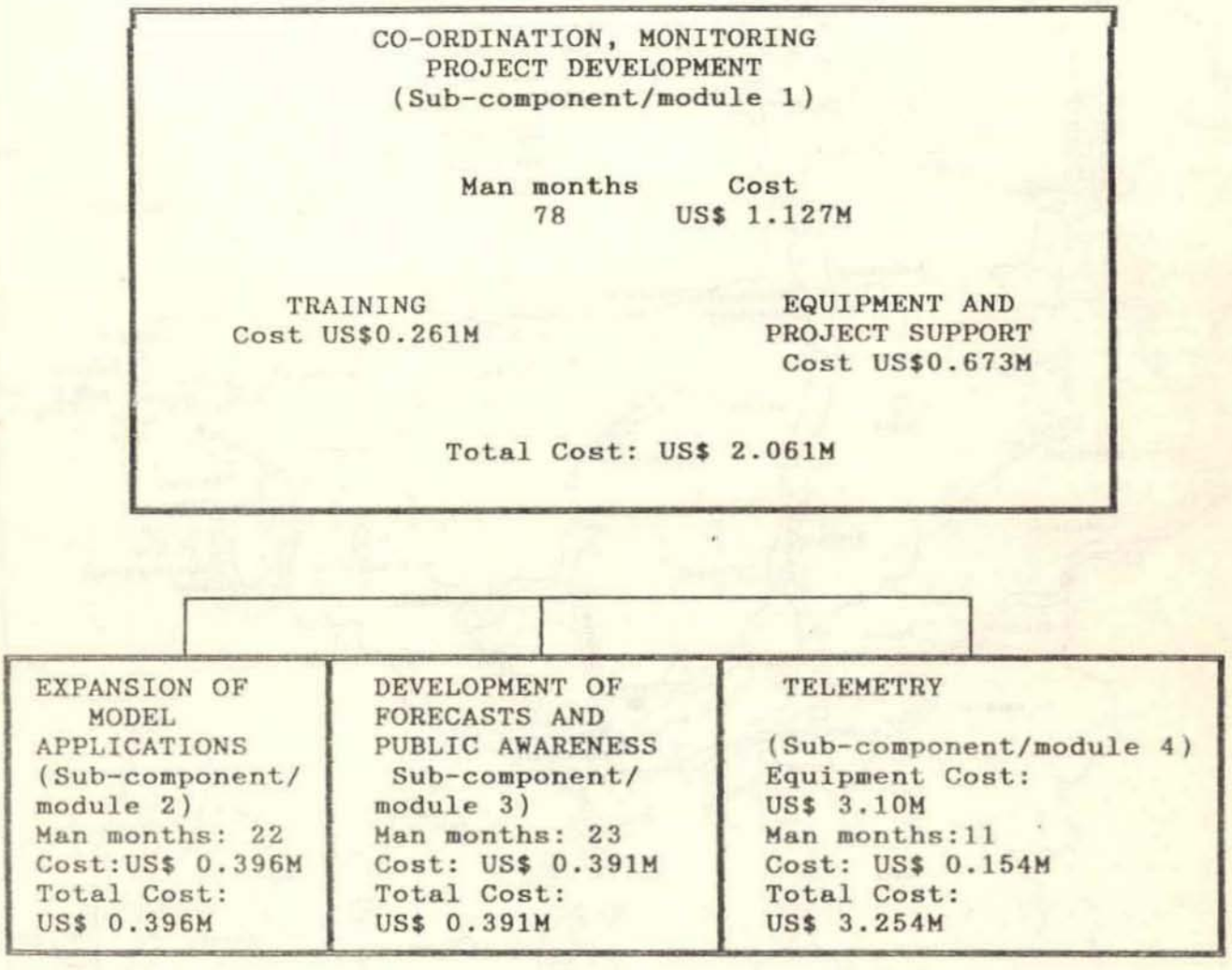
Station Showing The Forecast
Dissemination Points

FIG - 6



Main Activities of FAP 10 and Interrelationship with other FAP Components.

FIG – 7



Project Component

FIG-8

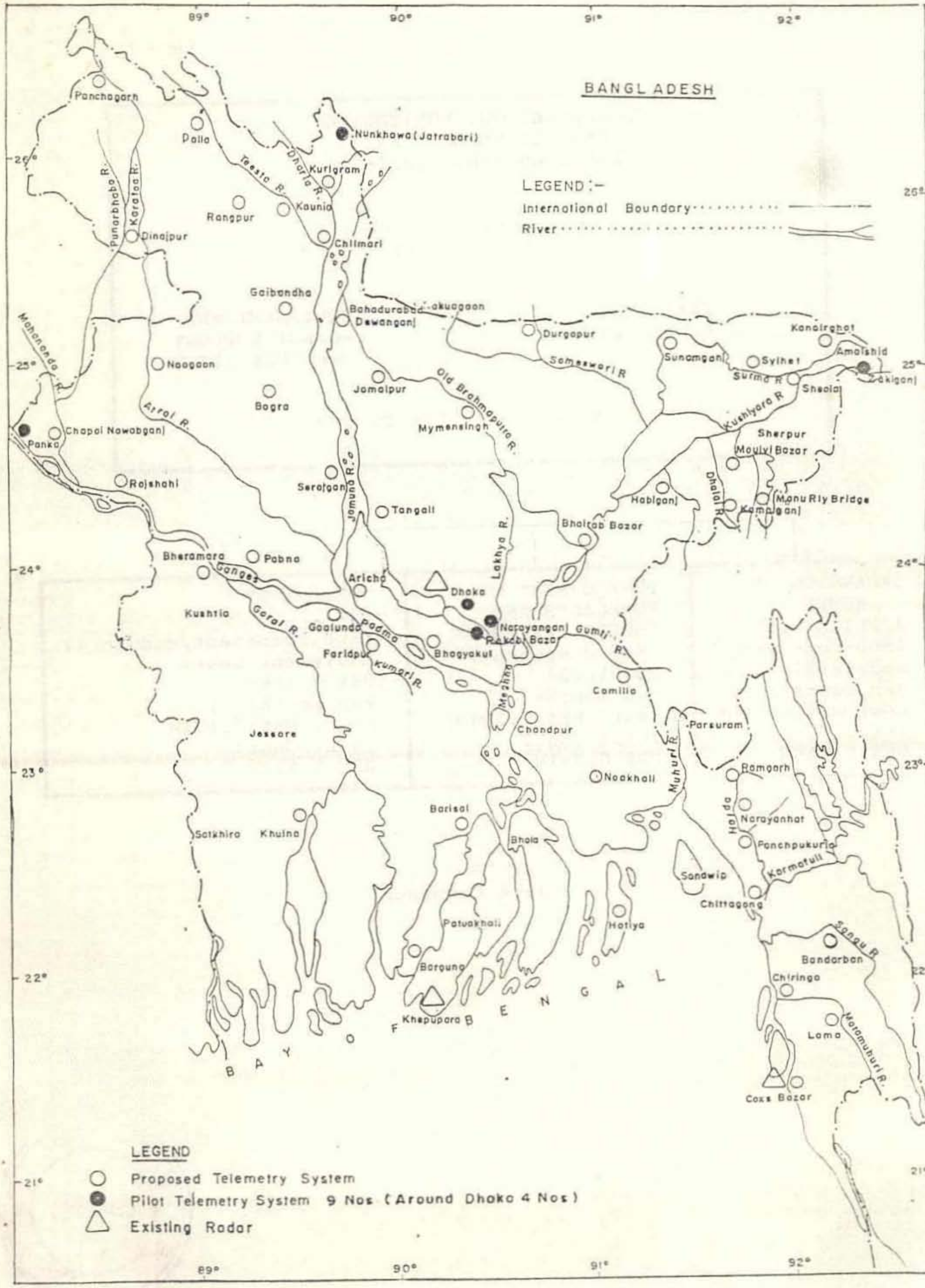

BANGLADESH
LEGEND :-
International Boundary
River
89°
90°
91°
92°
26°
25°
24°
23°
22°
21°
Panchagarh
Dalia
Nunkhowa (Jatrabari)
Teesta R.
Dharla R.
Kurigram
Punarbhaba R.
Karatoa R.
Rangpur
Kaunia
Dinajpur
Chilmari
Gaibandha
Bahadurabad
Dewanganj
Lakuagaon
Durgapur
Kanairghat
Amalshid
Zakiganj
Sunamganj
Sylhet
Surma R
Sheola
Somesswari R
Mahananda R.
Naogaon
Bogra
Jamalpur
Old Brahmaputra R.
Mymensingh
Kushiyara R
Sherpur
Moulvi Bazar
Atrai R.
Chapai Nawabganj
Panka
Rajshahi
Serajganj
Jamuna R.
Tangail
Habiganj
Dhalai R.
Manu Rly Bridge
Kamalganj
Lakhya R.
Bhairab Bazar
Bheramara
Pabna
Ganges
Aricha
Dhaka
Kushtia
Gorai R.
Goalundo
Padma
Narayanganj
Rekabi Bazar
Gumti R.
Faridpur
Bhagyakul
Kumar R.
Meghna
Comilla
Chandpur
Jessore
Parsuram
Muhuri R.
Ramgarh
Noakhali
Halda R
Narayanhat
Barisal
Satkhira
Khulna
Bhola
Panchpukuria
Sandwip
Karnafuli
Chittagong
Patuakhali
Hatiya
Sangu R
Bandarban
Barguna
Chiringa
Khepupara
BAY OF BENGAL
Lama
Matamuhuri R.
Coxs Bazar
LEGEND
Proposed Telemetry System
Pilot Telemetry System 9 Nos (Around Dhaka 4 Nos)
Existing Radar

FIG. 9

WORK PLAN

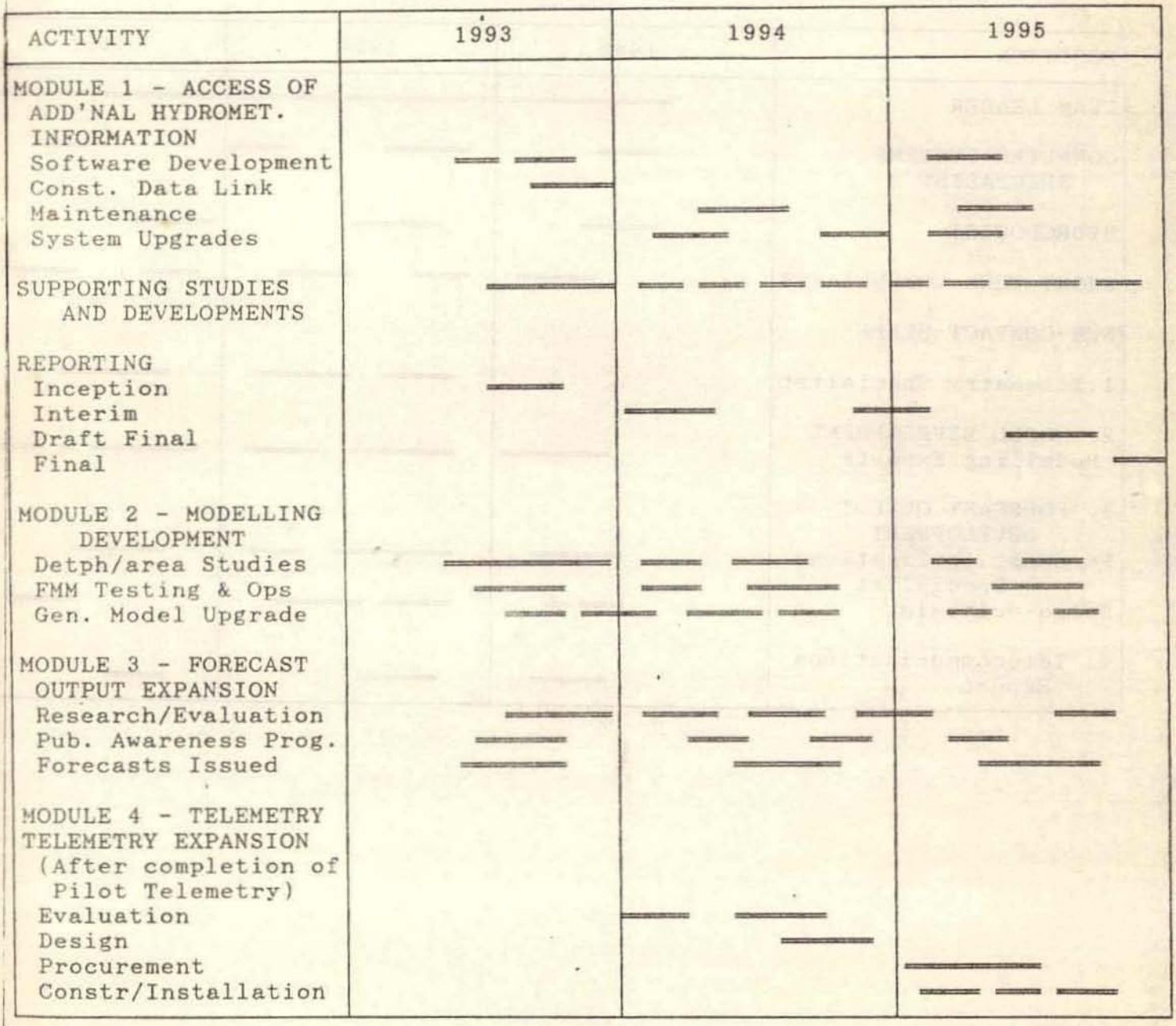


FIG. 10

STAFFING PROGRAMME

POSITION	1993	1994	1995
TEAM LEADER	═══	═══	═══
COMPUTER SYSTEMS SPECIALIST	═══	═══ ═══	═══
HYDROLOGIST	═══	═══	═══
SHORT TERM CONSULTANTS	═══	═══ ═══	═══ ═══
SUB-CONTACT STAFF			
1.Telemetry Specialist		═══ ═══	═══
2. MODEL DEVELOPMENT Modelling Experts	═══	═══ ═══	═══ ═══
3. FORECAST OUTPUT DEVELOPMENT			
Forecast Applications Specialist	═══	═══ ═══	═══
Socio-economist	═══	═══ ═══	═══
4. Telecommunications Expert	═══	═══	═══

ANNEX 1

DISSEMINATION LIST

1. President's Secretariat (Bangabhaban)
2. Prime Minister's Secretariat (Computer Cell)
3. Hon'ble Minister, Ministry of Irrigation, Water Development & Flood Control.
4. Hon'ble Minister, Ministry of Relief & Rehabilitation
5. Hon'ble State Minister, Ministry of Irrigation, Water Development & Flood Control
6. Secretary, Ministry of Irrigation, Water Development & Flood Control
7. Secretary, Ministry of Agriculture
8. Secretary, Ministry of Relief & Rehabilitation
9. Secretary, Information & Broadcasting
10. Director General, Relief & Rehabilitation
11. Control Room, Relief & Rehabilitation
12. The News Editor, BSS, Dhaka
13. The News Editor, BTV, Rampura
14. The News Editor, Radio Bangladesh, Agargaon
15. Public Information Department (PID)
16. Flood Information Cell, Greater Dhaka City.
17. D G Bangladesh Red Crescent Society, Moghbazar, Dhaka.
18. Chairman, SPARRSO, Agargaon, Dhaka.
19. Director, Bangladesh Meteorological Department (BMD) Agargaon, Dhaka.
20. Chairman, BARC, Farmgate
21. D. C., Dhaka
22. Chairman, Bangladesh Water Development Board.
23. Member, Planning, BWDB
24. Member, Implementation, BWDB
25. Member, O & M, BWDB
26. Member, Administration, BWDB
27. Member, Finance, BWDB
28. Chief Engineer, Planning, BWDB
29. Chief Engineer, Hydrology, BWDB
30. Chief Engineer Monitoring, BWDB.
31. Chief Engineer, Food for Works, BWDB
32. Chief Engineer, North Eastern Zone
33. Chief Engineer, South Western Zone, Faridpur
34. Member/Chief Engineer, Joint River Commission
35. Director, Public Relation
36. Superintending Engineer, Dhaka Circle
37. Director, Planning Scheme-1,

38. Director, Surface Water Hydrology-1
39. Director, Surface Water Hydrology-2
40. Director, Ground Water Circle-1
41. Director, Ground Water Circle-2
42. Director, Joint River Commission
43. CSO to Chairman
44. Executive Engineer, NEM Division, Dhaka.
45. Executive Engineer, SEM Division, Comilla
46. Executive Engineer, SWM Division, Faridpur
47. Executive Engineer, NM Division, Pabna
48. Executive Engineer, C&I Division, Dhaka
49. SDE, Hydrological Sub-Division, Chittagong
50. SDE, Hydrological Sub-Division, Comilla
51. SDE, Hydrological Sub-Division, Brahmanbaria
52. SDE, Hydrological Sub-Division, Mymensingh
53. SDE, Hydrological Sub-Division, Sylhet
54. SDE, Hydrological Sub-division, Rajshahi
55. SDE, Hydrological Sub-Division, Pabna
56. SDE, Hydrological Sub-Division, Dinajpur
57. SDE, Hydrological Sub-Division, Faridpur
58. SDE, Hydrological Sub-Division, Khulna
59. SDE, Hydrological Sub-Division, Jessore
60. SDE, Hydrological Sub-Division, Barisal

ANNEX 2

RADAR OBSERVATION OF RAINFALL

The use of radar for measuring rainfall has been developing steadily over the past 25 years. From experimental and research applications, radar now forms an integral part of flood monitoring and warning networks in many countries.

The radar cannot operate in isolation. It requires sophisticated computer hardware and software support, both for operation and for analysis of the information into a useable form for flood forecasting. Following are the radar facilities in the existing system :

1. The existing radar instrument at BMD, Agargaon, will be retained, along with its operator console. The echo analysis hardware and software will be replaced by a new PC version. Computer facilities will also be provided for integrated processing of information from other rainfall stations.

2. Processed information, i.e. visual display of rainfall distribution and intensity, quantitative catchment rainfall depths, etc. will be transmitted by an appropriate system to FF&WC. Direct integration with the database as necessary.

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ANNEX 3

TRAINING PROGRAMME

The training programme will be developed as the project progresses and must retain a certain amount of flexibility. It is envisaged that the training will cover the topics listed below, with the likely duration of training indicated. The countries indicated are those known to have appropriate facilities or courses available, and further details would be obtained by the project when established.

- Maintenance of telemetry equipment and systems, 6 man/months.
- Computer System Management, 4 man/months.
- Advanced hydraulic/hydrological modelling, 6 man/months.
- Hydrodynamic/Hydraulic modelling, 8 man/months.
- Hydrological forecasting, 5 man/months.
- Meteorological/remote sensing applications, 4 man/months.
- Impact assessment/disaster preparedness, 4 man/months.
- Meteorological/Hydrological applications of radar, 4 man/months.
- Study Tours, 6 man/months.
- In-service training.

ANNEX 4

JOB DESCRIPTIONS

Team Leader/Project Manager

The requirement is for someone experienced in project management in developing countries in the water or environmental sector. He/she should have a higher degree and/or professional qualifications and background in hydrology, water resources or meteorology. The main duties are:

- co-ordinate all project activities and be responsible for the financial administration;
- implement the work plan of the project, including studies, training and procurement;
- in conjunction with each specialist and consultant, define the detail of their work programmes;
- identify the project needs for short term consultants and assist in their selection;
- prepare all project reports for the implementing agency;
- liaise with and directly advise the counterpart agency to give technical and operational support to the expansion of flood forecasting activities;
- assist and advise on the day to day operations of FF&WC.
- liaise between government departments for the progress of the project and with other projects, particularly those under FAP;

Computer Systems Specialist

This position requires a suitably qualified computer systems manager, with post-graduate or professional qualifications, having experience in a UNIX environment. A working background with a water resources based operation in a developing country would be an advantage. The main tasks are:

- ensure the operational compatibility between the FF&WC LAN and all new developments, especially telemetry and radar;
- advise and assist with system developments in support of day to day forecast operations and database manipulations;

- advise and assist with the development of the LAN and prepare specifications for all hardware and software upgrades;

- supervise the incorporation of monitoring and data processing developments within the UNIX system, in particular the weather satellite and GIS facilities;

- evaluate the requirements for staff development and training in systems management and arrange overseas and local training programmes.

Hydrologist

This specialist should preferably hold a post-graduate qualification in hydrology or water resources, with at least eight years of working experience. This should include involvement with flood studies and some working experience in monsoon Asia. Some practical field experience would be an advantage. The main tasks to be undertaken will be:

- to develop the capabilities for carrying out specific and detailed hydrological studies within FF&WC;

- ensure that the database is capable of supporting studies, and if necessary, build up this up from the national database at Surface Water Hydrology-2;

- liaise closely with other programmes of the study to ensure full availability of data;

- supervise hydrological work undertaken by BWDB and/or local consultants engaged on the project;

- train staff of FF&WC in flood studies.

Telemetry Specialist

The requirement is for an experienced and suitably qualified specialist in telemetry instrumentation and operations in the water sector. He/she should have a tertiary educational qualification (degree or higher diploma) and professional registration in electronics. At least 10 years' experience of design and management with a major hydrometric telemetry network, including forecasting and warning applications is required. Experience in developing countries is essential. The main tasks are:

- to ensure the operational compatibility of the Pilot Telemetry System with the modelling, database and forecast functions of FF&WC;

- evaluate the performance of the pilot telemetry with the aim of defining further developments in telemetry for FF&WC;

- plan any telemetry expansion, and supervise the procurement, construction, installation and testing of new stations;

- advise the Team Leader and liaise with other projects on telemetry applications;

- assist and advise FF&WC staff on the maintenance and repair of telemetry installations and equipment.

Forecast Applications Specialist

This specialist is expected to have a degree and professional qualification/registration in hydrological or meteorological related subjects. However, experience and background are probably of more importance. He/she should have extensive experience of work with a major river forecasting undertaking and have been particularly involved with public awareness/emergency planning activities. Some experience of work in developing countries would be an advantage. The main duties are:

- review and develop the forecast outputs of FF&WC, to incorporate both improved forecast techniques and user requirements;

- liaise with forecast users within BWDB to improve operational response;

- liaise with other government departments, NGO's and the private sector to ascertain their forecast requirements;

- assist the Ministry of Relief and Rehabilitation through the activities of FAP 11 in developing dissemination requirements for warning and emergency situations;

- participate in pilot studies on areal flood forecasting to relate results to suitable output formats;

- train and advise FF&WC staff in the production of forecast outputs, bulletins and reports, particularly for media information;

- advise on and assist in development of publicity material, particularly visual, for public awareness programmes.

APPENDIX A

Summary of Achievement of Outputs

Immediate Objective 1 - First Phase

Output 1.1 Radar Calibrated and operational for quantitative precipitation forecasts.	Achievement incomplete : equipment functional but only qualitative assessment possible.
Output 1.2 Strengthening of wireless network.	Achieved.
Output 1.3 Automatic data transfer and facsimile system between FF&WC, BMD and SPARRSO.	Partially achieved : facsimile installed, other data transfer by teleprinter via message switching system at BMD.
Output 1.4 Upgrading of FF&WC to Directorate.	Not achieved.
Output 1.5 Partly upgraded computer system.	Achieved.
Output 1.6 Improved accuracy & lead time of forecasts and forecast of flash floods.	1st part achieved, 2nd part - Pilot study complete.
Output 1.7 Support, if required, for forecast exchange with co-riparian countries.	Not required.
Output 1.8 Reconnaissance survey for nationwide telemetry system.	Achieved

Immediate Objective 2 - First Phase

Output 2.1 Preparation of Project Document for main project.	Achieved during second phase.
Output 2.2 GOB inputs identified, work plan and equipment list prepared.	Achieved.

Immediate Objective 1 - Second Phase

Output 1.1 Pilot Telemetry Scheme established	Not achieved : design completed. The work being executed by BWDB directly.
Output 1.2 Wireless network upgraded and mobile workshop provided.	Achieved.
Output 1.3 Improvement of hydrometric network.	Achieved.
Output 1.4 Weather satellite system installed.	Achieved.

Immediate Objective 2 - Second Phase

Output 2.1 Increased forecast accuracy on main rivers.	Achieved.

Immediate Objective 3 - Second Phase

Output 3.1 Computer local area network established.	Achieved.
Output 3.2 New database system installed and operational.	Achieved.
Output 3.3 Proposal for improved organisational framework for FF&WC.	Achieved. (Submitted to BWDB)
Output 3.4 Support for nationwide data acquisition and dissemination system.	Achieved

Immediate Objective 4 - Second Phase

Output 4.1 Overseas training in hydrological modelling, hydrology, telemetry, etc.	Achieved.
Output 4.2 On the job training in modelling, data processing, telemetry, etc.	Achieved

Statement showing the name of the proposed Telemetry and Radar stations (Ref. Fig. 8)

TELEMETRY SYSTEM (PROPOSED)

Sl.No	Station	Sl.No	Station
1.	Panchagarh	21.	Bhagyakul
2.	Dalia	22.	Khulna
3.	Kurigram	23.	Barisal
4.	Kaunia	24.	Barguna
5.	Rangpur	25	Chandpur
6.	Chilmari	26.	Noakhali
7.	Gaibandha	27.	Hatiya
8.	Dewanganj	28.	Lama
9.	Jamalpur	29.	Bandarban
10.	Mymensingh	30.	Panchpukuria
11.	Bogra	31.	Narayanhat
12.	Naogaon	32.	Ramgarh
13.	Chapai Nawabganj	33.	Comilla
14.	Rajshahi	34.	Bhairab Bazar
15.	Bheramara	35.	Sheola
16.	Serajganj	36.	Kanairghat
17.	Tangail	37.	Sylhet
18.	Aricha	38.	Sunamganj
19.	Goalondo	39.	Durgapur
20.	Gorai Rly Br	40.	Nakuagaon

PILOT TELEMETRY

Sl.No	Station
1.	Pankha
2.	Noonkhawa (Jatrabari)
3.	Jakiganj
4.	Narayanganj
5.	Rekabi Bazar
6.	Dhaka - 4 Nos.

RADAR (EXISTING)

Sl.No	Station
1.	Dhaka
2.	Cox's bazar
3.	Khepupara