

A. HYDROLOGY

1.5 NWMP: National Water Management Plan Project

In order to conform with up-to-date preparation step of the NWMP this Section is arranged by citing from “Introduction” of Part A: The Context in dNWMP Volume 2 Main Report issued in July 2001 that is opened to public through the WARPO website (<http://www.warpo.org/>).

1.5.1 Background

(1) A call for a new plan

National level planning of the water resources of Bangladesh dates back to 1964 when the East Pakistan Water Development Board’s Water Master Plan was published. Later in 1986 the Master Plan Organisation prepared a draft National Water Plan, which was updated in 1991. The severe floods of 1987 and 1988 prompted widespread support from the international community for the Flood Action Plan, a series of five regional plans and supporting studies, culminating in the Bangladesh Water and Flood Management Strategy (BWFMS) Report prepared by the Flood Plan Coordination Organisation (FPCO) in 1995. The latter was subsequently revised re-issued in 1998.

These reports and the accompanying studies have contributed to a substantial appreciation of the nation’s water resources, although successive plans have varied significantly as to how best develop them. This was recognised in the 1995 report, which noted the limitations of earlier plans, which had focused too heavily on agricultural development without adequate consideration of the needs of other sectors. A criticism of earlier plans was that the social and environmental impacts of water resource development were not being addressed. Responding to this, BWFMS recommended that the Government should formulate a National Water Policy that addressed these issues and that a comprehensive National Water Management Plan (NWMP) should be prepared within this framework. It was also recommended that FPCO should be merged into the permanent Water Resources Planning Organisation (WARPO) with a mandate to prepare NWMP, to monitor activities within the sector and to provide information and advice on best practice.

The Government acted promptly to implement these recommendations. WARPO, which was formed in 1992, took over the functions of FPCO in January 1996. A National Water Policy was prepared after extensive discussion and was approved in November 1998 by National Water Resources Council. In parallel, arrangements were made to launch the NWMP and Consultants were mobilised on in March 1998 to provide assistance to WARPO in preparing a comprehensive water management plan and strengthening WARPO to continue the process thereafter.

(2) Approach to preparation of the NWMP

The approach to preparing this plan has been both structured and highly participatory. Three main phases were identified from the outset. These are illustrated in Figure A1.5-1 overleaf.

- **Inception Phase**, during which data and information started to be assembled and the overall approach was reviewed and timetables were revised.

- **Options Phase**, during which sectoral issues were identified from widespread consultations, and on a similar basis options were developed to address these issues in the context of the directions by then given by the National Water Policy. Taking full account of the reactions received, an assessment framework was constructed to test the different options against various criteria, including their ability to meet different national goals. This led to the identification of alternative strategies for consideration by Government.
- **Plan Preparation**, which commenced with the Government considering and determining a Development Strategy from the alternatives provided. Preparation of the Plan proceeded in accordance with the directives given both by the Policy and this Strategy, from which a series of programmes of action have been determined, which together form the building blocks to the overall management plan.

(3) Importance given to participatory planning

In line with Policy requirements for participatory planning, widespread consultation has been undertaken throughout the preparation of the plan. Efforts have been made to engage a wide range of stakeholders at each stage of the plan preparation.

People's Participation and Consultation Programme: Three rounds of consultation have been undertaken in 28 Districts spread across the country. Round 1, conducted at para to thana levels focussed on identifying water-related issues that concerned people most and what they considered could be done about it. Round 2, conducted at village to District levels, sought to verify what had been learnt from the first round and explore possible options. The third round, at Thana and District levels, took back the developed options for review and suggestions. Independent reports on each round were commissioned from the Bangladesh Institute of Development Studies (BIDS).

Agency Consultations: Early in the programme all Government agencies with a stake in the water sector were identified and invited to nominate two representatives to be members of a Contact Group. All the main published reports have been circulated to the Contact Group, and meetings arranged to discuss their views.

Workshops: A series of National Workshops have been held, involving a wide range of audience comprising NGOs, donors, academics, Government staff media representatives. Topics raised at these workshops included the Inception Report, identification of issues and options and major issues that arise from consideration of those options. Workshops will be held regionally and nationally on the draft Plan also. In addition to these, group discussions have been held during option formulation with subject matter specialists and eminent experts, chaired mostly by Secretaries from different Ministries.

Bi-lateral discussions: Numerous meetings, both formal and informal, were held with different agencies and individuals to seek information on different topics. Latterly this included a series of one-to-one meetings with donors to appreciate their perspectives.

A. HYDROLOGY

Web site: WARPO established a web site early in the proceedings, on which copies of published reports and other relevant information have been posted. A quarterly WARPO Newsletter was launched, which inter alia has kept people informed of the progress of NWMPP and advertised the web site.

(4) Formative steps in the planning process

It is important to recognise that a number of steps in the planning process have played a particularly important part in development of the Plan. These are briefly highlighted below.

The **Terms of Reference** provided to the Consultants, as agreed by both the Government and the World Bank, prescribed the general approach to be adopted and laid down a number of important principles from the outset. The ToR required that the NWMP should be a rolling plan to be reviewed and updated every five years, and that it would provide a firm plan for the first five years, an indicative plan for the subsequent five years and a perspective plan for the long term (25 years). Also, the ToR established three main sets of considerations to guide the formulation of the Plan.

- The first consideration is that the Plan should be forward looking to what Bangladesh's society and economy could be in future, notwithstanding the valuable lessons from the past. This requires designing water resources policies, programs and projects to help promote structural change in the national economy, with a perspective well into the 21st century (at least 50 years ahead).
- The second consideration is that the Plan must be realistic about the prospects for institutional and implementation capacity, and everything possible should be done to rationalise and strengthen institutional capacity.
- Thirdly, the Plan should be seen as an interactive consultative process. It should provide a long-term planning framework compatible with national goals and objectives and with sound environmental management principles, and represent a flexible planning system capable of continuous evolution.

The ToR also stipulated that the primary goal of the NWMP should be to contribute to national economic development through rational development of water resources while protecting the natural environment and improving the quality of life of the citizens of Bangladesh.

The **National Water Policy**, approved in November 1998 and published in January 1999), reconfirmed WARPO as being responsible for preparation of the NWMP under the oversight and guidance of the National Water Resources Council. The preface to the Policy requires that the NWMP will provide necessary advice on follow-up actions to be taken up for implementing the policies enunciated in the National Water Policy. The Declaration of Policy also makes clear that the purpose of the Policy is to ensure continued progress towards *fulfilling the national goals of economic development, poverty alleviation, food security, public health and safety, decent standard*

of living for the people and protection of the natural environment.

The Policy describes the NWMP as a plan that addresses *the overall resource management issues in each region and the whole of Bangladesh, and providing directions for the short, intermediate, and long runs. The plan will be executed by different agencies as determined by the Government from time to time. The NWMP and all other related plans will be prepared in comprehensive and integrated manner, with regard for the interests of all water-related sectors. The planning methodology will ensure co-operation across sectors and people's participation in the process. Within the macro framework of the NWMP, sector agencies of the Government and local bodies will prepare and implement sub-regional and local water-management plans in conformance with the NWMP and approved Government project appraisal guidelines. The Executive Committee of the National Water Resources Council (ECNWRC) will resolve any interagency conflict in this regard.*

The **Development Strategy** for the NWMP, approved by the Executive Committee of the NWRC in June 2001, was drawn up after following the widespread consultations described above and extensive assessment of alternative measures. The document stipulates that a balanced strategy, giving equal weight to each national goal, is the most appropriate course to follow at this time.

It also sets out a framework for action within which the NWMP is to be formulated, making clear the steps that Government intends to take to ensure development of effective institutions and legal and regulatory measures and to enable efficient and equitable management of the sector as a whole. It further sets out the main aims and focus of activities within each sub-sector, such that these may proceed in a coordinated manner consistent with achieving Policy objectives.

1.5.2 Scope of the National Water Management Plan

Drawing upon the formative statements above, the scope of the National Water Management Plan has been determined as follows:

- (i) The overall objectives of the NWMP are to contribute in a balanced fashion to the overall national goals of economic development, poverty alleviation, food security, public health and safety, decent standard of living for the people and protection of the natural environment;
- (ii) The purpose of the NWMP is to operationalise directives given in the National Water Policy, and to do so in accordance with the Government approved Development Strategy;
- (iii) The NWMP is to be a framework plan to guide (but not prescribe), in an integrated and comprehensive manner, the actions of all concerned with developing and managing water resources and water services;
- (iv) It is to be a rolling plan to be reviewed and updated every five years, providing a

A. HYDROLOGY

firm plan for the first five years, an indicative plan for the subsequent five years and a perspective plan for the long term (25 years), all set in the context of what may happen at least 50 years ahead;

- (v) The Plan has to be realistic about the prospects for institutional and implementation capacity, and should seek to rationalise and strengthen institutional capacity.

1.5.3 Structure of the National Water Management Plan

The National Water Management Plan is presented in five volumes, as follows. Details of how to make best use of the document are given in Chapter 16:

Vol	Title	Purpose
1	Executive Summary	To enable a quick overview of the Plan as a whole
2	Main Report	
	Part A: The Context	Summarises the context within which the Plan has been prepared and the driving forces determining the need for future actions
	Part B: The Plan	Describes the Plan components and their expected impacts, how these fit into a management information system, and the risks and the prospects for managing risks
	Part C: Implementation	Describes the phasing of Plan components and funding Arrangements requirements, sets out key linkages, describes how the Plan can be monitored and evaluated, and finally actions now required
3	Investment Portfolio	Describes each of the component programmes by subsector, setting out Policy context, purpose and outline, financing and institutional arrangements, indicators, existing documentation, linkages and risks
4	Regional Plans	Summarises the Plan components by Hydrological Region
5	Supporting Information	
	Annex A: National Water Policy	Restatement of National Water Policy
	Annex B: Development Strategy	Restatement of Development Strategy for the National Water Management Plan
	Annex C: Environmental	Assesses the environmental implications of the overall

Assessment	plan
Annex D: Supporting Information	Documents information assembled under the NWMPP provides lists of acronyms and defines specific words as used in the NWMP

1.5.4 Supporting Documents

Supporting documents are listed in Annex D of the NWMP. This provides a full listing of the information prepared under the NWMPP. . These comprise:

- Published Project Reports Five main reports prepared between June 1998 and to date
- Topic Papers Fifteen discussion notes prepared during the options phase
- Other Reports Twenty three reports on various specific subjects, including studies made on the Ganges Dependent Area
- Working Papers Forty five internal papers prepared by individual specialists on the NWMPP team
- NWRD data holdings Two hundred sets of data compiled jointly by WARPO, NWMPP and EGIS II in collaboration with data collecting agencies

All the above are available with WARPO, virtually all in electronic form.

1.5.5 Target Audience

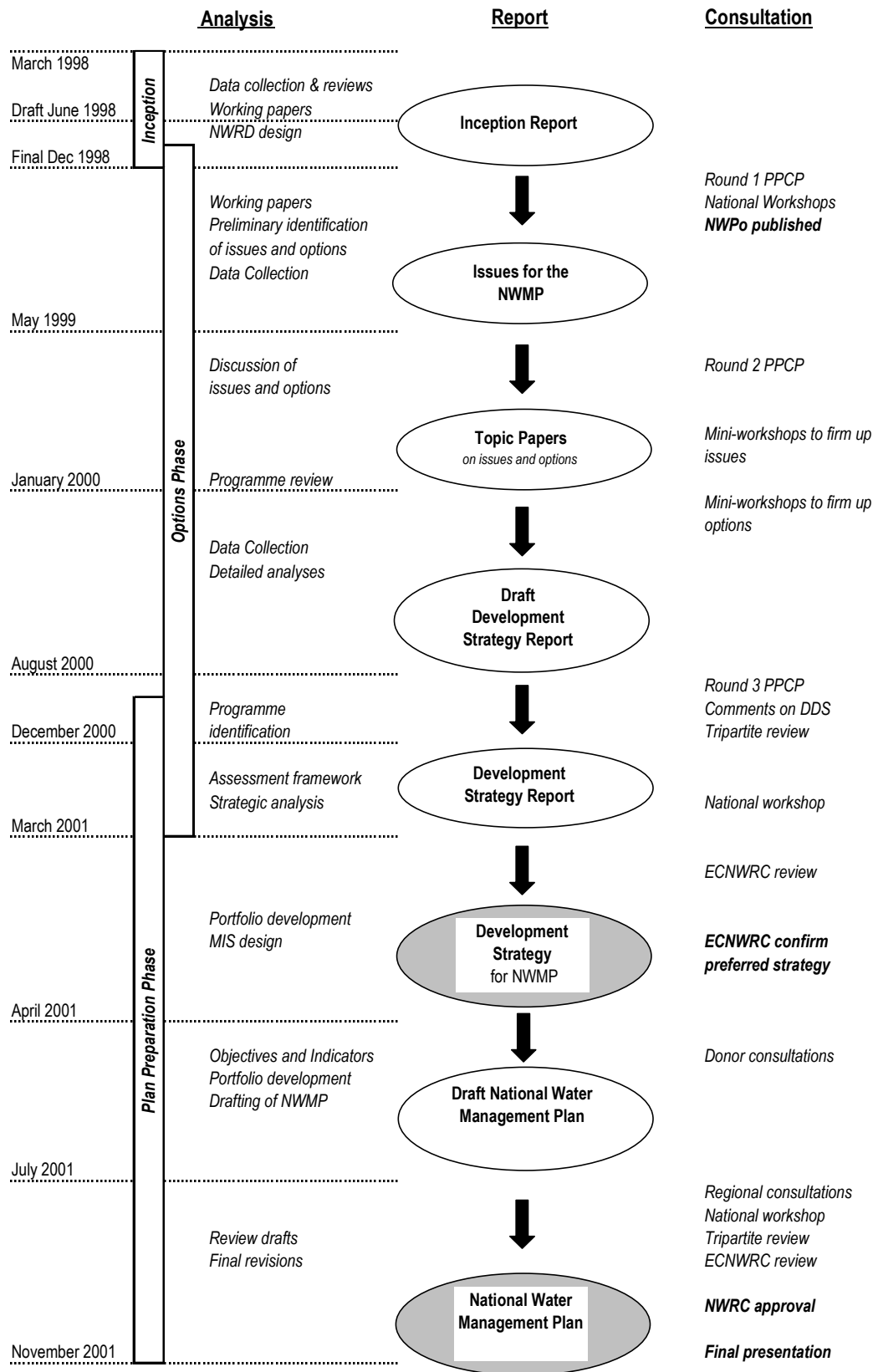
The National Water Management Plan is intended to be of use to all agencies and organizations engaged directly or indirectly in the water sector.

- NWRC and the Government To set out how their policies are to be implemented, to Government appreciate the funding and other actions required of Government to implement the plan, and to provide a framework by which to monitor plan implementation
- Line agencies and Local To provide a framework for their own planning and Government programmes
- Civil Society To understand how GoB's plans will affect them

A. HYDROLOGY

- Private Sector To identify market, service provision and investment opportunities
- Funding Agencies To identify and plan their funding support programmes

Figure A1.5-1: Main Steps in the Preparation of the NWMP



A. HYDROLOGY

1.6 NWRD: National Water Resources Database

1.6.1 Retrospective

Information has become essential for planners at all levels as complexities related to management decisions continue to grow. The support is urgently required by the Water Resource Management Plan for Bangladesh in meeting the great challenge of resolving diverse problems and issues in water sector planning. Although there have been past initiatives to establish a methodical and consolidated system to provide data or information related to the sector, the process has proved to be more complex than anticipated as the data are collected by different organizations in different formats and are difficult to access. But for national or regional level planning and management all data should be authentic or reliable, compatible and readily accessible.

Under the Flood Action Plan (FAP) efforts were made to co-ordinate project mapping through FAP19 "Geographical Information System". Afterwards the EGIS project was started to continue the work of FAP19 and also of the FAPI6 "Environmental Study". An important objective of this project was to support WARPO, among others through the development of a database for water resources planning. This is the background how the concept of NWRD initiates. NWRD is therefore to make up a huge leeway between the demand the constraints of the planners, providing data with reasonable accuracy from a single database of a single organization. The work was started with a joint team comprising staff of EGIS-II, SWMC and NWMP under the direction of WARPO to develop NWRD. Work on NWRD has continued since then.

1.6.2 NWRD Overview

(1) Necessity of Database

The primary activity of NWRD is to meet the demand of water resource planners for a consolidated and reliable data bank. The data in NWRD have been collected from different sources in many different formats (digital and paper), and maps produced in different scales and projections, all of which stored in different locations. For optimal usefulness, it is necessary to put the data into a relational database format and store in a centralized and easily accessible location with proper protection facilities.

In order to ensure security of the database, its back-end is designed with SQL server and is made user-friendly by designing the front end with GIS based graphical user interfaces and Visual Basic. NWRD is therefore a systematic database, which ensures security and convenience and is established as a national level data provider.

(2) Overall Objectives

Overall Objectives of NWRD are to update the existing database and establish an information management system:

- To support macro level water resource planning, i.e., NWMP;
- To organize the data collected from different agencies/organizations/projects;
- To improve the data quality; and
- To make the data available to users.

(3) Quick Overview on NWRD Activities

Collection of Data: WARPO contacted 24 agencies to ascertain what their data holdings are and started collecting data from them.

Processing of Data: NWRD has processed and captured data with modern GIS and database management facilities.

Storing the Data: The multi-faced data collected from different sources are put in NWRD at a relational database format and stored in a centralized, secured and easily accessible location.

Quality Control: Assurance of quality data is of prime importance in NWRD. Therefore this process is going on with extensive field verification.

Development of Application Tools: For easy access and extraction of data, NWRD has developed useful and user-friendly tools.

Development of Metadatabase: To give access to all level of users and to browse through the NWRD database a Metadata system has been developed which itself is a database.

Documentation of Database: All information regarding the NWRD data layers including their process descriptions are documented.

Dissemination of Data: NWRD is disseminating data to all level of users with reasonable accuracy in a systematic and consolidated format.

(4) Introducing NWRD Data Sets

NWRD possesses almost 300 data layers in several main groups. These are:

Base Data: Covers administrative boundaries at various levels: national, division, district, thana, and union, planning unit, catchment, navigation, power sector, project information, airway, railway, roads, rivers, waterbodies and topography.

Surface Water: Includes water level, discharge, salinity, sediment and information from MPO and SWMC.

Groundwater: Covers water level, water quality, abstraction, aquifer properties, lithology and

A. HYDROLOGY

information from MPO.

Soil and Agriculture: Includes agro-ecological zones, crop suitability and crop statistics, drought maps, fertilizer use, land type and soil association.

Fisheries: Covers fish catch data.

Forest: Includes forest land data.

Socio-Economic: Encompasses census, charland, and economic data.

Meteorological: Covers rainfall, evaporation, humidity, temperature, wind speed, sunshine hour data.

Environment: Covering data related to indicative parameter, industry, natural disaster, surface water quality.

Images: LANDSAT, IRS and RADARSAT images covering different regions or in some cases the whole country.

1.6.3 Special Features of NWRD

Quality Control: The simple collection, generation and storing of data do not fulfill the requirements of water sector planners as almost all data are in raw format and need at least a primary or obvious error check. This is related to the issue of data quality, which is a long-term and on-going process requiring the involvement of data collecting agencies and field verification.

NWRD checks the obvious errors of time series and spatial data, and has developed two guidelines to standardize quality control procedures, namely the guidelines for Spatial data quality assessment and Time Series data quality assessment.

The Spatial Data Quality Guideline is divided into two parts, 'Quality Management Standard', which follows the ISO and International Cartographic Associations, and 'Quality Management for NWRD', which describes the quality control procedures of spatial data in NWRD. **The Time Series Data Quality Guideline** deals with the hydrometric and the hydro-meteorological data.

Metadatabase Development: One of the major responsibilities of NWRD is the development of an Information Management System (IMS) to meet the needs of water sector planners. In this connection, NWRD has developed the MetaData System, which itself is a database will be available at the Web site. It can be mentioned here that Metadata is "data about data". It is the background information, which describes the content, quality, condition, and other appropriate characteristics of data.

1.6.4 Development of Tools

(1) Application Tools

During the development of NWRD, a number of application tools were developed to facilitate different types of activities. These application tools are simple to use and through a single interface, a number of events can be performed by these tools. For example, with the Statistical Tool simple statistical parameters can be computed, analyzed results can be displayed in graphical, chart or tabular format and stored as well as exported in different formats. The tool also facilitates the analysis of time series data of any year or period.

Other than the Statistical Tool, ArcView and SQL server based tools and applications were developed for the front-end user for searching, exporting, editing, viewing, and representing data. The advanced Analysis Tool will help planners to generate useful information. Dissemination tool is to disseminate information or data which also includes price estimation, invoice, data exporting for CD writing, etc. These tools were developed under the activities of NWRD which can be used in different field of services.

(2) GeoKey

Geokey is a metadata software developed by Geodan BV, Amsterdam. This software has been used for developing a metadatabase by integrating with NWRD. Two types of search are available such as Keyword-base Search and Spatial search. Keywords can be searched in one or more metadatabase.

(3) Generic Query and Display Tools

This ArcView application is the front-end to the user querying for data in the NWRD database. By using this tool one can display data as theme for shapefile, Grid and image and other information in the tabular format. Tabular data can be linked to shapefiles by using 'Spatial Link'. This tool can query the data layers on the basis of three hierarchical orders as designed for the NWRD database.

(4) Advance Query Tools

Spatial Data Conversion tool converts spatial data between different themes already loaded into Arcview using generic query tool. Available conversion types are: Point-to-Polygon, Polygon-to-Polygon and Polygon-to-Point. Point to polygon conversion type can be used with one of the three methods: Simple, Thiessen and Interpolation.

(5) Time Series Viewer Tools

This user friendly tool is developed in a Visual Basic environment to display, edit and export the time depended data, which are defined as time series data. There are also some facilities for selecting multiple year and type and superimpose the data. This tool can display data as chart for a

A. HYDROLOGY

single or multiple stations for any specified time intervals by retrieving data from the SQL server. The edit option facilitates in checking and correcting time series data.

(6) Export Tools

A user-friendly generic export tool has been developed for easy exporting of data from the NWRD. This tool is developed to export data in different formats in the Visual Basic environment for the potential users. The subset of tabular data kept into the SQL Server can be selected and exported at any location. Time series data can be selected by the station name or identification number. Desired start and end time of data retrieved can also be specified. As users have opportunity to extend the functionality of the system with their own desktop tools and analysis, a facility is provided to export data out of the system into standard formats.

(7) Statistical Tools

This tool performs simple statistical analysis on time-series data and represents the output as graph. Simple statistical analysis (i.e. Sum, Average, Min, Max) can be done on time-series data. Data can be summarized yearly (dry, wet and full), monthly, decadal and daily basis. The tabular output of the statistical analysis can be exported as Excel, Dbase or Text file.

(8) Dissemination Tools

This tool is very interactive in disseminating the data and information from NWRD at WARPO. The major functions of this tool are to display and prepare data availability, estimation of price, invoice, and data receipt and finally to export data for CD writing. This tool is very flexible for selecting time series data on user requirement. It can retrieve the data and price from the SQL server and provide the facilities for data dissemination in a short time.

1.6.5 Database Management

(1) Dissemination Process

Dissemination of information will be ensured through open access for all users to NWRD data. Normally, such open access of information does not exist due to data ownership and lack of legislation in Bangladesh. A nominal price is charged to users for accessing data, covering just a fraction of the costs of copying, storage, maintenance, updating, collecting and processing the data.

A metadata base has been developed for data cataloguing and made accessible through the Intranet/Internet, which will be most effective in disseminating information. The dissemination process is subject to some terms and conditions that control the mode of dissemination, payment and rules for using, holding or transferring data.

(2) Data Storage & Archiving

Data Storage & Archiving of NWRD is an issue for the long term sustainability of the database. All data are stored in a single SQL database server to facilitate the use of these data. As the data were collected from different sources and were diverse in nature, it became necessary to group the data and store these according to their types. Data archiving in NWRD is generally done in tape backup and CD for the safety of the database.

(3) Documentation

Documentation is very essential for a database like NWRD that contains huge and diversified data. Documentation protects a database from losing any information. Developing technical notes, metadatabase, manuals, and reference guides are the major activities in the process of documentation. Technical notes contain a comprehensive information about the source, quality, lineage, process description, format, and extent of data and other relevant characteristics. The notes serve to give data users an overall idea about data and, therefore, help them to pick out what they need for their intended application. Metadata is a concise form of technical notes, which can also be used for data browsing, transferring, etc. Source code of the tools are documented along with the recommendations for future enhancement.

(4) Future Maintenance

Future Maintenance of NWRD consists of data collection from various fields such as hydrology, meteorology, socio-economics, demography, etc., which needs to be continuously updated. NWRD should be in an operational state soon in order to keep pace with the changes of information technology and other computer facilities.

Some proposals for the future operation of NWRD are:

- Establish a protocol for entering new data, correcting existing data, meeting the need for new data set, and updating attribute data.
- Development of a system to circulate the updated information at a certain intervals (monthly or quarterly), and in this connection, arranging orientation programs for all potential users.
- Removal of institutional barriers and problems.
- Adoption of an integrated approach for quality control.
- Establishment of a permanent linkage between WARPO and other data collecting agencies.
- Establishment of a protocol for data dissemination.
- Arrangement for feedback from users.

A. HYDROLOGY

There will be an institutional set-up with a permanent skilled team that will be capable of handling, updating, maintaining and disseminating data.

1.7 GIS Data: Geographical Information System

1.7.1 NWRD Data Sets

NWRD possesses more than 360 data layers in several main groups as mentioned in Sub-section 1.6.2. Table A1.7-1 shows a list of GIS data abstracted from the above data layers to testify their availability for the Study purpose.

Concepts of GIS data are briefly described in terms of metadata with several printout maps as follows:

(1) Catchment of NAM (NE)

ABSTRACT : A spatial data layer of the NAM catchment boundary of North Eastern region delineated by Surface Water Modelling Centre.

HISTORY OF DATA LAYER : Originally NAM catchments were delineated under the projects SWSMP1 (Surface Water Simulation Modelling Programme 1) & SWSMP2 on the basis of MPO catchments. Later SWMC redefined the NAM catchments.

(2) District Boundary (64)

ABSTRACT : A spatial data layer of 64 district (third lowest administrative unit) boundaries of Bangladesh along with the attribute information derived from Geo-master Database published by Bangladesh Bureau of Statistics (BBS) in 1991.

HISTORY OF DATA LAYER : Original source of this data layer is 17 Land Resource Inventory Maps (AEZ zone maps) produced by Bangladesh Agricultural Research Council (BARC) under FAO/UNDP Agricultural Development Adviser Project, Ministry of Agriculture, Govt. of Bangladesh in December 1985, at 1:250,000 scale. The maps were captured by Agricultural Sector Team (AST) project funded by CIDA using a GIS software, TYDAC SPANS.

(3) BWDB FCDI Project Location (Embankment Line)

ABSTRACT : The data layer contains all embankment locations of BWDB (Bangladesh Water Development Board) FCDI (Flood Control Drainage & Irrigation) Projects with attribute information.

HISTORY OF DATA LAYER : Source of this data layer are the maps (1: 50,000) prepared by ECDS (Engineering Consultancy and Development Services Ltd.) under the project 'Updating the Inventory of Water Development Systems - BGD/87/021 of UNDP1991'. BWDB Jurisdiction Maps (1:1,25,000 and 1: 2,50,000) have also been used for projects embankment identification in some cases. Digital database from Water Sector Improvement Project (WSIP) of BWDB 1999 has been used for attribute information.

A. HYDROLOGY

(4) BWDB FCDI Project Location (Polygon)

ABSTRACT : Location of the Flood Control Drainage and Irrigation (FCDI) project areas that are defined by BWDB.

HISTORY OF DATA LAYER : The data layer has been digitized in Arc/Info (Unix & NT Workstation) environment from the maps (1: 50,000) prepared by ECDS (Engineering Consultancy and Development Services Ltd.) under the project 'Updating the Inventory of Water Development Systems - BGD/87/021 of UNDP 1991'. BWDB Jurisdiction Maps (1:1,25,000 and 1: 2,50,000) have also been used for projects identification in some cases. Project attribute information has been collected from Water Sector Improvement Project (WSIP) of BWDB, 1999.

(5) Railine

ABSTRACT : A spatial data layer showing the railway network of Bangladesh along with other attribute information.

HISTORY OF DATA LAYER : Railway network of Bangladesh was captured by the AST (Agricultural Sector Team) project funded by Canadian International Development Agency (CIDA) using a GIS software, 'TYDAC SPANS'. AST captured the map from 17 Land Resource Inventory Maps, (AEZ zone maps) produced by BARC under FAO/UNDP Agricultural Development Adviser Project (BGD/81/035) Ministry of Agriculture, Govt. of Bangladesh, December 1985. ISPAN (Irrigation Support Project for Asia and Nearest) converted this data layer into ArcInfo Generated format. This data layer has been updated in September 2000 by NWRD using recent railway maps collected from Bangladesh Railway.

(6) Major Rivers

ABSTRACT : A spatial data layer containing the trans-boundary rivers and rivers having width equal to or above 100m including BWDB gauge stations and SWMC model rivers.

HISTORY OF DATA LAYER : ISPAN (Irrigation Support Project for Asia and Nearest) captured the rivers that were equal to or above 50-meter width, from SPOT multi spectral image 1989. EGIS- I updated this data layer using SPOT multi-spectral image and EGIS-II enhanced the existing data adding Model and some other Major rivers. After-wards NWRD has captured the rivers of Chittagong region from LANDSAT TM image 1997.

(7) Transboundary Rivers

ABSTRACT : A spatial data layer representing the rivers that cross the international boundary of Bangladesh and flow through more than one country.

HISTORY OF DATA LAYER : Using the existing river network map NWRD has generated this data layer by identifying the transboundary rivers, according to a report published by JRC (Joint

River Commission). River network map of NWRD originates from ISPAN. ISPAN captured the rivers that were equal to or above 50 meter wide from SPOT multispectral image 1989. EGIS- I updated this data set using SPOT multispectral image. After-wards NWRD has captured the rivers of Chittagong region from LANDSAT TM image 1997 and updated other parts of the existing data layer in accordance with changed river course.

(8) Asian Highway

ABSTRACT : A spatial data layer showing the Asian Highway passing through Bangladesh, identified by Department of Roads and Highways with other associate attribute information derived from RHD Road NetWork Database, Annual Report 1997-98.

HISTORY OF DATA LAYER : Department of Roads and Highways generated this data layer.

(9) National and Regional Highway of RHD

ABSTRACT : A spatial data layer showing the national and regional road network of Bangladesh with other associated attribute information identified by Department of Roads and Highways (RHD).

HISTORY OF DATA LAYER : Department of Roads and Highways generated this data layer.

(10) Thana Boundaries (490)

ABSTRACT : A spatial data layer of 490 thana (second lowest administrative unit) boundaries of Bangladesh along with the attribute information derived from Population Census Book 1981 published by Bangladesh Bureau of Statistics (BBS) in 1991.

HISTORY OF DATA LAYER : Original source of this data layer is 17 Land Resource Inventory Maps (AEZ zone maps) produced by Bangladesh Agricultural Research Council (BARC) under FAO/UNDP Agricultural Development Adviser Project, Ministry of Agriculture Govt. of Bangladesh in December 1985, at 1:250,000 scale. The maps were captured by Agricultural Sector Team (AST) project, funded by CIDA using TYDAC SPANS system. Later ISPAN, under FAP19 converted this database into Arc/Info Generate format and created thana boundaries, checked it and appended 464 thana boundaries. International boundary captured by ISPAN from Toposheets published by SOB at 1:50,000 scale, has also been incorporated to this data layer. In addition NWRD has captured new 26 thana using Police Station Maps and BBS Community Series, appended 490 thana boundaries and updated the coastal boundary from LANDSAT Image 1997 to prepare this data layer.

(11) Digital Elevation Model (DEM)

ABSTRACT : A grid data layer representing the continuous elevation of the land surface of Bangladesh. (See Map A1.7-1; Applied to contour map in Haor Area)

A. HYDROLOGY

HISTORY OF DATA LAYER : Master Plan Organization (MPO) digitized national level grid of elevation points of 1 km by 1km from the topographic data of Bangladesh Water Development board (BWDB). FAP19 increased this resolution to 500m by 500m grid and developed a national level DEM with 300m resolution in 1995. Missing data are infilled by NWRD using BWDB Contour maps, irrigation maps and SOB Topo maps and regenerated the national digital elevation model with 300 m resolution in 1999. Sundarban area is infilled with a value of 1 meter.

(12) Union Boundaries (4451), 1991

ABSTRACT : A spatial data layer of union boundaries (lowest administrative unit) of Bangladesh along with the attribute information derived from Geomaster Database, 1991 published by Bangladesh Bureau of Statistics (BBS).

HISTORY OF DATA LAYER : Union boundaries have been captured from the Police Station Maps published by Directorate of Land Record and Survey (DLRS). The source maps were compiled between 1922-1964. Some maps were also compiled after this period. Scale of these maps were 1"=1mile. For Sundarbans area union boundaries have been delineated with the help of river course and small atlas of BBS and have been captured from Reserve Forest maps published by Survey of Bangladesh. Geocoding in the maps has been done according to the Geomaster database collected from Bangladesh Bureau of Statistics (BBS). Other attribute information have been attached to the spatial data layer according to the same source.

(13) Perennial Waterbodies, 1999

ABSTRACT : A spatial data layer representing the location of perennial water bodies of Bangladesh.

HISTORY OF DATA LAYER : ISPAN (Irrigation Support Project for Asia and Nearest) captured the perennial water bodies from SPOT multi spectral image for FAP 19. EGIS-I updated the data layer adding more information from SPOT image. Following this NWRD has enhanced it with some missing information from SPOT 89 image, LANDSAT 97 image and IRS 98 image.

(14) Physiographic units

ABSTRACT : A spatial data layer related to soil type, showing the physiographic division of Bangladesh with other associated attribute information. (See Map A1.7-2; Applied to Char Area and Haor Area)

HISTORY OF DATA LAYER : This data layer has been uploaded into NWRD from National Data Bank of EGIS. Source of this data set is Land Resource Inventory Maps produced by Bangladesh Agricultural Research Council (BARC) under FAO/UNDP Agricultural Development Adviser Project (BGD/81/035) Ministry of Agriculture Govt. of Bangladesh, December 1985, at 1:250,000 scale. ISPAN (Irrigation Support Project for Asia and Nearest) captured the data from the source maps under FAP19.

(15) Flood Regime Land Type

ABSTRACT : A spatial data layer showing average floods depth during the monsoon season. The data theme results from a GIS analysis involving topographic information and digital soil map. (See Table A1.7-2 and Map A1.7-3; Presenting flood depth)

HISTORY OF DATA LAYER : UNDP-FAO Land Resource Appraisal of Bangladesh for agricultural development classified inundation depth according to landscape position in their AEZ mapping. FAP 19 used the inundation attribute data linked to the soil association map units. FAP 19 produced inundation land type map using the soils and topographic data layers.

1.7.2 Application to Study

The selected GIS data are practically applied to the selection of Upazilas and Unions for the Study. Detailed descriptions of the applied results are given in the Volume of Supplementary Report E. Infrastructural Development.

Table A1.7-1: Selected Data Layer

Serial No	Geo KeyID	Source Name	Description of Data Layers	Data Source & Scale	Data Group	Data Type	Data Format	NWRD
8	146	Catchments of NAM(NE)	Catchment boundary of NAM(North East) delineated for surface water modelling by Surface Water Simulation Modelling Program in 1990	SWMC	Base Data	Catchment	Arcview Shapefile	✓
28	6	District boundaries (64)	District boundaries (64) generated by NWRD from AEZ mapping based on 1991 Population census	AEZ 1:250,000 map	Base Data	District	Arcview Shapefile	✓
49	681	BWDB FCDI Project Locations (All Embankment Line)	All embankment locations of BWDB FCDI Projects captured by NWRD from Inventory of Water Development Systems 1991 published by BWDB	BWDB, Inventory of water development systems 1991, 1:50,000 scale	Base Data	Project	Arcview Shapefile	✓
52	670	BWDB FCDI Project Locations (Polygon)	BWDB FCDI project locations as closed boundaries (Polygon) captured by NWRD from Inventory of Water Development Systems 1991 published by BWDB	BWDB, Inventory of water development systems 1991, 1:50,000 scale	Base Data	Project	Arcview Shapefile	✓
57	218	Railline	Rail Line location of Bangladesh generated by Bangladesh Railway in 1999 and updated by NWRD	Bangladesh Railway 1999, Scale 1:601920 Updated using IRS image	Base Data	Railway	Arcview Shapefile	✓
63	15	Major Rivers	Major river system of Bangladesh captured by FAP19 and NWRD from SPOT89 image and LANDSAT97 image	SPOT 89 & Landsat 97 images 1:50,000 (20m), (30m) BWDB & BIWTA	Base Data	River	Arcview Shapefile	✓
66	432	Transboundary Rivers	Transboundary rivers demarked by NWRD according to a report published by Joint River Commission and captured from SPOT89, LANDSAT 97 image	SPOT 89 & Landsat 97 images 1:50,000 (20m), (30m) BWDB & BIWTA	Base Data	River	Arcview Shapefile	✓
67	217	Asian Highway	Asian highway generated by RHD	RHD	Base Data	Road	Arcview Shapefile	✓
70	236	National and Regional Highway of RHD	National and regional highway map generated by RHD and updated by NWRD	RHD	Base Data	Road	Arcview Shapefile	✓
81	1	Thana boundaries (490)	Thana boundaries (490) generated by NWRD from AEZ mapping based on 1991 population census	AEZ 1:250,000 map	Base Data	Thana	Arcview Shapefile	✓
83	17	Digital Elevation Model	Digital elevation model of Bangladesh at 300m resolution	BWDB irrigation map 1:40,000 SoB Topo 1:50,000	Base Data	Topography	GRID	✓
85	129	Union Boundaries(4451), 1991	Union boundaries (4451) captured by NWRD from Police Station maps published by DLRS	DLRS 1 in 1 mile scale map 1:63,630	Base Data	Union	Arcview Shapefile	✓
87	9	Perennial waterbodies, 1999	Perennial water bodies of Bangladesh captured by NWRD from SPOT89, LANDSAT97 and IRS image	SPOT 89, Landsat 97, IRS image 98, SoB Topo 1:50,000 (20m), (30m), (6m) 1:50000	Base Data	Waterbodies	Arcview Shapefile	✓
236	248	Physiographic Units	Physiographic units of Bangladesh captured from AEZ mapping by FAP19/NWRD	SRD/IBARC, Land Resource Database	Soil and Agriculture	Agro Ecological Zone	Arcview Shapefile	✓
249	265	Flood Regime Landtype	Flood regime landtype generated from a GIS analysis involving digital elevation model and soil classification dataset by FAP19	SRD/IBARC	Soil and Agriculture	Land type	Arcview Shapefile	✓

Table A1.7-2: Land Classification by Flood Depth

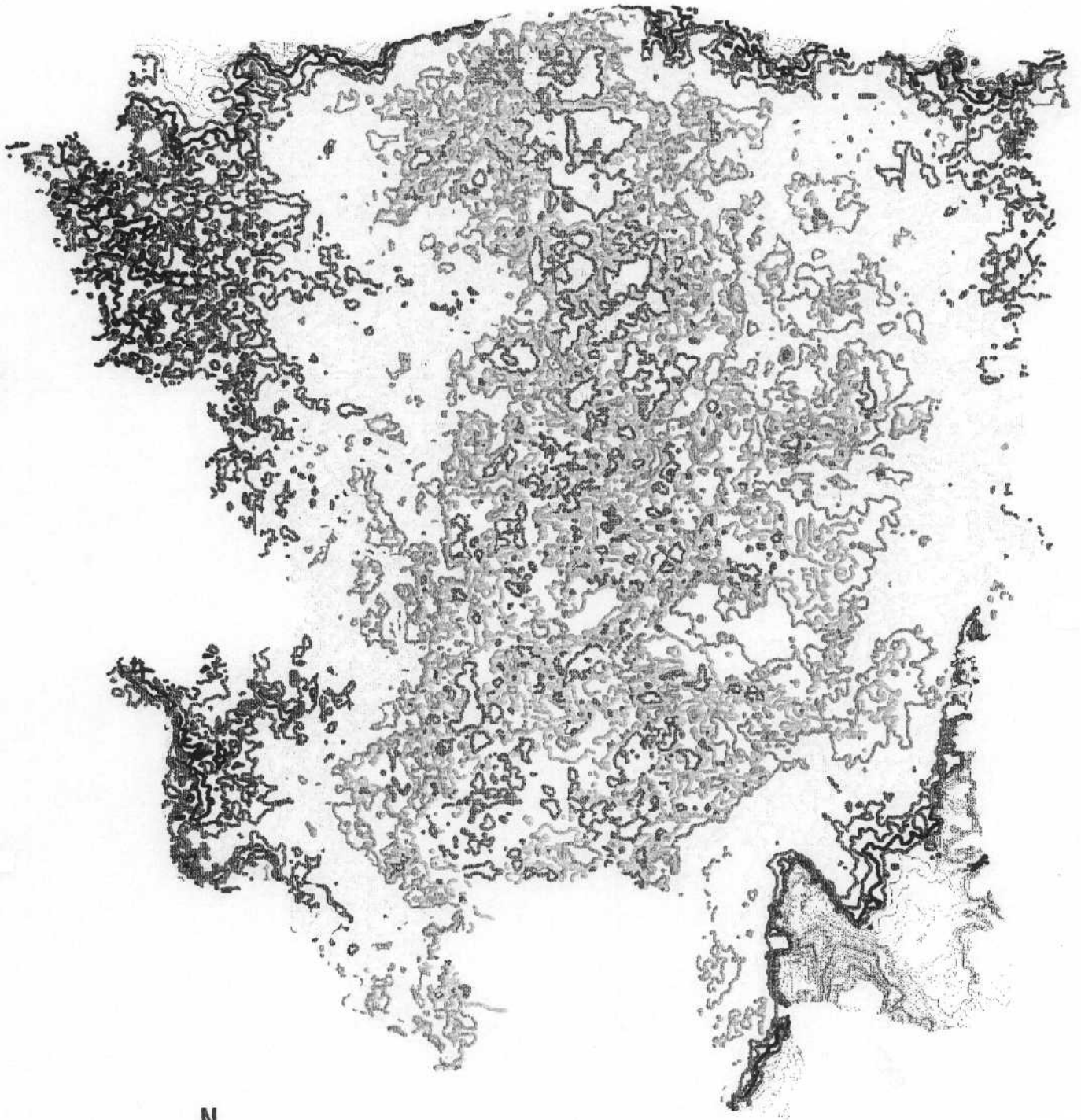
(Source: Draft NWMP)

Land Classification	Phase	Depth of Flooding	Area ** (million ha)	Area ** (%)	Flooding Volume * (MCM)	Flooding Volume * (%)	Suitable Type of Rice	Description
Highland (H)	F0	0-30 cm	3.5	36.8	5,250	6.9	HYV	Intermittent flooding, land suited to HYV rice in wet season.
Medium Highland (MH)	F1	30-90cm	3.2	33.7	19,200	25.2	Local Variety	Seasonal flooding, land suited to local varieties of aus and T aman in monsoon season.
Medium Lowland (ML)	F2	90-180 cm	1.6	16.8	21,600	28.3	B aman	Seasonal flooding, land suited to B aman in wet season.
Lowland(L)	F3	180-300 cm	1.1	11.6	26,400	34.6	B aman	Seasonal flooding, land on which B aman can be grown in wet season.
Very Lowland (VL)	F4	>300 cm	0.1	1.1	3,750	4.9	None	Seasonal or perennial flooding does not permit growing of B aman in the wet season
Total			9.5	100.0	76,200	100.0		

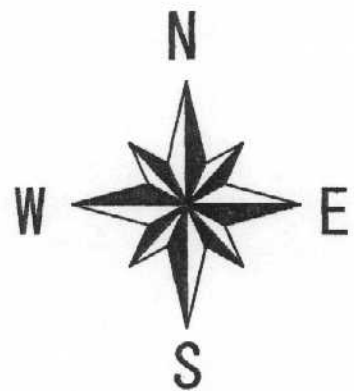
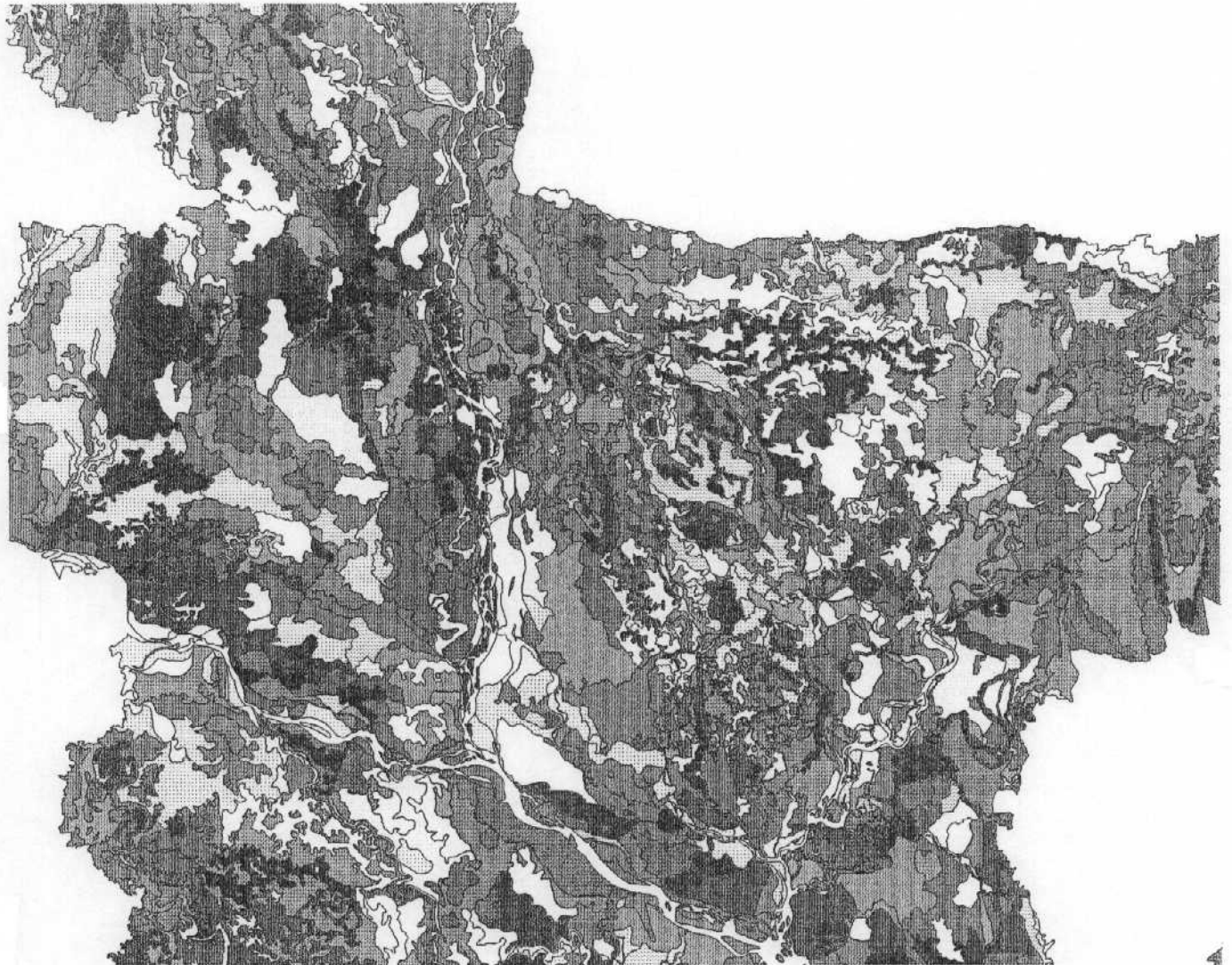
* Notes: Flooding Volume = Depth of Flooding x Area

**Indicative values under 'Normal Year' construed with 3 years out of 4 or 5 according to Reference (6) pp11, 183-188.

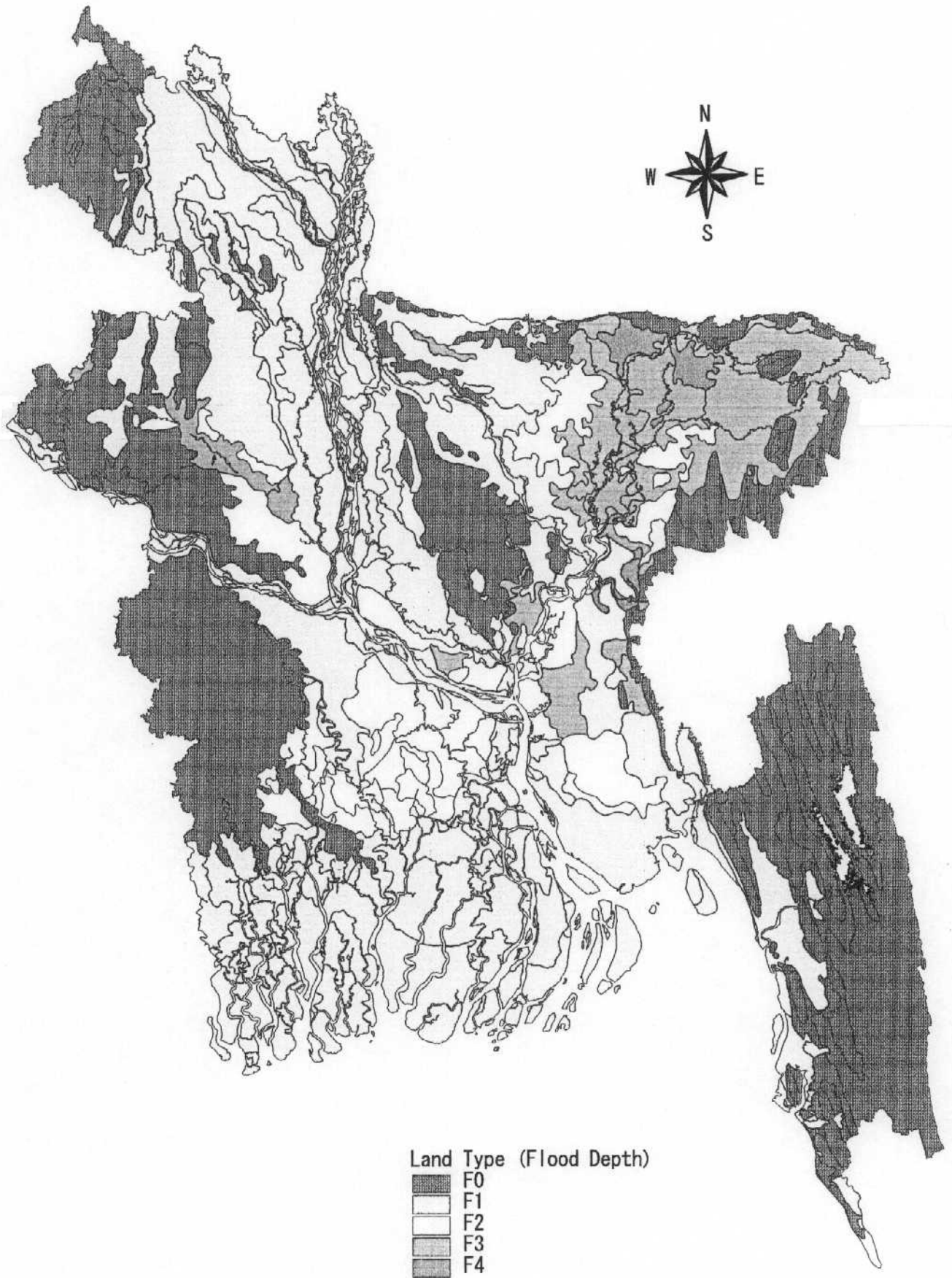
Map A1.7-1: Digital Elevation Model



Map A1.7-2: Physiographic Units



Map A1.7-3: Flood Regime Land Type (Bangladesh)



Map A1.7-4: Flood Regime Land Type (Haor Area)

