CHAPTER 11 IMPLEMENTATION PROGRAM

11.1 General

The proposed project covers the entire area of Bangladesh and should be implemented as soon as possible. However, a flood forecasting and warning system cannot be used effectively simply by installing equipment. A number of studies and projects should be undertaken before and during the implementation of this project.

In consideration of the realistic implementation of the project in terms of the financial capability and manpower available in the BWDB, a **pilot project is proposed** prior to implementation of the overall scheme. However, some **priority studies should also be done** in parallel with the pilot project.

11.2 Selection of Pilot Project

11.2.1 General

A pilot project should be implemented in an area where flood disasters occur more frequently and the emergency realization against flood disaster is stronger. For this reason, **NE Regional Operation System (Sylhet) is selected as a pilot project area.** A proposed telemeter system, to be controlled from the central office, will be installed for the other regions.

11.2.2 *Features of Pilot Project*

Project features are presented below with the data transmission network and data transmission flow shown in **Figures 11.2.1** and **11.2.2**, respectively.

(1) Observation System (for all regions)

Manual Observation System

No change is proposed.

Telemeter System

Water level observation: supersonic (sonar) type sensor/sensing pole (float) type sensor

Rainfall observation: tipping bucket type

(2) Data Transmission System

Manual Observation System

Digital transmission system: mobile communication system (HF data transmission system)

Automatic recording system in computer in control station:

Sylhet Region: automatic recording to regional control station

Other regions: automatic recording to central control station directly

Telemeter System (for all regions)

From gauging stations to regional control station: BWDB VHF Link

From regional station to central control station: BWDB HF Link

(3) Analysis System

All the data from both manual observation and telemeter stations are to be used.

Regional Control System: Sylhet only

Forecasting with regional model

Monitoring with observed data from telemeter system

Central Control System

Forecasting with nationwide model (Supermodel)

(4) Warning Dissemination System

Warning Message Dissemination (Forecast): Sylhet only

From regional control station to O&M office, DC office, Upazilla office: e-mail, fax, telephone with T&T public line

Point-to-Point Direct Data Dissemination (Telemeter only)

From telemeter gauging station to O&M office, Upazilla office: VHF Link

Warning Dissemination at Local Level

From Upazilla/Union to Inhabitant/Shelter: Fax, telephone, bike, speaker and visit

11.3 Priority Study on the Project Component

11.3.1 Criteria for Priority Study

The main problems of the existing FFWS are:

a) Flood forecasting and warning message is not utilized effectively.
b) Operation and Maintenance system is not sufficient.

The main reasons for those problems are:

a) The responsibility of river management is not clarified.
b) Dissemination and response system is not sufficient.
c) BWDB organization is not effective for river management.
d) The basic information for river management is not collected in a usable form such as a database.

To overcome these problems strong willingness to seek solutions is essential. In addition, an implementation plan incorporating a reorganization plan and coordination

with other donors and sectors will be necessary.

11.3.2 Project Components

(1) Formulation of O&M Plan

An Operation and Maintenance Plan (O&M Plan) for the Improved FFWS should be formulated by BWDB itself. This should be applicable for the actual Operation and Maintenance Work immediately after implementation of the improved FFWS.

(2) Clarification of River Management

A national water code is urgently required to coordinate water sector development planning. The responsibility of river management should be clarified in the code.

(3) Strengthening of Dissemination and Evacuation (Response)

A Comprehensive Disaster Management Program (CDMP) is currently being prepared with UNDP assistance. The components of the project are a) Capacity Building, b) Partnership Development, c) Community Empowerment, d) Research Information Management, and e) Response Management. It is strongly recommended to UNDP and DMB to take up part of the warning dissemination of the FFWS in their CDMP.

(4) Institutional Study

For conducting effective river management utilizing the proposed FFWS, the existing organization of the BWDB should be improved. However, changing an organization's structure is very difficult and sensitive. A step-wise institutional study should be planned. The "*Terms of Reference*" *for this study has been prepared and is attached in* the **Supporting Report**.

i) Regional Organization Plan for Pilot Project

It is proposed that one regional office should be established as a pilot project to demonstrate the efficiency of the regional system. Therefore, before commencing the pilot project, a regional organization plan for the pilot project area should be prepared and initiated. This will also assist the institutional study.

ii) Operating and Monitoring of Pilot Project

After implementation of the Pilot project, monitoring should be undertaken related particularly to operation and maintenance and coordination with other agencies concerned. The institutional study should consider the output from this monitoring for more possible and effective reorganization.

iii) Institutional Study

After considering the institutional study mentioned above and monitoring, a study for regionalization should be done. Within its framework, a study of re-organization of central hydrology will be undertaken for effective operation of

the regional system. Until the end of the institutional study, all other regions may be operated under the centralized system.

(5) Collecting Information on River Management and Identification of Danger Level

i) Collecting Information on River Structures

Information on river structure, such as location, construction year and characteristics, should be collected and ledger sheets for each structure prepared.

ii) Preparation of Operation Manual

An operation and maintenance manual for river management including river structures should be prepared.

iii) Preparation of DEM (Digital Elevation Model)

An updated DEM should be prepared for deriving inundation maps.

iv) Preparation of Flood Hazard Map

On the basis of information such as river structures, O&M manual and DEM, a hazard map should be prepared. This will be utilized for river management including improvement of FFWS and shown to habitants for evacuation.

v) Review/Identification of Danger Level

On the basis of the hazard map and considering livelihoods of local inhabitants and river structures, proper forecasting points should be selected and danger levels for these locations reviewed.

vi) Survey of River Cross-section

The updating of river cross-sections for the regional model should be conducted based on the existing data survey by BWDB.

11.4 Financial Arrangement

Project costs for the pilot scheme were estimated in terms of investment cost and annual O&M cost. These are outlined in the following table and were based on the calculation procedures described in **Section 9.2.1**.

Investment Cost (Unit: Million Taka)

	Item	Foreign	Local	Total
A	Direct Cost for Installation	523.7	130.9	654.6
B	Administration	0.0	6.5	6.5
C	Engineering	91.6	6.5	98.2
D	Training	3.6	0.4	4.0
E	Contingency	33.2	3.1	36.3
F	Price Escalation	2.6	11.5	14.1
	Total	**654.7**	**158.9**	**813.7**

Annual O&M cost (Unit: Million Taka)

Items	Cost
A. Staff	20.6
B. Repair, maintenance	17.3
C. Other O&M	13.3
Subtotal	51.2
D. Depreciation	90.8
Total	**142.0**

11.5 Implementation Schedule

11.5.1 Overall Schedule

After completion of the Feasibility Study, it usually takes some time before implementation of a Project. The overall implementation schedule is given in **Table 11.5.1**. This Study is expected to be completed by December, 2003. It will take about a year for the financial arrangements for the Project. The pilot project is expected to commence in early 2005 and operate from early 2007. During and after the installation, engineering support will be essential.

11.5.2 Components of the Pilot Project

(1) Designing and Preparation of Tender Document

The Project will start with detailed design followed by pre-construction activities, which include tender document preparation and bidding assistance. It will take one year for completion of detailed design.

(2) Implementation and Supervision

After design and preparation of tender documents, it is expected to take one year for procurement and construction. During implementation, supervision by the Consultant will be undertaken.

(3) Operation and Monitoring

After implementation of the system, operation will start. For smooth and effective operation of the pilot project, engineering technical support should be provided for two years.

11.5.3 Components of the Priority Study

(1) Formulation of O&M Plan

Formulation of the O&M plan should be completed by the end of 2003.

The O&M plan was submitted by GOB on December 15, 2003, and it is attached as **Attachment-4** in the **Supporting Report**. The comments and observations of the Study Team on this O&M plan are discussed in **Section 12.3** and also in **Attachment-5** in the **Supporting Report**.

(2) Clarification of River Management

A national water code is now under preparation and must be completed by the end of 2004.

(3) Strengthening of Dissemination and Evacuation

Inclusion of the FFWS in NWMP and CDMP should start immediately after completion of the Feasibility Study.

(4) Institutional Study

For the institutional issues, a number of work items should be implemented in parallel with the FFWS Project. In particular, the institutional study should be started immediately after completion of this Feasibility Study.

A regional organization plan for the pilot project should be completed prior to the completion of its implementation. Setting up of the pilot regional office at Sylhet should start in parallel with the detailed design for the overall FFWS Project so the two can contribute to the regional office setup. It is expected that the regional office should be established at least 6 months prior to completion of the FFWS improvement project (that is by mid-2006). Details are presented in **Table 11.5.1**.

Monitoring of the pilot project should be started immediately after its implementation. The institutional study should take into account the results of the monitoring of the pilot project.

(5) Collecting the Information for River Management

Preparation of an operational manual, ledger book and facilities database should start after completion of the current Feasibility Study. Preparation of an updated DEM is also expected to be completed before the end of the detailed design for improvement of the FFWS. After collecting the necessary information, hazard map preparation and identification of forecasting points and associated danger levels will also be commenced.

11.5.4 Implementing Agencies

(1) Implementing Agencies for each Component

The implementing agency for the pilot project will be the Planning (ADG) of BWDB. However, for the implementation of the priority studies, coordination with other sectors and some donors are necessary. The assumed implementing agencies of the priority studies are outlined in the following table.

Implementing Agencies by Component for the Priority Studies

Priority Study	Implementing Agency	
	Bangladesh side	Foreign side
a. Formulation of O&M Plan	BWDB	
b. Clarification of River Management	Ministry of Water Resources (MOWR)	
c. Strengthening of Dissemination and Response System	MOWR and the Ministry of Disaster Management and Relief (MDMR)	UNDP
d. Institutional Study	BWDB	Foreign donor agency
e. Collection of information on river management and review of danger level		
- Collection of information on river structures - Preparation of operation manual - review/identification of danger level	BWDB	Foreign donor agency
- Preparation of digital elevation model (DEM) - Preparation of flood hazard map	BWDB, Survey of Bangladesh, and LGED	Foreign donor agency
- Survey of river cross-sections	BWDB	

(2) Arrangement of Implementing Agencies

For implementation of the pilot project, hydrology division should provide the necessary coordination. For better coordination, a **"Task force system"** in the BWDB is proposed. Hydrology division and O&M division staff will work together under a task force formed by staff of both divisions.

CHAPTER 12 CONCLUSION AND RECOMMENDATIONS

12.1 Conclusion

12.1.1 Proposed System

Through in-depth study of the present FFWS and its associated problems, the proposed project was formulated taking into consideration possible solutions for the problems as summarized below.

Present Flood Forecasting and Warning System, Problems Encountered and Possible Solutions:

(1) Observation System

a) Manual observation currently adopted has resulted in the acquisition of erroneous data sometimes contributing to low accuracy of flood forecasting.
b) Important gauging sites (boundary condition sites only) are to be replaced by a telemeter system to eliminate human error in recording and data transfer.

(2) Data Transmission System

a) Data transmission from manual observation sites to the FFWC is currently undertaken using SSB HF radio transmission via voice communication. This can be very inconvenient for operation, sometimes resulting in erroneous data transmission.
b) The SSB HF radio transmission system is to be changed to a digital HF transmission system to create an automatic data input system to eliminate manual operation errors.

(3) Analysis System

Flood Analysis:

a) The analysis system has been considerably enhanced through the application of the MIKE 11-based hydraulic approach. However, estimation of boundary conditions for forecasting can be significantly in error, particularly in flash flood areas.
b) Hydrometeorological data from India is needed. For many years, the GOB has tried to obtain such data from India but with only limited success. There are many difficulties yet to be solved and the GOB should try further to acquire additional information from India. Apart from this, the GOB should also utilize data from weather radars operated by BMD.

Warning Message:

a) Warning messages have been based on the real time observation data and results of flood analysis. The problems involved in the warning messages include: i) not well understood by the people, ii) improper danger levels, iii) inaccurate inundation hazard map due to outdated topographic information, iv) inaccurate forecasts, v)

insufficient lead time, and vi) insufficient warning to the river-related structures including those managed by BWDB.

b) For these problems, individual item by item reviews should be undertaken before and during implementation of the proposed project. For this purpose, technical and engineering assistance will be required.

(4) Warning Dissemination System

a) BWDB is mandated to disseminate flood warning messages down to district level. DMB and Local Government are obligated to disseminate flood warning at the local level. However, flood warning messages have not always reached the end beneficiaries, those are the local people, who wish and need to receive them. Furthermore, and most importantly, Divisional Offices of BWDB have not always received flood forecasts although it is essential for emergency operation and maintenance of river structures.

b) Good coordination between Hydrology and O&M Services of BWDB should be secured through a re-organization of BWDB's set-up. A possible solution is to establish regional offices of BWDB or regional offices of Hydrology Services. The former is the best solution although it will take much time to realize. The latter could be adopted as an intermediate measure.

(5) Response System

a) The response system should provide i) confirmation of receipt of warning message and ii) actions to be taken based on the warning message. However, it is not always sure if the messages are received by the end users. As a result, it is not sure if the end user takes necessary actions for evacuation and emergency operation of the river structures.

b) The response system should be implemented by DMB given its mandate. However, the evacuation system has not been fully established and there is an insufficient number of evacuation centers. The Comprehensive Disaster Management Program (CDMP) being undertaken by UNDP should be enhanced with support of BWDB as a member of the existing Disaster Management Committee.

(6) Institutions

a) Operation and maintenance of FFWS is controlled by FFWC in Dhaka. It is unsatisfactory from many aspects including lack of gauge readers, insufficient maintenance of FFWS, no response system established, insufficient budget and manpower. Ultimately this has resulted in sometimes poor data acquisition. More importantly, the FFWS network does not always cover the objective areas suffering flood damage leading to a lack of sureness, accuracy, timeliness and official-ness related to the flood warnings.

b) A Regional Disaster Management system should be established so that the FFWS is utilized more effectively to meet the actual requirement of the end users.

Proposed System:

In view of the current system and its problems being encountered as mentioned above, the following scheme is proposed. It consists of a **Regional Operation System + Manual & Telemeter Combined Observation System** as summarized below.

(1) Regional Operation System

Five regional operation systems and one supervising control station are to be established.

Five Regional Operation Systems

- North-East (NE) Region: Control Station in Sylhet
- North-West (NW) Region: Control Station in Rangpur
- South-East (SE) Region: Control Station in Chittagong
- South-West (SW) Region: Control Station in Barisal
- North-Central (NC) Region: Control Station in Dhaka

One Supervising Control Station

- Supervising Control Station in FFWC, Dhaka

(2) Manual & Telemeter Combined Observation System

Currently 91 water level gauging stations within Bangladesh are incorporated in the analysis of the FFWS. This number is considered appropriate for flood forecasting purposes. However, the hydrological data for selected stations in India should be added for improving the flood forecast analysis.

As mentioned before, the manual observation currently adopted has sometimes resulted in the transfer of erroneous data. Therefore, some gauging stations are proposed to be changed to an automatic telemeter system.

The number of proposed telemeter stations (water level gauges) is limited to the important stations providing boundary conditions for flood analysis. Other gauging stations remain as manual observation stations. The proposed gauging stations are summarised below.

Proposed Gauging Stations

Region	NE	NW	SE	SW	NC	Supervising C.S. / Total
Location	Sylhet	Rangpur	Chitta-gong	Barisal	Dhaka	Dhaka, FHC
W. Level	***18***	***22***	***9***	***17***	***25***	***91***
Manual	11	17	7	12	21	68
Telemeter	7	5	2	5	4	23
Rainfall	***14***	***15***	***11***	***15***	***13***	***68***
Manual	7	10	9	10	9	45
Telemeter	7	5	2	5	4	23
Total	***33***	***37***	***20***	***32***	***38***	***159***

(3) Feasibility Design

The feasibility design has been developed taking the following into consideration.

a) Location of Gauging Stations

River course shifting with heavy erosion and sedimentation are key issues to be considered in deciding the locations of the gauging stations. Gauge sites were selected based on a detailed field reconnaissance at feasibility level. The selected locations included those not significantly affected by river shifting or, as much as possible, where existing river structures (hard points) could be used to fix the gauges.

b) Gauge Type

For water level observations, sensing pole type and/or supersonic type gauges were adopted after considering existing site conditions.

c) Transmission System

An automatic data input system was applied with a digital HF transmission system.

d) Analysis System

The existing Supermodel will be used for nation-wide analysis covering the entire area of Bangladesh. For regional operation, regional models with some modification will be applied.

Additional data acquisition from India will be utilized as much as possible to improve flood forecast accuracy. Weather radar data of BWD will also be utilized in the analysis system.

Upgrading of the flood forecast message will be enhanced with more accurate and more readily understood information.

e) Dissemination System

Under current regulations, BWDB is mandated to disseminate the warning message down to district level. However, the BWDB will act as a member of NDMC to ensure the dissemination of the warning message to the end users. To respond to the requirements of the local people particularly in flash flood areas, a point-to-point dissemination system will be employed.

f) Response System

Coordination among the related agencies is proposed with BWDB staff to be members of NDMC.

12.1.2 Institutional Set-up for Operation of the Proposed System

For effective operation and maintenance of the proposed system, a new organizational set-up is proposed as follows.

(1) Reorganization of Central Hydrology

For more effective operation and maintenance of FFWS and current hydrology services, the following reorganization is proposed.

a) Creation of a Flood Hydrology Circle (FHC), which comprises "Data Collection Division", "Data Transmission Division", and "Forecasting Division", in the Central Office of BWDB
b) Current PFFC (Processing and Flood Forecasting Circle) will be renamed Flood Hydrology Circle.
c) The other three circles will remain as at present.

(2) Regional Set-up

a) Regional offices of Hydrology will be created in five regions.
b) Each regional office of Hydrology will have four circles, namely, FHC, GWHC, SWHC, and RMRC.

(3) Regulation of New Set-up

a) A Central supervising FHC will be established based on the current FFWC. This office will have a mandate for flood forecasting at the national level. The forecast flood levels at the boundaries of the regional models will be informed to the Regional Offices of FHC for use in regional flood forecasting. The Central FHC will also give advice to the Regional FHCs.
b) Regional FHCs will provide flood forecasts based on the data transmitted from the Central FHC and actual weather conditions in each regional area. The Regional FHCs may disseminate these results locally based on it own judgments and in relation to local conditions.

(4) Other Institutional Issues

In addition to the above, the following are proposed in terms of institutional issues with regard to FFWS operation.

a) Appropriate budget allocation to the O&M of FFWS
b) Preparation of ledger sheet of rivers in Bangladesh
c) Preparation of ledger sheets of river structures
d) Promulgation of water/river code for Bangladesh

12.1.3 Project Cost Estimate

The project cost was estimated based on Investment Cost and Annual Operation and Maintenance Cost.

(1) Investment Cost

Project investment cost is estimated at 1,148 million Taka including equipment cost, construction cost of related civil works, government administrative cost, engineering cost for detailed engineering and procurement assistance, staff training cost, contingency and price escalation.

(2) Annual Operation and Maintenance Cost (O&M Cost)

Annual O&M Cost is estimated at 65.6 million Taka including staff personnel cost, repair and maintenance cost, and other miscellaneous operation and maintenance costs. Other than the annual operation and maintenance cost, annual depreciation cost of 136.8 million Taka should be considered for budgeting for replacement of equipment whenever necessary. In Bangladesh, depreciation cost is usually not included in the annual operation and maintenance cost for most infrastructure projects. It is suggested that annual depreciation cost be considered for all infrastructure projects.

12.1.4 Implementation Plan

(1) Total Project

Project implementation is assumed to take four years, the first year for detailed engineering, second year for procurement and installation, and third and fourth years for operation and monitoring of the system.

During and after completion of the construction works, technical support by Consultants will be essential.

(2) Pilot Project

The Bangladesh Government, however, has a different opinion on the project implementation in terms of the regional operation system as itemized below.

a) Project implementation is to be conducted on a pilot project basis.
b) The first pilot project is for the Sylhet area where more serious flood damage related to flash floods occurs.
c) The other areas for regional operation of the system will be implemented after due experience of the pilot project.
d) The first pilot project will include the FFWS covering the entire country (proposed nation-wide FFWS) as well as the regional operation system for Sylhet Region as follows:
   - A regional operation system will be established for the Sylhet Region consisting of a regional Hydrology in Sylhet.
   - All other regional operation systems will be implemented in the future.
   - At this stage of the development, all proposed observation systems will be constructed, but a regional office of Hydrology will only be established at Sylhet as a pilot project. All other regional FFWSs (except Sylhet) will

therefore be conducted in the Central Office of FHC.

e) In this alternative stage-wise development, the estimated investment cost is 813.7 million Taka. Necessary annual operation and maintenance cost is estimated at 51.2 million Taka.
f) The Pilot Project scheme may be adopted when it is confirmed that its Operation and Maintenance can be properly undertaken. A suitable O&M Plan should be prepared by BWDB.

12.1.5 Project Evaluation

(1) Economic Evaluation

Economic evaluation of the proposed project was conducted based on the evaluation of costs and benefits attributable to the proposed FFWS.

Benefit estimation was rather complicated as there are no standard criteria for its estimation for projects such as an FFWS. Therefore the benefits were estimated by means of an interview survey that is similar to a willingness-to-pay survey. The interview survey was conducted as a social survey for the people affected by flood damage and also for staff of BWDB. The data obtained included estimates of avoidable damage (as a percentage basis) both with and without an FFWS.

The result of the economic evaluation indicated the proposed project has an EIRR of approximately 26%.

(2) Other Evaluations

Given the type of project, it can be said that there is unlikely to be any negative social or environmental impact due to the FFWS. Rather it is likely that the project would contribute positively to social stability.

12.1.6 Recommendation

In conclusion, the project is highly evaluated from economic, social and environmental viewpoints and is technically feasible.

It is noticeable, however, that the project involves a rather sophisticated system and therefore sound operation and maintenance is essential to ensure the systems remain functional.

It is strongly suggested that BWDB consider the following to maximize the effective utilization of the system once implemented.

a) Secure the necessary O&M budget for operation and maintenance works
b) Establish appropriate organizations with well-experienced and capable management and staff for overall supervision of system operation.
c) Establish the following as part of comprehensive river management practice:
   - Promulgate water code or river code
   - Collate ledger sheets of river structures for their operation and maintenance

both generally and in response to flood warnings from the FFWS; such structures are important beneficiaries of the FFWS output

Overall, it is recommended that this proposed project be implemented at the earliest possible time provided the necessary and appropriate O&M work and budgets can be secured.

12.2 Recommendations

12.2.1 Implementation of the Project

(1) Pilot Project

The pilot project is proposed to be established in terms of the regional operation system as itemized below.

a) Project implementation is to be conducted on a pilot project basis.
b) The first pilot project is for the Sylhet area where serious flood damage occurs due to the occurrence of flash floods.
c) The other areas for regional operation systems will be implemented after due experience in the pilot project.
d) The first pilot project will include the FFWS covering the entire area of Bangladesh (nation-wide FFWS) as well as the regional operation system for Sylhet Region as follows:
   - A regional operation system will be established for the Sylhet Region consisting of a regional FFWC in Sylhet.
   - All other regional operation systems will be implemented in the future.
   - At this stage of the development, all proposed observation systems will be constructed, but a regional office of Hydrology will only be established at Sylhet as a pilot project. All other regional FFWSs (except Sylhet) will therefore be conducted in the Central Office of FHC.

(2) Priority Study for Pilot Project

Formulation of O&M Plan

An Operation & Maintenance Plan (O&M Plan) of Improved FFWS should be formulated by BWDB. This should be able to be implemented for the actual Operation and Maintenance Work immediately after implementation of Improvement of FFWS.

Clarification of River Management

A national water code is urgently required to coordinate water sector development planning. The responsibility of river management should be clarified in the code.

Strengthening of Dissemination and Evacuation (Response)

A Comprehensive Disaster Management Program (CDMP) is currently being prepared with UNDP assistance. The components of the project are a) Capacity Building, b) Partnership Development, c) Community Empowerment, d) Research Information

Management, and e) Response Management. It is strongly recommended to UNDP and DMB to take up part of the warning dissemination from the FFWS in their CDMP.

(3) Institutional Study

Regional Organization Plan for Pilot Project

Before implementation of the pilot project, a regional organization plan should be in operation and so should be developed.

Monitoring of Pilot Project

After pilot project implementation, a monitoring study should be undertaken considering operation and maintenance and coordination with agencies concerned. The institutional study should consider the output from this monitoring for further and more effective reorganization.

Institutional Study

In light of the organization plan and monitoring, a study for regionalization will be undertaken. This will included assessing the need for re-organization of central hydrology to promote more effective operation of the regional system.

(4) Collecting Information of River Management and Identification of Danger Level

Collecting the Information for River Structures

The information of river structures, such as location, construction year, and characteristics, should be collected and prepared in the form of ledger sheets.

Preparation of Operation Manual

Operation and maintenance manuals for river management including river structures should be prepared.

Preparation of DEM (Digital Elevation Model)

A DEM should be prepared using updated topographic information for development of hazard maps.

Preparing Flood Hazard Maps

On the basis of the above information on river structures, O&M manual and DEM, hazard (inundation) maps should be developed. These will be utilized for river management including improvement of FFWS and used by local people for evacuation.

Review/Identification of Danger Level

On the basis of inundation maps, people's livelihoods and river structures, proper locations for analysis points should be selected and danger levels defined.

Survey of River Cross-sections

The updating of river cross-sections is important for regional (as well as nation-wide) modeling.

(5) Arrangement of Implementation Agencies

For the implementation of the pilot project, coordination with O&M division will be essential. The main counterpart will be hydrology division of BWDB, but a task force system in the BWDB is necessary for efficient implementation. Hydrology and O&M divisional staff should work together under the same umbrella.

12.2.2 Improvement of Organization

(1) Reorganization of Central Hydrology

Even in the regional setup, reorganization of central Hydrology is required to avoid duplication of responsibility and to provide streamlining of the job functions and better coordination.

(2) Regional Setup

Considering all the above factors along with technical, hydrological, financial, and organizational issues, and maximum utilization of present facilities, it is proposed to create five regions of Hydrology. These are Northwest (NW), North Central (NC), Northeast (NE), Southwest (SW) and Southeast (SE).

Regional office location should consider availability of various logistical facilities and better river management. Based on these, the regional offices are proposed to be established at Dhaka, Chittagong, Barisal, Rangpur and Sylhet.

(3) Institutional Study

Institutional change is very sensitive and requires careful, in-depth planning. It was therefore beyond the scope of the present Study. Hence, it is proposed to undertake a separate institutional reform study for in-depth analysis of the above proposal.

As BWDB is fully aware of the severe constraints of the present system, there is already one proposal put forward by BWDB for institutional study. A draft TAPP was prepared in 2001 with the title "Institutional Strengthening of Hydrological Services in Bangladesh". However, that Study has not yet commenced (end of 2003).

In line with the proposal for a separate institutional reform study, "Terms of Reference" have been prepared and are attached in the **Supporting Report**.

(4) Pilot Project

It is proposed that at least one regional office should be established as a pilot project to demonstrate the efficiency of the regional system. This will also assist the institutional reform study. The Northeast (NE) region is proposed to be taken up for the pilot study

because of that area's vulnerability to flash flooding. Until the end of the institutional reform study, all other regions will be operated under the centralized system.

(5) Other Institutional Issues

Apart from the two institutional issues, that is the re-organization of Hydrology central office and establishment of Regional Hydrology Offices, a number of other steps should be taken in order to improve the functions of BWDB. These are summarized below.

a. There must be an operational manual for BWDB facilities. In addition, a ledger book must be maintained for each facility.
b. Vacancies in the key technical positions must be filled urgently.
c. A database must be prepared for all BWDB facilities.
d. Incentive mechanisms should be introduced for increasing motivation of BWDB staff.
e. Issues of FFWS must be included in the National Water Management Program.
f. Sub-sector studies should be undertaken to identify specific schemes in the light of NWMP.
g. A nationwide water balance study should be updated periodically.
h. In the up-coming UNDP-financed CDMP, FFWS should be clearly defined.
i. A national land use policy is to be prepared for coordinated development planning.
j. A national water code is urgently required to coordinate water sector development planning.
k. Detail flood damage must be assessed.

12.2.3 Operation and Maintenance Budget

The O&M Budget for the existing FFWS is inadequate. For this reason, the existing telemeter system is not operated and utilized effectively. Therefore, if the Bangladesh Government requires a sophisticated system such as the proposed telemeter system, an increase in the O&M budget will be essential.

The O&M budget is estimated in **Chapter 9**. A summary of O&M cost estimation for the existing system (actual and required) and with the FFWS project is shown below:

Operation and Maintenance Cost

(Million Tk.)

Items	Actual O&M Cost	Required O&M Cost for Existing System	Project O&M Cost
Staff	24.4	24.4	23.0
Repair, Maintenance	1.7	10.5	27.1
Other O&M	8.0	9.4	15.5
Subtotal	***34.1***	***44.3***	***65.6***
Depreciation	0.0	26.3	136.8
Total	**34.1**	**70.6**	**202.4**

(1) Staffing

O&M staff costs with the FFWS project are estimated to reduce by 1.4 million Taka from existing actual O&M costs, reflecting a reduction in staff numbers for the improved system.

(2) Repair and Maintenance

If repair and maintenance expenditure is insufficient, the system will face problems and may not be utilized fully.

If systems and equipment are installed, a sufficient budget must be allocated for repair and maintenance. As a general estimate, repair and maintenance cost equivalent to around 0.5% to 1.0% of equipment cost and 10% of computer cost are necessary.

Repair and maintenance cost for the existing FFWS is 1.7 million Taka but actually 10.5 million Taka is realistically required. For the proposed project this will increase to 27.1 million Taka.

(3) Other O&M

Communication cost including T&T and vehicles is the main cost of 'other O&M'. If this allocation is not sufficient, dissemination will also not be sufficient and the system will not be utilized effectively.

(4) Depreciation Cost

Systems and equipment will definitely have to be replaced in the future. Hence, a depreciation cost is necessary to cover this. In Bangladesh, depreciation cost is not considered for most projects, but if the FFWS is to continue indefinitely thought should be given to including depreciation as a legitimate project cost.

(5) Evaluation of O&M cost

For improved FFWS, a budget of around 65.6 million Taka will be necessary to cover O&M costs. Compared with the present budget of BWDB, this O&M cost is considerably higher and must be arranged.

12.3 Pre-arrangement for Project Implementation

The O&M plan for the proposed project was prepared by the BWDB, approved by the GOB, and submitted to the JICA Study Team on December 15, 2003. This O&M plan is included in the **Supporting Report** as **Attachment-4** as it is. The comments of the Study Team on the Plan are given also in the **Supporting Report** as **Attachment-5** in detail.

The plan covers necessary items for the proper operation and maintenance activities such as necessary manpower, budget, organization, and so on. However, the plan seems to be insufficient and still has rooms to be brushed up especially for the topics of;

- Existing Telemeter System,
- Regional Operation System (Institutional Aspect), and
- Cooperation with O&M Division of BWDB and Other Agencies.

In terms of the institutional/organizational issues, the Study Team fully understands that it is difficult for BWDB to make detached decision, because BWDB is the one which is subject to be changed. And this causes the gaps between the Study Team and BWDB to remain unsolved.

To make the efforts made by BWDB and GOB fruitful, an institutional study should be undertaken before or in conjunction with the implementation of the Project. The Terms of Reference (TOR) of the institutional study is drafted by the Study Team as given as **Attachment-1** of the **Supporting Report**. The proposals issued both by the GOB and the Study Team can be examined in detail and adjusted through this institutional study from much wider viewpoint. Although the Water Management Improvement Plan (WMIP) funded by the World Bank (WB) is undergoing, the study on the organizational reform of BWDB is not within the scope of this WMIP according to the WB.

The GOB may be highly appreciated if it thinks about this recommendation positively and makes official request to the WB or other foreign assistance agencies.

12.4 Necessary Arrangements for Effective FFWS Operation

12.4.1 Water Code or River Code in Bangladesh

A Water Code or River Code for Bangladesh is essential for river management. This should cover all sectors related to river and water, watershed management, water use including water resources development, flood control, water quality management and river environment management.

According to the WARPO, the Government of Bangladesh is now preparing the Water Code or River Code and a Draft has been completed. However, the Study Team was not provided with a copy as it is not yet authorized. It is not known when it will be enacted.

As mentioned in **Chapter 2.8**, the GOB has issued the National Water Policy, National Water Management Plan and other relevant policies bearing on the water sector. These materials may be used as the implementing rules and regulations of the Water Code when it is promulgated. This implies that those policies could be integrated in the National Water Code or River Code. The JICA Study Team recognized that the National Water Code or River Code will be enacted in the near future.

Although the Study Team has no knowledge of the contents of the draft of the Water Code or River Code, it is recommended that the following are clearly stated in the document, in addition to existing regulations from the viewpoint of flood control:

a) Classification of Rivers in terms of responsibilities of the Government on river management, that is either Central or Local Government

(For this purpose, a ledger sheet of rivers should initially be prepared defining "The Rivers in Bangladesh")

b) River area and land ownership of the river area
c) Utilization of river area
d) Other relevant factors

12.4.2 Issues Regarding International Rivers

As mentioned in **Chapters 3** and **5**, effective flood forecasting and warning in Bangladesh requires acquisition of additional data and information from India and their incorporation into the modeling system of FFWC. In light of the slow progress of the JRC talks with regard to the proposal made by Bangladesh in 1996, it is important for FFWC to take the following actions as soon as possible:

- To collect all data and information transmitted from India through the point-to-point exchange arrangement on a continuous basis;
- To incorporate all data and information sent from India, i.e. those coming through the IMD-BMD arrangement, point-to-point exchange data, rainfall data obtained from the website, and any other relevant information into the modeling system of FFWC; and
- To conduct simulations using the available data from India to determine their usefulness and limitations and present the results to the Bangladesh JRC for further negotiations with the Indian side.

In addition, as advised in **Section 12.3.4** below, the operation rules and records of barrages on key rivers in India should be made available and a trans-boundary water release warning system must be established as an essential measure to mitigate artificial flood damage. MOWR is advised to take initiatives to (re)include these issues in the JRC agenda.

While pursuing further dialogue and negotiations at the government level, supplemental efforts at the non-governmental level would be needed for building trust and understanding between Bangladesh, India and Nepal. "Second track" approaches being undertaken or planned for this purpose can be supported with a particular focus on flood management. Detailed technical level dialogue and exchanges involving government engineers of the three countries (Bangladesh, India and Nepal) to the extent possible in unofficial meetings and forums will help promote an environment for similar exchanges at the government level, as was experienced in the 1990s leading up to the conclusion of the 1996 Ganges Treaty.

In addition to flood management, efforts aiming at long-term, rational solutions looking at the entire river courses need to be pursued to address other issues such as water shortage, water quality, sedimentation, bank erosion, ecology and environment. The attention in Bangladesh in recent years appears to have shifted to the construction of river schemes within the country including the proposed Ganges barrages to augment dry season flows. However, the proposed schemes identified in the draft National Water Management Plan require further, detailed studies. While undertaking

further studies on these schemes, negotiations aimed at comprehensive management frameworks for the GBM Rivers should be promoted.

The first step needed towards such a direction is to conduct an objective study to determine water balance in the GBM, based on which a master plan can be developed. Simultaneously, free and wider sharing of all relevant information and data on the common rivers and projects and interventions thereon needs be promoted. "Second track," non-governmental level dialogue and activities and a skilled and neutral intervention of a third party at the government level would be required to facilitate the process.

In the meantime, BWDB needs to strengthen its domestic river management system as part of its efforts toward international river management. In particular, it is important to consistently monitor, analyze and report on such aspects as water level, discharge, sedimentation, groundwater, water quality, and salinity on key rivers. This will help identify exact problems encountered in international rivers, which will in turn enhance the negotiation capacity and position of Bangladesh vis-à-vis co-riparian countries.

12.4.3 Flood Damage Survey

Flood damage data are indispensable and provide a basic parameter for the estimation of benefits attributable to the FFWS. Unfortunately, there are no comprehensive official flood damage data in the BWDB. A flood damage survey was therefore undertaken during the current study to obtain more detailed and objective data.

The following recommendations are made regarding flood damage information.

(1) Integration of Information on Flood Damage

As already mentioned in **Section 2.6**, many Governmental and non-Governmental agencies are concerned with collecting information on flood damage. The major agencies concerned are FFWC under BWDB, DMB and DRR (Directorate of Relief and Rehabilitation) under MDMR, EMB, Disaster Forum Bangladesh and newspapers. Within each agency there is, however, no systematic collation or integration of flood damage information between them. The urgent tasks to be tackled with regard to flood damage include: (i) a review of the existing system of organization and information in each agency as soon as possible, and (ii) to improve the existing organization and systems of the concerned agencies with the aim of integrating information between them.

(2) Establishment of Information System of Flood Damage

A comprehensive, integrated information system of flood damage is indispensable to accurately record and define flood damage. FFWC (under BWDB) and DMB should be the core agencies of this system. Data on flood damage should be collected systematically from the actual damage areas.

(3) Preparation of Database

Flood damage data should be continuously recorded as a time series of information on a database in the core agencies such as FFWC. The time series are very useful to identify trends in historical flood damage, particularly regarding changes in damage with severity of flooding, and could be utilized for the forecasting of long-term flood damage and appropriate flood disaster management and approaches to mitigation.

(4) Preparation of Manual for Flood Damage Survey

Limited flood damage surveys have been conducted separately by the various agencies. The form of survey and sampling methods should, however, be unified by preparing a manual for flood damage survey.

(5) Implementation of Flood Damage Survey

The following information and studies are necessary to be included in a flood damage survey.

Flood Prone Area by Return Period

Flood prone areas by return period are the basic data for flood damage estimation. As there is no comprehensive and official data in Bangladesh, this is urgently required.

Land Use by Category

Land use data and contour maps by category could be the base for estimation of flood damage by category. There is a detailed agricultural land use map but the existing contour map is based on topographic conditions in 1960. This is outdated and to estimate the actual conditions of land use the contour maps need to be updated.

Category of Damage

It is necessary to classify flood damage into categories such as assets (agriculture, building and infrastructure), human life (injuries and death) and the suspension of socio-economic activities. More detailed categories may also be necessary depending on the type of study being carried out.

Value of Assets

Estimated flood damage is required in money terms and the unit value must be set up by category.

Value of Human Life

The value of human life is basically very difficult to define as it has no market price. However, fatalities are prevented through the FFWS and this must be reflected as a benefit of the FFWS in the same way as other damage categories. Consideration needs to be given to how to estimate this benefit. Some methods have been developed in relation to life insurance for injuries and death by sickness and accident.

Damage Rate by Return Period and by Inundation Depth

The damage rate by return period and by inundation depth is generally set up on the basis of value of assets and damage by category.

12.4.4 Operation and Maintenance Record of River Structures and FFWS

At present there is no ledger sheet of river structures and FFWS. The JICA Study Team was informed that the O&M Circle, Central Office is now preparing a database of the river structures.

The ledger sheets are a prerequisite for operation and maintenance of the river structures. Therefore, it is strongly recommended that they be completed as soon as possible and should include the following items.

- Project Features
- Operation and Maintenance Records
- Damage and Repair Records
- Emergency Protection Works
- Large Scale Rehabilitation Works

The ledger sheets should be updated annually reflecting the activities taken during the previous year. They would then be useful for planning operation and maintenance works in coming years. More effective operation would contribute to cost savings. Reference can be made to a format from the Questionnaire Survey conducted by the Study Team and its results presented in **ANNEX-III**. The format of the ledger sheets can be prepared with some modifications to that format as required.

TABLES

Table 2.4.1 Water Level Record of 1988 and 1998 Floods

River	Station	Recorded Maximum WL (m PWD)	Danger Level* (m PWD)	Peak of the Year (m PWD)		Days above Danger Level	
				1988	1998	1988	1998
Dhalia	*Kurigram*	27.50	26.50	27.25	27.22	16	30
Teesta	Dalia	52.97	52.25	52.89	52.20	8	NA
Teesta	Kaunia	30.52	30.00	30.43	29.91	38	NA
Brahmaputra	Noonkhawa	28.10	27.89	NA	27.35	2	NA
Brahmaputra	Chilmari	25.06	24.00	25.04	24.77	15	22
Jamuna	Bahadurabad	20.62	19.50	20.62	20.37	27	66
Jamuna	Sirajganj	15.12	13.75	15.12	14.76	44	48
Jamuna	Aricha	10.58	9.14	10.58	10.76	31	68
Old Brahmaputra	Jamalpur	18.00	17.00	17.83	17.47	8	31
Old Brahmaputra	Mymensingh	14.02	12.50	13.69	13.04	10	33
Buriganga	Dhaka	7.58	6.00	7.58	7.24	23	57
Lakhya	*Narayanganj*	6.71	5.50	6.71	6.93	36	71
Turag	Mirpur	8.35	5.94	NA	7.97	NA	70
Turag	Tongi	7.84	6.08	NA	7.54	NA	66
Kaliganga	Taraghat	10.39	8.38	10.39	10.21	65	66
Karatoa	Panchagarh	72.65	70.75	70.95	71.08	1	3
Punarbhaba	Dinajpur	34.40	33.50	34.25	34.09	4	3
Mahananda	Chapai Nawabganj	22.25	21.00	21.98	23.01	32	60
Little Jamuna	Naogaon	15.63	15.24	NA	15.48	NA	17
Padma	Pankha	22.97	21.50	NA	24.14	NA	66
Padma	Rajshahi	20.00	18.50	19.18	19.68	24	28
Padma	Hardinge Bridge	15.04	14.25	14.87	15.19	23	27
Padma	Goalundo	9.83	9.83	9.83	10.21	41	68
Padma	Bhagyakul	7.58	7.58	7.43	7.50	47	72
Gorai	Gorai Rly Br	13.65	13.65	13.65	13.45	25	25
Surma	Kanaighat	15.26	13.20	15.10	15.00	75	73
Surma	Sylhet	11.95	11.25	11.95	11.72	21	14
Surma	Sunamganj	9.46	8.25	9.30	8.90	62	56
Kushiyara	Amalshid	18.28	15.85	17.50	17.61	65	54
Kushiyara	Sheola	14.33	13.50	14.09	14.14	80	37
Manu	Manu Rly Br	19.39	17.07	18.95	18.63	66	6
Manu	Moulvi Bazar	13.25	11.75	13.01	11.68	25	NA
Khowai	Habiganj	11.55	9.50	11.00	11.44	14	8
Someswari	Durgapur	15.15	13.00	14.31	13.92	30	7
Upper Meghna	Bhairab Bazar	7.66	6.25	7.66	7.33	68	68
Gumti	Comilla	13.56	11.75	12.79	12.90	17	11
Muhuri	Parshuram	14.85	13.00	12.42	14.60	48	9
Halda	Narayangat	18.25	14.63	NA	16.57	NA	21
Halda	Panchpukuria	11.55	9.50	10.05	10.44	6	4
Sangu	Bandarban	20.38	15.25	16.80	15.25	3	1
Sangu	Dohazari	9.05	7.00	NA	7.42	NA	2
Matamuhuri	Lama	15.45	12.25	12.18	13.05	NA	2
Feni	Ramgarh	21.41	17.37	NA	17.50	NA	1

Source : FFWC

Note : Danger level (D.L.) of each station is defined by BWDB as follows:

- for Non-embanked River : about annual average flood level
- for Embanked River : slightly below design flood level of the embankment

Table 2.5.1 FAP Components

FAP No.	Activities	Funding Source	Amount in 10^6 US$ equivalent
	Main Components (11 Components)		
1	Brahmaputra Right Embankment Strengthening	IDA	3.36
2	Northwest Regional Study	UK, Japan	4.60
3	North Central Regional Study	EU, France	3.56
3-1	Jamalpur Priority Project	France, EU	2.85
4	Southwest Area Study	UUDP,ADB	3.83
5	Southeast Regional Study	UNDP	2.20
6	Northeast Regional Study	Canada	14.6
7	Cyclone Protection Project	EU,IDA	1.00
8A	Greater Dhaka Protection Project	Japan	3.00
8B	Dhaka Integrated Flood Protection Project	ADB	0.57
9A	Secondary Town Integrated Protection Project	ADB	0.55
9B	Meghna River Bank Protection Project	IDA	1.15
10	Flood Forecasting and Warning Expansion	UNDP, Japan	5.70
11	Disaster Preparedness Project	UNDP, Japan, Denmark	1.10
	Supporting Studies (15 Studies)		
12	FCD/1 Review	UK, Japan	1.60
13	Operation and Maintenance Study	UK, Japan	0.60
14	Flood Response Study	USA	0.32
15	Land Acquisition and Resettlement Study	Sweden	0.40
16	Environmental Study	USA	4.04
17	Fisheries Study and Pilot Project	UK	3.40
18	Topographic Mapping	Finland, France, Switzerland	6.71
19	Geographic Information System	USA	4.36
20	Compartmentalization Pilot Project	Netherlands, Germany	17.09
21/22	Bank Protection, River Training and Active Flood Control Management	Germany, France	40.00
23	Flood Proofing Pilot Project	USA	0.30
24	River Survey Program	EU	14.70
25	Flood Modeling and Management	Denmark, France, Netherlands, UK	4.39
26	Institutional Development Program	UNDP, France	3.60
	Macro-economic Study (Special Study)	France	0.41

Table 2.5.2 Brief Features of the Completed and On-going Projects (1/2)

	1	2	3	4	5	6	7	8	9	10	11	12	13
Name of Project	**Jamuna River Bank Protection Project**	**Ganges Kobadak Irrigation Project (GK Irrigation Project)**	**Khulna-Jessore Drainage Rehabilitation Project**	**Char Development and Settlement Project-II**	**Meghna-Dhonagoda Irrigation Project**	**Command Area Development Project**	**Teesta Barrage Project Phase-1**	**Chandpur Irrigation Project**	**Compartmentalization Pilot Project (CPP)**	**Coastal Embankment Rehabilitation Project**	**Briganga River Bank Protection and Development Project (Right Bank)**	**Amirpur-Vandercot-Baliadanga Project**	**River Bank Protection Project (Brahmaputra)**
Type of Project	Preventing merger of Jamuna and Bangali rivers	Supplemental Irrigation	Poverty reduction by agricultural production	Improvement of socio-economic conditions	Flood control, Drainage, Irrigation	Sustainable increase in winter dry season agri.production	Increase of agricultural production	Flood control, drainage and irrigation	Agricultural development	Rehabilitation of embankment	Flood control/ resettlement of illegal settlers / ecological protection	Multisectral project including flood control and socio-economic development	Bank protection work in the Brahmaputra River)
Location	Jamuna West bank, Sariakandi / Sirajganj :NW Region	Right bank of Ganges, D/S Hardinge Bridge: (SW Region)	South-western Region (SW Region)	Noakhali, Luxmipur,Feni and Chittagong (NE Region)	Chandpur facing Jamuna & Dhonagoda River (NW Region)	Pabna IRDP / MDIP Projects facing to Jamuna, Padoma and Meghna (NE & NW	Upstream Teesta River a tributary of Jamuna (NW Region)	Chandpur, Laxmipur Districts facing left bank of Meghna, & Dakatia R (NE Region)	Tangail District facing left bank of Jamuna R.	Several hundred km along the coastal line	Dhaka City (Central zone)	South-east side of Khulna city bounded by the Vairab, Rupsha, Kazibasa and Pshhur	Sariakandi & Sirajganj Sadar, Bogra & Sirajganj Districts
District / Upa-zilla	Sariakandi / Sirajganj	Kushtia, Chuadanga, Zinaidha, Magura	Jessore and Khulna	Six upazillas	15 Unions of Upazilla Matlab, Chandpur		Teesta, Atrai, Shantahar-Bogra, Bogra-Kaunia	3 upzilla in Chandpur, 3Upazilla in Laxmipur	4upazilla, Tangail	21 coastal polders	Dhaka City	Khula City	
Major objectives	Flood Control	Irrigation	Drainage improv't	Char Development and Settlement	Irrigation	Upgrading of command areas of past irrigation projects	Irrigation	Irrigation	Agricultural development	Erosion control, agricultural &forestry development		Flood control/ prevent salinity/ drainage/ socio-economic development	To prevent merger of the Brahmaputra and Bangali rivers, to protect Sirajgani town
Implementing agency	BWDB	BWDB	BWDB	BWDB	BWDB	BWDB	BWDB	BWDB	BWDB	BWDB	BWDB	BWDB	BWDB
Existing structure	Bank protection 220km												
Beneficial		2million	800,000									9500	175,500
Project features													
	Project-1	Project area:197,500ha	Project area:100,600ha	Project area:88,000ha	Project area:17,584ha	**Pabna Irrigation & Rural Development Project**	Command area:750,000ha (Phase-1 :154,250ha)	Project area:53,363ha	Project area:13,305ha	Project area:240,000ha	Protection from illegal settlers:	Embankment 52km	Concrete block: About 2,583,000 pieces
	Location: Sariakandi	Irrigable area: 142,000ha	Culyivable area 78,000ha	**BWDB Part**	Irrigation area:13,602ha	Project area:184,000ha area:184,000ha	Irrigable area:540,000ha (Phase-1:111,406ha)	Irrigable area:28,423ha	Cultivable area:9,858ha	House holds: 200,000 Population:1.2million	River side protection: 7.748km	Nolua river closer with several sector works	Geotextile: 451705 m2
	Component-1	Pump house-2 nos	River dredging:30km	Flood embankment:32.3km	Pump station:4units	Irrigation area:18,870ha	Barrage:1no. L=615m	Pum house: 6pumps 5,67m3/s each	Embankment:60km	Embankment: 570km (Existing)	Bridges:15nos Culverts: 2nos Small structures: 5nos	Gross area of 7,330ha	Dredging: 6,809,738 m3
	Groin	Main Pumps: 3units 36.83cfs each	drainage channel:555km	Drainage Channel:164km	Flood embankment:60km	Flood embankment:25km	Head regulator:1no. L=110m	Regulator with navigation lock:1no	Canal:96km	Sluice:300nos (Existing)	Environment deve. Forestation / bench/ 5.32km	Cultivable area of 5,600ha	
	Revetment 111m	Subsidiary pumps: 12units 3.54cfs each	River cloure:1no.	Irrigation Channel:4.9km	Drainage channel:125.5km	Protection :3.72km	Closure dam:1no. L=2,470m	Regulators:4nos	Intake:15nos	Rehabilitation of embankment:120km	Road: 7.748km River digging: 0.189km3		
	Shank 134m	Discharge: 153cfs	Outlet:21nos.	Drainage Sluice:10n0s	Irrigation canal:218km	Irrigation canal:256km	Flood by-pass:1no. L=610m	Flood embankment:100km	Outlet:17nos	Rehabikitaion of slope protection:10km	Others: LS		
	Component-2	Main canal 193km	Embankment:33km	Irrigation inlets:2nos	Main canal:34km	Drainage channel:50km	Silt trap:1no.	main irrigation canal:58km	Control:37nos	Rehabilitation of sluice:41nos			
	Hard point, Mathurapara	Secandary canal 467km	Access road:111km	Access road:8.4km	Secondary canal:64km	Pump st.:2 stations repair	Flood embankment:80km	Secondary canal:754km	Bridge / culvert:25nos				
	Revetment 661m	Tertiary cnal 995km	River bank	Culvert:21nos	Tertiary canal:120km		Main canal:34km	LLP:1,600nos	Groyne:2nos				
	Cross-bar 935m	Drainage canal 971 km	Regulator:7nos	**LGED Part**	Regulator:69nos		Secondary canal:L=290km						
	Component-3	Pump house-2 units	Culvert / Bridges:38nos	Rural road:58.37km	Irrigation Conduit:14nos		Tertiary canal:L=325.24km						
	Hardpont, Link	Flood control emb.39km	Foot bridges:30nos	Bridge and culvert:34nos	Drainage conduit:39nos	**Meghna-Dhonagoda Irrigation Projects**	Drainage canal:L=250km						
	Revetment 679m	hydraulic structure]:2184	Pipe outlet:2nos	Cyclone shelter:27 nos	Chech gate:42nos	Project area:17,584ha	Irrigation str.:1,110nos						
	Cross-bar 420m	Inspection road: 228km		Domestic pund:47nos	Combined	Irrigation area:13,602ha	Drainage str.:50nos						
	Component-4	Outlet:3500nos		DPHE Part	Sescape:17nos	Flood embankment:38km	Turn out:2,000nos						
	Embankment 6km	Electlicity: 14mw		Deep tube well:27nos	Aquiduct:3nos	Protection :42km	Inspection road:100km						
	Project-2	Dredger: 18"*2nos, 12"*2nos		Sanitary latrine:2,864nos	Drainage outlet:9nos	Irrigation canal:183km							
	Location: Sirajganj			**DAE Part**	Bridge:72nos	Drainage channel:47km							
	Component			On-farmresearch	Turn-out:744nos	Pump st.:2 stations							
	River training 2.55km			Demonstration plot									
				Training									
				afforestation									
				MoL Part									
				Settlement:3,224hh									

Table 2.5.2 Brief Features of the Completed and On-going Projects (2/2)

	1	2	3	4	5	6	7	8	9	10	11	12	13
Name of Project	**Jamuna River Bank Protection Project**	**Ganges Kobadak Irrigation Project (GK Irrigation Project)**	**Khulna-Jessore Drainage Rehabilitation Project**	**Char Development and Settlement Project-II**	**Meghna-Dhonagoda Irrigation Project**	**Command Area Development Project**	**Teesta Barrage Project Phase-1**	**Chandpur Irrigation Project**	**Compartmentalization Pilot Project (CPP)**	**Coastal Embankment Rehabilitation Project**	**Briganga River Bank Protection and Development Project (Right Bank)**	**Amirpur-Vandercot-Baliadanga Project**	**River Bank Protection Project (Brahmaputra)**
Implementation and O&M													
Const. Period	May-96/Dec-2001	1955/56-1982/83	1986/Dec.2002	1999/2000-2003/2004	1979/80-1987/88	Imple. 1996.97-2002/03	1960-1998	1963-1978	1991/92-1999/2000		2001/02-2004/05	1998/98-2000/01	1996-2001
Construction stages		2 Stages(1st:55-70/2nd:60-83)				On-going	Barrage constr.1979-1998				On-going	Completed	Completed
Const. Cost(mil. Taka)	7,533.10	738.9	2,572.40	1,278.2	1,750.3		9,695.29	543.0	1,172.60	5,000	663.093	190.525	7,533.10
	F:5,290.8 / L2,242.30			F:2,93.1 / L:985.1	F:482.8 / L1,267.6			F:171.5 / L37.15					GOB:2,242.3 IDA:5,290.8
Rehabilitation (mil. Taka)		2125.6											
Annual OM Cost(mil.Tk)		290			46.3			50.0	9.2				
Financing	IDA, GOB		ADB, GOB	GON, WFP, GOB	ADB, GOB		SFD, IDB, AFD, GOB	IDA, GOB	Netherlands, German, GOB				
Consultant	S.W.Halcrow / EPC		SMEC		Chu0-Kaihatu / Prakaushali Sagsad		Local consultants						Sir William Halcrow & Partners (UK) and Engineering and Planning Consultant (B)
Contractor	Hyundai / Jan De Nul /Local						Local contractors						Hyundai-Jan De Nul JV
Annual income(mil.Taka)								2000.0	156.0				NA
Cropping intensity								151%→234%	191%→264%				NA
Present situation							Upgrading Phase-1 project under thisProject	Implementation of erosion protection					
Consideration													
Present condition	Design flood: 100yr with free board of 1.5m	Completed but so much OM for dredging (30-40 thausand m3/y)	Special pilot project for river maintenance and land reclamation in Beel	Small island cretaed by delata development	Completed but needs heavy bank erosion protection	New project for further development of the completed project	Completed big irrigation project	Completed	Large scale Compartmentalization project	Completed, but need heavy rehabilitation work of bank protection		Current progress 10%	
Problem	Serious erosion	Pump rehabilitation is required	Completed but need embankment rehabilitation	Suffered by Cyclone, and huge rehabilitaion needed	Not stable land area due to erosion, and costly protection work	Agricultural production increase is remarkable, but maintenance is	Water coming from India is uncertain in dry season.	Huge rehabilitation work needed	will bring another problem on flood concentaration	Not stable land area due to erosion	Many illegal establishment and dockyards	Very poor people due to hindrance of production	
	Heavy maintenance work	Not active performance	Monitoring essential	Affected by Cyclone	Costly drainage pump operation	Serious bank erosion	Huge sedimentation	Subject to heavy erosion		Huge sedimentation and erosion		Lack of fund	
Conceivable Solution & necessary actions	There would be dangerous case of bank breaching	Waiting for pump replacement fund	Theoretical approach needed. Special fund is to be considered	Social & Economical viability be studied	River morphology study and detailed environmental study be	Geo-textile slope protection is doubtful.	International agreement of water allocation is essential	River morphological study including deltaic development study	Overall water resources development and flood control study are needed	River morphological study including deltaic development study		Feasibility study should be conducted for looking for financial source	
	FFWS shall be provided	Flood control works are essential	Very interested delta development process		Costly OM for pump station operation	Monitoring is needed for bank protection	FFWS should be provided						

Table 2.5.3 Summary of Questionnaire Survey on Operation and Maintenance of River Structures (1/2)

No.	Divisional Office	Zone	Prepared by	No. Pjts	Summary of Response			
					Flood Warning	OM Manual	Need of FFWS	Avoidable Damage by
1	Bogra	NW	Md. Mukhlesur Rahman	2	Partly received	None	?	50.0%
2	Sirajganj	NW	Md. Abdul Hamid, Md.Nizamul Haque Bhuivan, Tanan Kumar	1	Received	Ready	Necessary	50.0%
3	BRE, O&M Sirazgonj	NW	Tapan Kumar Saha	?	Received	Instruction	Necessary	90.0%
4	Pabna	NW	Md. Kamalur Rahman Talukder	1	Not received	None	Not necessary	50.0%
5	Bera	NW						
6	Barisal	S	Md. Akhtar Husain, EE	?	Received	None	Necessary	55.0%
7	Patuakhali	S						
8	Barguna	S	Md. Shajhan Md.Abdul Malek Mia	17	Received	None	Necessary	80.0%
		S	Md. Abdul Baset Sarker	?	Received	None	Necessary	45.0%
9	Dinajpur	N	Md. Afsur Ali Md. Amjad Hossain	12	Sometimes	Partly ready by Pjt	Necessary	27.5%
10	Bhola-1(S.D)	S	Shelim Ahsan	2	Received	None	Better than nothing	20.0%
11	Bhola, S.D, II	S						
12	Rangpur	S						
13	Gaibandha	N	Md. Mokhlesur Rahman	?	Not received	None	Necessary	75.0%
14	Kwigram	N						
15	Lalmonirhat	N						
16	Dalia, Nilphamari	N						
17	Nilphamari	N	No mentioned	2	Not received	None	Necessary	50.0%
		N	Md. Yeasin Ali	?	Sometimes	None	Necessary	75.0%
18	Shedpur, Nilphamari	N						
19	Thakurgaon	N	Md. Shahid Hossain Chowdhury	4	Not received	None	Necessary	27.5%
		N	Md. Mozaffar	?	Not received	None	Necessary	80.0%
		N	Md. Golam Sawar	?	Not received	None	Necessary	90.0%
20	Panchagar	N	Md.Matiur Rahman	4	Not received	None	Necessary	15.0%
21	Moulvibazar	NE	Kaji Abu Bakar Siddique, Siddiqur	11	Sometimes	None	Necessary	30.0%
22	Snargonj	NE	Sunil Baran Debny	?	Received	None	Necessary	20.0%
23	Slhet	NE						
24	Hobigonj	NE						
25	Tangail	C	Syed Ahsan Ali	?	Not received	None	Necessary	50.0%
26	Jamalpur	C						
27	Netrokona	C	Md. Abdul Batn	?	Not received	None	Necessary	50.0%
28	Mymensingh	C	A.K.M. Azherul Islam	?	Not received	Ready	Necessary	60.0%
29	Cht. I	SE						
30	Cht.II	SE						
31	Comilla	NE						
32	Ghumati	NE						
33	Faridpur	SW						
34	Ramgamati	SE						
35	Luxmipur	SE						
36	Naokhali	SE	S.M. Ataur Rahman	2	Sometimes	None	Necessary	55.0%
37	Cox's Bazar	SE	Shambha Nath Biswas	1	Not received	None	Better than nothing	25.0%
38	Feni	NE	?	1	Received	Ready	Necessary	70.0%

Table 2.5.3 Summary of Questionnaire Survey on Operation and Maintenance of River Structures (2/2)

No.	Divisional Office	Zone	Prepared by	No. Pjts	Summary of Response			
					Flood Warning	OM Manual	Need of FFWS	Avoidable Damage by
39	Dhaka O&M-I	C	Md. Mokibur Rahman / Mashiur Rahman / I.M. Reazul Iaasan/ Ashraf Jamal	4	Received	None	Necessary	50.0%
40	Dhaka O&M-II	C	Md. Sajidul Rahman Sarder	1	?	?	Necessary	60.0%
41	Rajbari	SW						
42	Gopalgonj	SW						
43	Madaripur	SW	Md. Nazrul Islam MD.Mainnddin	4	?	?	?	50.0%
44	Saritpur	SW						
45	Khulna-I O&M	SW	Proddyut Kurna Saba Md.Lutfor Rahman Ensrdyut Kr.Saha	11	Sometimes	None	Necessary	31.0%
46	Khulna-II O&M	SW						
47	Satkhira-I O&M	SW						
48	Satkhira-II O&M	SW						
49	Bagerhat	SW	Rezaul Mustafa Ashafudula Md. Abdul	9	Sometimes	None	Necessary	30.0%
50	Jessore	SW						
51	Narail	SW						
52	Nababgonj	NW						
53	Naogaon	NW	Md. Afzal Hossain	10	Sometimes	None	Necessary	21.0%
54	Natore	NW	Md. Sanaullah, Md.Montezer Rahman	7	Received	None	Necessary	80.0%
55	Rajshahi	NW	Md.Abu Bakr Khan Md.Mohsin Shaik	?	Sometimes	None	Necessary	50.0%
56	Magura	SW						
57	Jhenaidah	SW						
58	Chuadanga	SW						
59	Kushita	SW						
60	Chandpur	NE	Amanullah	1	Received	Ready	Necessary	80.0%
A	Interviewed		Number of OM Divisional Offices	14	Rate of Interviewed	23.3%		
B	Received Responses		Number of OM Divisional Offices	21	Rate of Response	35.0%		
	Total (A+B)		Interview + Responded	35		58.3%		
			Total Number of Projects	107				
	Evaluation		Positive answer /Highest		11	4	28	90.0%
			Negative answer /Lowest		10	25	1	15.0%
			Medium answer /Average		14	6	6	51.3%

Notes:

1. Flood warning message: Received / Sometime received / Not received
2. OM Manual for emergency operation: Ready / Under preparation / No Manual / Instruction only
3. Need of FFWS: Necessary / Better than nothing / No need
4. Avoidable damage by FFWS: Mitigation of flood damage by FFWS in %, rate of avoidable damage to total damage
5. ?: No response
6. Evaluation

	Flood warning	OM Manual	FFWS	Avoidable Damage
Possitive answer /Highest	Received	Ready	Necessary	Maximum
Negative answer /Lowest	Not received	None	Not necessary	Minimum
Medium answer /Average	Others	Others	Others	Average

From interview survey only, but no response to questionnaire survey

Table 2.6.1 Historical Performance of Losses and Damage by Flood in Bangladesh

Year	Affected Area		No. of Deaths	Flood Damage		Exchange Rate (Tk./US$)
	(km^2)	Share in Total Area (%)		Million Tk.	Million US$	
1954	36,800	24.9	112	1,200	343	3.5
1955	50,500	34.2	119	1,230	351	3.5
1956	35,400	24.0	N.A.	900	257	3.5
1957	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1958	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1959	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1960	28,400	19.2	N.A.	N.A.	N.A.	N.A.
1961	28,800	19.5	N.A.	N.A.	N.A.	N.A.
1962	37,200	25.2	117	560	140	4.0
1963	43,100	29.2	N.A.	N.A.	N.A.	N.A.
1964	31,000	21.0	N.A.	N.A.	N.A.	N.A.
1965	28,400	19.2	N.A.	N.A.	N.A.	N.A.
1966	33,400	22.6	N.A.	N.A.	N.A.	N.A.
1967	25,700	17.4	N.A.	N.A.	N.A.	N.A.
1968	37,200	25.2	126	1,160	290	4.0
1969	41,400	28.1	N.A.	N.A.	N.A.	N.A.
1970	42,400	28.7	87	1,100	220	5.0
1971	36,300	24.6	120	N.A.	N.A.	N.A.
1972	20,800	14.1	N.A.	N.A.	N.A.	N.A.
1973	29,800	20.2	N.A.	N.A.	N.A.	N.A.
1974	52,600	35.6	1,987	28,490	2,849	10.0
1975	16,600	11.2	N.A.	N.A.	N.A.	N.A.
1976	28,300	19.2	N.A.	N.A.	N.A.	N.A.
1977	12,500	8.5	N.A.	N.A.	N.A.	N.A.
1978	10,800	7.3	N.A.	N.A.	N.A.	N.A.
1979	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1980	33,000	22.4	N.A.	N.A.	N.A.	N.A.
1981	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1982	3,140	2.1	N.A.	N.A.	N.A.	N.A.
1983	11,100	7.5	N.A.	N.A.	N.A.	N.A.
1984	28,200	19.1	N.A.	N.A.	N.A.	N.A.
1985	11,400	7.7	N.A.	N.A.	N.A.	N.A.
1986	4,600	3.1	N.A.	N.A.	N.A.	N.A.
1987	57,300	38.8	1,657	35,000	875	40.0
1988	89,970	61.0	2,379	100,000	2,500	40.0
1989	6,100	4.1	N.A.	N.A.	N.A.	N.A.
1990	3,500	2.4	N.A.	N.A.	N.A.	N.A.
1991	28,600	19.4	N.A.	N.A.	N.A.	N.A.
1992	2,000	1.4	N.A.	N.A.	N.A.	N.A.
1993	28,742	19.5	N.A.	N.A.	N.A.	N.A.
1994	419	0.3	N.A.	N.A.	N.A.	N.A.
1995	32,000	21.7	N.A.	N.A.	N.A.	N.A.
1996	35,800	24.3	N.A.	N.A.	N.A.	N.A.
1997	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1998	100,250	67.9	918	160,000	3,556	45.0
1999	32,850	22.3	N.A.	N.A.	N.A.	N.A.
2000	35,700	24.2	N.A.	N.A.	N.A.	N.A.
2001	4,000	2.7	N.A.	N.A.	N.A.	N.A.

Source : FFWC and News in published in the Daily Ittefaq

Note : Total land area of Bangladesh is 147,000 km^2

Table 3.2.1 Summary of Status, Problems and Conceivable Solutions of Current FFWS (1/3)

Component	Present Status	Problems Encountered	Conceivable Solutions
1. Observation System	• 91 water level gauging stations (manual operation) • 56 rainfall gauging stations (manual operation) • 13 automatic water level gauging stations (float type) • 6 automatic rainfall gauging stations (tipping bucket type) • The interval of manual observation of water level is 3 hours (from 0600hrs. To 1800hrs). In case of abnormal flood situation, the interval is 1 hour. • The interval of manual observation of rainfall is 24 hours (the gauge is checked 0600hrs. Every morning). • The interval of automatic observation (water level and rainfall) is 1 hour (transmitted by means of telemeter system). • Eight automatic water level stations out of 13 are not operational as of February 2003. • Four automatic rainfall gauging stations out of 6 are not operational as of February 2003.	• Miss reading of manual gauging equipment • Default of observation and inconsistency of time of observation due to lack of gauge reader • Default of observation and inconsistency of time of observation due to lack of accessibility. • Insufficient clearance of rainfall gauging stations • Interruption of water level observation in the night time • Sifting of the location of staff gauges in accordance with the rising and lowering of water level • Insufficient operation and maintenance (O&M) of automatic gauging equipment • Being washed out or being buried due to the frequent river course sifting	• Strengthening of the reliability of observed hydrometeorological data and ensuring of regular observation by installation of automatic gauging equipment • Acquisition of sufficient clearance for rainfall gauging stations • Prevention of washing out or burying of water level gauging station by installations of stations at existing river structures • Strengthening of operation and maintenance system for gauging equipment
2. Data Communication System	• The manually observed hydrometeorological data is transmitted to FFWC through voice communication by means of HF-shortwave wireless. • Although there are 14 telemetric observatories, those data are not utilized for current FFWS. • Data of 5 observatories out of 14 are available at FFWC.	• Transmission of wrong information due to noise or miss operation of wireless equipment • Weak operation and maintenance system due to lack of budget and manpower • Unexpected interruption of public telecommunication lines of BRTA and BTTB	• Installation of telemeter system • Establishment of digital data transmission system from the manually operated hydrometeorological ganging stations • Strengthening of operation and maintenance system for telecommunication equipment • Establishment of own telecommunication lines

(to be continued)

Table 3.2.1 Summary of Status, Problems and Conceivable Solutions of Current FFWS (2/3)

Component	Present Status	Problems Encountered	Conceivable Solutions
3. Analysis System	• Quasi-2-dimensional hydrodynamic calculation by means of MIKE11-Supermodel2001 is conducted. • Time consumption for hydraulic calculation: 20 minutes • Generation of flood inundation maps by means of MIKE11-GIS • Time consumption for generation of inundation map: 60 minutes (including import of the result of hydraulic calculation) • Real-time simulation and forecast simulation (24, 48, 72 hours) are conducted. • Number of modeled branches: 272 • Number of link channels (virtual water ways): 227 • Weirs: 38, Culverts: 15 • Number of river cross sections input in the model: about 1,100 (Survey result of BWDB) • Number of sub-catchments for rainfall-runoff model: 114 • Number of rainfall gauging stations for input of rainfall-runoff model: 37 • Number of boundary conditions (water level, discharge) required for model run: 52 • Actual (observed) data of 23 stations out of 52 is available, and the boundary conditions for remaining 29 stations are estimated based on the observed data from nearby stations. • Number of water level forecast points: 54 (as of December 2002) • Evaluation of the forecasting accuracy at each forecast point is made every year after the end of flood season. • The model shows excellent accuracy in monsoon flood area, but the accuracy is sometimes poor in flash flood areas. • The update and expansion of analysis model are conducted by IWM (Institute of Water Modeling).	• Input errors due to manual input operation • Insufficient use of exiting telemetric data due to lack of interface • Insufficiency for short cycle flood phenomena such as flash flood due to one day interval of model simulation • There is a model requirement that future hydrological status of boundary stations should be input for future water level forecast, and those future boundary conditions are estimated by FFWC staff based on the experiences. • Low accuracy of generated flood inundation maps due to old topographic information • Impossibility of water level forecast more than 72 hours ahead due to limitation of hydrometeorological information in the upstream countries • Difficulties in staff training due to the complication of setting up and running of simulation model • Non-availability of manuals for operation of supermodel (Only the manuals for original software published by DHI are available.)	• Development of automatic input system • Update of topographic information • Strengthening of applicability for flash flooding by more frequent operation of the forecasting model • Extension of lead time and establishment of the method of accurate boundary forecast by collection of continuous hydrometeorological information of upstream countries • Training of staff for the ability of model operation and update and preparation of operation manual

(to be continued)

Table 3.2.1 Summary of Status, Problems and Conceivable Solutions of Current FFWS (3/3)

Component	Present Status	Problems Encountered	Conceivable Solutions
4. Warning Dissemination System	• Flood warning is issued by FFWC based on the monitoring and simulation. • Flood bulletin is issued by FFWC in daily basis in monsoon (May – October). • FFWC sends flood bulletin or warning to office of PM, local government authorities, the media, NGOs, and donors by means of telephone, facsimile, e-mail and so on. • Flood information is also disseminated through FFWC's web page. • The types of information are, observed rainfall, observed water level, water level forecast (24 and 48 hours ahead), flood inundation map and so on. • Observed water level in m PWD and the gap between observed water level and Danger Level (DL) is reported. • Officially, the flood warning issued by FFWC is transmitted to local inhabitants through Disaster Management Committee (DMC) of each District, Upazilla, Union etc.	• Flood warning information does not reach local inhabitants (there are missing links between Upazilla and Union levels). • There is no enough time for local inhabitants to take necessary actions due to insufficient lead time. • People do not understand the meaning of flood warning due to unclearness of warning messages. • The information on the safety of river related structures is not included in the warning messages. • The recipients do not understand the accuracy or reliability of forecasted water level because the accuracy and reliability are not mentioned in the flood warning issued by FFWC.	• Establishment of reliable dissemination route from FFWC to local inhabitants • Definition (clarification) of responsibilities of concerned agencies in the flood situations • Extension of the lead time • Clarification of the contents of flood warning messages (visualization by means of flood hazard maps in local level, review of danger levels, etc.) • Indication of current and forecasted safety level of major river structures • Clarification of the forecast accuracy by forecast point and making the accuracy official
5. Response System	• Officially, the response activity is headed and supported by DMC of each local authority. • Dissimilar to cyclone response, there are no organizations for response or flood fighting, inhabitants therefore take actions based on their own experiences and judgements. • In case of abnormal flood situation, inhabitants evacuate on highways, flood dikes, or other relevant buildings.	• There is no organization for flood response and flood fighting. • There is no flood evacuation shelter, while totally 1,841 cyclone shelters are effectively used. • People do not want to evacuate due to lack of security of their houses and properties. • Lack of transportation for flood evacuation • Bad environmental conditions for living at evacuated places • Lack of knowledge of inhabitants for flood response and flood fighting • Lack of space for the evacuation of livestock • Lack of guidelines for the mitigation of flood damages • Lack of guidelines for prevention of damage for river structures	• Establishment of organizations for flood response and flood fighting (effective assistance of DMC, NGOs, etc.) • Establishment of flood shelters (flood evacuation centers) • Ensuring of security or houses and properties of local inhabitants • Ensuring of transportation in flood situation • Management and improvement of environment at the places where people evacuate • Strengthening of the people's awareness on flood response and flood fighting • Ensuring of space for evacuation of livestock and agricultural products • Preparation of guidelines for prevention of flood damages for river structures

Table 3.3.1 Existing Conditions of FFWC Hydrometeorological Network

	Manual Rainfall	Manual Water Level	Automatic Rainfall [3]	Automatic Water Level [3]
Number of Stations Survey	67	88 [1]	15	17
Number of Stations:				
• Operational	64	87	5	5
• Poor Site Conditions Possibly Affecting Data Accuracy	32	3	1	0
• Instruments In Good Condition	62	80	5	8
Method of Real-Time Data Transfer [2]:				
• Wireless	39	61	NA	NA
• Telephone	2	13	NA	NA

Note: (1) Three stations from list provided by FFWC (91 sites) were not surveyed in detail as they did not operate in dry season (during inspections).

(2) Real time data sent by wireless or telephone. Data also later sent by post to FFWC/BWDB.

(3) Excludes telemetry stations (see Table 3.5.2 for these details).

NA Not Applicable as continuous recorder charts collected and sent to BWDB.

Table 3.3.2 Status of Existing Automatic Telemetry Network

Station Name	Data Type	Current Status Recorder Equipment	Current Status Telemetry Equipment	Comments
Millbarak (Dhaka Region) (1)	Water Level	WL Not Operating	Not Operating	Station being moved (Feb, 2003).
Narayanganj (Dhaka Region) (1)	Water Level Rainfall	WL Operating RF Operating	Operating Operating	-
Tongi (Dhaka (Dhaka Region) (1)	Water Level	WL Operating	Operating	-
Rekabi Bazaar (Dhaka Region) (1)	Water Level	WL Operating	Operating	-
Mirpur (Dhaka Region) (1)	Water Level	WL Operating	Operating	-
Nayerhat (Dhaka Region) (1)	Water Level	WL Operating	Operating	-
Zakiganj (Sylhet Region) (1)	Water Level Rainfall	WL Operating RF Operating	Not Operating	Telecommunication equipment removed, WL and RF recorders checked by FFWC and operational at that time.
Pankha (Padma R. Border) (1)	Water Level Rainfall	WL Not Operating RF Not Operating	Not Operating	Telecommunication equipment removed, WL recorder originally destroyed in 1998 flood. New station now totally silted, no possibility of becoming operational. RF recorder removed.
Jatrapur 1 (Jamuna R. Border) (1)	Water Level (Low Flow)	WL Not Operating	Not Operating	Telecommunication equipment removed, WL recorder destroyed by flood, no possibility of future operation.
Jatrapur 2 (1)	Water Level (High Flow) Rainfall	WL Not Operating RF Not Operating		WL recorder badly damaged by flood, local erosion a serious problem, unlikely to become operational. RF recorder removed.
Shaistaganj (Sylhet Region) (2)	Water Level	WL Operating	Not Operating	Antenna badly directed, telecommunication problem, WL recorder checked by FFWC and operational at that time.
Manu (Sylhet Region) (3)	Water Level Rainfall	WL Not Operating RF Operating	Operating	Intermittent telecommunication problems, currently under investigation. WL recorder operating intermittently, RF recorder operating.
Dhalai (Sylhet Region) (2)	Water Level	WL Operating	Not Operating	Telecommunication equipment removed, WL recorder checked by FFWC and operational at that time.
Sherpur (Sylhet Region) (2)	Water Level	WL Not Operating	Not Operating	Telecommunication equipment removed, WL recorder destroyed in 1992 flood.
Kamalganj (Sylhet Region) (3)	Rainfall	RF Not Operating	Not Operating	Telecommunication equipment removed.

Note: (1) Installed in 1996 by BWDB (2) Installed around 1985 (3) Installed around 1985, upgraded in 1996

Table 3.4.1 Information Collected by FFWC

Big Item	Detail Item	Communication tool to FFWC	Received from	Remarks
Rainfall	Cloud information of Rader	BMD Data network	BMD	
	Rainfall information of BMD Gauging Station	BMD Data network	BMD	
	India Rainfall data	Internet	India home page	
		BMD Data network	BMD	
	BWDB Rainfall (For FFWS)	Wireless Radio Telephone Mobile phone		Every 3hours (Flood season)
	BWDB Rainfall (For Telemeter)	Telemeter		Hourly
	BWDB Rainfall (For analyzing)	Post mail		Monthly
Water-level	India Water-level data	BMD Data network Telex(Back Up)	BMD	When W.L reaches 50 cm below D.L
	India Water-level data (near boarder)	Wireless Radio	India wireless gauging station	When W.L reaches 50 cm below D.L
	BWDB Water-level (For FFWS)	Wireless Radio Telephone Mobile phone		Every 3hours (Flood season)
	BWDB Water-level (For Telemeter)	Telemeter		Hourly
	BWDB Water-level (For analyzing)	Post mail		Monthly
Satellite Weather information	NOAA	Satellite		
	GMS, WAFS, NOAA	BMD Data network	BMD	

Table 3.4.2 Information Disseminated by FFWC

Item	Communication Tool for Dissemination	Disseminating Agency
Flood Bulletin	Fax and E-Mail	Television Newspaper Radio Internet EOC BWDB Divisional Office NGO Relative Governmental organizations

Table 3.4.3 Detailed Condition of Telemeter System (1/2)

No	Station Name	Condition	Cause	Others
Dhaka Area				
Control Center		**Working**		
Repeater	Ramna	**Working**		
1	Tongi	**Working**		
2	Mirpur	**Working**		At Survey, Gauging Station was not working for the reason of destroyed solar panel. But, solar panel was repaired later.
3	Rikabibazar	**Working**		
4	Millbarack	Under Shifting	The gauging house is shifting to another place.	The Place where the station was installed is planned on the new road.
5	Nayarhat	**Working**		
6	Narayanganj	**Working**		Battery water was shortage.
Jatrapur Area				
Repeater	Kurigram	Not Working	Receiving data from Dhaka is good. But, sending data to Dhaka is not good. There is doubt of BTTB Line's reliability.	BWDB requested BTTB many times to check and recover the line. But, BTTB have never replied.
7	Jatrapur	Not Working	Water Level Gauging Pipe was destroyed by flood (2002). Telecommunication equipment was removed.	The river structure was also destroyed by flood. More strong structure should be designed.
Panka Area				
Repeater	Nawabganj	Not Working	Equipment was flooded (1998), and has not been repaired.	
8	Panka	Not Working	Gauging station has not been operated because the water flow of branch river moved. Telecommunication equipment was removed.	Gauging Station was installed not at Padma river but at branch river(1995).

Table 3.4.3 Detailed Condition of Telemeter System (2/2)

No	Station Name	Condition	Cause	Others
Maulvibazar Area				
Repeater	Maulvibazar	**Working**		For these two years, the connection between BWDB repeater equipment and BTTB Multiple equipment was disconnected few times.
9	Sherpur	No Working	Equipment has had many troubles because the equipment was old type installed in 1985. Equipment was removed.	Old type equipment cannot be repaired, because spare parts are out of stock and old type parts are not available in Japan.
10	Shayestaganj	No Working	The direction of antenna is not for repeater station.	We heard the equipment is good.
11	Dhalai	No Working (Equipment is old and removed)	Equipment has had many troubles because the equipment was old type installed in 1985. Equipment was removed.	Old type equipment cannot be repaired, because spare parts are out of stock and old type parts are not available in Japan.
12	Manu	Partially Working (one problem)	Transmitting Rainfall data is good, but transmitting Water-level is not good.	The problem is now under investigation.
13	Kamalganji	No Working	Equipment has had many troubles because the equipment was old type installed in 1985. Equipment was removed.	Old type equipment cannot be repaired, because spare parts are out of stock and old type parts are not available in Japan.
Bianibazar Area				
Repeater	Bianibazar	No Working (Bad connection between BTTB and BRTA)	The connection between BRTA and BTTB has been bad (1995). BWDB has not used the relay line and Zakiganji gauging station since 1995. The BWDB equipment was removed to a small room and gathers rust.	The data from gauging station was received at BRTA repeater station first, and send to BTTB repeater station. For the first, the connection between BRTA and BTTB was good. But few days later, the connection was bad. After Connection was bad, BWDB requested BTTB and BRTA to check and recover the line many times. But, BTTB and BRTA have never replied.
14	Zakiganji	No Working	Condition of Equipment is good. BWDB has not used the gauging station because the repeater line has been bad.	

Table 3.5.1 Summary of Flood Forecasting Errors Period 2001-2003

Location	Average Error (m) Exceeded For Given Percentage of Time					Av. MAE (m)	Av. Max. (m)
	50%	40%	30%	20%	10%		
Flash Flood Areas (6 Stations)							
24hr	0.15	0.20	0.26	0.38	0.56	0.25	1.66
48hr	0.29	0.38	0.51	0.66	0.93	0.43	2.29
72hr	0.36	0.49	0.66	0.89	1.20	0.55	2.70
Monsoonal Flood Areas (26 Stations)							
24hr	0.05	0.06	0.08	0.11	0.16	0.07	0.49
48hr	0.09	0.12	0.15	0.20	0.28	0.13	0.74
72hr	0.14	0.18	0.23	0.29	0.41	0.20	1.05

Table 3.5.2 Summary of Boundary Estimation Errors Period 2002-2003

Location	Average Error (m) Exceeded For Given Percentage of Time					Av. MAE (m)	Av. Max. (m)
	50%	40%	30%	20%	10%		
Flash Flood Areas (12 Stations)							
24hr	0.18	0.24	0.31	0.40	0.61	0.29	1.60
48hr	0.27	0.35	0.47	0.64	0.90	0.42	2.04
72hr	0.34	0.44	0.59	0.82	1.11	0.51	2.21
Monsoonal Flood Areas (4 Stations)							
24hr	0.06	0.07	0.09	0.13	0.20	0.09	0.63
48hr	0.12	0.16	0.20	0.25	0.36	0.17	0.89
72hr	0.19	0.24	0.29	0.39	0.52	0.25	1.03
Tidal Flood Areas (5 Stations)							
24hr	0.14	0.19	0.24	0.31	0.43	0.21	0.95
48hr	0.20	0.26	0.31	0.40	0.52	0.25	0.97
72hr	0.25	0.30	0.37	0.46	0.60	0.30	1.34

Table 3.8.1 Flood Sector Institutional Relation Matrix (1/7)

Parameters	National Water Resources Council (NWRC)	National Economic Council (NEC)	Ministry of Planning and Finance	Ministry of Water Resources	Ministry of Education
Policy making	Approves water sector national policy	Prepares national level development policy framework	Helps NEC in national development policy formulation	Prepares water resources management and development policy	X
Laws and regulation	Approves water sector laws and regulations	X	Prepares regulations on implementation, expenditure, and procurement	Prepares water sector laws and regulations, and procurement procedures	X
Strategic planning	Directive roles in water sector planning	Prepares long term national development plan		Prepares national level sector planning	X
Implementation	X	Approval of all major projects	Acts as the clearing house of all projects	Small scale project approval, sector coordination	X
Monitoring and Information Management	X	Project implementation monitoring on national basis	Project implementation monitoring, expenditure control, implementation evaluation	Expenditure control, project execution monitoring	X
Awareness raising	X	X	X	Prepares guidelines	Disaster (including flood) management is incorporated in the curriculum
Research, education and training	X	X	X	Prepares guidelines	X
Resource mobilization	X	Makes investment policy decision	Resource allocation, delegation of financial power	Budget recommendation	X

Table 3.8.1 Flood Sector Institutional Relation Matrix (2/7)

Parameters	Water Resources Planning Organization (WARPO)	Bangladesh Water Development Board (BWDB)	Hydrology Services of BWDB	Flood Forecasting and Warning Center (FFWC)	Joint Rivers Commission (JRC)
Policy making	Acts as secretariat of NWRC	Operational policy preparation	X	X	X
Laws and regulation	X	Design criteria, internal rules of procedures	X	X	X
Strategic planning	Prepares national water resources program and regional planning	Project based planning and design	X	X	X
Implementation	X	Apex implementation body Procurement of services	Relevant project implementation Hydrological data acquisition, processing, archiving and dissemination	Real time data collection, data processing, and issue flood warning	Deals with trans boundary water issues, carry out negotiations, maintain liaison
Monitoring and Information Management	Water resources need assessment	Project monitoring, Water resources monitoring	Hydrological monitoring	Self assessment	Monitors trans boundary water issues
Awareness raising	X	Formation of water management groups Small scale programs	Through FFWC	Small scale program	X
Research, education and training	Undertakes research projects	Arrange in-house training	Specialized training	Undertakes specific research	X
Resource mobilization	X	Project wise fund allocation Collection of water levies	X	X	X

Table 3.8.1 Flood Sector Institutional Relation Matrix (3/7)

Parameters	Institute of Water Modeling (IWM)	Center for Environment and GIS (CEGIS)	Disaster Management Bureau (DMB)	Directorate of Relief and Rehabilitation	Emergency Operation Center (EOC)
Policy making	X	X	X	X	X
Laws and regulation	X	X	X	X	X
Strategic planning	X	X	Planning on disaster management, preparation of guidelines, Preparation of Local Disaster Action Plan	Planning on relief and rehabilitation	X
Implementation	Work as out sourced body	Work as out sourced body	Pre-disaster preparedness	Apex body for relief distribution and post disaster rehabilitation	Information dissemination Emergency coordination Relief requirement information collection and compilation
Monitoring and Information Management	In-house monitoring	In-house monitoring	Disaster monitoring	Monitors relief and rehabilitation operation	Emergency situation monitoring Relief monitoring
Awareness raising	X	X	Comprehensive program on awareness raising Disaster management training Curriculum preparation	X	X
Research, education and training	Various research projects	Various research projects	Relevant research	X	X
Resource mobilization	Self generating	Self generating	X	X	X

Table 3.8.1 Flood Sector Institutional Relation Matrix (4/7)

Parameters	District Administration	Upa Zilla Administration	Union Council	NGO	Ministry of Health
Policy making	X	X	X	X	Prepares health related development policy
Laws and regulation	X	X	X	X	Prepares health related laws and regulations
Strategic planning	X	X	Union level planning	Internal planning	Health sector planning
Implementation	Coordination of district level development activities Warning dissemination and evacuation coordination Law and order Disaster management Relief Coordination	Warning dissemination and evacuation management body Coordination of Upa-Zilla level development activities Act as a link between District and Union Law and order Disaster management Relief corodination	Front line warning dissemination body; and major evacuation implementation body Small scale infra structure development Relief distribution Law and order through community police Birth and death registration	Works in warning dissemination evacuation Relief distribution Rehabilitation program	Health sector coordination including emergency field hospitals and other related health services
Monitoring and Information Management	Disaster monitoring Relief situation monitoring Law and order monitoring	Disaster monitoring Relief situation monitoring Law and order monitoring	Disaster monitoring Relief situation monitoring Law and order monitoring	Field level monitoring	Health situation monitoring
Awareness raising	Through District Disaster Management Committee (DMC)	Through Upa-Zilla Disaster Management Committee (DMC)	Through Union Disaster Management Committee (DMC)	Major force in awareness raising	Health related awareness building
Research, education and training	X	X	X	Extensive research	Relevant research
Resource mobilization	X	X	Can retain holding tax	Self generating	Budget recommendation

Table 3.8.1 Flood Sector Institutional Relation Matrix (5/7)

Parameters	Space Research & Remote Sensing Organization (SPARRSO)	Bangladesh Meteorology Department (BMD)	Telecommunication Service Providers	Research and Education Institutions	Media
Policy making	X	X	X	X	X
Laws and regulation	X	X	X	X	X
Strategic planning	X	X	X	X	X
Implementation	Provides data to BWDB (satellite image) Satellite image based damage assessment	Provides data to BWDB (rainfall, radar image) Providing weather forecast	Telecommunication licensing Ensures data and information communication Maintaining communication service during disaster Arrange temporary communication channel during disaster	Research on each step of planning and implementation	Plays major role on flood warning dissemination
Monitoring and Information Management	Indirect monitoring	X	X	X	Informal monitoring
Awareness raising	X	X	X	Indirect awareness building	Principal player of public awareness building
Research, education and training	Relevant research	Relevant research	X	Human resource development	X
Resource mobilization	X	X	X	Partly self generated	Self generating

Table 3.8.1 Flood Sector Institutional Relation Matrix (6/7)

Parameters	Department of Public Health Engineering (DPHE)	Local Government Engineering Department (LGED)	Bangladesh Inland Water Transport Authority (BIWTA)	Roads and Highways Department (RHD) / Bangladesh Railway (BR)	Private Sector
Policy making	X	X	X	X	X
Laws and regulation	X	X	X	X	X
Strategic planning	Planning on water supply, sanitation and urban drainage	Rural infrastructure planning	River navigation management related planning	Transport planning	X
Implementation	Implementation of nationwide water supply, sanitation and urban drainage projects except Dhaka and Chittagong Emergency disaster response	Flood proofing and small scale flood protection works (up to 1000 ha) Rural infrastructure implementation	Navigation route maintenance River dredging Ferry terminal and inland port operation	Construction and maintenance of roads, highways, small ferry terminals, bridges	Discrete participation in various steps, but mostly as out sourced contractor
Monitoring and Information Management	Sector monitoring	Sector monitoring	X	Sector monitoring	X
Awareness raising	Health related awareness raising	Own program	X	X	X
Research, education and training	X	X	X	X	X
Resource mobilization	X	X	X	X	X

Table 3.8.1 Flood Sector Institutional Relation Matrix (7/7)

Parameters	Red Cross Society	Armed Forces Services	Fire Service and Civil Defense	Police services	Department of Environment (DOE)
Policy making	X	X	X	X	X
Laws and regulation	X	X	X	X	X
Strategic planning	Provides input for government planning	X	X	X	Environmental sector planning
Implementation	Disaster assessment, relief distribution, Cyclone warning dissemination, cyclone evacuation,	Helps civil administration for emergency flood fighting, rescue, and evacuation Relief distribution	Emergency flood fighting, rescue, and evacuation Relief distribution	Emergency flood fighting, rescue, and evacuation Relief distribution Maintain law and order	Environmental degradation prevention Improvement of environment Assessment of environmental impact due to flood
Monitoring and Information Management	Disaster monitoring	X	X	X	Monitoring environmental issues
Awareness raising	Extensive public awareness program	X	X	X	Own program
Research, education and training	Training for CPP volunteers	X	X	X	Own program
Resource mobilization	National and international fund mobilization	X	X	X	X

Table 3.8.2 Comparative Analysis of Organizational Setup of Hydrology in Relation to FFWS

Components of FFWS	Decentralized System	Centralized System
1. Observation and data collection	a. Better monitoring of gauge readers b. Quick maintenance response for gauge stations	a. Difficult to closely monitor gauge readers. b. Inefficient maintenance response
2. Data transmission and communication	a. Shorter transmission path to regional office, so less prone to disruption b. Quick maintenance response for wireless or other equipment	a. Longer transmission path, so more chance for disruption b. Inefficient maintenance response
3. Processing and flood forecasting	a. Possible to use regional model b. Local context can be taken into consideration easily c. More qualified staff for model operation will be required d. More equipment will be required	a. Super model is used b. Difficult to taken into consideration the local context c. Existing staff is sufficient d. Existing equipment is sufficient
4. Warning dissemination	a. Better interaction for warning dissemination b. Possible to involve with local administration c. Easier to have warning feedback mechanism	a. Less interaction for warning dissemination b. Not possible to involve with local administrative c. Difficult to have warning feedback mechanism
5. Response system	a. Closer monitoring of evacuation situation b. Better involvement with response system for river structures	a. Inefficient monitoring of evacuation b. Difficult to involve with response system for river structure

Table 4.5.1 Task of Improved FFWS

	Operation		Maintenance	
Task of FFWS	Item	Division in charge	Item	Division in charge
Observation	Gauge Reading	Regional FH	Discharge measurement	Surface Water (Region)
			Measurement of the cross section	River Morphology (Region)
			Restoration of gauging structure Set staff gauge and measure the level Automatic gauge maintenance Telemeter system maintenance	Regional FH
			Correction of gauging tool (Discharge) Making gauging tool (Staff gauge, Rainfall gauge)	Instrumentation Division
Transmitting	HF Tanciever Operation	Central FHC Regional FH	HF Tranceiver Maintenance	Central FHC Regional FH
Analysis	Collect the observed data Analysis Supervise Edit	Central FHC Regional FH	Store the Posted data Store the cross-section data Store the discharge data	Processing Division
			Modification of analysing model Modification of Hazard map System Hardware Maintenance	Central FHC Regional FH
Dissemination	Send Fax and E-mail	Central FHC Regional FH		
Response	Help in the evacuation	Regional FH		

Hatched: Task of Improved Organization or New Organization

Not Hatched: Task of Surface Water(Region) and River Morphology (Region) (same as exsisting arrangement)

Table 4.5.2 Staffing of Improved FFWS

Division	Operation Task	Maintenance Task	Manager				Technical Staff	Support Staff	Gauge Reader
			SE	XEN	SDE	AE			
Regional FH	(Data Collection Division)	(Data Collection Division)		1x5	1x5	1x5	3x5	8x5	85 (Mannual) 5 (Telmeter)
	Gauge Reading and Sending by mobile (or HF Tranceiver)	Restoration of gauging structure							
		Set staff gauge and measure the level							
	(Data Transmission Division)	(Data Transmission Division)			1x5	1x5	3x5		
		Automatic gauge Maintenance							
		Telemeter system Maintenance							
		HF Tranceiver Maintenance							
		FFWS Hardware Maintenance							
		Mobile sets Manage							
	(Forecasting Division)	(Forecasting Division)			1x5	1x5	3x5		
	Set boundary condition	Validation of analysing model							
	Run the Regional Model (Making Regional BULLETIN)	Computer System Maintenance							
	Edit the BULLETIN	FFWS Software Maintenance							
	Confirm dissemination of Fax, E-mail								
	Communicate with local O&M staff								
Central FHC	(Data Collection Division)	(Data Collection Division)	1	1				7	
	(Data Transmission Division)	(Data Transmission Division)		1	1	1	3		
		HF Tranceiver Maintenance							
		FFWS Hardware Maintenance							
	(Forecasting Division)	(Forecasting Division)		1	1	1	3		
	Set boundary condition	Validation of analysing model							
	Run the Supermodel (Making Country BULLETIN and Hazard Map)	Modification of Hazard map							
		Computer System Maintenance							
		FFWS Software Maintenance							
	Edit the BULLETIN								
	Confirm dissemination of Fax, E-mail, and WebSite-Upload								
Total			1	8	17	17	51	47	90
Grand Total									231

Table 5.3.1 History of Negotiations and Implementations on the Sharing of the Ganges Waters at Farakka (1/3)

The classification of the phases in this table follows the one provided by A. Nishat (2001), which is based on the approaches and progress at the bilateral negotiations.

Phase I: 1951-74 (Negotiations and the establishment of the Joint Rivers Commission)	
1951	Pakistan called Indian attention to reports on India's plan to build a barrage at Farakka to divert 40,000 cusec out of a dry season average flow of 50,000 cusec into the Bhagirathi-Hooghly tributary to provide silt-free flow into Calcutta bay.
1957	Pakistan proposed the services of the UN for the cooperative development of the eastern river systems.
1960 -62	Expert-level meetings held to "exchange data on projects of mutual interests."
1961	India informed Pakistan that the construction of the Farakka barrage had begun. A series of attempts were made by Pakistan to arrange a minister-level meeting.
1963	The two sides agreed to have one more expert-level meeting.
1968	The meeting of experts was finally held. Pakistan concluded that reaching an agreement on sharing the data was not possible.
1968 -70	Meetings at the level of secretary were held.
1970	India completed the construction of the Farakka barrage.
1972	India and Bangladesh agreed to establish the Indo-Bangladesh **Joint Rivers Commission** to "develop the waters of the rivers common to the two countries on a cooperative basis." The question of Ganges was excluded and would be handled only by the two prime ministers.
Phase II: 1974-76 (An initial agreement and negotiations)	
1975	India asked Bangladesh that the feeder canal at Farrakka be run during the current period of low flow. The two sides agreed to a limited trial operation of the barrage (discharge between 11,000 and 16,000 cusec in ten-day periods from 21 April to 31 May 1975 with the remainder of the flow guaranteed to reach Bangladesh).
1975 - 76	India continued to divert the Ganges waters at Farakka after the trial run and a full capacity of the diversion (40,000 cusec) without a new agreement.
1976	Bangladesh lodged a formal protest against India with the UN General Assembly, which adopted a consensus statement encouraging the parities to meet urgently at the ministerial level for negotiations with a view to arriving at a fair and expeditious settlement.
Phase III: 1977-82 (The first Treaty)	
1977	**The first Ganges Water Treaty** (for five years) was signed. The treaty was comprised of the following three parts: Part A: A schedule of sharing of the water reaching Farakka from 1 January to 31 May on a 10-day basis (34,500 cusec for Bangladesh and 20,500 cusec for the Calcutta port were provided during the leanest 10-day period of 21-30 April). Part B: JRC carrying out an investigation into and a study of schemes proposed by either government for augmentation of the dry season flows of the Ganges. Part C: A review of the agreement after the expiry of three years.
1978	Under the Part B of the Treaty, the two governments exchanged their **proposals for a long-term solution for augmenting the dry season flow of the Ganges.** The Indian proposal: to construct a barrage on the Brahmaputra at Jogighopa with a gravity-link canal falling into the Ganges at Farakka. The gravity-link canal was to be supplemented at appropriate stages with storage on Brahmaputra and Barak rivers.

Table 5.3.1 History of Negotiations and Implementations on the Sharing of the Ganges Waters at Farakka (2/3)

	The Bangladesh proposal: to construct a number of storage dams in the upper reaches of the Ganges basin in Nepal and India. (The data and information used were taken from "India's Water Wealth" by Dr. KL Rao's and the statements on storage potential and notes handed over in different meetings by India and the information and data collected from Nepal.) (No decision was reached regarding these proposals.)
Phase IV: 1982-88 (Two MoUs)	
1982	Before the expiration of the 1977 Treaty in November, the two governments signed an **MoU** for continuing the arrangement to share the flows of the Ganges for another two dry seasons in 1983 and 1984. It was agreed that a further and final sharing agreement would be reached immediately after the completion of a pre-feasibility study of the augmentation schemes proposed earlier. (The studies were exchanged in 1983 but did not result in an agreed recommendation for the optimum solution for augmentation. The MoU expired in 1984.)
1985	A second **MoU** signed on the sharing of the Ganges dry seasons flow through 1988 based on the same formula as in the 1977 Treaty and establishing a Joint Committee of Experts (JCE) to work out a long-term scheme(s) for the Ganges flow augmentation and to identify alternatives for the sharing of the water resources.
1986	JCE approached Nepal with a proposal to acquire data on storage sites of Nepal. When the Nepalese side raised questions about Nepal's involvement and mutuality, JCE's response was not positive and as a result the data were not made available to JCE. As a result the work of JCE ended inconclusively. (The MoU expired in 1988.)
Phase V: 1988-96 (Negotiations in the absence of any agreement)	
1988	A meeting of the two heads of governments decided to assign the secretaries of water resources to work out an integrated formula for long-term sharing of flows of all the common rivers.
1990	The secretaries' committee held six meetings over three years from 1990. The need for immediate allocation of the Ganges and Teesta waters was emphasized. In the wake of 1988 flood, the relationship between sharing agreements and augmentation proposals became a critical issue.
1991	Nepal proposed to involve Bangladesh in the Saptakosi High Dam Storage Project, but it did not receive positive response from India.
1992	The two prime ministers discussed the issue of Ganges water sharing and directed their respective ministers to renew their efforts for a long-term solution.
Phase VI: 1996 to date (The second Treaty)	
1996	**The second Ganges Water Treaty** (for 30 years) was signed, providing the following: - An allocation of the Ganges water flows at Farakka by 10 day periods from 1st January to 31 May every year based on a specific formula (which is more streamlined than the earlier version provided in the 1977 Treaty). - Agreements to (i) cooperate in finding a solution to the long-term problem of augmenting the flows of the Ganges and (ii) conclude water-sharing arrangements with regard to other common rivers.
1996	1st meeting of the Joint Committee for Joint Inspection and Monitoring of the sharing of the Ganges Waters at Farakka was held and agreed on the procedures of the Joint Committee, procedures for sharing the waters, setting up of the teams at Farakka and Hardinge Bridge, relevant guidelines, etc.
1997	During the third 10-day period of March 1997, the availability of Ganges flow at Farakka fell below 50,000 cusecs. Consultations were held between the two governments in accordance with Article II of the Treaty. India proposed adjustments to Article II to reflect one of the

Table 5.3.1 History of Negotiations and Implementations on the Sharing of the Ganges Waters at Farakka (3/3)

	following options: (i) sharing will be on a 50:50 basis when the flows are below 50,000 cusecs; (ii) sharing in a manner so that the minimum flow for either side does not fall below 20,000 cusecs; or (iii) sharing in a manner that the minimum flow for either side will not be reduced below15,000 cusecs. Bangladesh responded that Bangladesh needs to receive 35,000 cusecs as guaranteed in the Treaty for technical reasons and the Treaty provisions should be maintained. During 1-10 April Bangladesh received an average of 15,737 cusecs, falling below the minimum provided in the Treaty. It was found that the data recorded at Farakka and Hardinge Bridge had discrepancies. JRC established a Joint Scientific Study Team (JSST) to examine the reasons.
1998	(June) 1st meeting of Joint Scientific Study Team (JSST) was held and agreed on a workplan. The final report was to be completed by December 2000. (November) 2nd meeting of JSST agreed on technical details of the study and on a joint reconnaissance survey of the Ganges river and areas adjacent to the river banks between Farakka and Hardinge Bridge.
1999	3rd meeting of JSST decided: (a) joint observation of flows of the Ganges at intermediate points between Farakka and Hardinge Bridge during the lean season of 2002 at Nimtita and Bhatupara; (b) during February-March 2000, joint cross-sectional surveys at the Ganges at locations between Farakka and Hardinge Bridge would be undertaken. A JSST status report was prepared. JSST requested the two governments to extend the time of submission of the final report till December 2001. (The report has not been completed yet as of September 2003.)
2001 April	In the Joint Committee meeting, India again proposed to consider adjustments to Article II(iii) in the even of flows falling below 50,000 cusecs. Bangladesh responded that the matter is beyond the mandate of the Joint Committee and needs to be referred to the two governments.

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- The 1977 Treaty
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- The 1985 MoU
- The 1996 Treaty
- Interviews with the Bangladesh JRC during the JICA FFWS study

Table 5.3.2 Second Track Activities for Possible External Assistance

1. Bangladesh Unnayan Parishad (BUP=Bangladesh Development Council)

Chairman:	Q K Ahmad (Economist)
Executive Director:	Kalilur Rahman (former JRC member, Engineer)
Address:	House No.50, Block D, Niketon, Gulshan-1, Dhaka-1212, Bangladesh
Tel:	+880-2-9890439
E-mail:	bup@citechco.net
Website:	www.bup-bd.org
Main activities:	As a non-governmental academic organization established in 1980, it has been engaged in research, policy dialogue and advocacy on various socio-economic, technical and international issues. Since 1990, BUP has been conducting a series of research and dialogue on regional cooperation on the GBM rivers in collaboration with like-minded institutions: Center for Policy Research (CPR) in India and Institute for Integrated Development Studies (IIDS) in Nepal. Members of CPR include Ramaswamy R. Iyer, former Secretary of Indian Ministry of Water Resources and R. Rangachari, former member of Central Water Commission. Incumbent officials of the three governments (including India) also participated in some of the workshops conducted for the purpose, making the process a fusion of official and second track diplomacy. Their work helped creating a positive momentum toward the conclusion of the Ganges Treaty and Mahakali Treaty in 1996.
Financial assistance:	Ford Foundation for the river related issues in the 1990s. Other donors provided funds for different projects include Government of the Netherlands, CIDA, SDC, ADB, ILO, FAO and UNDP. Global Infrastructures Research Foundation of Japan (GIF) is in contact with BUP for possible assistance.
Activities that can be supported by GOJ:	**1. Flood Forecasting and Management System in the GBM Region:** As follow up to the development of a sustainable development framework for the GBM region (which was published in 2001), BUP, CPR and IIDS in close cooperation with the Third World Center for Water Management (President: Asit K. Biswas) are currently planning to carry out an integrated three country flood management study. The approach needs care and sensitivity and can be conducted in two phases: i) a high-level invitation only workshop involving 25-30 people including government officials using the extensive political contacts of Prof. Biswas and Dr. Ahmad in the three countries (Prof. Biswas is already in discussion with Indian high officials); and ii) commissioning of 8-10 papers from the three countries on specific, inter-linking subjects of flood management, including technical, economic, institutional and social issues. Consolidated conclusions of these works will be sought to achieve through workshops. (Note: The Dutch Government was considering support to this initiative but has withdrawn it due to a recent drastic budget reduction.) Estimated budget: Approx. USD 125,000 Period: to be determined **2. Eastern Himalayan Rivers Study: Phase III** The propose d program is a follow-up to the activities conducted in the 1990s and consists of two parts: i) dissemination of the outputs of earlier studies and the results of the Ganges and Mahakali Treaties; and ii) in-depth studies focusing on the following themes: a. In-depth analyses of water based integrated development in the GBM; b. Modalities for cooperation in energy exchange between Nepal, India

Table 5.3.2 Second Track Activities for Possible External Assistance

	and Bangladesh; c. Multi-modal transport development with focus on waterway transport; d. Integrated approach to environmental protection and bio-diversity conservation; e. Environmental implications of Tipaimukh project for India and Bangladesh; and f. Assessment of long term potentials of Kosi river basin for Nepal, India and Bangladesh with a view toward integrated water development. (Note: The proposal has been submitted to Ford Foundation but the funding is unlikely, mainly due to their closing down of the Dhaka office.) Estimated budget: to be determined Period: 2.5 years

2. Global Water Partnership South Asia Chapter (GWP-SAS)

President:	Quamrul Islam Siddique (former Chief Engineer, former Chairman, BPDB, Currently President of Institution of Engineers, Bangladesh President)
Programme Coordinator	Reba Paul
Address:	Secretariat: LGED Annex Building (Level-5), Agargaon, Sher-e-Bangla Nagar, Dhaka 1207 Bangladesh
Tel:	+880-2-8116668, 9124027
E-mail:	qis@bol-online.com, gwp-sas-rwp@cgscomm.net
Website:	http://www.gwpforum.org
Main activities:	Global Water Partnership (GWP), established in 1996 with its secretariat in Stockholm, promotes Integrated Water Resources Management (IWRM) by creating forums at global, regional and national levels to disseminate knowledge on Dublin-Rio principles on water and sustainable development, to exchange experiences, and to mobilize financial and human resources. GWP is an international network open to all organizations involved in water resources management: developed and developing county governmental institutions, UN agencies, multilateral development banks, research institutes, NGOs and the private sector. Bangladesh Water Partnership (BWP) was formed in 1998 under the GWP umbrella involving different government, quasi-government, and non-government organizations and since 2002 has been serving as the secretariat of GWP's South Asia chapter. On-going and planned areas of activities include: i) water security, ii) awareness raising on water valuation, iii) dissemination of IWRM best practices, iv) promotion of dialogue on thematic issues, v) development of action plans and forging alliances, vi) gender mainstreaming, and vii) analysis of links between water and poverty.
Financial assistance:	GWP global activities are funded by UNDP, the World Bank and SIDA. (Funding can be provided directly to the South Asia Chapter.)
Activities that can be supported by GOJ:	A program on **Joint Activities to Reduce Flood Vulnerability in South Asia (Phase I)** is under preparation and seeks funding. Bangladesh Unnayan Parishad (BUP) has been identified as a "driver" of this program and will work with partner institutions in five countries in South Asia (Bangladesh, India, Nepal Pakistan, and Sri Lanka). During the first phase, country studies will be undertaken in each country with focuses on: flood risk assessment, flood-plan management measures, public awareness and community-based disaster preparedness and response, flood fighting,

	post-flood relief and reconstruction, possibilities of introducing flood insurances, assessment of human and institutional capacities for flood management. Country studies will be synthesized leading to a regional report. A regional workshop will be convened to review the regional report, involving relevant experts, parliamentarians and bureaucrats as well. Estimated total budget: Approx. USD 628,350 Period: 2 years

3. Fellowship in South Asian Alternatives (FISAA)

Executive Director of the Dhaka Chapter:	Imtiaz Ahmed (Executive Director, Center for Alternatives, Professor of International Relations, Dhaka University)
Address:	House No.75, Apt. A3E, Road 8A, Dhanmondi, Dhaka 1209 Bangladesh
Tel:	8112484, 0173-001400
E-mail:	imtiaz@bangla.net, imtiazalter@hotmail.com
Main activities:	FISAA has six regional centers in South Asia, one in each of the six countries (Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka). It promotes research, interaction and networking among scholars and institutions in South Asia on selected areas of public interest. It is also a forum for alternative thinking, committed to putting the people first in the public policy process. It also aims at challenging the prevailing "intellectual isolation" in South Asia and developing regional perspectives on socio-economic and political issues that are common to the region. In 1997, it produced a booklet titled "Water, Power and People: A South Asian Manifesto on the Politics and Knowledge of Water," outlining key principles and visions for water governance. (The work was a joint collaboration of an engineer, a political scientist and a clinical psychologist.) In 2000, it organized a workshop of about 20 children (aged 14-16) selected through open competition from the six countries to discuss water issues in the region. Hostile atmosphere among the children (e.g. between Pakistani and Indian children) prevailing at the beginning of the workshop was transformed into friendship and enthusiasm through joint activities. The event was also participated by UNICEF and gained wide media coverage.
Financial assistance:	Ford Foundation
Activities that can be supported by GOJ:	FISAA wishes to conduct similar **workshops for children** as described above as well as for selected groups of adults on a regular basis, aiming at making long-term impacts through changing perceptions and mindsets of future as well as current policy makers. A roadmap and work plan can be developed jointly with GOJ.

4. Bangladesh Environment Lawyers' Association (BELA)

Executive Director:	Syeda Rizaana Hasan (Founder: late Mohiuddin Farooque, eminent lawyer of the Supreme Court of Bangladesh)
Address:	House No. 15A, Road No.3, Dhanmondi, Dhaka
Tel:	+880-2-8614283, 8618706
E-mail:	bela@bangla.net
Main activities:	- Established in 1992, BELA is a group of lawyers undertaking study, research, advocacy, public interest litigation, publication, etc. with the objective of ensuring a sound environmental and ecological order for all using legal mechanism as a tool.

Table 5.3.2 Second Track Activities for Possible External Assistance

	- On 10 September 2003, its senior advocate, M. Iqbal Kabir, together with other environmental and human rights lawyers and activists in Bangladesh, wrote a letter to the Chief Justice of the Indian Supreme Court protesting its decree in 2002 on the river linking project. - BELA's Executive Director, Dr. Ainun Nishat, and some other leading experts in the country are in the process of organizing a committee to protest against India's river-linking project and to raise awareness of the international community.
Financial assistance:	UNDP and others (no financial assistance identified yet for the river issue).
Activities that can be supported by GOJ:	To be identified.

5. South Asia Consortium for Interdisciplinary Water Resources Studies (SaciWATERs)

Convenor: Project Director:	Peter P. Mollinga Jasveen
Address:	Quarter No.20B, College Park Quarters, Road No.3, Banjara Hills Hyderabad 500 034 Andhra Pradesh, India
Tel:	+91-40-23544142
E-mail:	saciwaters@rediffmail.com
Website:	www.saciwaters.org
Main activities:	SaciWATERs is a consortium comprising of scholars, academic institutions and NGOs in the six countries of South Asia to tap interdisciplinary inputs across the boundaries of natural and social sciences with a view toward improving capacities for water resources management in the region. The organization places emphasis on pro-people, human development perspectives and promotes such civil society initiatives to reflect the views and voices of grassroots and marginalized sections of societies Recently it completed a publication titled "Higher Education on Water Resources in South Asia: Towards Capacity Building for IWRM," which reviewed existing institutions and curriculums of water resources related education and set out directions for reforms. A workshop in Dhaka was held in June 2002 preceding this publication. Second and third publications are currently in progress focusing on flood and draught respectively.
Financial assistance:	Government of the Netherlands
Activities that can be supported by GOJ:	To be identified.