Government of the People's Republic of Bangladesh

Ministry of Water Resources

National Water Management Plan

Volume 5

Supporting Information

December 2001

WARPO
পানি সম্পদ পরিকল্পনা সংস্থা

Water Resources Planning Organization

Government of the People's Republic of Bangladesh

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Water Resources Planning Organization

National Water Management Plan

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Foreword

The National Water Policy is reproduced in full in Annex-A. Each paragraph has been categorised as either a **T**(itle), **P**(reamble) or a **D**(eclaration of Policy).

The Policy is divided into six main sections, with 16 sub-sections under Policy:

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National Water Management Plan

Annex A

The National Water Policy

1999

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National Water Policy

Ref (§) Type

Content

1 T 1. INTRODUCTION

1.011 P Water is central to the way of life in Bangladesh and the single-most important resource for the well-being of its people. It sustains an extremely fragile natural environment and provides livelihood for millions of people. Unfortunately, it is not infinite and cannot be treated as a perpetual free gift of nature to be used in any manner chosen. The unitary nature of water makes its use in one form affect the use in another. Its availability for sustenance of life, in both quantitative and qualitative terms, is a basic human right and mandates its appropriate use without jeopardising the interest of any member of the society.

1.022 P Availability of water, including rainwater, surface water, and groundwater, in usable forms calls for its sustainable development, a responsibility that has to be shared collectively and individually by members of the society. Private users of water are the principal agents for its development and management and private investments need to be actively promoted in the water sector, ensuring equal opportunity to all. However, development of water resources often requires large and lumpy capital investment and generates economies of scale, which justifies public sector involvement. Government's role also becomes important because of the necessity of protecting the needs of the society at large and addressing important environmental as well as social issues such as poverty alleviation and human resources development.

1.033 P Water resources management in Bangladesh faces immense challenge for resolving many diverse problems and issues. The most critical of these are alternating flood and water scarcity during the wet and the dry seasons, ever-expanding water needs of a growing economy and population, and massive river sedimentation and bank erosion. There is a growing need for providing total water quality management (checking salinity, deterioration of surface water and groundwater quality, and water pollution), and maintenance of the eco-system. There is also an urgency to satisfy multi-sector water needs with limited resources, promote efficient and socially responsible water use, delineate public and private responsibilities, and decentralise state activities where appropriate. All of these have to be accomplished under severe constraints, such as the lack of control over rivers originating outside the country's borders, the difficulty of managing the deltaic plain, and the virtual absence of unsettled land for building water structures.

1.044 P The water policy provided hereunder, lays down the broad principles of development of water resources and their rational utilisation under these constraints. It will help guide both public and private actions in the future for ensuring optimal development and management of water that benefits both individuals and the society at large.

2 T 2. DECLARATION OF NATIONAL WATER POLICY

2.011 P As water is essential for human survival, socio-economic development of the country and preservation of its natural environment, it is the policy of the Government of Bangladesh that all necessary means and measures will be taken to manage the water resources of the country in a comprehensive, integrated and equitable manner. The policies enunciated herein are designed 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.

2.022 P The National Water Policy will be reviewed periodically and revised as necessary. It will guide management of the country's water resources by all the concerned ministries, agencies, departments, and local bodies that are assigned responsibilities for the development, maintenance, and delivery of water and water related services as well as the private users and developers of water resources.

3 T 3. OBJECTIVES OF NATIONAL WATER POLICY

3.011 P The water policy of the government aims to provide direction to all agencies working with the water sector, and institutions that relate to the water sector in one form or another, for achievement of specified objectives. *These objectives are broadly*:

3.01a D a. To address issues related to the harnessing and development of all forms of surface water and ground water and management of these resources in an efficient and equitable manner

3.01b D b. To ensure the availability of water to all elements of the society including the poor and the underprivileged, and to take into account the particular needs of women and children

3.01c D c. To accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing

3.01d D d. To bring institutional changes that will help decentralise the management of water resources and enhance the role of women in water management

3.01e D e. To develop a legal and regulatory environment that will help the process of decentralisation, sound environmental management, and improve the investment climate for the private sector in water development and management

3.01f D f. To develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement of the water management objectives through broad public participation

4 T 4. NATIONAL WATER POLICY

4.001 P The policies set forth herein are considered essential for addressing the objectives of improved water resources management and protection of the environment. Every public agency, every community, village and each individual has an important role to play in ensuring that the water and associated natural resources of Bangladesh are used judiciously so that the future generations can be assured of at least the same, if not better, availability and quality of those resources.

4.01 T 4.1 River Basin Management

4.011 P Basin planning provides the most rational basis of development of water resources under the influence of one or more major rivers. International river basins, however, such as the Ganges basin, the Brahmaputra basin, and the Meghna basin present special problems. Due to its location as the lower-most riparian, Bangladesh has no control over the rivers entering through its borders. The adverse effects of this are the floods and water scarcity, which occur frequently. Although the 1996 Treaty on Sharing of the Ganges Waters with India has brought some relief to the drought-prone area of the southwest, the water shortage problem during the dry season is likely to aggravate in the Ganges and other basins with rising demands of the increasing population. It is, however, encouraging to note that the relevant provision of the treaty will provide the basis in the future for discussion on sharing of waters of the common rivers.

4.012 P It may take considerable effort and time for Bangladesh to work out joint plans for different river basins with other co-riparian countries. As a long-term measure, therefore, it is the policy of the government to undertake essential steps for realising basin-wide planning for development of the resources of the rivers entering its borders.

4.013 P The Government will endeavour to enter into agreements with co-riparian countries for sharing the waters of international rivers, data exchange, resource planning and long-term management of water resources under normal and emergency conditions of flood, drought and water pollution. While moving towards the attainment of basin-wide plans in the long run, it will also be necessary for Bangladesh to concentrate on the development of individual hydrological areas to meet short and intermediate term requirements.

4.014 P *The policy of the Government of Bangladesh, in the short and intermediate term, for fostering international cooperation in water management is to:*

4.01a D a. Work with co-riparian countries to establish a system for exchange of information and data on relevant aspects of hydrology, morphology, water pollution, ecology, changing watershed characteristics, cyclone, drought, flood warning, etc., and to help each other understand the current and emerging problems in the management of the shared water sources.

4.01b	D	b. Work with co-riparian countries for a joint assessment of all the international rivers flowing through their territories for better understanding of the overall basins' potentials.
4.01c	D	c. Work jointly with co-riparian countries to harness, develop, and share the water resources of the international rivers to mitigate floods and augment flows of water during the dry season.
4.01d	D	d. Make concerted efforts, in collaboration with co-riparian countries, for management of the catchment areas with the help of afforestation and erosion control for watershed preservation and reduction of land degradation.
4.01e	D	e. Work jointly with co-riparian countries for the prevention of chemical and biological pollution of the rivers flowing through these countries, by managing the discharge of industrial, agricultural and domestic pollutants generated by human action.
4.01f	D	f. Seek international and regional cooperation for education, training, and research in water management.
4.02	**T**	**4.2 Planning and Management of Water Resources**
4.021	P	The Government recognizes that the process of planning and managing water resources requires a comprehensive and integrated analysis of relevant hydrological, topographical, social, political, economic, environmental and institutional factors across all related water-using sectors.
4.022	P	The intricate nature of drainage systems within the country requires that activity for planning and management of the nation's river systems is undertaken within the context of hydrological regions. The principal river systems create natural boundaries for these regions. The hilly areas of the east form another hydrological region.
4.023	P	*Henceforth, to address these issues the policy of the Government will be as follows:*
4.02a	D	a. The Water Resources Planning Organisation (WARPO) will delineate the hydrological regions of the country, based on appropriate natural features, for planning the development of their water resources.
4.02b	D	b. WARPO will prepare, and periodically update, a National Water Management Plan (NWMP) addressing 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.
4.02c	D	c. 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.
4.024	P	*Within the macro framework of the NWMP:*
4.02d	D	d. 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.
4.02e	D	e. The Bangladesh Water Development Board (BWDB) will implement all major surface water development projects and other FCDI projects with command area above 1000 hectares. The Local Government will implement FCDI projects having a command area of 1000 hectares or less after identification and appraisal through an interagency Project Appraisal Committee. Any interagency dispute will be resolved by means prescribed by the Government.
4.02f	D	f. The participation of all project affected persons, individually and collectively, will be ensured in the planning, design, implementation, and operation and maintenance (O&M) of publicly funded surface water resources development plans and projects. Local Governments (Parishads) will be the principal agencies for coordinating these efforts. Community level self-help groups (private) and Non-Government Organisations will also be relied on to assist in the participatory process.
4.025	P	*The Government will further:*
4.02g	D	g. Frame rules, procedures, and guidelines for combining water-use and land-use planning

4.02h	D	h. Frame, and periodically revise, the rules, procedures and guidelines on all aspects of water management
4.02i	D	i. Make social and environmental assessments mandatory in all plan development
4.026	P	*Through its responsible agencies, the Government will:*
4.02j	D	j. Undertake comprehensive development and management of the main rivers through a system of barrages and other structural and non-structural measures
4.02k	D	k. Develop water resources of the major rivers for multipurpose use, including irrigation, fisheries, navigation, forestry, and aquatic wildlife
4.02l	D	l. De-silt watercourses to maintain navigation channels and proper drainage
4.02m	D	m. Delineate water-stress areas based on land characteristics and water availability from all sources for managing dry season demand
4.02n	D	n. Take steps to protect the water quality and ensure efficiency of its use
4.02o	D	o. Develop early warning and flood-proofing systems to manage natural disasters like flood and drought
4.02p	D	p. Designate flood risk zones and take appropriate measures to provide desired levels of protection for life, property, vital infrastructure, agriculture and wetlands. *In this regard the following principles will guide future action*:
4.02p i	D	i. Regions of economic importance such as metropolitan areas, sea and air ports, and export processing zones will be fully protected against floods as a matter of first priority. Other critical areas such as district and upazila towns, important commercial centers, and places of historical importance will be gradually provided reasonable degree of protection against flood. In the remaining rural areas, with the exception of those already covered by existing flood control infrastructure, the people will be motivated to develop different flood proofing measures such as raising of platform for homesteads, market places, educational institutions, community centers, etc., and adjusting the cropping pattern to suit the flood regime.
4.02p ii	D	ii. In future all national and regional highways, railway tracks, and public buildings and facilities will be constructed above the highest ever-recorded level of flood in the country. This principle will also apply in cases of reconstruction of existing structures of this nature.
4.02p iii	D	iii. All plans for roads and railways embankment will adequately provide for unimpeded drainage.
4.02q	D	q. Undertake survey and investigation of the problem of riverbank erosion and develop and implement master plans for river training and erosion control works for preservation of scarce land and prevention of landlessness and pauperisation.
4.02r	D	r. Plan and implement schemes for reclamation of land from the sea and rivers.
4.03	**T**	**4.3 Water Rights and Allocation**
4.031	P	The ownership of water does not vest in an individual but in the state. The Government reserves the right to allocate water to ensure equitable distribution, efficient development and use, and to address poverty. The Government can redirect its use during periods of droughts, floods, cyclones, and other natural and man-made disasters, such as contamination of groundwater aquifers that threaten public health and the ecological integrity. Allocation rules will be the formal mechanism for deciding who gets water, for what purpose(s), how much, at what time, for how long, and under what circumstances water use may be curtailed. Rules for water allocation will be developed for in-stream needs (ecological, water quality, salinity control, fisheries and navigation) during low-flow periods; for off-stream withdrawal (irrigation, municipal and industrial, power), and for groundwater recharge and abstraction. Allocation for non-consumptive use (e.g. navigation) would imply ensuring minimum levels in water bodies used for that purpose.
4.032	P	*Henceforth, the policy of the Government to regulate the use of water, where required, will be exercised in the following manner:*

4.03a D a. The Government will exercise its water allocation power in identified scarcity zones on the basis of specified priorities.

4.03b D b. In general, the priority for allocating water during critical periods in the water shortage zones will be in the following order: domestic and municipal uses, non-consumptive uses (e.g. navigation, fisheries and wild-life), sustenance of the river regime, and other consumptive and non-consumptive uses such as irrigation, industry, environment, salinity management, and recreation. The above order of priority could however be changed on specific socio-economic criteria of an area by local bodies through local consensus.

4.03c D c. For sustaining rechargeable shallow groundwater aquifers, the Government will regulate the extraction of water in the identified scarcity zones with full public knowledge.

4.03d D d. Specific drought monitoring and contingency plans will be prepared for each region experiencing recurrent seasonal shortages of water with due consideration to conjunctive use of rainwater, surface water and ground water and alternative ways of satisfying demand. The contingency plan will include action to limit the use of groundwater according to priorities. Appropriate provisions of law should be made to protect specific users' rights in these extreme cases.

4.03e D e. The Government may empower the local government or any local body it deems fit, to exercise its right to allocate water in scarcity zones during periods of severe drought, and it will monitor the water regime and enforcement of the regulations through specifically designed mechanisms.

4.03f D f. The Government may confer water rights on private and community bodies to provide secure, defensible and enforceable ownership/usufructuary rights to ground water and surface water for attracting private investment.

4.03g D g. In specifying surface water rights, the minimum requirement of stream-flow for maintaining the conveyance channel will be ensured.

4.04 T 4.4 Public and Private Involvement

4.041 P Water resources management requires involvement of the public and private sectors, communities and individuals that benefit from the delivery of water-related services. The ultimate success and effectiveness of public water resources management projects depends on the people's acceptance and ownership of each project. It is important to delineate the roles and responsibilities of every one involved in water resources management. The principle that community resources should be managed by the community concerned, along with local government institutions unless a greater national interest prevails, should guide water resource management. It is recognised that women have a particular stake in water management because they are the principal providers and carriers of water, main caretaker of the family's health, and participants in many stages of pre and post harvest activities. *The policies of the Government regarding the respective roles of the public and private sectors are*:

4.04a D a. Government's investments in water programme will be directed towards creation of public goods or for addressing specific problems of market failure and protecting particular community interests.

4.04b D b. Policies and programmes of any public agency involving water resources will be coordinated with the policies and programmes of all other public and private bodies to build synergy and avoid conflict.

4.04c D c. Public water institutions will, to the extent feasible, use private providers of specific water resources services in carrying out their mandates, giving preference to beneficiary groups and organisations.

4.04d D d. The management of public water schemes, barring municipal schemes, with command area up to 5000 ha will be gradually made over to local and community organisations and their O&M will be financed through local resources.

4.04e D e. Public water schemes, barring municipal schemes, with command area of over 5000 ha will be gradually placed under private management, through leasing, concession, or management contract under open competitive bidding procedures, or jointly managed by the project implementing agency along with local government and community organisations.

4.04f D f. Ownership of FCD and FCDI projects with command area of 1000 ha or less will gradually be transferred to the local governments, beginning with the ones that are being satisfactorily managed and operated by the beneficiary/ community organisations.

4.04g D g. Appropriate public and private institutions will provide information and training to the local community organisations for managing water resources efficiently.

4.04h D h. Enabling environment will be created for women to play a key role in local community organisations for management of water resources.

4.04i D i. Government, where appropriate, will restructure its present institutions and design all future institutions for efficient implementation of the above policies.

4.05 T 4.5 Public Water Investment

4.051 P The Government considers that a consistent and uniformly applied analytical framework for project appraisal is essential to equitable, efficient and effective water resources management. A true multi-objective analysis of the water needs of an area, and the formulation of options for investment and management must consider the interrelations among different sources of water, different management schemes and the interaction between needs of different users and purposes. Investments in infrastructure may displace people and disturb ecosystems and, as such, broader water resources planning assessments and specific project appraisals must consider these cross-sectoral implications.

4.052 P *The policy of the Government in this regard is to ensure that:*

4.05a D a. Water resource projects, as far as possible, are developed as multipurpose projects with an integrated multi-disciplinary approach from planning to implementation to monitoring.

4.05b D b. Planning and feasibility studies of all projects will follow the Guidelines for Project Assessment (GPA), the Guidelines for People's Participation (GPP), the Guidelines for Environmental Impact Assessment (EIA), and all other instructions that may be issued from time to time by the Government.

4.05c D c. All relevant analytical procedures and evaluation methods, such as mathematical modelling, physical modelling, cost-benefit analysis, risk analysis and multi-criteria decision making are routinely used as part of water resources planning and project appraisal.

4.05d D d. Public water projects are designed with specific provision for future disinvestment, if and when feasible.

4.05e D e. Interests of low-income water users, and that of women, are adequately protected in water resource management.

4.05f D f. There is continuous updating and archiving of water resource data and basic information by relevant public sector agencies.

4.06 T 4.6 Water Supply and Sanitation

4.061 P The rural areas of Bangladesh suffer from lack of quality drinking water. Surface water supplies are generally polluted and groundwater, which till now had been the best source of safe drinking water, is contaminated with arsenic in many parts of the country. Heavy withdrawals of groundwater for irrigation have also lowered the water table in many areas below the effective reach of hand tubewells. Seepage of agro chemicals into shallow aquifers may also pollute water for human and animal consumption. Salinity intrusions from seawater deep into the land in the southwest are rendering groundwater unfit for consumption. Cities and urban areas too are facing the problem of receding water table due to heavy groundwater extraction. These water supply and sanitation problems have obvious implications for public health. Diarrheal diseases, arising largely from drinking unsafe water, are a leading cause of death in the rural areas. Lack of proper sanitation and drainage facilities, inadequate water supply, and insufficient health and hygiene education are the primary causes of diseases in the urban areas. Lack of access to safe water supply in the rural areas is a special hardship for women who have to carry water over long distances, with significant impact on their health and productivity.

4.062 P *To address these problems, it is the policy of the Government to:*

4.06a D a. Facilitate availability of safe and affordable drinking water supplies through various means, including rainwater harvesting and conservation.

4.06b D b. Preserve natural depressions and water bodies in major urban areas for recharge of underground aquifers and rainwater management.

4.06c D c. Mandate relevant public water and sewerage institutions to provide necessary drainage and sanitation, including treatment of domestic wastewater and sewage and replacement of open drains and construction of sewers, in the interest of public health.

4.06d D d. Empower, and hold responsible, municipalities and urban water and sewerage institutions to regulate the use of water for preventing wastage and pollution by human action.

4.06e D e. Mandate local governments to create awareness among the people in checking water pollution and wastage.

4.07 T 4.7 Water and Agriculture

4.071 P Support of private development of groundwater irrigation for promoting agricultural growth will continue, alongside surface water development where feasible. But there will be a renewed focus towards increasing efficiency of water use in irrigation through various measures including drainage-water recycling, rotational irrigation, adoption of water conserving crop technology where feasible, and conjunctive use of groundwater and surface water.

4.072 P Water allocations in irrigation systems have to be done with equity and social justice. At the same time, serious consideration should be given to non-point pollution of water systems by fertilizer and pesticides that are either leached to the groundwater or washed off the fields to rivers and lakes. *For this purpose, the policy of the Government is to*:

4.07a D a. Encourage and promote continued development of minor irrigation, where feasible, without affecting drinking water supplies

4.07b D b. Encourage future groundwater development for irrigation by both the public and the private sectors, subject to regulations that may be prescribed by Government from time to time.

4.07c D c. Improve efficiency of resource utilisation through conjunctive use of all forms of surface water and groundwater for irrigation and urban water supply.

4.07d D d. Strengthen crop diversification programmes for efficient water utilisation.

4.07e D e. Strengthen the regulatory system for agricultural chemicals that pollute ground and surface water, and develop control mechanism for reducing non-point pollution from agro-chemicals.

4.07f D f. Strengthen appropriate monitoring organisations for tracking groundwater recharge, surface and groundwater use, and changes in surface and groundwater quality.

4.08 T 4.8 Water and Industry

4.081 P Excessive water salinity in the southwest region is a major deterrent to industrial growth. Also, pollution of both surface and groundwater around various industrial centers of the country by untreated effluent discharge into water bodies is a critical water management issue. *The policy of the Government in this regard is that*:

4.08a D a. Zoning regulations will be established for location of new industries in consideration of fresh and safe water availability and effluent discharge possibilities.

4.08b D b. Effluent disposal will be monitored by relevant Government agencies to prevent water pollution.

4.08c D c. Standards of effluent disposal into common watercourses will be set by WARPO in consultation with DOE.

4.08d	D	d. Industrial polluters will be required under law to pay for the cleanup of water-body polluted by them.
4.09	**T**	**4.9 Water and Fisheries and Wildlife**
4.091	P	Fisheries and wildlife are integral aspects of economic development in Bangladesh and strongly linked to advancement of target groups, poverty alleviation, nutrition, and employment generation. Availability of water for fisheries is thus important from the point of view of sustenance as well as commercial ventures. *It is, therefore, the policy of the Government that*:
4.09a	D	a. Fisheries and wildlife will receive due emphasis in water resource planning in areas where their social impact is high.
4.09b	D	b. Measures will be taken to minimise disruption to the natural aquatic environment in streams and water channels.
4.09c	D	c. Drainage schemes, to the extent possible, will avoid state-owned swamps and marshes that have primary value for waterfowl or other wildlife.
4.09d	D	d. Water bodies like baors, haors, beels, roadside borrow pits, etc. will, as far as possible, be reserved for fish production and development. Perennial links of these water bodies with the rivers will also be properly maintained.
4.09e	D	e. Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding.
4.09f	D	f. Brackish aquaculture will be confined to specific zones designated by the Government for this purpose.
4.10	**T**	**4.10 Water and Navigation**
4.101	P	Inland navigation is of substantial economic importance to Bangladesh because its numerous watercourses provide the cheapest means of transportation. Siltation, however, has disrupted river communications in many water channels. De-siltation of these channels is required not only to restore their navigational capability but also to assist surface drainage. *The policies of the Government in this regard are*:
4.102	D	a. Water development projects should cause minimal disruption to navigation and, where necessary, adequate mitigation measures should be taken.
4.10b	D	b. Minimum stream-flows in designated rivers and streams will be maintained for navigation after diversion of water for drinking and municipal purposes.
4.10c	D	c. Dredging and other suitable measures would be undertaken, wherever needed, to maintain navigational capability of designated waterways.
4.11	**T**	**4.11 Water for Hydropower and Recreation**
4.111	P	Bangladesh has limited potential for hydropower due to its flat terrain and the absence of suitable reservoir area. However, it may be possible to build mini hydropower plants at small dam and barrage sites. A major environmental concern of hydropower development is the impediment to a river's natural flow imposed by structures built on it. A hydropower facility may be restrictive for fish movement also.
4.112	P	Use of water for recreational purposes is useful for developing tourism facilities. Introducing these facilities at the sites of reservoirs, lakes, dighis (big ponds), sea resorts, etc. would help the tourism industry of the country. *The policy of the Government is therefore that*:
4.11a	D	a. Mini-hydropower development schemes may be undertaken provided they are economically viable and environmentally safe.
4.11b	D	b. Recreational activities at or around water bodies will be allowed provided it is not damaging to the environment.
4.12	**T**	**4.12 Water for the Environment**

4.121 P Protection and preservation of the natural environment is essential for sustainable development. Given that most of the country's environmental resources are linked to water resources, it is vital that the continued development and management of the nation's water resources should include the protection, restoration, and preservation of the environment and its bio-diversity including wetlands, mangrove and other national forests, endangered species, and the water quality. Accordingly, water resource management actions will take care to avoid or minimise environmental damages.

4.122 P Water quantity and water quality issues are uniquely linked. Poor water quality affects the availability of fresh water for different uses. Contamination of surface water bodies and groundwater aquifers by agricultural pollutants, industrial discharge, domestic pollution, and non-point source urban runoff exacerbate water quality problems and endanger both natural ecosystem integrity and public health. Other environmental problems include: excessive soil erosion and sedimentation, waterlogging and salinisation of agricultural land, groundwater depletion, watershed degradation and deforestation, reduction of biodiversity, wetland loss, saltwater intrusion, and coastal zone habitat loss.

4.123 P Henceforth, all agencies and departments entrusted with water resource management responsibilities (regulation, planning, construction, operation, and maintenance) will have to enhance environmental amenities and ensure that environmental resources are protected and restored in executing their tasks. Environmental needs and objectives will be treated equally with the resources management needs. *It is, therefore, the policy of the government that all water management agencies and related natural resources departments will*:

4.12a D a. Give full consideration to environmental protection, restoration and enhancement measures consistent with the National Environmental Management Action Plan (NEMAP) and the National Water Management Plan (NWMP).

4.12b D b. Adhere to a formal environmental impact assessment (EIA) process, as set out in EIA guidelines and manuals for water sector projects, in each water resources development project or rehabilitation programme of size and scope specified by the Government from time to time.

4.12c D c. Ensure adequate upland flow in water channels to preserve the coastal estuary eco-system threatened by intrusion of salinity from the sea.

4.12d D d. Protect against degradation and resuscitate natural water-bodies such as lakes, ponds, beels, khals, tanks, etc. affected by man-made interventions or other causes.

4.12e D e. Completely stop the filling of publicly-owned water bodies and depressions in urban areas for preservation of the natural aquifers and environment.

4.12f D f. Take necessary steps to remove all existing unauthorised encroachments on rivers and watercourses and to check further encroachments that cause obstructions to water flows and create environmental hazards.

4.12g D g. Stop unplanned construction on riverbanks and indiscriminate clearance of vegetation on newly accreted land.

4.12h D h. Encourage massive afforestation and tree coverage specifically in areas with declining water table.

4.12i D i. Enforce the "polluter pay" principle in the development of regulatory guidelines for all regulatory actions designed to protect public health and the environment.

4.12j D j. Provide education and information to the industrial and farming communities on self-administered pollution control mechanisms and their individual and collective responsibilities for maintaining clean water sources.

4.13 T 4.13 Water for Preservation of Haors, Baors, and Beels

4.131 P Water bodies like haors, baors, and beels are precious assets of Bangladesh with unique regional characteristics. Apart from their scenic beauty, they have great economical and environmental value. Even during extremely dry seasons, when the smaller beels turn into quagmires, the haors and the baors retain considerable amount of water. These water bodies account for a large share of the natural capture fisheries and provide a habitat for a wide variety of aquatic vegetation and birds. They also provide sanctuary to migratory birds during winter. The haors and the beels usually connect to some adjoining river through khals.

4.132 P In the past, many beels have been drained through engineering interventions and turned into cropland for immediate gains. The adverse effects of such interventions have been deleterious to the environment. They have destroyed the fish and aquatic vegetables that thrive in these wetlands and are important in the diet of the rural poor. They have also blocked the flow of wastes, discharged from the flood plains and domestic sources, which naturally move out of the beels through the khals into the river's drainage system. Only submersible dikes have provided tangible benefits in certain haor areas by enabling cultivation of high yielding variety boro rice.

4.133 P The Government believes that in order to assist the natural processes of groundwater recharge, maintenance of aquatic life and ecological balance, disposal of wastes through the dynamic river system, and for turning the huge water bodies into recreational areas, their planned development is essential.

4.134 P *It is, therefore, the policy of the Government that:*

4.13a D a. Natural water bodies such as beels, haors, and baors will be preserved for maintaining the aquatic environment and facilitating drainage.

4.13b D b. Only those water related projects will be taken up for execution that will not interfere with the aquatic characteristics of those water bodies.

4.13c D c. Haors that naturally dry up during the winter will be developed for dry season agriculture.

4.13d D d. Take up integrated projects in those water bodies for increasing fish production.

4.13e D e. Natural water bodies will be developed, where possible, for recreational use in support of tourism.

4.14 T 4.14 Economic and Financial Management

4.141 P Changes are required in the system of prices and other economic incentives affecting water demand and supply in Bangladesh. Unless the users pay a price for water, there will be a tendency to misuse and deplete it under scarcity conditions. Desirable practices such as conjunctive use, water-saving agricultural and industrial technologies, water harvesting, water transfers, and water recycling, both within and between sectors, will emerge only when users perceive the scarcity value of water.

4.142 P A system of cost recovery, pricing, and economic incentives/disincentives is necessary to balance the supply and demand of water. Cost recovery of services such as flood control, drainage, irrigation, and wastewater treatment has not been considered adequately. Failure to recover O&M cost leads to decline of service quality and deterioration of the system. This, in turn, makes the consumers less willing to pay for the deteriorating services. An important principle, for the long-term, in this regard is that public service agencies should be converted into financially autonomous entities, with effective authority to charge and collect fees. The participation of users in managing and maintaining water facilities and operations is an important element of financial accountability. *It is, therefore, the policy of the Government that*:

4.14a D a. Water will be considered an economic resource and priced to convey its scarcity value to all users and provide motivation for its conservation. For the foreseeable future, however, cost recovery for flood control and drainage (FCD) projects is not envisaged in this policy. In case of flood control, drainage, and irrigation (FCDI) projects water rates will be charged for O&M as per Government rules.

4.14b D b. Relevant public water supply agencies will be gradually given authority to charge for their services.

4.14c D c. Recovery of O&M cost will, as far as possible, be made through private collection means such as leasing and other financial options. Beneficiaries and other target groups will be given preference for such contracts.

4.14d D d. The pricing structure will match the goals and needs of the water provider and the population served. Water rates will be lower for basic consumption, increasing with commercial and industrial use. The rates for surface and groundwater will reflect, to the extent possible, their actual cost of delivery.

4.14e D e. Water charges realised from beneficiaries for O&M in a project would be retained locally for the provision of services within that project.

4.14f D f. Effective beneficiary participation and commitment to pay for O&M will be realised at the project identification and planning stages by respective public agencies.

4.14g D g. Appropriate financial incentives will be introduced for water re-use and conservation, responsible use of groundwater, and for preventing overexploitation and pollution.

4.15 T 4.15 Research and Information Management

4.151 P Informing policy makers of the choice of appropriate technology to meet policy goals and make them aware of their significance and impact is an essential requirement of a dynamic water management policy. It is important to reach a common understanding between specialists, planners, politicians and the general public about the changing environment and the optimal ways and means of achieving the national water management goals. As management decisions become increasingly complex and information-sensitive, the demand for supporting research and information management increases.

4.152 P *It is the policy of the Government in this regard to:*

4.15a D a. Develop a central database and management information system (MIS) consolidating information from various data collection and research agencies on the existing hydrological systems, supply and use of national water resources, water quality, and the eco-system.

4.15b D b. Restructure and strengthen, where appropriate, water resource and agriculture research institutions to undertake systematic research and analysis of water and land management issues and problems arising both nationally and internationally.

4.15c D c. Investigate thoroughly important flood control and management issues, such as the efficacy of coastal polders, for guiding future policy on structural interventions.

4.15d D d. Investigate important sociological issues, such as the phenomenon of interference with water structures (e.g. public cuts), and the motives and conflicting interests behind them, to assist the process of building public support and acceptance of government water management programmes.

4.15e i-iii D e. Strengthen and promote the involvement of public and private research organizations and universities to:

i. Develop and disseminate appropriate technologies for conjunctive use of rainwater, ground water and surface water.

ii. Develop and promote water management techniques to prevent wastage and generate efficiency of water and energy use.

iii. Produce skilled professionals for water management.

4.16	**T**	**4.16 Stakeholder Participation**
4.161	P	Decisions regarding water resources management can affect nearly every sector of the economy and the public as a whole, and stakeholder participation should be established in a form that elicits direct input from people at all levels of engagement. Stakeholder involvement should be an integral part of water resources management, at all stages of the project cycle. Towards that objective there should be a complete reorientation of the institutions for increasing the role of stakeholders and the civil society in decision making and implementation of water projects. The Government has to be at the core of the effort to help build the local institutions and to impart a precise awareness of the issues and an unambiguous understanding of their role in water management. Similarly, Government must lead the effort to ensure greater participation of women in this endeavour.
4.162	P	In order to ensure that all stakeholders actively and fruitfully participate in water resources management decision making at all stages, *it is the policy of the Government that*:
4.16a	D	a. The "Guidelines for People's Participation (GPP) in Water Development Projects" be adhered to as part of project planning by all institutions and agencies involved in public sector management of water resources.
4.16b	D	b. Guidelines for formation of water user groups (WUG) and similar community organisations will be formulated.
4.16c	D	c. Generally 25 percent of the earthwork of any public water project will be offered to specific target groups or beneficiaries.
4.16d	D	d. All opportunities are explored and efforts undertaken to ensure that the landless and other disadvantaged group are directly involved in participatory management of local water resources.
4.16e	D	e. New projects proposed by a community or local institution will be considered for implementation on a priority basis only when the beneficiaries have mobilised a certain percentage of the total cost as their contribution to the project.
5	**T**	**5. INSTITUTIONAL POLICY**
5.001	P	The governance and management of the national water resources require a great deal of coordination of existing institutions and in some cases reform and creation of new community-based institutions. Water resources management extends across many water using sectors as well as political jurisdictions and geographically and hydrologically diverse areas. Properly functioning institutions are essential for effective implementation and administration of the country's water and related environmental resource management policies and directives.
5.002	P	The Government will restructure and strengthen, where appropriate, the existing institutions to ensure that the agenda for reform and the action plan is implemented efficiently. Two important principles will govern institutional restructuring. Firstly, there should be separation of policy, planning, and regulatory functions from implementation and operational functions at each level of government. Secondly, each institution must be held accountable for financial and operational performance.
5.003	P	*It is the policy of the Government that:*
5.00a	D	a. The Government will formulate a framework for institutional reforms to guide all water sector related activities. It will periodically review the mandates of all water sector institutions and redefine their respective roles, as necessary, to ensure efficient and effective institutions commensurate with changing needs and priorities.

5.00b i-vi	D	b. The National Water Resources Council (NWRC) will coordinate all water resources management activities in the country, and particularly: i. Formulate policy on different aspects of water resource management. ii.Provide directions for optimal development and utilisation of the national water resources. iii. Oversee the preparation and implementation of the National Water Management Plan. iv. Provide directions on the development of efficient institutions for managing the water resources. v. Provide policy directives for appropriate coordination among different water sector agencies. vi. Look after any other water resource management matter that may require its attention.
5.00c i-iv	D	c. The Executive Committee of the National Water Resources Council (ECNWRC) will have the following responsibilities: i. It will provide directives on all matters relating to the planning, management, and coordination of water resources across all sectors, as may be required by the NWRC. ii. It will guide water management institutions at the national, regional, and local levels in the formulation and implementation of policies and plans for improved water management and investment. iii. It will apprise and advise the National Water Resources Council periodically on matters of water resource management. iv. It will undertake any other function, as may be required from time to time, by the NWRC.
5.00d i-vii	D	d. WARPO will be the exclusive government institution for macro-level water resource planning. It will also serve as the Executive Secretariat of the ECNWRC with the following principal responsibilities: i. Providing administrative, technical, and legal support to the ECNWRC. ii. Advising the ECNWRC on policy, planning, and regulatory matters of water resources and related land and environmental management. iii. Preparing and periodically updating the National Water Management Plan for approval of the NWRC. iv. Setting up and updating the National Water Resources Database (NWRD) and Information Management System. v. Acting as a "clearing house" for all water sector projects identified by different agencies and reporting to the ECNWRC on their conformity to the NWMP. vi. Undertaking any special study, as may be required by the ECNWRC, for fulfilling the objectives and programmes envisaged in the National Water Policy and the Bangladesh Water and Flood Management Strategy. vii. Performing any other function as may be assigned to it from time to time by the Government.
5.00e	D	e. The Government will lead the effort towards developing grass-root institutions, in conjunction with the civil society, for managing water resources at community levels.
5.00f	D	f. Public water projects will include a training component for transfer of knowledge and technology to the users that will be monitored by the executing agency at every stage of the project work.

6	**T**	**6. LEGISLATIVE FRAMEWORK**
6.001	P	Setting the appropriate legislative framework is fundamental to effective implementation of the water policy. The existing legislation related to any form of water management in Bangladesh requires supplementing in a number of key areas. This policy will be given effect through a National Water Code encoding specific provisions of the water policy to facilitate its implementation.
6.002	P	*The policy of the Government in this regard is:*
6.00a	D	a. To periodically review the provisions of the body of laws and regulations that have an impact on water resource management and to recommend changes and amendments in them for efficient coordination of the work of different water-related sub-sectors.
6.00b	D	b. To enact a National Water Code revising and consolidating the laws governing ownership, development, appropriation, utilisation, conservation, and protection of water resources.

National Water Management Plan

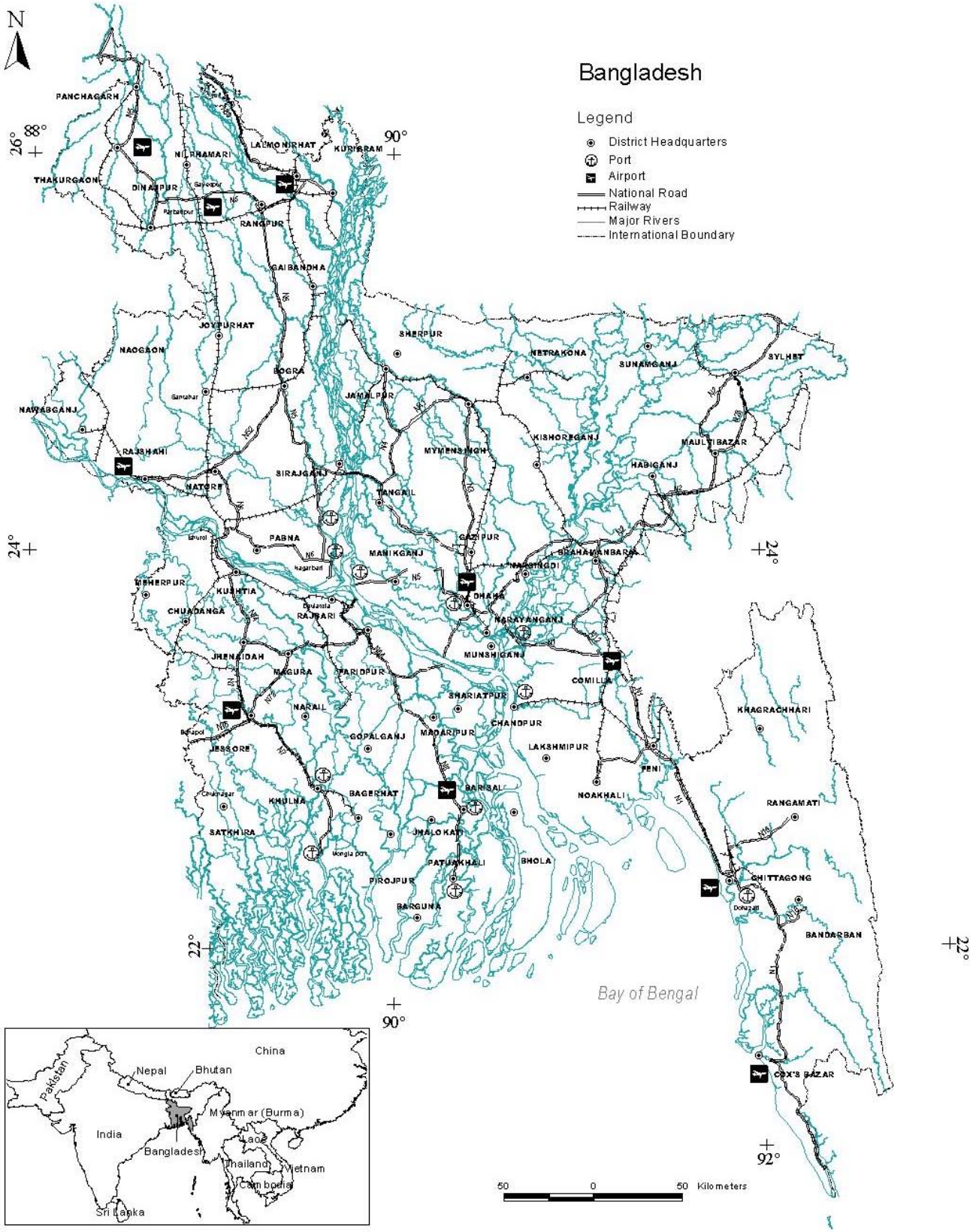
Annex B

Development Strategy

June 2001

December 2001

Contents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Major Rivers
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MEHERPUR
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China
Nepal
Bhutan
Pakistan
Myanmar (Burma)
India
Laos
Bangladesh
Thailand
Vietnam
Cambodia
Sri Lanka

1 Introduction

The Ministry of Water Resources published the National Water Policy (NWPo) for Bangladesh in early 1999. The Policy *lays down the broad principles of development of water resources and their rational utilisation under these constraints*. It is intended to *help guide both public and private actions in the future for ensuring optimal development and management of water that benefits both individuals and the society at large.*

In line with the requirements of the NWPo, the National Water Management Plan (NWMP) is being prepared in a comprehensive and integrated manner, with regard for the interests of all water-related sectors and taking full account of other sectoral policies of the Government. Widespread consultation has been conducted amongst a broad range of stakeholders throughout the country and, following a thorough assessment of development issues, different development options have been carefully considered and debated.

This Development Strategy sets out a framework for action within which the NWMP is to be formulated. It makes 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.

The Government entrusted the Water Resources Planning Organisation (WARPO) of the Ministry of Water Resources with preparation of the NWMP. The Plan is intended to provide the necessary advice on follow-up actions to be taken for implementing the NWPo, thereby contributing to national economic development through rational management of water resources, in a way that protects the natural environment and improves the quality of life for the people of Bangladesh.

The NWMP will be reviewed and updated every five years and set in the context of development indicators up to 50 years ahead. It will be a firm plan for the next five years, an indicative plan for the subsequent five years, and a perspective plan to 2025. 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 guidelines.

The planning framework suggested by the National Water Policy (NWPo) is one that addresses (i) national goals, (ii) improved management of the water sector, (iii) effective institutional, legal and regulatory measures, and (iv) efficient and equitable development measures. The main choices that have guided strategy formulation relate to the **emphasis** or priority to be given to **national goals,** the selection of an appropriate future **institutional framework**, and the selection of suitable sub-sectoral and regional **development measures**, taking account of their social, economic, environmental and technical merits and demerits.

Three main *strategic choices* have been considered, each representing a different understanding of the relative importance of the individual national goals:

(i) **Balanced Development Strategy**, where, in selecting development measures, equal importance is given to all six national goals:

- Economic development
- Poverty alleviation
- Food security
- Public health and safety
- Standard of living
- Protection of the natural environment

(ii) **Economic Growth Strategy**, where priority is given to the national goals of:

- Economic development
- Poverty alleviation
- Food security
- Standard of living

(iii) **Health and Environment Strategy**, where priority is given to the national goals of:

- Public health and safety
- Protection of the natural environment

Each Strategy sets a different path towards the same overall goal that reflects the long-term needs for developing the sector, the differences being in the order and the speed with which activities are taken up.

A wide range of development measures, identified through a participatory process, has been screened and evaluated in a two-stage process that has considered how well each addresses national goals and is applicable to current and future regional needs. The implications of phasing of the selected measures, reflecting the three main strategies, have been considered in the form of alternative short-, medium- and long-term programmes.

It is recognised that there is a need to continue to expand the knowledge of both water resources and system demands, in both cases in terms of quality, quantity and spatial and temporal variations. A key component of the strategy is therefore to address this at an early stage of the NWMP.

The Development Strategy for the Water Sector as enunciated here has been prepared after a review of these alternative strategies and their implications on the many different stakeholders in the water sector. From this, it has been concluded that a **Balanced Development Strategy**, giving equal weight to each national goal, is the most appropriate course to follow at this time.

2 Policy Objectives and Development Challenges

2.1 *The National Water Policy*

Water sector development must conform to and address the National Water Policy (NWPo) of 1999. Its prime intention is "….*to ensure progress towards fulfilling 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 six formative objectives as determined by the Policy can be summarised briefly as follows:

- To address issues related to the harnessing and development of all forms of surface water and groundwater and management of these resources in an efficient and equitable manner;
- To ensure the availability of water to all elements of the society including the poor and the underprivileged, and to take into account the particular needs of women and children;
- To accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing;
- To bring institutional changes that will help decentralise the management of water resources and enhance the role of women in water management;
- To develop a legal and regulatory environment that will help the process of decentralisation and sound environmental management, and will improve the investment climate for the private sector in water development and management; and
- To develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement of the water management objectives through broad public participation.

The achievement of these objectives requires a comprehensive implementation package involving:

- New legislation and regulations, particularly a Water Resources Act and a regulatory framework for private sector participation;
- Institutional development and strengthening at central and local levels;
- Consultation and participation with the direct beneficiaries in the hand-over and development of water schemes;
- Decentralisation and devolution of responsibility for management and operation of water schemes to local government and local water groups; and
- Private sector participation in the development, financing, management and operation of water schemes at the local and regional levels, as well as in the major

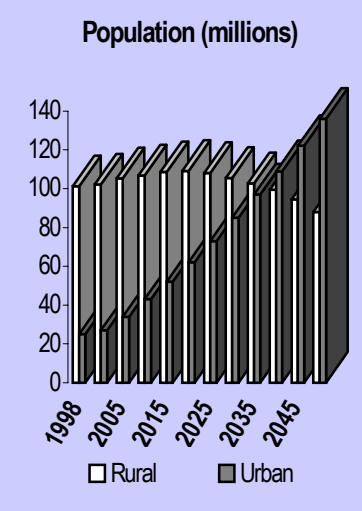
cities. This could involve companies with the appropriate qualifications, financial backing and expertise.

Together with implementation of a range of structural and non-structural measures designed to:

- Improve efficiency of resource utilisation through conjunctive use of all forms of surface water and groundwater for irrigation and urban water supply,
- Facilitate availability of safe and affordable drinking water supplies
- Comprehensively develop and manage the main rivers for multipurpose use
- De-silt watercourses to maintain navigation channels and proper drainage
- Develop flood-proofing systems to manage natural disasters
- Provide desired levels of protection in designated flood risk zones
- Implement river training and erosion control works for preservation of scarce land and prevention of landlessness and pauperisation.
- Reclaim land from the sea and rivers
- Develop mini-hydropower and recreational facilities at or around water bodies
- Implement environmental protection, restoration and enhancement measures consistent with the National Environmental Management Action Plan.

2.2 *Socio-Economic Challenges*

The package above represents a clear mission statement that the NWMP must address. It is important however, to appreciate that there are also social and economic imperatives that must be taken into account.



Population growth - The rate of population growth has slowed to less than 2% per year, but in absolute terms this still means that the population is projected to increase by 40% from about 129 million in 2000 to 181 million by 2025, and 224 million by 2050.

Urbanisation - Most of the predicted population increase is expected to be in urban areas, where, partly due to rural-urban migration, the population is expected to increase by 46 million in the next 25 years, from 27 million (21% of total) in 2000 to 73 million (40%) by 2025, and 136 million (60%) by 2050. Therefore, substantial investment and improved provision of social and economic infrastructure will be required in the urban areas.

Poverty alleviation - 57% of the population in rural areas and 51% in urban areas is classified as poor. Poverty is the country's most pressing socio-economic issue, and must

be addressed within a comprehensive planning framework that facilitates interventions which directly assist the poor.

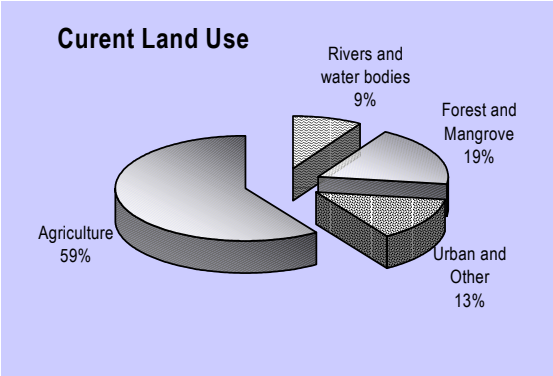
Economic growth and development - Sustained high-level economic growth is a key target in order to address the most pressing development problems. It is expected that the current economic growth rate of 5.5% will increase to at least 6% per year over the next 25 years. In a global market place, this will require further economic liberalisation and greater private sector participation (domestic and foreign).

Employment generation - Job-creation, particularly in the urban areas, will become a key policy issue. The projected growth in urban population means that some 14 million new employment opportunities will be needed in the next 25 years - and a further 21 million by the year 2050.

Democratisation and development - Demand is increasing for full consultation and participation at all stages in the planning and implementation of sector programmes and project interventions.

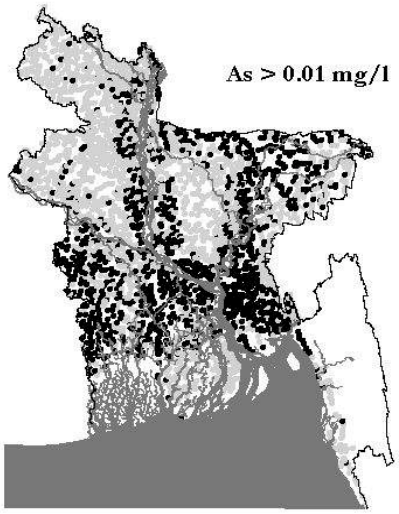
Education and public health - Major investments will be required in education and public health to eliminate illiteracy, develop new skills and ensure the well-being of all the people. Additional investment will be needed to manage the adverse impact of arsenic contamination.

Food security - The Government's target of rice and protein security to 2025 will require continuing yield improvements as well as the intensification and expansion of irrigation by private sector farmers.



Agriculture land availability – Pressure from urban expansion and other land uses will reduce land available for agriculture, and significantly reduce agricultural land per capita, imposing additional requirements for crop production.

2.3 *Environmental Challenges*



Major concerns have emerged relating to the natural environment and water-related impacts on fisheries. These already require urgent attention, and will become much worse, if left unattended.

Surface water quality – Severe problems are arising in industrial areas, particularly around Dhaka, and faecal contamination, mainly in urban areas, village ponds and small streams, is also a major problem. There are indications that aquifer pollution is also occurring in some of these areas. Major efforts are needed to arrest and reverse these trends.

Groundwater quality – The presence of arsenic in the shallow aquifer is a major threat to human health,

as it is both toxic and carcinogenic. Current understanding is that about 25% of the population are exposed to contamination exceeding Bangladesh standards, with a further 21% with supplies that do not meet the more stringent WHO standards. This dire situation requires priority attention, along with lesser issues of other contaminants.

Fisheries – Capture fishing on the flood plains has been a traditional activity of immense value to the poor. Stocks have declined rapidly in recent years due to water pollution, impeded migration routes and over-exploitation. Unless urgent steps are taken, capture fishing will become a thing of the past, at great commercial loss and raising major issues of protein security for the poor.

Watershed Management – In the upland and hilly areas, land degradation contributes towards increased soil erosion and impacts on the river systems as sediment loads increase. Forestry plays an essential role in watershed management and efforts are to sustain and expand forest areas in line with the Government's policy.

Environmental conservation and protection - The principal ecologically-sensitive areas of the country are under great pressure, both from encroachment and as sources for subsistence and production. Both the Sundarbans and the Tanguar Haor Basin of the Northeast, being Ramsar sites, merit special attention. There is a real danger that their degradation will become habitual. The key issue is to reverse this trend before there are no sites left worth conserving.

2.4 *Technical Challenges*

The physiography of Bangladesh, coupled with the demographic, socio-economic and environmental pressures, create many technical challenges. Some of these are relatively well understood, and solutions are available either within the country or can be found from elsewhere. However, in a number of strategically important areas, major challenges exist that relate to the specific circumstances occurring in Bangladesh.

Principal water-related issues in the regions

Common issues

- Improved urban and rural services
- Improved environmental management and pollution control
- The arsenic problem
- Improved local drainage and water management facilities

South West Region

- Preservation of the Sundarbans
- Restoration of dry season freshwater inflows to the region
- Maintenance the coastal embankment system
- Alleviation of coastal drainage congestion
- Improved cyclone protection
- Remedial actions for existing FCDI schemes
- Flood proofing needs in the charlands and low lying areas

North East Region

- Environmental management of the Haor Basin
- Remedial actions for existing FCD schemes
- Flood proofing of villages in the Haor Basin
- Erosion of old Brahmaputra left bank
- Drainage congestion in the Kalni–Kushiyara and other rivers
- Local development of hill irrigation

North Central Region

- Bulk water supplies and pollution clean-up for Dhaka City
- Flooding and drainage problems in parts of the region
- Flood proofing needs in the charlands and low lying areas

North West Region

- Erosion along the right bank of the Brahmaputra
- Flooding and drainage problems
- Remedial measures for existing FCD(I) schemes
- Drought in the western fringes, especially the High Barind
- Flood proofing needs in the charlands and low lying areas

South Central Region

- Maintenance of the existing coastal embankment system
- Siltation and drainage congestion
- Improved cyclone protection
- Flood proofing needs in the charlands and low lying areas

South East Region

- Gaseous aquifers
- Improved cyclone protection
- Maintenance of the existing coastal embankment system and drainage congestion
- Protection of newly accreted lands against tidal flooding
- Remedial action for existing inland FCDI schemes

Eastern Hills Region

- Small-scale irrigation development in the CHT
- Mini-hydropower development in the CHT
- Improved cyclone protection in the CCP
- Maintenance of the existing coastal embankment system

Rivers and Estuary Region

- An affordable long-term strategy for erosion protection
- An affordable long-term strategy for regional augmentation
- Flood proofing needs in the charlands and low lying areas
- Improved cyclone protection in the Meghna Estuary
- Erosion of Meghna River
- Timely protection on newly accreted lands

River maintenance – The river systems are the life-blood of Bangladesh, which have shaped the history and rich culture of the people. They are sources both of danger from flooding and erosion, and of sustenance for the water and sediments they contain. They provide an arterial transportation network for people, goods and fish migration, and keep salinity intrusion at bay. The Government is intent on maintaining the rivers to serve these purposes through comprehensive development and management of both the main and local river systems. The strategy to effect this combines the progressive development of barrages and local diversion structures where feasible, combined with dredging programmes to sustain adequate depths of flow to meet multipurpose use. At a local level, community participation in drain re-excavation will be encouraged also. The challenge is to do all this in a cost-effective manner, requiring careful planning of dredging and other works in a manner that effectively minimises re-siltation.

Erosion control – River bank erosion causes immense hardship to those affected and the Government is committed to mitigating this problem. Engineering works, particularly on the main rivers are expensive to build and maintain, and can be subject to high risk. Investigations into lower cost solutions including non-structural measures have been taken up and need to be further developed. A detailed review is needed of experience gained, with individual river plans prepared and/or updated on an integrated basis in the light of recent infrastructure development and changing land values. An *ad hoc* approach is to be avoided to this challenging problem.

Land accretion - With the increasing pressure on land, accretion is an important issue for Bangladesh, whether naturally occurring as part of the delta building process or in the course of shifts in river alignments. Technical means for securing accreted land, through measures such as the development of the Coastal Green Belt, will remain an important activity where possible. However, greater focus needs to be brought upon socio-economic development, including improvement of land tenure arrangements.

Coastal zone management – Policy recognises that management of water resources in the coastal zone requires further study. These areas suffer from salinity intrusion, cyclone storms, lack of fresh water and impeded drainage. Sites of environmental importance, such as the Sundarbans, are threatened by the dimunition of upland flows. The polder systems have created much benefit, but have had side effects, particularly in terms of poor drainage. Development of the shrimp industry has prompted significant social tensions. The Government is committed to help resolve these problems, and has already taken up a number of initiatives in this regard, such as afforestation of the foreshore to protect against tidal surges. From a water perspective, the challenge is to develop comprehensive and sustainable solutions that take account of the inter-action between tidal and upland flows on the water regime.

2.5 *Knowledge Gaps*

New challenges bring about the need for increased knowledge. Whilst it is recognised that many issues need to be studied in more detail as part of the development process, the following are seen as major knowledge gaps at national level. Filling these gaps is seen as an essential and integral component of the overall Development Strategy.

Climate change – The potential impacts of climate change resulting from global warming are of great importance to Bangladesh. In broad terms, evaporation to

precipitation ratios are expected to rise progressively, prompting an increase in irrigation water requirements unless offset by diversification towards dry-foot crops. Whilst groundwater resources may be little affected, dry season transboundary flows may reduce. Main river flooding may increase in duration and flash flooding will tend to be more frequent, as also will cyclones. Surge depths will increase and a sea level rise of 0.5m by 2050 would exacerbate drainage congestion. Accretion of new coastal lands may be slower as a result. Understanding the full implications of climate change for Bangladesh and developing an appropriate response requires further consideration.

Arsenic – The implications of arsenic contamination of the shallow aquifer are substantial and at the centre of many strategic choices. Although much research has already been conducted into its occurrence and possible solutions, there are still considerable gaps in the understanding of both. Key areas of research are the implications for food safety of irrigating with arsenic contaminated water, the horizontal and vertical extent of contamination, the prediction of whether aquifer contamination will change with time, and cost-effective solutions for immediate mitigation and long-term solutions.

Groundwater utility – The utility of groundwater depends on its quality, the level from which it must be pumped and its sustainable yield. Whilst some information is available about the latter, the implications of varying quality have not yet been fully quantified. Urgent attention is needed to improve knowledge about groundwater.

Natural environmental water requirements – The relationship between water and the natural environment is not well understood, and in few cases readily quantifiable. Particular issues relate to appropriate water management of wetlands, the impacts of changing salinity and morphological regimes on the coastal environment, requirements to sustain fish migration, and pollution control requirements. Establishing key indicators and thresholds for environmental health and sustainability is an early requirement

Long-term implications for water management – As the lower riparian state of three major river systems, Bangladesh intends to work with its neighbours towards overall basin management, with an early focus on the different hydrological regions and promoting information exchange. Signature of the Ganges Water Treaty in 1996 is an important milestone, and continued efforts will be needed to secure Bangladesh's share of the flows of the other 53 transboundary rivers. Though many of these rivers contribute only a small proportion of the overall balance, locally they are important. In the longer-term there will be increased competition for water and greater environmental risks. A continuing dialogue amongst the co-riparian countries and extensive further studies will be needed to develop appropriate long-term strategies in response to the increasing demands on the overall system.

Devolved and decentralised water management – A major challenge set by Policy is to devolve and decentralise management of water resources and services. A variety of approaches have been adopted in different countries, often on the basis of historical precedence and cultural preference. It is not possible as yet to be certain what will be the best approach for Bangladesh, and a period of experimentation is required, most notably for management of flood control and drainage schemes, and more generally for water supplies. In view of the emphasis given by Policy to this, a substantial effort is called for to investigate, test and assess the options.

Promotion of private sector participation - Similarly, increased private sector participation is a major Policy platform where there are considerable uncertainties as to what would work best in this country. Whilst there is room for optimism over the development of small businesses, increased participation in major infrastructure development and management is less certain. Again, there is a considerable body of knowledge in other countries, which have seen both success and failure in this regard, as well as early experience in Bangladesh's energy sector. Understanding PSP in the Bangladesh context, and the benefits it could bring in terms of improved efficiency and alternative funding sources, needs to be addressed at an early stage.

3 Institutional Development

3.1 *Main Aims*

The Government intends to follow sound institutional principles and thereby to separate policy, planning, and regulatory functions from implementation and operational functions at each level of government, whilst at the same time holding each institution accountable for financial and operational performance.

The main aims for developing water sector institutions are determined by the NWPo and the changes envisaged to the institutional framework are intended to bring about:

- The progressive withdrawal of central Government agencies from activities that can be accomplished by local institutions and the private sector, in line with Government's commitment to decentralised decision taking through transparent mechanisms with emphasis on stakeholder participation.
- To the extent feasible and warranted, contracting out of central Government agency functions
- Activities at Zila level and below being carried out by a mix of LGIs, community-based organisations (CBO) and the private sector
- The municipalities progressively taking over full responsibility for providing their own water-related services, supported by the private sector.

Local institutions and organisations need to be developed and/or strengthened to fulfil their established mandates. They need to be financially sustainable and be given direct access to funding to exercise their responsibilities. While they will be accountable to the tax-paying electorate, there will also be a need to ensure that appropriate standards are met. The role of central agencies will change over time and some restructuring will be required responsive to evolving needs, involving changes in staff mixes, re-training and the way in which business is conducted.

3.2 *Future Institutional Framework*

In adhering to these principles, the future institutional framework will contain the following main features:

- The National Water Resources Council, under the chairmanship of the Hon'ble Prime Minister, will continue to coordinate all water resources management activities in the country, including formulation of Policy and oversight of NWMP preparation and implementation. The Executive Committee of NWRC will support the Council through issuing directives required by NWRC and guiding institutions at all levels in formulating and implementing policies and plans for improved water resources management.
- The sector will be managed through national and regional framework plans that reflect both the Government's policies and the demands of the people. In time, national planning will be increasingly driven by consolidation of local plans.

WARPO will retain responsibility for national planning and Local Government, with advice and overview from WARPO, will be the focus for local planning.

- Activities will be coordinated at a national level by Planning Commission according to advice given by WARPO. At a local level, the present DLIPEC system will be phased out and replaced by District Committees under Local Government with support from BWDB.

- The sector will be regulated under law. DoE will continue its mandate to protect and enhance the environment. New independent regulatory bodies will be formed to ensure water service delivery meets appropriate standards cost-effectively. It is anticipated that NGOs will continue their advocacy role at least until regulation becomes fully established.

- The river systems and coastal embankments will be managed and developed by BWDB, which will be encouraged to operate on a regional basis.

- Groundwater will be monitored and managed by BWDB but will continue to be largely developed by the private sector.

- Local Government will be strengthened and will increasingly take on management of local water resources, water supply and sanitation developments, urban and peri-urban services and cyclone protection shelters. DPHE and LGED will support this effort and become progressively more accountable to LG at zila level and below.

- The recently constituted Haor Development Board will ensure integrated development and management of haors and wetlands in accordance with their mandate

- Existing FCD infrastructure (up to 5,000ha), currently operated by BWDB and LGED, will be handed over to local Government and/or community groups as soon as sustainable mechanisms to effect the transfer are established. Ownership of schemes up to 1,000ha will be transferred to Local Government.

- Management of existing and new public irrigation projects and FCD over 5,000ha will be progressively restructured in line with Policy in a manner to be determined through trial and testing.

- MoA, through its agencies such as DAE, BADC and BMDA, will continue to promote efficient and productive use of water amongst farmers through various appropriate measures.

- Disaster preparedness and relief operations will continue to be a key element of sector management, and under the continued direction of DMB. Disaster forecasting responsibilities will remain with BWDB and the Meteorological Department. Local Government, in concert with NGOs, will support flood proofing and bari-level cyclone protection measures.

- The private sector will be encouraged to participate in all water sector activities in varying ways. The main target areas of engagement are minor irrigation and water supply and sanitation services in both rural and urban sectors. Other areas of

possible involvement include management contracting and river dredging, in addition to existing construction and consultancy services.

In addition, Government will continue to support the capacity development and training of staff in all its organisations through in-service training programmes. From its position of neutrality, WARPO will be the instigator of sector-wide integrated water resources management programmes covering multi-disciplinary and inter-sectoral skill development. Most actions are seen as short-term requirements to initiate as quickly as possible the development of the water sector institutions, whereas training and capacity building of Local Government Institutions are seen as continuing into the long-term. Significant progress on FCD and FCDI scheme transfers cannot be expected in the short term until appropriate mechanisms have been tried and tested.

4 Creation of an Enabling Environment

4.1 *Main Aims*

An enabling environment is essential if all elements of society are to perform efficiently. The emphasis placed in the NWPo recognises that many of the activities hitherto carried out by central Government can be equally or better performed by others, provided that opportunity is given and the risks are acceptable. At the same time, rules and standards need to be observed and enforced.

The Government will progressively develop an enabling environment consistent with sound institutional principles and policy objectives through a series of measures aimed at providing a coherent and comprehensive set of documents that will make clear the rights, obligations and rules of business required for the sector as a whole.

Documents for Enabling Environment	WR Act	Under-laws & rules	Guidelines	Manuals
Institutions				
• Institutional framework (constructs)	■			
• Legal framework for organisations	■			
• Rights & obligations of organisations & individuals	■	■		
• Constitutions/mandates for organisations	❑	■		
Process/ Preparation				
• Steps required in development process	❑	■		■
• Consultation process to be followed	❑	■	■	■
• Mobilisation of grass root interests	❑	■	■	■
• Transfer of assets/management responsibilities	❑	■		■
• Mobilisation of private sector	❑	■		■
• Gender requirements and audit	❑	■	■	■
• Environmental requirements and audit	❑	■	■	■
Regulation and Economic Instruments				
• Technical standards	❑	■	■	
• Service supply standards	❑	■	■	

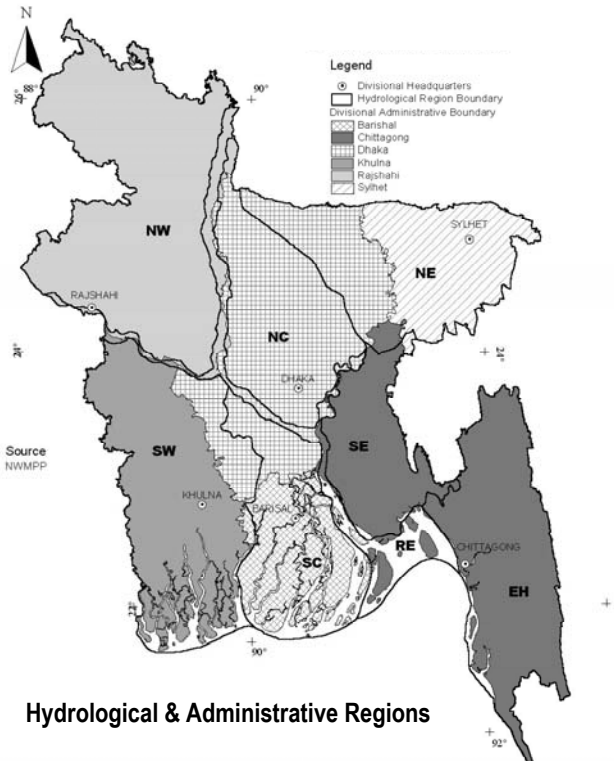
4.2 *Main Focus of Activities*

The measures summarised below are of fundamental importance to implementation of the NWMP.

Legislation - Existing legislation will be reviewed and a National Water Code will be drawn up covering all aspects of water rights and management. New legislation should provide GoB with adequate powers over water resources, whilst still being practicable enough to enforce. In doing so, the new Act will clearly define the responsibilities and powers of all relevant agencies, and define the means of co-ordinating activities within the sector. Powers to stop encroachment in rivers, for instance, will be clarified and strengthened. Legislation must also provide for securing and safeguarding the rights of the individual and the community, and govern the development of common property resources, to encourage and protect private sector investment and to provide for the transfer of public sector assets to LGIs and beneficiary groups.

Research and information management - Research and information management are necessary for effective planning and monitoring in the water sector. Adequate funding

for the NWRD will be provided. Major efforts are required to improve data availability and quality. Administrative barriers to the exchange of data will be removed. An effective data pricing policy will be drawn up. Data collection will be rationalised and appropriate and unified data standards adopted. Investment will be made in processing, archiving and dissemination.



Hydrological & Administrative Regions

Zones, guidelines and procedures - Zones are to be defined by WARPO in co-operation with relevant agencies both for planning and regulatory purposes. However, in many cases they can only be defined in detail at a local level. Zones for planning purposes are water-stress zones, drought-prone zones, four types of flood management zones, and river channels used for navigation. Regulatory zones are water scarcity zones, industrial zones, fisheries and wildlife zones, water body zones and brackish water zones. The Water Resources Act will provide for special powers in regulatory zones to enable Government to intervene in prescribed circumstances.

Guidelines and procedures are required to ensure appropriate standards are met and practices followed. Where appropriate, agencies must be fully empowered to set and enforce standards. Manuals will also be required to assist agencies and individuals in understanding how to meet the requirements of both Guidelines and standards. Manuals can also be aimed at promoting best practices. In most instances, guidelines and manuals should be thoroughly field-tested before adoption, but even so will need to be periodically reviewed to ensure that they are serving their intended purpose.

Priority will be given to establishing and testing guidelines associated with participatory management and mobilisation of grass root interests, along with development of a comprehensive set of environmental standards and guidelines. Attention will also be given in the early stage to identifying and promoting steps to broaden private sector participation and formalising consultation requirements. Approaches necessary to ensure a gender-balanced development and management process will be looked into further, and appropriate measures taken up in this regard.

WARPO will be entrusted with supporting development of each of the above in co-operation with all relevant agencies and with full public consultation.

Participatory planning and management - The Government will strengthen Participatory Planning and Management in the water sector. Alternative stakeholder-driven models need to be considered and field-tested first for management of different types of FCD schemes, public irrigation projects and rural village water supply and sanitation schemes. Policy directives must be adhered to and, as appropriate, different

arrangements will be considered involving line agencies, Local Government, community-based organisations and the private sector. The different models will be tested over an initial five-year period and evaluated before replication. During this period, the GoB will assess the possibility of introducing new local taxes to fund O&M and will also identify the circumstances by which centrally funded emergency relief is provided to the scheme operators. Adjustments to legislation may be required accordingly.

Promotion of women's participation - Increased women's participation in the water sector is a requirement of the NWPo and will be explored in the fields of project preparation and planning; employment in water schemes; training in the management and operation of local water supply and sanitation schemes; and increased involvement in the financial aspects of local water schemes (eg tariff billing and collection, book-keeping, etc). Changes in legislation will be introduced as required.

Media and awareness raising - Public awareness campaigns by all relevant agencies in the water sector are to be seen as an important vehicle for the active promotion of all the key components in the NWPo and the NWMP, fostering increased consultation and participation, and increased awareness of all water sector issues at local, regional and national levels.

Promoting private sector participation - Active private sector participation (PSP) in the water sector, particularly water supply and sanitation, will be promoted through the introduction of a regulatory framework and appropriate incentives and pricing policies, and improved provision for credit and access to investment resources. Important current initiatives to stimulate domestic and foreign investment in industry and power generation will be extended to cover the water sector and promote more local investment in the rural and peri-urban water sectors, including community-based initiatives and a fund to support low-cost appropriate technology solutions.

Regulatory and economic instruments - Regulatory and economic instruments are an important part of modern demand management in the water resources sector, and their utility and effectiveness need to be increased.

Registration of tubewells may be progressively established, but regulation of groundwater would be limited to control of over-abstraction, and particularly to restricting deep tubewell irrigation development in the coastal zone to limit saline penetration of the deep aquifer. Provision will be made to restrict surface water abstractions, other than for drinking and sanitation uses, in specific areas where there is a conflict in water resource allocation, and surface water diversions and damming of streams and khals where these create adverse impacts on downstream users.

Whilst a system should be introduced to monitor independently wastewater discharges to both surface and groundwater from municipal and industrial sources, pollution charges

will be raised and imposed on those not meeting standards. For existing industry, a limited investment fund will be established to assist polluters in reducing wastewater pollution to within acceptable limits.

In addition to this support for existing industries, subsidies will be introduced and/or adjusted to support investment in appropriate measures in arsenic-affected areas (rural and urban). Support for the installation of Tara pumps will be phased out and replaced with other more appropriate measures targeted at areas with severe seasonal water-table decline. A fund will be created to stimulate introduction of rural and peri-urban piped water supplies by small and medium private sector developers.

Cost recovery tariffs and procedures will be reviewed and new systems progressively introduced to properly reflect operational costs in the short-term. In the medium and longer terms, cost recovery will be introduced in accordance with the National Water Policy, other than for FCD. These may include: water charges in public irrigation schemes based on the crops grown and hours of pumping on DTW schemes; water charges for rural water supply schemes covering all operation and maintenance costs as a minimum; tariffs for urban water supply and sanitation providing for full cost recovery based on an increasing block tariff structure with expansion of metered supplies; and introduction of effective billing and revenue collection procedures in all schemes.

Development finance - The availability of and access to adequate investment resources will be one of the major challenges for the effective implementation of the NWMP. The government will explore all options with an open mind and with a clear commitment to make the water sector financially robust, viable and sustainable. Specific attention will be given to mobilising local capital sources through bonds and other means with the active involvement of communities and the private sector, the establishment of water and environment funds, and the active encouragement of the international private sector. Following a study of the range of possibilities, Government will take up measures to promote alternative sources of finance.

The importance in establishing an effective enabling environment means that the main thrust of the activities will be taken up in the short-term. Some activities will run over into the medium-term, as it will take time to develop all the necessary measures.

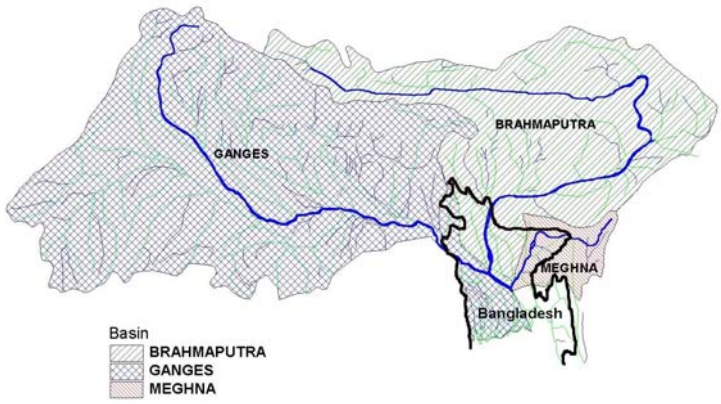
5 Main River Development

5.1 *Main Aims*

In line with NWPo, the main aims for the main river systems are to ensure that they are comprehensively developed and managed for multipurpose use through a variety of measures, including a system of barrages, and other structural and non-structural measures. The Government also intends to work towards international river basin planning to realise the full potential benefits of these rivers.

5.2 *Situation Assessment*

The main river systems are of great strategic importance to Bangladesh and have deeply influenced the culture and ways of the people over the centuries. Transboundary monsoon flows are a major contributing factor to flooding and drainage congestion, and also the cause of significant hardship by bank erosion. On the positive side, the rivers provide an effective arterial system for transportation of goods and people and for fish migration, reduce saline intrusion in the estuary and are a major strategic reserve of fresh water in the dry season. However, it may take some time to formulate an overall long-term strategy for the main rivers as there are a number of fundamental issues for which major studies and research efforts are required. Some are already in progress, others need to be taken up in the short-term to provide guidance to medium-term actions.



5.3 *Main Focus of Activities*

The key areas of further study and research, in addition to improved resources estimation, are:

- To investigate the options and the feasibility of a range of identified **inter-regional potential developments** that would make multipurpose use of the main river dry-season flows. An ongoing study of the Options for the Ganges Dependant Area is expected to establish the most appropriate method of utilising the Ganges waters secured under the Ganges Treaty. An inter-regional study of the potential of the Meghna river to serve the needs of the Northeast and Southeast regions by means of a barrage and/or by river pumping is required to establish the best choices for these regions.

- To investigate the potential for developing the waters of the Brahmaputra to meet medium-and long-term requirements. In considering bridge projects on

rivers, the possibility of combining them with barrages will be considered to optimise investment.

- To review and update the **master plan for erosion control** in the Brahmaputra and studies for other major rivers to ensure cost-effective development of erosion control measures in the light of experience gained over the last decade and the investments now made in bridge works.

Notwithstanding the need for the studies above, the broad strategy is envisaged as outlined below.

Development of surface water resources for multi-purpose use - Most of the Northeast, Southeast and Southwest regions are dependent upon surface water. The Northwest and North Central regions would also require surface water. First priority can therefore be assigned to development of surface water resources in the Southwest (to make optimal and expeditious use of the waters established under the 1996 Treaty on the basis of the on-going studies of the Gorai River Restoration Project and of the Ganges Barrage), and second to the Northwest, North Central and Northeast regions by utilisation of the Brahmaputra river water. The development of the Meghna water is also required to benefit North East and South East region. Developments of surface water in the Eastern Hills as found viable should also proceed, as this region has little groundwater. Medium- to long- term plans will be conditioned by the availability of flows in the Ganges and the updated assessments of other resources, principally for the Northwest and North Central regions.

River management for navigation and erosion control - Maintenance and/or expansion of navigation routes will be on the basis of well designed and managed dredging programmes. The development of barrages as determined above would alter the conditions of many of the river systems, which may serve to reduce the amount of dredged volumes in the future. In the short-term, the proposals for development of improved navigation around Dhaka, principally through dredging, may be taken further, but efforts should be made to integrate this activity with the overall development of Dhaka city flood protection and drainage. In view of the high investment and maintenance costs involved, and acknowledging the strong social need to manage river erosion, an urgent review of experience gained over the last decade is warranted. The affordability of engineering works will be a significant consideration, and must be compared against the merits and demerits of a soft approach involving resettlement and improved local services.

Development of hydropower - The main prospects for hydropower are mini-hydropower in the Eastern Hills and at barrage sites as and when constructed. Each

prospect needs to be considered on its own merits, and a strategy adopted that it is opportunistic, since the quantum of power developed is unlikely to be significant at a national level. Projects such as enlargement of Kaptai may be considered, but must be subjected to thorough environmental impact assessment. Mini-hydropower development is very much a local level issue.

With the possible exception of mini-hydropower, all investments are expected to be funded by central Government. Mini-hydropower development is generally suitable for a measure of private sector participation in development and financing. Other than hydropower and possibly some elements of main river pumping, little or no cost recovery can be expected. As a consequence, GoB will take into careful account the revenue funding of O&M that would be needed in determining appropriate solutions.

6 Towns and Rural Areas

6.1 *Main Aims*

In the towns (ie excluding the major cities) and rural areas, the main aims are, to the extent feasible and affordable, to satisfy increasing demands for safe drinking water and sanitation, and within the towns to provide adequate flood protection and stormwater drainage.

To achieve this, the principal objectives will be to provide a safe and reliable supply of potable water and sanitation services to all the inhabitants in the towns and rural areas, along with effective facilities for wastewater disposal to safeguard public health and protect the environment. In selected towns with facilities of economic importance, flood protection will be provided as a priority, and phased implementation of reasonable flood protection facilities will be introduced in Zila and Upazila towns.

Significant sustainable improvements will be targeted in operational efficiency and service delivery with prime responsibility decentralised to local government with active community participation and consultation, and special emphasis given to the role of women. Both community and private sector participation in the provision of water supply and sanitation services are to be promoted with an overall intention that affordable and financially sustainable services are offered to all levels of society, with particular emphasis on the poor and disadvantaged sections of the community.

Indicative service targets are given as shown for provision of water supply, sanitation, flood protection and stormwater drainage in the towns (large and small) and rural areas. Targets for private sector participation have been included as these also have bearing on funding and implementation capacity.

Towns and Rural Areas
Indicative Targets for Water Supply, Sanitation & Stormwater Drainage

	2005	2010	2025	2050
Water Supply				
Provision of arsenic mitigation facilities	70%	100%	100%	100%
Access to safe water for basic needs (towns and rural areas)	95%	100%	100%	100%
Provision of household piped water (towns)	50%	70%	90%	100%
Provision of household piped water (rural areas)	10%	10%	40%	90%
Water quality surveillance	40%	60%	100%	100%
Sanitation				
Access to appropriate sanitation (towns & rural areas)	70%	100%	100%	100%
Provision of household waterborne sanitation (towns)	10%	30%	70%	90%
Provision of household waterborne sanitation (rural)	5%	10%	20%	35%
Private Sector Participation				
Town water supply and sanitation	5%	15%	25%	50%
Rural water supply and sanitation	80%	95%	95%	95%
Flood Protection & Stormwater Drainage (towns only)				
Provision of flood protection in towns	50%	75%	100%	100%
Provision of stormwater drainage in towns	25%	40%	70%	100%

6.2 *Situation Assessment*

Future demands for water supply services will be driven in response to various driving forces, including population growth and economic development. Whilst urban population will rise relatively rapidly, overall population in the rural areas is expected to stabilise, although there will be increased clustering of people into villages and demand

for more sophisticated services. Per capita demand will increase as incomes and standards of living rise and services improve.

The shift in the Government's position from provider to that of financing partner, regulator and facilitator of the water sector will require far-reaching institutional changes to be taken up. Consumers will also be expected to accept changes in concept, such as a shift from investing in individual household hand pumps to investing in and contributing to the management of shared systems. An increased emphasis on participatory planning will enable consumers to consider a range of products and to invest personal resources in those facilities they feel to be most desirable. Community-managed low-cost systems are expected to become a major part of future new initiatives.

These same forces will prompt a change from a simple pit latrine to a pour-flush latrine. While modest increases in household water consumption will not create drainage problems, the next stage of urban development is the introduction of water-borne sanitation. This will substantially increase the demand for water and necessitate investment in drainage systems. Low-cost solutions may be adequate in some areas, but sewerage systems and effective treatment will become necessary in more densely occupied urban areas to avoid widespread pollution of surface and groundwater resources.

Seasonal drawdown can be expected to become both more extensive and severe. Present knowledge, which is still insufficient, indicates that the area of arsenic contamination may remain more or less constant over time, although it is possible that it may intensify in the medium- term while reducing in intensity in the long- or very long-term. The demand for flood-free land to build on will continue to grow, due to increased population and expansion of the commercial and industrial sectors. The challenge for the future is how to encourage prudent development in appropriate locations, which does not have adverse effects on existing water resources, drainage or flooding regimes.

The mobilisation of sufficient funds to pay for the water-related components of urban infrastructure is an existing problem that will have to be addressed. Quality of service and willingness to pay are two closely related factors, though willingness to charge is also important. The private sector is already investing in land development in urban areas and, while it is currently willing to include water supply as part of these developments, the private sector rarely provides sewerage and effluent treatment.

6.3 *Main Focus of Activities*

Activities for this sub-sector fall into four categories: water supply, sanitation, flood protection and stormwater drainage.

Water supply - Considerable progress has been made in the provision of potable water supplies in towns and rural areas in the 1990s. However, arsenic contamination of groundwater has become a serious health hazard that must be addressed with the highest priority. Present estimates indicate that at least 30 million people are at risk and about half the total population face a potential risk. The areas

most seriously affected are the South East, South West, South Central and North East Regions. Short-term interventions are being tested (arsenic filters and household removal facilities), and medium- to longer-term solutions are being studied to access safe deeper aquifers below 250-300m. In arsenic-affected areas alternative sources, such as surface water, are to be considered.

In addition to other water quality issues such as the occurrence of iron and boron in groundwater, other important regional water supply constraints that will be addressed are: (a) seasonal draw-down of groundwater causing shortfalls in potable water supplies in the rural areas of parts of the North West, North Central and South West Regions; (b) saline intrusion in ground and surface water sources in the coastal belt of the South West, South Central, South East and Eastern Hills Regions; and (c) inequity of access to safe water sources in the North East, North Central, South West and Eastern Hills Regions.

The main options for water supply in the towns and rural areas cover a mix of technical alternatives that will address the issues of poverty, equity of access, affordability, sustainability and service improvements over the plan period. Local area systems (small piped systems based on water drawn from arsenic- and pollution-free sources and community level systems) for both peri-urban and rural areas should offer medium- to long-term water supply improvements, coupled with a framework for active community and private sector participation with the primary focus on the poor and disadvantaged sections of society. Towns (large and small) should also benefit from the progressive development of municipal water supply systems that will be the responsibility of the local municipality or a regulated private sector operation.

Sanitation - Adequate and appropriate sanitation in towns and rural areas will have important public health, poverty alleviation and environmental impacts. Viable options are expected to be: (a) rural areas - pit latrines and household latrines with septic tanks; and (b) towns - pit latrines, household latrines with septic tanks, community sanitation facilities, and smallbore sewerage systems. Delivery of the required improvements will involve the active collaboration of local municipalities, community based organisations and the private sector in all regions of the country.

Flood protection and **stormwater drainage -** These options are directed only at towns (large and small) in the medium- to long-term. For flood protection, the main choice is whether to raise land or develop peripheral protection. Land raising is attractive because it limits the requirement for Government investment, but is generally only practicable in areas of urban expansion, new towns or specific urban sites. In most instances, peripheral embankment protection will be the most expedient solution, but will require full stakeholder consultation, and appropriate local revenue raising to ensure adequate maintenance.

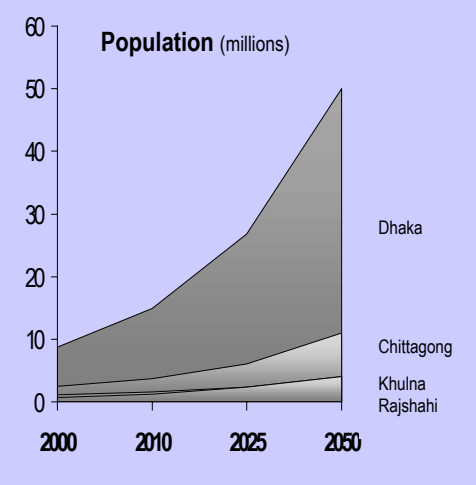
Adequate stormwater drainage should be an integral component in municipal infrastructure, but it is often inadequate or overlooked in the planning process. The Government will address this issue in the medium- to long-term, with a preference for gravity systems wherever possible.

Financing of towns and rural area service infrastructure is expected to come from a variety of sources. Whilst priority needs to be attached to arsenic mitigation measures, in a regional context the satisfaction of demands requires initially a catch-up first, as well as substantial investments for the future.

7 Major Cities

7.1 *Main Aims*

The major cities considered are the Statistical Metropolitan Areas (SMA), namely Dhaka, Chittagong, Khulna and Rajshahi. One of the major challenges is to address the development requirements of the urban sector, particularly Dhaka, which is expected to become one of the megacities of Asia. As in the preceding section, the main aims for these major cities are, to the extent feasible and affordable, to satisfy increasing demands for safe drinking water and sanitation and provide adequate flood protection and stormwater drainage. Options for wastewater management and recycling will be explored.



The overall objectives are similar to those in the towns and rural areas, namely provision of effective facilities to safeguard public health and the environment, attainment of significantly improved standards of operational efficiency and service provision with active community participation and consultation, promotion of private sector participation in water supply and sanitation, and provision of affordable and sustainable services to all city dwellers with particular emphasis on the poor and disadvantaged. Indicative targets for levels of service are given here for provision of water supply, sanitation, flood protection and stormwater drainage in the major cities.

Major Cities
Indicative Targets for Water Supply, Sanitation and Stormwater Drainage

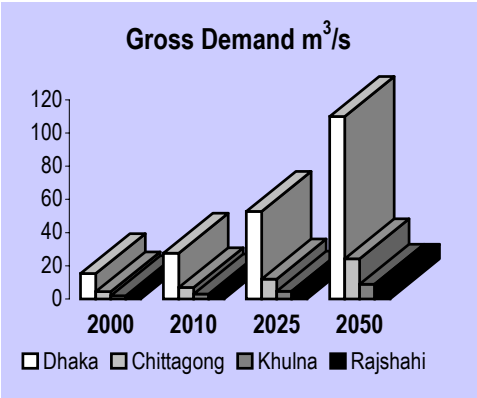
	2005	2010	2025	2050
Water Supply				
Access to safe water for basic needs	98%	100%	100%	100%
Provision of household piped water	65%	75%	90%	95%
Sanitation				
Access to appropriate sanitation	90%	100%	100%	100%
Provision of household waterborne sanitation	60%	70%	85%	90%
Stormwater Drainage				
Provision of stormwater drainage	50%	70%	100%	100%

7.2 *Situation Assessment*

The main water-related issues affecting these four major cities are concerned with service delivery, institutional development and financial issues, and a bold and innovative, market-led strategy for the major cities is called for reflecting the National Water Policy and providing leadership to the rest of the sector.

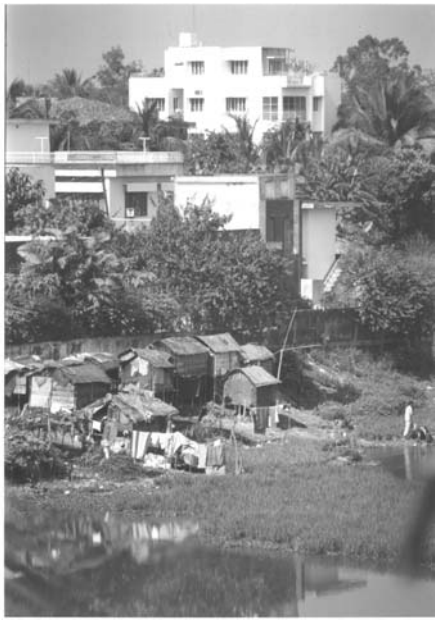
All the cities have been the subject of one or more urban development master plans, with expansion forecasts into adjacent areas. However, the historical trend has been for densification of the existing areas because the infrastructure to support new development has rarely been put in place. Infrastructure constraints are likely to cause development to continue to happen where it is feasible and affordable, which may not coincide with the published plans. Transportation infrastructure and location of employment

opportunities, which lie outside the water sector, are two of the key factors that will propel the future growth patterns.



A rapid increase is forecast in demand for water supply arising from the combination of increasing population and rising standards of living. Provision of this water will result in a corresponding need for improved drainage and sanitation arrangements. High land values, the absence of good transportation infrastructure to facilitate commuting, the pressure to maximise the benefits from flood-free or flood-proofed land, and the desire to reduce encroachment on agricultural land all combine to encourage vertical development. Provision of adequate and reliable water supply and sanitation is essential to make high-rise developments habitable. The demand and the need for these services exist. The challenge for the future is to provide them. Slums already house a substantial proportion of the city populations. Even if the proportion of slum dwellers is held constant, there will be a large increase in their numbers. They will need access to basic water and sanitation services.

While it is feasible for apartment blocks to have their own wells as a source of water (subject to available groundwater resources), local disposal of effluent may not be possible. City supplies are most effectively planned as shared systems with provision for water supply, sewerage and storm drainage. Currently public access to water and sewerage, and roads and electrification, is not arranged in advance of development and developers adopt the easiest available short-term solution. One of the major constraints to the provision of adequate shared infrastructure will be the problem of land acquisition. New urban development initiatives are needed that may involve the development of new sites for cities (and towns), development of dormitory towns and suburbs for the major cities and development of designated and controlled industrial zones. These are key issues for Ministry of Land to address under a National Land Use Policy.



Future consumers will expect not only sufficient water, but also water of a quality that is safe to drink without further treatment. However, while the quality of water entering the distribution system is under the direct control of the supplier, the quality of water reaching the consumer is more difficult to control, particularly if distribution pressures are low. Therefore sufficiency and reliability of supply are basic requirements for the achievement of a reliable quality.

Future requirements for sanitation will be largely based on the volume of water supplied (including private wells), most of which will be returned to the drainage system. The location of major water consuming/polluting industries will need to be planned and

controlled. Therefore provision for major new industries may not be included under the city water supply and sanitation, but account must be taken of already existing industries.

Investment in storm water drainage will be needed wherever there is new urban development, while infill development will increase the runoff in existing urban areas. Urban expansion may be onto more flood prone land, so that the demand for flood protection can be expected to increase. In addition, sea level rises and other anticipated effects of climate change would reduce the existing level of protection, where it is already provided.

7.3 *Main Focus of Activities*

Activities for this sub-sector fall into four categories: water supply, sanitation, flood protection and stormwater drainage.

Water supply and sanitation - The four major cities are expected to triple in population over the next 25 years. Dhaka is expected to absorb most of the increase, rising from nearly 9 million in 2000 to 27 million by 2025.

Major efforts will be needed to develop bulk water supplies and efficient delivery systems. Groundwater is already over-exploited in Dhaka and surface water systems will be needed from the Padma and possibly from the Brahmaputra rivers. Future configurations will depend on urban expansion plans, but development of the Dhaka–Tangail axis may be a likely outcome, favouring bulk supply system from near the Bangabandhu Bridge. The other cities will continue with a mix of groundwater and some surface water.

Various options are open for expansion of delivery systems. These may include Local Area Systems (FM hand pumps and small piped systems) to meet water demands in localised and peri-urban areas, particularly poor and disadvantaged communities, and Main Water Supply Systems (distribution systems supplied by, as appropriate, a combination of DTWs, well-fields and major surface water development) that would be progressively developed to serve an increasing proportion of each city's population. Local Area Systems will also provide the focus for direct individual and community participation in financing (partial), owning and operating community based systems.

The growth in urban water demand will stimulate the need for expansion and improvement in the full range of sanitation options throughout the planning period. The main driving forces will be public health safeguards, environmental protection and the living conditions of the urban poor. The appropriate sanitation options identified for the four major cities are individual and local community facilities (pit latrines, household latrines with septic tanks, community sanitation facilities and small bore sewerage systems) that will satisfy hygienic sanitation requirements in localised and peri-urban areas, particularly poor and disadvantaged areas, with conventional waterborne sewerage systems with wastewater treatment offering the main long-term solution for effluent disposal in the four major cities.

The main constraints to the full development of these measures that will need to be overcome are expected to be institutional and financial.

Flood protection and stormwater drainage - Most of the necessary flood protection structures for the four major cities are in place and adequate for the next 25 years. The only exceptions are the Dhaka Eastern Flood Embankment and modest additional works for the three other cities. However, as the major cities continue to expand, appropriate urban planning along with improved, extended stormwater drainage systems will be necessary to minimise the socio-economic impact of storm water flows. The main options are gravity and pumped drainage systems, although the final choice will be site specific.

Institutional and financial reform - Important issues to address are (a) the pace and focus of institutional change; (b) widening private sector participation in the provision of water and sewerage services; and (c) setting tariffs that more appropriately reflect real resource costs.

A sustained programme to implement changes in the institutional and financial framework is required, based on the principles of effective demand management and improved incentives through appropriate governance, ownership and organisational structures, and through appropriate financing systems. The improved incentives will encourage operational efficiency and improved service delivery; and, coupled with realistic tariffs set at full cost recovery levels, develop sound commercial and financial viability of the urban water sector agencies, enable private sector participation, and attract funding for capital investment in the sector.

The main components of a demand-lead incentive-based strategy may include the following: (a) creation and/or strengthening of autonomous municipal enterprises, allowing in practice full responsibility for the management, operation and financial viability to an autonomous municipal company with its own board of directors and experienced technical managers; (b) commercialisation of the urban water and sanitation sector to encourage and promote private sector participation through management contracts, BOOT schemes and concession agreements; (c) introduction of market-oriented financial systems to promote financial viability and efficiency in the utilisation of resources mobilised on market terms; and (d) establishment of the necessary Regulatory Framework. Financing of major city service infrastructure is expected to come from a variety of sources.

8 Disaster Management

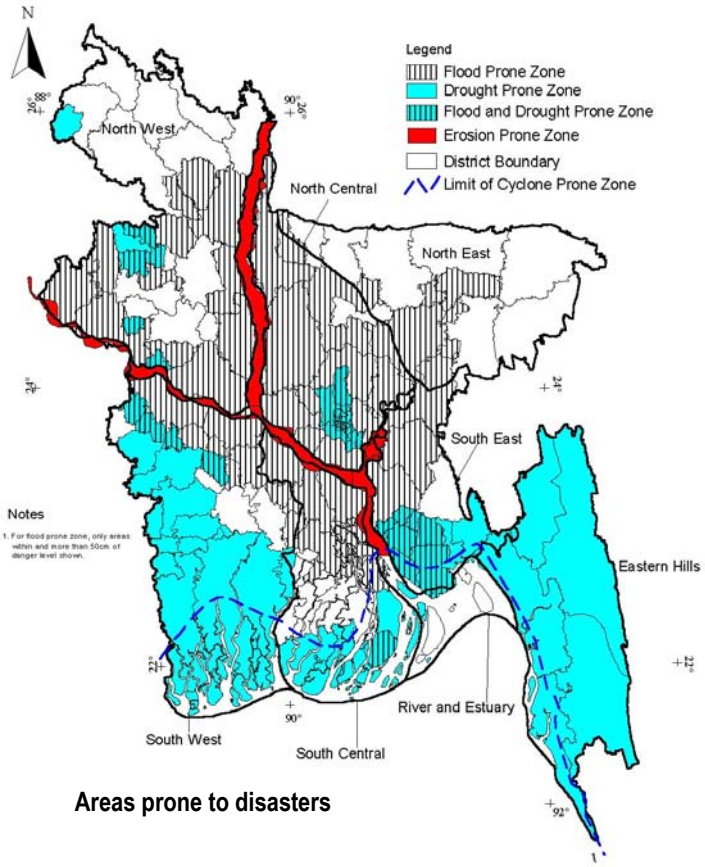
8.1 *Main Aims*

Disaster management (including disaster preparedness) involves prevention and mitigation measures, preparedness plans and related warning systems, emergency response measures and post-disaster reconstruction and rehabilitation. Over the last decade, disaster management has become recognised as both a necessary and legitimate element of overall water management.

Accordingly, in acknowledging that some people will always be at risk, the main aims for water-related disaster management are to provide the means by which, through a combination of structural and non-structural measures and to the extent feasible and affordable, people are adequately warned of an approaching disaster, are equipped to survive the disaster with as much as possible of their assets intact, and are adequately supported in rebuilding their lives thereafter.

8.2 *Situation Assessment*

Water-related natural disasters are a relatively common occurrence in Bangladesh. In this context, they are taken to include floods, droughts, cyclones and riverbank erosion. Each impacts on the livelihoods of those affected, but with different severity. However, these days it is generally only cyclones that pose a direct threat to people's lives. Displacement due to erosion and inadequate facilities during and after major floods can create major hardship and health problems. Establishment of the Disaster Management Bureau in 1994 signalled Govern-ment's intention to view disasters in a more comprehensive manner. Forecasting facilities, preparedness planning and post-disaster relief efforts have reduced the severity of disaster impacts on those affected. The NGO community has also responded in a major way, building on the experienced gained in 30 years of supporting community development in the country at a grass-root level. What is now required is to build upon the collective knowledge and capacity to manage disasters in a more comprehensive and effective manner.



Areas prone to disasters

8.3 *Main Focus of Activities*

Cyclone protection - A major acceleration of the cyclone-proofing programme is required in parallel to separate measures to improve the management of the coastal embankment system. Development of improved conventional shelters-cum-schools will proceed initially in areas of highest risk at an appropriate density to provide access to all. In parallel to this, killas will be constructed in areas unsuited to shelters within the high-risk areas. Also, low cost bari-based schemes will be pilot-tested and evaluated in the short-term.

In the medium-term, a mix of all three options may be envisaged, with an initial target of providing protection throughout the area with a 1:30 year return period. Extension into lower risk areas (up to 1:100 year return period) is foreseen as demand driven and probably appropriately through bari-based systems if these are shown to be effective.

In the meantime, continued efforts will be made to steadily improve the cyclone-warning systems and disaster preparedness programmes. Along the coastal fringe, afforestation with appropriate species will be continued to provide protection against storm surges.

Flood proofing - Flood-proofing of the rural population in the Haor Basin (rather than flood control) and in the charlands and high priority activities will be completed within the medium-term.

Raising of national and regional highways and, to the extent feasible, railways will be expected to proceed as part of the network upgrading programmes and, as such may extend into the long term. Raising feeder and rural roads will be determined in the context of disaster management plans. Flood forecasting and warning systems will be continually upgraded as technologies for data acquisition, processing and dissemination improve.

Riverbank maintenance and erosion control - Efforts will continue to identify cost-effective designs for erosion control on medium and small rivers in the short- to medium-term. A system for erosion forecasting will be developed and tested in parallel to this. Integrated river management plans will be prepared (covering erosion control, dredging and other elements of river maintenance, such as pollution control, abstraction, navigation and environmental needs). Areas subject to a high risk of erosion and those with other urgent requirements will be prioritised in the context of these plans, with more widespread programmes being introduced in the medium-term. GoB will need to take steps in the short-term to identify the basis for funding maintenance works.

Drought management - Development of a reliable drought forecasting and warning system will be viewed as a short-term need. Once established and proven, it will be supplemented by dissemination programmes targeted at promoting supplementary irrigation for aman and aus principally. Efforts to drought-proof rural water supplies will run in parallel, as described above.

Implementation of the strategy will require close co-operation between the Ministry of Disaster Management and Relief, the numerous other GoB entities whose activities are affected by water-related disasters, local government, the ICZM Programme, the development partners, the NGOs and the private sector.

Whilst there is scope for partial beneficiary financing of flood-proofing and low-cost cyclone protection programmes, the majority of the costs will have to be borne by Government with little or no expectation of cost-recovery.

9 Agriculture and Water Management

9.1 *Main Aims*

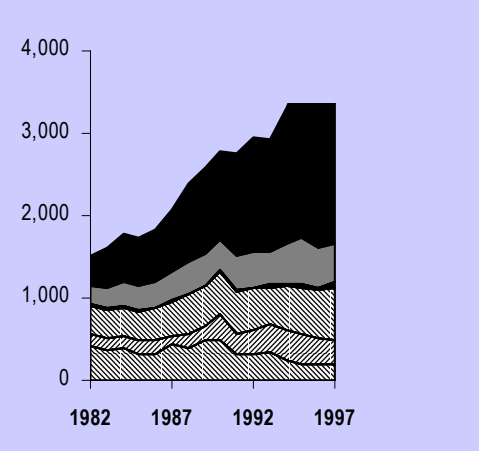
Bangladesh's overall agricultural policy objective is to expand and diversify agricultural production and to maintain food security, especially with regard to sustaining near self-sufficiency in rice. Whilst achievement of these aims is primarily the responsibility of the agricultural sector, the water sector has an important role to play by removing constraints that may be caused by either shortage or excess of water.

9.2 *Situation Assessment*

Irrigation has been, and is likely to continue to be, the major water sector contributor to agricultural growth. In addition to the expansion of irrigated rabi cropping, especially boro, an increase in the supplementary irrigation of aman can also be expected in the future. Past policies of a liberal approach to minor irrigation have paid considerable dividends, and at issue is how long current growth rates in minor irrigation will be sustained. Groundwater irrigation is limited to about 56% of the country and the main concerns are whether this will need to be curtailed due to possible arsenic contamination and the threat of its entering the food chain, and the impacts seasonally lowered watertables have on rural domestic supplies. The former is still being studied, and the latter can be addressed by deepening domestic supply wells and developing other sources.

Bangladesh is signatory to the international convention on Persistent Organic Pollution. The rapid adoption by farmers of high yielding varieties of rice has prompted an increase in the use of insecticides with attendant risks of pollution of water resources. The Government is committed to a policy of promoting integrated pest management. Monitoring of water quality will be strengthened and appropriate measures to counter pollution will be taken where found necessary.

Surface water irrigation in the hands of private LLP operators is the cheapest form of irrigation providing water is available nearby in sufficient quantities. It is applicable to 44% of the country where groundwater is not available and to those parts of the groundwater areas where deficits may be expected due to low recharge or arsenic limitations. Despite its attractiveness, surface water irrigation has developed more slowly than groundwater irrigation in both the public and private sectors. The main constraints had been the non-availability of the required public sector investments and the issue of the availability of water at the point where it is needed. To overcome this requires a more efficient distribution of water from the main river systems through regional rivers, generally short-lengths of transfer channels, and improved local channel networks, combined with efforts to promote conjunctive use of surface and groundwater where feasible.



Augmentation of regional rivers could enable the entire irrigable area ultimately to be irrigated if required. However, the extent to which irrigation is taken up will depend on the feasibility of individual schemes and the extent to which the future demand for irrigation is off-set by other agricultural improvements, such as the availability of better seeds and varieties and improved husbandry.

Past experience with flood control has been mixed on the other hand, and Government's policy is to discourage further development and to rationalise the large stock of existing schemes and improve their management. Over the last forty years, much of the flood plains have been brought under flood control schemes and there are only a few areas left. These are generally either too deeply flooded or are adjacent to particularly unstable rivers. In the coastal zone, embankments have made an important contribution by providing protection against tidal flooding and mitigating the impacts of cyclones, but suffer similar management problems. In much of North East Region, submersible embankments provide partial flood protection, which has produced clear benefits, despite the high maintenance costs. Policy requires that an environmental audit is conducted on all flood control and drainage (FCD) schemes, that all remedial work and future management are conducted on a participatory basis, and that management of all but the largest schemes should be progressively transferred to local Government and community organisations.

Poor drainage is a severe problem throughout most of the country, but due to high outfall levels during the flood season there is no major generic solution (partly because pumped drainage is not justifiable for most agricultural land). Consequently, improvements to drainage have to be considered on a case by case basis, both at regional and local levels. Improved drainage would shorten the duration of flooding and would allow post-monsoon cropping to start earlier.

9.3 *Main Focus of Activities*

These activities below need to be considered in the context of institutional changes and improvements to the enabling environment, both considered earlier.

Expansion and support to minor irrigation development - Expansion of tubewell irrigation will continue to be encouraged in all areas where over-exploitation is not an issue and where arsenic contamination is not considered to be a health-hazard if the water is used for irrigation purposes. Study of the implications for public health of irrigating with water contaminated with arsenic is a vital area of research. Some increases in seasonal drawdown can be anticipated and a mitigation programme for rural water supplies is a more cost-effective solution than attempting to limit tubewell irrigation. Future growth of tubewell irrigation will be better assured through Government-supported promotion of cheaper force-mode pumps.

Government will take steps to support expansion of LLP irrigation by increasing the availability of water at the farm boundary (see Public Irrigation Development below).

Improved on-farm water management (OFWM), which has attracted little attention in the past, in the form of improved farm channels is a potentially useful measure where savings in irrigation water use per hectare will result in expansion of irrigated crop area. OFWM will be supported mainly for LLP irrigation in the coastal zone and other water-short areas of Bangladesh

Public irrigation development - Activities involving public investment in surface water irrigation fall into five main sub-categories. Firstly, actions are required to improve the performance and management of existing BWDB irrigation schemes to avert the progressive deterioration of scheme infrastructure and performance that otherwise will occur. This will entail a mix of structural improvements combined with steps to both improve scheme management and cost recovery on all BWDB schemes.

Secondly, new works will be required to develop regional river systems to distribute water when diverted from the main rivers to augment surface water supplies for LLP irrigation. This is being studied for the GDA at present, but may also be applicable for the NE/SE regions from a Meghna Barrage, and for the NW/NC from the Brahmaputra Barrage. These channels would generally require a measure of re-profiling, some cross-regulation and to the least extent possible, new inter-river transfers.

Thirdly, new lower-cost major irrigation schemes may be taken up where feasible. Larger pumped schemes are expected to be applicable in the South East in particular. Rubber dams, commanding normally much smaller areas, are appropriate for schemes in the coastal and other areas where they will not interfere with downstream users.

Fourthly, in certain areas where groundwater is available but too costly to attract private investment and surface water is not available nor planned to be made available in the future, then Government may consider development of subsidised DTW schemes. These may arise in and around the high Barind where depths to groundwater are great, and in the far Northwest where drilling costs are high due to the boulder-strewn sub-soils. Support may be provided through provision of direct subsidies to private investors, or by development along the lines of the Barind Integrated Area Development Project (BIADP).

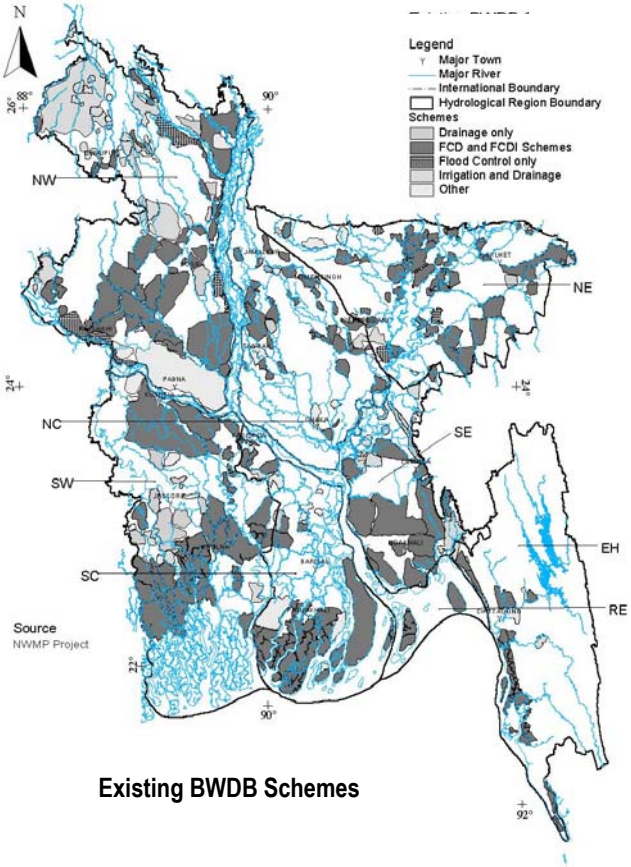
Fifthly, there are currently some limited opportunities to develop locally available surface water resources in a manner that will promote further expansion of LLP irrigation. However, this will substantially increase with the measures above to develop inter-regional transfers and improved flows in the regional rivers. Such local developments will fall under the purview of Local Government, whose capacity to implement such programmes in an orderly and cost-effective manner will need strengthening.

River maintenance - River improvement programmes will be prepared in an integrated manner giving due importance to all users and environmental and fish migration

requirements. The plans will identify dredging and erosion control measures, taking account of new flood protection requirements for areas of high economic importance as defined by Policy. Potential and actual sources of pollution will be identified along with areas of encroachment. In formulating programmes, actions will be prioritised taking account of social, environmental and economic criteria. Activities on regional river systems will be coordinated with improvements to local channel systems in a manner that leads to cost-effective and sustainable improvement of the surface water resource system by all concerned.

Regional drainage improvements will require case by case consideration and justification. It is improbable that all those so far identified by the concerned agencies will prove viable. Dredging and desiltation by mechanical or manual means nevertheless can be particularly effective where it is combined with other measures that will effect a regime change in the river and thereby reduce maintenance dredging. BWDB will continue to be responsible for the main and regional river systems, whilst local drainage and local improvements to water management generally will remain the responsibility of Local Government. Although in some instances local works can proceed without consideration of wider developments, in general far better solutions can be achieved if planned in a manner compatible with regional augmentation and drainage improvements.

Flood control and drainage - Four main areas of activities have been identified related to flood control and drainage. The first and foremost is the rationalisation of the existing FCD schemes in line with policy requirements. To achieve this, will require a long-term management plan with four distinct phases: (i) full development of a scheme inventory, initiating a programme of environmental audit and preparation of a Management Plan, (ii) development and pilot testing of procedures for scheme assessment and future management arrangements along with completion of environmental audit, (iii) evaluation of second phase and update of management plan, and (iv) a full programme to complete rationalisation of schemes and bring them under revised management arrangements.



Existing BWDB Schemes

Rationalisation of schemes will be considered case by case and may include rehabilitation, remodelling or pro-active disengagement from certain sick schemes. Emphasis throughout will be on participatory planning and management of the schemes with the long-term aim of achieving improved overall scheme performance, eliminated or properly mitigated adverse

environmental impacts, and financial sustainability.

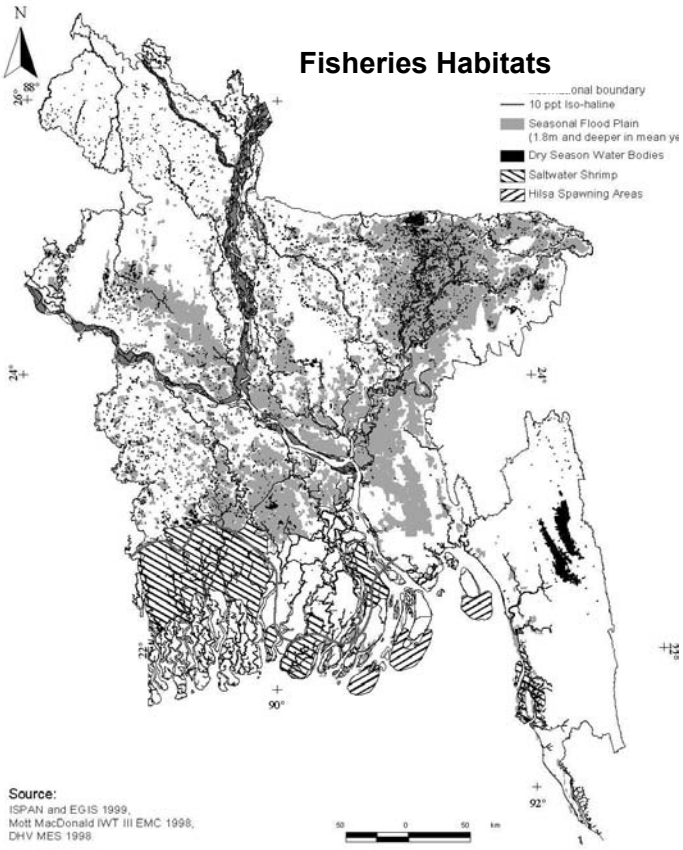
The principles above will apply equally to coastal embankments as to that inland. However, the expectation is that all coastal schemes will be retained in principle due to their particular importance. Nevertheless studies are needed to assess ways by which drainage congestion in the coastal areas can be alleviated, which will have bearing on the way in which individual schemes are rehabilitated. Some new coastal embankments are envisaged on newly accreted land (although premature empoldering should be avoided), and the process of afforestation of sea-facing embankments will be continued.

Financing of all minor irrigation development and structural aspects of on-farm water management would be borne by the private sector and farmers. Otherwise, implementation of minor irrigation support programmes is expected to be the responsibility of DAE's Water Management and Agricultural Engineering Wing. Local works programmes would come under Local Government with the support of LGED. MoA, possibly with assistance from BADC, would be responsible for development of the DTW schemes described above. BWDB would be responsible for the remainder of the programmes. Close coordination between Local Government and BWDB will be essential in developing improved access to surface water and improved drainage.

10 Natural Environment and Aquatic Resources

10.1 *Main Aims*

The NWPo contains substantial provision for protection and improvement of the natural environment and aquatic resource management and there are numerous national environmental rules and guidelines. The key objectives in relation to the natural environment and fisheries are: to ensure provision of clean water for multipurpose uses; to restore and maintain fish habitats; to ensure provision of water for sustainable use, and preservation of key features of wetlands; and, to protect the aquatic environment in the future, especially by institutionalisation of EIA and environmental management procedures.



Forestry is also an important element of the natural environment, and is an effective means of preventing degradation of upland watersheds. The Government is committed to massive afforestation, including development of the Coastal Green Belt.

However, environmental interventions are not merely confined to water management, but must include the full range of supporting activities, including people's sensitisation and empowerment and institutional reform and strengthening in the water sector. Most of the environmental actions in the water sector are closely linked to actions needed in other sectors.

The fulfilment of these objectives will need dedicated application by all the institutions and individuals active in all sectors. They will involve significant changes in the way environmental concerns are treated and, not least, substantial investment in water pollution clean-up.

10.2 *Situation Assessment*

Water quality is an issue of increasing concern. In addition to the pressing issue of widespread arsenic contamination of the shallow aquifer and other pollutants in groundwater, surface water quality has deteriorated in recent years mainly as a result of man-made pollution. Whilst faecal contamination is often found in and around

settlements, industrial pollution and inadequate waste treatment are causing a major problem in certain "hot-spots" around the country. Dhaka, and the rivers downstream, is the worst affected, but concerns exist in almost all towns and cities. In Dhaka, there is evidence that the aquifer is also becoming polluted. Laws and standards have been established, but are so far proving ineffective by themselves to combat these problems.

Fish and fisheries resources, both as part of the natural environment and as a resource for human exploitation, are of major importance to the country, especially for the very poor. They are under serious threat from over-exploitation and water pollution. With capture fisheries facing the possibility of effective extinction within the next 10 to 15 years, there is an urgent need to address the issue in a comprehensive manner.

Water management for sensitive areas (essentially the wetlands) is complex, given the wide variety of ecological conditions they represent, but a major planning constraint is the lack of knowledge of the basic aquatic ecology. The ecologically sensitive areas are under great pressure, both from encroachment and as sources for subsistence and production, and there is a danger that their degradation will become habitual. The key issue is to reverse this trend.

Bangladesh is signatory to various international conventions and protocols, including the Convention on Biodiversity, Ramsar Convention, Framework Convention on Climate Change, and Convention on Combating Desertification. The Government is committed to fulfilling its obligations under these conventions.

Main elements of Regulatory Measures for Environmental Protection and Improvement

Land zoning of industries, with supporting measures such as communal treatment of wastes and including both inclusion and exclusion zoning and incorporation of the measures into plans for new and expanded Export Processing Zones and the development of industrial parks;

Enforcement of the DoE WQS, EIA and environmental audit regulations and strengthened Ambient Water WQS against which to evaluate effluent emissions. Specific supporting measures include expansion of the environmental courts and new fixed-rate penalties linked to concentrations of specific pollutants in discharges. These options, in turn, imply the development of specialist environmental lawyers and forms of legal aid or self-help actions to allow access to legal services by the public. Enforcement action will be essential.

Clean-up and Hot-spot Pollution Prevention will involve a nation-wide programme to reduce pollution emissions and rehabilitate water bodies, including contaminated bed sediments, with the urban ponds and river reaches a priority. The aim will be to make the water bodies once again suitable for multipurpose clean water use, with an emphasis on the prevention of pollution. Industry will be required and encouraged to install the necessary processes and facilities to reduce harmful emissions to acceptable levels, with loans and other financial incentives as well as regulation and other measures. Continuation of the DAE programme of IPM will help to prevent excessive pollution by agrochemicals. Implementation of the programme will require a major strengthening of the capabilities of the DoE and other GoB entities involved.

Re-focussed National Water Quality Monitoring Programme will need expanding to include discharge ('end-of-pipe') sampling and/or identifying the sources of specific pollutants found in receiving waters.

10.3 *Main Focus of Activities*

Water pollution and control - Urgent action is needed both to clean-up pollution hot spots and to prevent (re-)pollution of cleaned-up locations and ecologically sensitive areas, with the relative emphasis depending on local priorities. The latter will be determined on the basis of the benefits to people (eg potable, bathing/household water supplies)

and to important ecological - mainly aquatic - sites, especially those providing the habitat for major fisheries as well as fish migration routes.

In national terms, the priority is to prepare a National Industrial Pollution Control Plan, with the aim of tackling the major polluters over a 10 to 15 year period and subsequent follow-up of lesser polluters. In order of national priority the actions will be carried out in the NC Region, focussing on Greater Dhaka, the Chittagong area of EH Region and the SW Region (Khulna and Mongla), followed by the NW, NE, SE and SC Regions, and lastly the Chittagong Hill Tracts.

The programme will consist of a mix of regulatory and non-regulatory measures with full support of the Government. Regulatory measures will form a significant part of the strategy.

Water management for fisheries - There is an urgent need for a national capture fisheries study leading to a Fisheries Master Plan. Both overlap the interests of the water sector and are seen as essential steps to enhancing the value of the water resource system.

The prime concern with capture fisheries is the provision of suitable habitats for maintaining biodiversity as well as fish production, for which good quality water is essential. In addition, two key sets of water requirements are vital: provision of sufficient areas of water in the dry season water bodies and provision of appropriate river and floodplain flows, plus adequate and fish-friendly hydraulic connections between the floodplains and the main river system. A major water management issue is the great damage done to capture fisheries by past interventions (notably by FCD/I works).

Based on the Fisheries Master Plan, an important NWMP requirement is therefore for a National Fishpass Programme with the aim of urgently appraising the effectiveness and practicalities of mitigation measures and, especially, of constructing fish passes. This will be followed by implementation of appropriate measures at selected sites. With the problems of land-use conflict and soil salinisation resulting from salt-water shrimp (bagda) production, zoning of bagda shrimp production will also be introduced.

Water management for ecologically-sensitive areas - In the context of the water sector, there are two ecologically-sensitive areas of outstanding importance, the Sundarban mangrove area and parts of the Haor Basin wetlands, the former as a World Heritage Site and both as Ramsar Sites. The many other water bodies in the country are also ecologically sensitive, but are individually smaller and subject to much more intensive pressures of encroachment and exploitation. A programme for improved water management for the Haor Basin will ensure the aims of both waterfowl conservation under the Ramsar Convention and the conservation of mother fish stocks for both commercial and subsistence fishing. Similarly a programme to improve water management for the Sundarbans concerns the increased future inflows of fresh water through the Gorai River system (currently under study) in order to maintain or improve the Sundarbans' productivity and biodiversity.

Sustainable development of the country's wetland resources implies application of broad water management options for water bodies as a whole. A programme will be taken up to identify, and define management conditions for, ecologically critical areas and for combining these into a National Integrated Wetlands Management Programme.

Supporting environmental measures - In themselves, the above measures will not be sufficient. The extent, variety and local variation of the many environmental problems mean that GoB is unlikely ever to have the full resources to 'safeguard the environment' solely through government bodies. Even with the support of the many environmentally-concerned organisations, NGOs and individuals, action is unlikely to be successful without two essential major changes: (i) considerably increased public awareness of the environmental issues and how they affect people's lives, and (ii) in response to the demands of the people, the development of genuine commitment to take action by all agencies of Government.

Mass mobilisation through a public awareness and empowerment programme and community participation will be built in to all the future environmental programmes, to help ensure that the planning and implementation is sustainable and responsive to all levels of society, from senior managers in national technical organisations and administrative bureaucrats, through their regional and district personnel to village and small communities. It will involve both government and non-government organisations. Mere awareness raising will not be sufficient and the means to ensure access of people to effective remedies must be included. Many different agencies, government and non-government, will participate. The programme will be nation-wide, and will have to be long-term, continuing for at least 25 years with the aim of establishing environmental protection as a political reality in the country and a real force for change.

Institutional reform and strengthening - institutional reform and strengthening are needed to address fundamental environmental weaknesses in the present institutional set-up, including: the lack of an holistic approach to environmental issues; the lack of mechanisms to incorporate genuine 'bottom-up' environmental initiatives into planning and implementation of developments, and the lack of environmental appreciation within institutions, leading to poor inter-agency co-ordination and co-operation. The component will include improved inter-agency communications particularly with regard to strategic planning and project preparation and implementation. Improved communications and sharing of expertise and information will be a major feature.

The main thrust for pollution clean-up will lie with the concerned municipalities in co-operation with BWDB and DoE. Measures to promote more effective management of fisheries will require co-operation between Department of Fisheries and BWDB. Management of local water bodies is generally a responsibility of Local Government, but in the specific cases above, they will need support from DoFi, BWDB and LGED. Special measures will also be taken up for the Sundarbans and the Haor basins of the Northeast. Promotion of environmental awareness will be a responsibility of DoE, but all agencies will be concerned with this issue, both internally and externally.

All measures above will require central Government funding. Pollution control measures for industry beyond the initial clean-up will be expected to be borne by the concerned industry, as also will a portion of the initial clean-up costs.

National Water Management Plan

Annex C

Environmental Assessment

December 2001

Contents

Tables

1 Key Environmental Objectives for Development of the Water Sector

The development of the environmental component of the NWMP follows the key strategic environmental objectives given in the Government's Development Strategy for the NWMP (WARPO 2001) as follows:

- Provision of clean water for sustainable, multipurpose use;
- Restoration and maintenance of fish habitats;
- Preservation of key features of wetlands;
- Protection of the aquatic environment in the future, especially by institutionalisation of environmental assessment (EA) and environmental management procedures.

This Section presents a brief overview of the proposals in the environmental cluster of NWMP objectives and an overall EA of the NWMP.

2 Legal, Regulatory and Institutional Framework

2.1 *The Legal and Regulatory Framework*

The NWMP environmental programmes are designed to comply with all the environmental sections of the NWPo and related GoB Policies, notably on fisheries and the environment, and to ensure that their provisions are proactively included in development planning of the water resources sector. Provisions and recommendations in the Fifth Five-Year Plan and the earlier consultations under the National Environmental Action Plan (NEMAP; MoEF 1995/96) have also been taken into account.

The following documents set the legal and regulatory framework for management of the water resources environment:

(a) The 1995 Environmental Conservation Act;

(b) The 1997 Environmental Conservation Rules, including the Water Quality Standards (WQS);

(c) The 1997 EIA (Environmental Impact Assessment) Guidelines for Industries, issued by the DoE (Department of Environment);

(d) The 1999 Environmental Court Act.

The 1995 Environmental Act is an enabling act giving the Director-General of the DoE under the Ministry of Environment and Forest (MoEF) the powers and functions to deal with pollution and other 'brown' issues and extends its mandate into 'green' issues. The DoE has the authority to draw up rules and guidelines for managing the environment. The Law also designates the DoE as the body responsible for defining and enforcing the EIA procedures outlined in the Conservation Rules.

The EIA Guidelines for Industries cover significant water sector interventions, including flood control embankments, polders, dykes, water supply and sewage treatment, as well as roads and bridges. All of these water sector interventions, with the exception of bridges below 100m in length and feeder and local roads, fall under the 'Red' category. This requires the most stringent EA process to be followed as part of the construction, re-construction and extension of these projects.

There are only comparatively minor gaps in the environmental legal and regulatory framework related to the water sector; the most important concerning WQS for multipurpose use of ambient water bodies, zoning of industries and legally-binding EA guidelines for the water sector.

2.2 *The Institutional Setting*

(a) The DoE

The DoE is the primary institution for environmental management and setting and enforcement of the environmental regulations. Its key duties related to the water sector include:

- pollution control, including the monitoring of effluent sources and ensuring mitigation of environmental pollution;
- setting the Water Quality Standard (WQS) for particular uses of water and for discharges to water bodies;
- defining EIA procedures and issuing environmental clearance permits - the latter being legal requirements before proposed projects can proceed to implementation;
- providing advice or taking direct action to prevent degradation of the environment;
- declaring Environmentally Critical Areas (ECAs) where the ecosystem has been degraded to a critical state. ECA status confers protection on land and water resources through a series of environmental regulations.

  (The Forestry Department is responsible for Sensitive Area protection in the following four types of legally protected areas: wildlife sanctuaries, game reserves, Reserved Forests and Natural Reserved Forests).

However, the DoE has consistently been under-resourced and needs further institutional strengthening. The Sustainable Environmental Management Programme (SEMP) has recently commenced this with the help of the UNDP. SEMP includes a Policy and Institutions sub-programme within SEMP, which has a component on "Capacity Building for Environmental Legislation and Policy Analysis". Linked with this is the Bangladesh Environmental Management Project (BEMP) supported by the Canadian Government, which over a five-year period is strengthening the DoE.

(b) WARPO

WARPO is responsible for water sector planning at national level and is responsible for establishing and maintaining the NWRD. It has important co-ordinating functions in its capacity as the secretariat of the NWRC and as the 'clearing house' for water sector projects. The Environment Section of WARPO plays a full part in the environmental aspects of these institutional roles.

The balance between command-and-control versus incentive-based pollution-control measures is not yet decided, nor are the roles and activities of other bodies with environmental responsibilities (eg WARPO and DoF) yet fully co-ordinated with those of the DoE; neither, indeed, are those of the major funding agencies. The World Bank, amongst others, has noted the lack of integration in overall water

management policy-making and implementation, despite the cross-sectoral nature of water quality issues.

(c) **Other Organisations**

Apart from DoE and WARPO, other government departments with an interest in environmental management of water resources are the Department of Fisheries (DoF) and the Forestry Department (FD). The DoF is responsible, with the Ministry of Land for the management of public waterbodies. The Forest Department has a mandate to declare reserve forest areas and protected areas, the latter often within the reserve areas. These declared reserve forests are often sensitive environmental areas, either natural coastal mangroves or upstream catchment areas with implications for watershed management. The DPHE is responsible for ensuring safe drinking water supplies and improved sanitation conditions in rural and urban areas.

There are also important non-government institutions with environmental interests, the Coalition of Environmental NGOs (CEN) being the representative lobbying organisation for national NGOs on environmental matters. In addition, several single-issue NGOs have area-based operations and specific interests which impinge on the environmental sector.

Moves to improve the institutional setting for the sector have already started. The NWPo sets the National Water Resources Council (NWRC) as the co-ordinating body for water resources management in Bangladesh, mandating WARPO as its secretariat and the apex planning agency for water resources. For the future, however, if the water resources environment is to be treated in a more integrated and co-ordinated way, much more inter-agency and inter-ministerial co-operation will be needed. In addition, devolution of decision-making to local levels of the government administration will be necessary, with full participation of NGOs and local communities. Radical changes in outlooks and working practices are needed.

2.3 *Operation of Environmental Regulations*

In general, the appropriate policy and legal framework required for effective pollution control and environmental management is already in place or soon will be. The issues for NWMP are therefore how the policy objectives will be implemented and the legislation effectively enforced. Ensuring compliance with the established regulations is one of the key tasks for the future.

Basic water quality data is an essential prerequisite for any compliance programme. However, there are two major omissions in the present monitoring exercises, as far as the aquatic environment is concerned:

(a) The main programmes concentrate on industrial pollution sources, as opposed to receiving water bodies. There are also comparatively few data on discharges from industrial operations which could form the basis for assessing compliance with the discharge WQS and, if necessary, the basis for prosecutions;

(b) the sampling is concentrated on industrial and urban locations, with comparatively little attention to monitoring water quality at, or upstream of, ecologically-sensitive sites that would provide an 'early-warning' system of increasing pollution.

Several aspects related to the first of these issues are being addressed but, realistically, the magnitude of the pollution clean-up and control tasks facing the country are too great for government agencies alone. None have a remit broad enough to deal with all the environmental issues related to the water sector, nor are likely ever to have the resources to do so. Given these institutional weaknesses, the recent examples of private prosecutions against environmental offenders provide pointers for possible future control of pollution and other environmental problems, provided effective public support can be mobilised.

Implementation of the EIA procedures through the DoE is relatively new and has not had time to establish itself.

3 The Environmental Setting

The main features of the environmental setting that have shaped the formulation of the NWMP, and especially the environmental components, include:

- The dominance of water in the natural environment of Bangladesh, given that over one fifth of the country is flooded in the average monsoon and 9% of its area is covered by waterbodies. A fundamental environmental concern for the whole country is, therefore, to ensure healthy and sustainable habitats for the many species of flora and fauna, both aquatic and terrestrial, that depend on these resources;

- The fundamental resource base provided by the aquatic environment for the highly productive inland fisheries, which reportedly employs nearly two million full-time and 12 million part-time fishermen, accounting for about 3% of total GDP and 60% of animal protein intake. Capture fisheries are of crucial importance for the very poor as a freely-available source of nutrition and income;

- The major resource represented by the 170,000ha of seasonally or permanently flooded wetlands, among which are sites in the Haor Basin and in the Sundarbans declared as Ramsar sites, recognising their international importance in support of important biodiversity. Parts of the Sundarbans are also a UNESCO World Heritage Site.

The maintenance of key ecological features of the waterbodies and wetlands, and their connections with the rivers and watercourses, must therefore form an essential part of the Plan. The intention is both to safeguard the natural environment and to provide a fundamental basis for the wellbeing and sustainable development of the natural and social environments. Degradation of the water resource environment is already far advanced and the Plan must include urgent, short-term action to try to retrieve the situation as well as longer-term measures to improve and maintain aquatic resources in a healthy state.

4 Environmental Assessment of the Plan

4.1 *Objectives*

Apart from assessment of the overall impacts of the Plan, the objectives of the NWMP EA are to provide a sector-wide environmental assessment and to provide recommendations for environmental management that ensure integration of environmental concerns into the long-term development and investment planning of the water sector. The following form the specific criteria for the sector assessment; they are aimed at the more process-based (as opposed to the more prescriptive programme and project) elements:

- an environmentally-friendly and sustainable plan;
- promotion of an integrated approach to the (aquatic) environment and related decision-making;
- 'mainstreaming the environment' - ie establishing the background for subsequent project and programme EAs, incorporating the national (aquatic) environmental strategy objectives; remedying data deficiencies and incorporating (aquatic) environmental concerns - and people's participation - into future planing and project/programme implementation;
- consideration of aspects outside the scope of normal project EAs, notably:
  - intersectoral issues;
  - cumulative and long-term effects
  - global changes.
- 'safeguarding the natural environment' for the future - ie specific measures (some urgent) to halt, and where possible, redress the present degradation of the aquatic environment - with special attention to water quality and fisheries needs;
- promotion of human health and well-being - including lives, livelihoods, social equity and economic development;
- development of the necessary supporting activities to achieve the above, notably institutional development and raising environmental awareness of the public as part of an general empowerment campaign to produce action on environmental issues.

The selection and assessment of these high-level concepts are to some degree subjective, but objective measures are built into the Plan in the form of individual indicators and thresholds for progress and impact monitoring of each programme.

A fundamental requirement of the NWMP, following the NWPo, is that each programme will be subject to its own environmental (and social) assessment during the subsequent planning, design and implementation stages. Individual projects will,

of course, be subject to the normal EA procedures covered by the updated Guidelines for EA of FCD/I Projects (DoE/WARPO 2001) and the Guidelines for Industry, which contain the DoE regulations that apply to water sector interventions. It is also intended that the Guidelines for EA in the Water Sector, at present planned by WARPO and the DoE, should also apply.

4.2 *Assessment Constraints*

A major constraint for planning in the water sector, and for the corresponding EAs, is the lack of wide-ranging and reliable data on key ecological features. Consequently, many of the fundamental facts and inter-relationships are very poorly, if at all, understood and the indicators and thresholds used to monitor the state of the water resource environment are generally very rough and ready. The EA, therefore, is merely an initial assessment based on current information; the expectation is that subsequent NWMPs will contain more detailed and quantified evaluations as more data become available.

4.3 *The Future-without- NWMP*

Without NWMP (and the expanded capacity of WARPO) the environmental input to development planning in the water sector would be piecemeal and largely confined to EA studies of individual projects. Until now, there has been no organisation or procedures to deal with environmental objectives and impacts at higher planning levels in a systematic way. Were this to continue, there would be a real danger that cumulative and interacting impacts would be overlooked - across sectors, organisations and features of the wider environment - and both positive and negative environmental impacts would be missed. Significant damage to the natural aquatic environment might result. The NWMP provides the starting point for the wider issues to be addressed. The specific risks of proceeding without the NWMP are summarised in Table 4.1.

Without the NWMP, provisions for environmental data collection and research, and collection of data into a central, quality-checked and readily-available source, the present uncertainties over the effectiveness of proposed measures to safeguard the environment would continue. Without controls based on objective criteria, the present environmental degradation would be likely to accelerate, with irreversible loss of critical economic and ecological resources.

Although other initiatives are under way, without the NWMP programmes the scope and pace of incorporating environmental concerns and people's participation into water sector planning and implementation would be very much slower and less wide-ranging. With GoB unable to tackle every issue through government agencies alone, many future developments detrimental to the environment would be likely to proceed virtually unchecked, again with severe damage to aquatic resources. Much government decision-making in the sector would remain non-transparent.

Table 4.1: Environmental Implications of the Future-without-the-NWMP

Cluster	Focus	Environmental Consequences
ID Institutional Development	WARPO DoE BWDB Local Government Disaster Management Bureau Meteorological Department New Regulatory Bodies FCD and FCD/I management	Failure to develop cross-sectoral water management. Largely unco-ordinated, piecemeal developments with no specific framework for safeguarding the aquatic environment
EE Enabling Environment	Legislation Research and Information Management Zones, Guidelines and Procedures Participatory Planning and Management Media and Awareness Raising Promoting Private Sector Participation Regulatory and Economic Instruments Development Finance	Lack of effective (as opposed to merely nominal) instruments for environmental impact control, especially of cumulative effects, eg of effluents. Widespread pollution of receiving waters from unzoned industries. Poorly-developed and ineffective mobilisation of public opinion - and lack of political will for change. Lack of effective measures to ensure compliance with / enforcement of environmental rules and regulations
MR Major Rivers	Studies Erosion Control Dredging for Navigation Hydropower Abstraction Regional River Management Major River Barrages Water Distribution Networks	Lack of fundamental data on the water resource system. Major environmental degradation due to river erosion. Impacts of unco-ordinated barrage developments and water abstractions. Less environmentally-friendly designs and operation of river works, barrages and abstraction schemes. Lack of effective EA and consequent environmental degradation
TR, MC Major Cities, Towns and Rural Areas	Arsenic Mitigation Water Supplies Sanitation Flood Protection Stormwater Drainage	Unco-ordinated approaches to arsenic contamination problems and to water supply / sanitation developments, without inclusion of environmental considerations
DM Disaster Management	Cyclone Protection Flood Proofing Water Supply Drought Proofing	Further loss of lives and livelihoods from cyclone impacts.
AW Agriculture and Water Management	Irrigation Scheme Development Improved Water Management Coastal Flood Control and Drainage Inland Flood Control and Drainage Coastal Protection and Afforestation	Unco-ordinated FCD/I development and lack of effective EA leading to environmental degradation from abstractions, sedimentation etc. Continued agricultural encroachment on waterbodies.
EA Environment and Aquatic Resources	Pollution Clean-up and Control Water Management for Fisheries Water Management for Ecologically-Sensitive Areas Essential Supporting Interventions	Increasing major industrial and urban pollution of waterbodies. Loss of, or very severe reduction in, inland fish (especially commercially-valuable spp) and other aquatic species. Further degradation of, and encroachment into, wetlands and waterbodies. Lack of an effective voice for the poor and socially-disadvantaged on environmental issues. Lack of integrated approaches to the aquatic environment

4.4 *The Future-with NWMP*

The assessment of NWMP against key sectoral environmental objectives is summarised in Table 4.2.

Table 4.2: Summary Environmental Assessment of the NWMP Cluster Objectives

NWMP Cluster Objective	Contribution to Major Sectoral Environmental Objective[2]											
	Water pollution reduction	Fish habitat improvement	Cross-cutting approaches	Mainstreaming the environment	Safeguarding the natural environment	Social equity and people's participation	Human health and welfare	Sustainable economic development	Addressing long-term issues	Institutional capacity-building	Establishment of reliable and available data
ID Institutional Development											
The national institutional framework for the water sector regulated, decentralised and devolved			+++	+++	++	++	+	+	++	+++	+++
Capacities of the restructured water sector institutions strengthened in line with future demands					++	+	+	+	++		++
EE Enabling Environment											
Rights, obligations and rules of business as they apply to all water sectors stakeholders promulgated via a coherent and comprehensive set of documents	++	++		++		++	+	+	++	+	+
Development and management of water sector resources, institutions and infrastructure characterised by the use of reliable, well organised data and targeted adaptive research		++						+	++	++	+++
User commitment to the sustainable and wise use of the country's water resources	+++	+++		++	+++	+++	++	++	+++		

NWMP Cluster Objective	Contribution to Major Sectoral Environmental Objective[2]											
	Water pollution reduction	Fish habitat improvement	Cross-cutting approaches	Mainstreaming the environment	Safeguarding the natural environment	Social equity and people's participation	Human health and welfare	Sustainable economic development	Addressing long-term issues	Institutional capacity-building	Establishment of reliable and available data
Water sector costs shared between public, private and user entities according to comparative advantage						++		++	++		
MR Major Rivers											
Main and regional rivers comprehensively developed for multi-purpose use		+++	+	+	+	+	++	++	++		
TR Towns and Rural Areas											
Demand for safe and reliable drinking water supplies and services satisfied in towns and rural areas							+++				
Demand for sanitation facilities and services created and satisfied in towns and rural areas	+++						+++				
Large and small towns protected from flooding and stormwater run-off							+++	+++			

NWMP Cluster Objective	Contribution to Major Sectoral Environmental Objective[2]											
	Water pollution reduction	Fish habitat improvement	Cross-cutting approaches	Mainstreaming the environment	Safeguarding the natural environment	Social equity and people's participation	Human health and welfare	Sustainable economic development	Addressing long-term issues	Institutional capacity-building	Establishment of reliable and available data
MC Major Cities											
Demand for safe and reliable drinking water supplies and services satisfied in the Statistical Metropolitan areas							+++				
Demand for sanitation facilities and services created and satisfied in the Statistical Metropolitan Areas							+++				
Statistical Metropolitan Areas protected from flooding and stormwater runoff							+++	+++			
DM Disaster Management											
Lives, livelihood and national infrastructure protected or mitigated against inundation damage by structural and non-structural means		–					+++	+++	+++		
AW Agriculture and Water Management											
Water-related constraints on agricultural production minimised		––					++	++			

NWMP Cluster Objective	Contribution to Major Sectoral Environmental Objective[2]											
	Water pollution reduction	Fish habitat improvement	Cross-cutting approaches	Mainstreaming the environment	Safeguarding the natural environment	Social equity and people's participation	Human health and welfare	Sustainable economic development	Addressing long-term issues	Institutional capacity-building	Establishment of reliable and available data
EA Environment and Aquatic Resources											
Sufficient clean water for multi-purpose use	+++			++	+++		+++	++			
Adequate quality, connectivity and habitat water parameters for the preservation and improvement of aquatic and dependent terrestrial biomass and biodiversity		+++			+++		++	++			
Public committed to, and empowered to demand, environmental improvement and sustainable development of water-dependent resources	+++	+++	++	++	+++	+++	++				

Key to Impacts:

Major ■ Moderate ■ Minor ■ Positive + Negative –

Note
1 The actual impacts will depend on which programmes and components are implemented
2 Impacts may be reduced if appropriate mitigation measures can be implemented
3 Institutional strengthening, studies, research and public awareness-raising / empowerment will assist, but often only indirectly, all the key sectoral environmental objectives
4 Fish being taken as an indicator for aquatic spp in general; this objective therefore includes ecologically-sensitive areas, such as wetlands

4.5 *Important Environmental Concerns*

The NWMP preparation exercise identified 10 important environmental concerns at the national level, as listed in Table 4.3. The concerns were derived from several sources, including the earlier Flood Action Plan reports, expert consultations, and the wide-ranging public participation exercises of both NWMP and the National Environmental Management Action Plan (NEMAP, 1995/6).

Table 4.3: Important Environmental Concerns for the NWMP

Water related diseases/safe drinking water
Surface water quality
Ground water quality
Sensitive areas/biodiversity
Floods and drainage
Erosion, accretion and sedimentation
Cyclones
Fish and fish resources
Navigation, accretion/sedimentation
Low rainfall and river flows

The IECs form the key criteria for the overall EA of the Plan shown in Table 4.4; the potential beneficial and adverse impacts being discussed briefly in the following sections. At this stage the assessments can only be 'potential', because the actual impacts depend on:

(a) exactly which programmes and components are implemented;

(b) the order in which implementation takes place, because this affects the cumulative and residual impacts;

(c) individual site characteristics, which can only be assessed in more detailed IEE/EIA studies of specific interventions.

4.6 *Main Beneficial Environmental Impacts of the NWMP Clusters*

The assessments in Table 4.4 indicate that the potential major environmental benefits of the NWMP fall into three main groups:

- Human health improvements resulting from (i) the water supply and sanitation activities in the cities, towns and rural areas, (ii) the clean-up and prevention of water pollution (including those related to flood-proofing);
- Improvements in livelihoods - with associated health and well-being - resulting from (i) flood protection / proofing, (ii) erosion, drainage and flood control (urban and rural; inland and coastal), (iii) coastal protection, (iv) disaster management and (v) irrigation development;

- Improvements to the water-dependent natural environment - including both sustainable development of resources and conservation of biodiversity and essential ecological features - as a result of changed water management for fish/fisheries and ecologically-sensitive areas.

These are all supported by elements of the institutional development, enabling environment and environment and aquatic resources clusters.

4.7 *Main Adverse Environmental Impacts of the NWMP Clusters*

The adverse environmental impacts of the NWMP are comparatively few, since the formulation of the Plan was governed by the many environmental clauses in the NWPo. The negative impacts arise not so much from the objectives of the clusters as from the details of possible options, for which there are two main areas of concern:

- the impacts of major river developments involving barrages. Whatever the positive impacts of additional water supplies that barrage construction brings, there are inevitable adverse impacts on the natural environment, especially on migration of fish and other aquatic species, and the consequent secondary impacts on biodiversity and productivity. Navigation is also adversely affected. Full mitigation of all these impacts is not possible and there are always residual impacts.

- the cumulative and residual impacts of water abstractions from rivers - for which, again, full mitigation is not possible - and the downstream effects on river flows, sedimentation and saline intrusion, as well as the secondary impacts on aquatic species, ecologically-sensitive areas and navigation.

Within the Plan, provision for mitigation of the adverse impacts includes the stricter application of procedures for environmental clearance to such projects, following the new Guidelines for EA of FCD/I Projects (DoE/WARPO 2001) which were drawn up during preparation of the NWMP. The NWMP measures for water management for fish/fisheries and for ecologically-sensitive areas will also ensure mitigation and/or management of the adverse impacts.

Table 4.4: Summary Assessment of the Potential Impact of the NWMP Programmes on the Natural Environment[1]

NWMP Clusters and Main Components	Impact by Main Important Environmental Concern[2]								
	Disease / Drinking Water	Surface Water Quality	Ground-water Quality	Sensitive Areas / Biodiversity	Floods and Drainage	Erosion / Accretion	Fish / Fisheries	Navigation	Low Rainfall and River Flows
ID Institutional Strengthening									
Strengthening of BWDB, DoE, Local gov, WARPO etc[3]									
EE Enabling Environment									
Legislation, procedures, research, participation, awareness, finance	+	+	+	+			+		
MR Major Rivers									
Studies, erosion control, dredging						+ +	– –	+ +	
Abstractions, barrages and other works		+ + / – –		+ + / – –		+ + / – –	– –	+ + / – –	+ +
Regional surface water networks		+		+ +	+ / –		+ +	+ +	+ +
TR Towns and Rural Areas									
Arsenic mitigation, water supplies	+ + +				–				
Sanitation	+ + +	+ + +	+						
Flood protection and stormwater drainage	+			–	+ + +	– –	–	–	
MC Major Cities									
Review and asset management study[3]									
Water supplies	+ + +				–				

NWMP Clusters and Main Components	Impact by Main Important Environmental Concern[2]								
	Disease / Drinking Water	Surface Water Quality	Ground-water Quality	Sensitive Areas / Biodiversity	Floods and Drainage	Erosion / Accretion	Fish / Fisheries	Navigation	Low Rainfall and River Flows
Sanitation	+ + +	+ + +	+						
Flood protection and stormwater drainage	+				+ + +		– –	– –	
DM Disaster Management									
Cyclone shelters and platforms[4]				–	+ / –				
Flood proofing	+ +				+ + +				
River bank erosion control						+ + +			
Capacity-building of disaster experts					+ +	+ +			
Drought-proofing									+ +
AW Agriculture and Water Management									
Irrigation and improved water management		–	–	– –			– –		+ + / – –
Inland / coastal flood control and drainage				–	+ + / – –	+ + / – –	– –		
Coastal protection and afforestation				+	+ +	+ +			
EA Environment and Aquatic Resources									
Pollution clean-up and control	+ + +	+ + +	+	+			+ +		
Water management for fisheries		+		+			+ + +		
Water management for ecologically-sensitive areas		+		+ + +			+ +		

NWMP Clusters and Main Components	Impact by Main Important Environmental Concern[2]								
	Disease / Drinking Water	Surface Water Quality	Ground-water Quality	Sensitive Areas / Biodiversity	Floods and Drainage	Erosion / Accretion	Fish / Fisheries	Navigation	Low Rainfall and River Flows
Essential supporting interventions[3]									

Key to Impacts:

Major ■ Moderate ■ Minor ■ Positive + Negative –

Note
1 The actual impacts will depend on which programmes and components are implemented
2 Impacts may be reduced if appropriate mitigation measures can be implemented
3 Institutional strengthening, studies, research and public awareness-raising / empowerment will have positive, but indirect, impacts on most IECs
4 'Cyclones' does not appear as an IEC as cyclone action cannot be altered by the Plan; however, remedial measures are included in the Disaster Management Cluster and will have major positive impacts

5 The Natural Environmental Component of the NWMP

5.1 *Compliance with the National Water Policy*

The natural environmental component of the NWMP has been carefully formulated to conform to, and to address all the requirements of, the environmental clauses in the NWPo, as shown in Appendix A. The relevant NWPo clauses are shown in the Programme Description Profiles in the Investment Portfolio - as are the National Environment and Fisheries Policy requirements that have been covered.

5.2 *Compliance with Other National Policies*

The overall Plan makes several positive contributions to the environmental objectives of other national policies, as summarised in Table 5.1. The main contributions relate to positive developments in agriculture, fisheries, water supply and sanitation, whilst also providing checks against the adverse impacts of industrial development.

Table 5.1: NWMP Contribution to Objectives of Policies Relevant to Water and the Environment

National Policy and Key Water-related Environmental Issues	Issues for the NWMP and Corresponding NWMP Components
Agriculture: Increased food crop production for food security; environmentally friendly, sustainable agriculture; strengthening of agro-forestry; research (eg on fish and rice); introduction of improved high-yielding varieties	Possible land use competition and increased water pollution from chemicals Participatory planning and water management, including FCD/I, and public awareness-raising ID 003; EE 004, 006, 010; AW 006, 007; EA 010
Education and Awareness: Introduction of environmental education	Complementary to NWPo environmental awareness-raising. EE 010; EA 010
Energy: Expansion of generating capacity	Chemical and heat pollution of water Pollution clean-up, control and monitoring; application of EA procedures / WQS EA 001 to 003
Fisheries: Conservation of fish breeding grounds and habitats, prevent further drainage of standing waterbodies; promote fisheries development in all waterbodies; support shrimp culture avoiding damage to coastal mangrove forest	Provision of adequate, good quality water for fish/fisheries. Pollution clean-up, control and monitoring; water management for fisheries and ecologically-sensitive areas; public awareness raising EA 001 to 005, 007, 008, 009
Forestry: Wildlife protection and biodiversity conservation; re-afforestation; prevention of adverse impacts on mangroves and other ecosystems; integrating of trees and traditional land uses, expansion of forest area	Reduced sedimentation/erosion (hills and coasts) from afforestation activities. Cyclone protection. Land use competition. Coastal protection afforestation; water management for ecologically-sensitive areas. AW 008; EA 007, 008 and 009

National Policy and Key Water-related Environmental Issues	Issues for the NWMP and Corresponding NWMP Components
Housing and Urbanisation (draft): Urban infrastructure: water supply and sanitation improvements	Land use zoning implications for water quality management and encroachment into environmentally-sensitive areas Urban water supply and sanitation including regulatory bodies; water pollution clean-up, control and monitoring. ID 002; TR 003, 005; MC 001 – 004, 006 – 009'
Industry: Raising industrial share of GDP from 10% to 25% in ten years; encouragement of private enterprise; environmentally sustainable development, conforming to Law; ISO 14000 certification encouraged	Increased production/dispersal could increase severity and spread of pollution problems Regulatory and economic instruments, including EA application; water pollution clean-up, control and monitoring; public awareness-raising and empowerment. EE 003, 005, 012; EA 001 to 003 and 010
Land Use: Agricultural land zoning; provisions for leasing of inland open waters; coastal greenbelt creation; participatory forestry on roads	Supports water resource environmental requirements Coastal protection afforestation; water management for fisheries AW 008; EA 004, 005
Natural Hazards: Flood and cyclone forecasting	Effects of global warming: rainfall pattern changes, and sea-level rise Disaster management, including institutional strengthening ID 009-010; DM cluster
Safe Drinking Water Supply and Sanitation: Increased and sustainable basic water supply and sanitation; mitigation of arsenic problems; stormwater drainage in urban areas; community participation and social awareness	Implications for surface water quality and groundwater arsenic mitigation Urban water supply and sanitation including regulatory bodies; water pollution clean-up, control and monitoring. ID 002; TR 003, 005; MC 001-004, 006-009;
Transport and Communication (draft): Prevent water management conflicts and co-ordinate land use	Conforms with water resource aims; water management implications of embankment construction EA application. EE 005; EA 001
Land Use: Environmentally-friendly land-use. Zoning for agriculture, residential areas. No change waterbody areas: Includes river dredging. Application of NWPo and Fisheries Policy. Strict regulation of waste disposal; proper waste collection and sanitation in cities. Integrated management in the Coastal Zone. Industry controls to prevent land and environment (but not specifically water) degradation.	Possible agriculture – fish/fisheries conflicts. Pollution control benefits form waste, sanitation and zoning measures. NLUPA potentially beneficial for waterbody maintenance. Key areas for co-ordination with WARPO EA application; pollution clean-up and control; water management for fisheries and ecologically-sensitive areas EE 005; EA 004, 005, 007, 008, 009
New Agricultural Extension: Control and prevention of pollution and degradation; EIAs and monitoring; environmentally-sound practices, such as integrated pest management (IPM)	Control and prevention of pollution(eg by IPM) are directly relevant to the water resources sector EA application; pollution clean-up and control EE 005; EA 004, 005, 007, 008, 009
Wetland (draft): Wetland conservation, sustainable development and biodiversity conservation; maintenance of wetland functions; people's participation in development decisions; wetlands survey and database:	Conforms with, and overlaps, NWPo; careful definition of wetlands required Database development; water management for ecologically-sensitive areas; awareness-raising vand empowerment EE 007; EA 007 to 010

The NWMP Institutional Development (ID), especially of WARPO, DoE and local government, awareness-raising / empowerment campaigns (EE 010 and EA 010) and regional programmes (EA 006) will also contribute positively to many of the other sector policy objectives.

5.3 *Compliance with NEMAP Recommendations*

The Plan as a whole also takes fully into account the recommendations relevant to the water sector formulated by NEMAP (1995/6), as shown in Table 5.2.

Table 5.2: NWMP Compliance with the NEMAP Environmental Recommendations for the Water Sector

	NEMAP Environmental Concern	NWMP Environmental Programme[1]
1	Safe drinking water / water pollution	EA 002 Pollution clean-up; Arsenic mitigation[1] TR 001 to 004 Urban and rural water supplies
2	Agro-chemical pollution	EA 002 Pollution clean-up (DAE component)
3	Sanitation provisions	TR 005 and 006 Urban and rural sanitation
4	Social issues generally	EE 006 GPWM
5	Lack of public environmental awareness	EE 010 and EA 009 Awareness / empowerment
6	Natural disasters, including floods, droughts and cyclones	ID 008 Disaster Management bureau strengthening TR 007 and 008; MC 010 to 017 Urban flood protection and drainage DM 001 to 006 Cyclone shelters, killas and flood-proofing
7	Water (environment) issues related to FCD/I projects, including emergency audit and fish passes	Preliminary audit and new draft EA Guidelines for FCD/I complete. ID 003 FCD/I Management rationalisation EA 005 Fish passes. AW 007 Inland and coastal FCD infrastructure EE 004 Guidelines and Manuals
8	Guidelines for environmental review of water sector projects	As (7) above
9	Water scarcity	OGDA Study complete AW 001, 002, 005 and 006 Improved water management AW 003 Surface water irrigation schemes MR 002 to 005 River abstractions and barrages MR 006 Regional River Improvement
10	Salinity intrusion	MR 007 and 008 GDA and SE water distribution networks
11	Wild fish stocks; tidal fish nurseries; (credit for) shrimp zoning and hatcheries	EA 006 and 7 Fisheries Master Plan and Fish passes MR 006 Regional River Improvement
12	Waterlogging, flooding and drainage	As (6) above
13	Siltation	MR 006 MR 011 River dredging for navigation
14	Water sector database	MIS / NWRD established
15	Groundwater and lack of guidelines	EE 008 Research and Development EE 007 Guidelines and Manuals
16	Restoration of aquatic habitats	EA 006 to 008 ESA water management
17	Cross-border water supplies	OGDA Study complete MR 001 Main River Studies and Research
18	Upper river catchment erosion	MR 001 Main River Studies and Research.

Note 1 The arsenic problem, clearly a relevant issue, was identified after the NEMAP programme; it is covered in TR 001 and 002, Urban and rural arsenic mitigation.

5.4 *Compliance with Environmental Rules and Regulations*

The NWMP environmental programmes are carefully tailored to comply and actively support the current environmental rules and regulations, with some - comparatively minor - improvements planned. Potential breaches of these regulations and other environmental protection guidelines (eg the EA Guidelines and the GPWM) are discussed under the Risks and Assumption sections of the Programme Profiles. Key parts of the Pollution clean-up programme (EA 002), the People's awareness and empowerment programme (EE 010 and EA 010) and the Institutional reform programme (EA 010) are specifically formulated to strengthen the formal and informal means of ensuring compliance. Where progress indicator thresholds for environmental concerns have already been defined (eg WQS), the Plan emphasises that these must be followed in all water sector planning and implementation unless and until improved ones are formulated during implementation of the Plan. Criteria for FCD/I project EAs are set out in the new FCD/I EA Guidelines (DoE/WARPO 2001) and others will be added in the forthcoming Water and other Sector Guidelines being prepared by the WARPO and the DoE.

6 Environmental Management

6.1 *Environmental Planning Outline*

No separate environmental management plan (EMP) is contained in the NWMP, as the environmental components form an integral part of the Plan itself, and EMPs for specific developments will be a feature of subsequent planning and design stages. However, the environmental actions have been prioritised according to the following scheme (details appear in the Programme Descriptions Profiles in the Investment Portfolio):

Short-term:

- Start of the Pollution Action Plan, concentrating initially on 'fast-track' pilot clean-up projects for major pollution hot-spots (EA 001 and 002) and of a strengthened water monitoring programme (EA 003);
- Measures to safeguard the water resources of ecologically-critical areas before they become further degraded;
- Formulation of a Fisheries Master Plan to (i) establish the ecological parameters and thresholds necessary for a sustainable and diverse fish population, (ii) identify and quantify threats to fish habitats and (iii) specification of measures by which to combat them (EA 004). Start of a 20-year fish-pass programme;
- EA 008: Review of the major waterbodies, with recommendations on appropriate gazetting of new ECAs and changes to the laws and regulations. Definition of water requirements - key indicators and threshold values - for preservation of aquatic habitats. Preparation of phased management plans, based on wide stakeholder consultations, including follow-up to the OGDA, GRRP and Sundarban Biodiversity studies and development of water resource measures to help preserve essential aquatic habitats Application of the EA Guidelines for FCD/I projects and for the water sector when available (EE 004).
- Nationwide consultations with all environmental stakeholders, to establish a coordinated, inter-sectoral people's awareness and empowerment campaign and institutional reform programme (EA 009 and 010). Carefully-targeted pilot schemes and a coordinated package of supporting activities within and outside the water sector. Preparation of new EA Guidelines for the Water Sector;
- Examination of the potential benefits of an integrated approach for each stakeholder organisation, not least the synergistic benefits from cost-sharing and mutually-accessible resources. Establishment of an institutional framework and timetable for co-operation (and, where possible, integration) of activities Development of institutional capacity-building strategies in key topics such as environment and responsiveness to local initiatives.

Establishment of effective working links between agencies at programme/ project levels.

Medium term:

- As part of the five-yearly NWMP reformulations, review, modification and consolidation of the environmental programme contents and implementation arrangements;
- Progressive refinement of ECA water requirements and development of measures to ensure maintenance of minimum (dry season) water demands for ecological purposes. Formulation of integrated river and wetland management programmes (MR 006 to 009 and EA 008);
- Formulation and implementation of a comprehensive nationwide environmental awareness and empowerment programme, with increasing emphasis on local bodies and creation of political pressures to help ensure compliance with environmental laws and regulations - mainly through non-regulatory means, but backed by legal actions where necessary.
- Development of co-operative inter-agency strategic planning approaches; monitoring and adjustment of the arrangements in parallel with on-going training and capacity-building.

Long term:

- A shift in emphasis from clean-up to monitoring and maintenance of clean waters;
- Continuation of water management for fish and ecologically-sensitive areas;
- Continuation of awareness and empowerment campaigns, progressing over 25 years to cover all the major water resource environmental problems in the country. Intended also (i) to strengthen the joint influence of different stakeholders (especially the poor and socially disadvantaged) and (ii) to address strategic issues and help create the opportunities for advocacy of environmental issues and political / institutional reforms for a positive change in governance and operational procedures;
- Review and re-assignment of responsibilities for programme implementation, supervision and review as institutional development progresses, with particular attention to co-operation between the participating agencies and devolution of decision-making to lower levels, with - in particular - development of mechanisms to bridge 'demand-driven' pressures and 'supply-side' institutions.

6.2 *Environmental Interrelationships*

Many of the programmes of the NWMP will have inter-related impacts on the environment, with implications both within and outside the water sector. An essential feature of the development of these programmes, therefore, is that they are

not undertaken in isolation, but as part of a more 'holistic' approach that draws together the programmes into co-ordinated actions in which the linkages are taken into account as the basis for integrated programmes. However, at the present state of knowledge, the basic features and environmental relationships of the water resource system as a whole are poorly understood, so a truly holistic approach could not be developed for this first NWMP. However, WARPO is currently working towards this goal in the form of studies on the State of the Water Resources System; the results will contribute to formulation of the next plan. For the present Plan, Table 6.1 provides a summary of the main linkages of the present NWMP Strategy and the main agencies involved.

Table 6.1: Major Environmental Links between Aspects of NWMP Strategy[1]

Strategy Element	Environmental Issues	Main Agencies Involved
1 Pollution Prevention and Clean-up		
Drainage[3] and sanitation in major cities, towns and rural areas	Prevention of new, or worse existing, surface water and groundwater pollution hotspots: treatment and disposal methods and siting; O&M. Zoning of water-consuming and polluting industries; measures for communal effluent clean-up before disposal into waterways; O&M Increased risk of agro-chemical pollution of surface and groundwater, requiring water quality monitoring and minimising of risks by IPM[4 5]. Application of EA regulations; compliance with WQS[5]. Strengthened ambient WQS for multipurpose use. Regulatory and non-regulatory approaches	BWDB, Municipal authorities and utilities, DoI, DoA, DAE, LGED
Industrial expansion[4]		
Irrigation development		
Water pollution and control		
2 Integrated River and Wetland Management		
Integrated river development for multipurpose use	Impacts of developments on the natural aquatic habitat - especially fish[2]: water flows, levels, depths, velocities, areas and the connectivity along rivers and between rivers and floodplains. Sediment, saline intrusion in estuaries. Cumulative and residual impacts, especially downstream of water abstractions Water management for sustainable development. Application of EA regulations.	BWDB,LGED, BIWTA, DMB, DoE, FD, DoF
River development for navigation and erosion control		
Hydropower, barrage and reservoir developments		
River erosion control as part of disaster management		
Irrigation structures and water distribution		
Integrated wetlands management programme		
3 Ecologically-sensitive Area Management		
Flood-proofing in the Haor Basin	Land-use conflicts arising from socio-economic developments (especially agriculture) and wetland habitat preservation needs (see below). Aquatic environment impacts as (2) above Maintenance / improvement of productivity and conservation, especially in the Sundarban (biodiversity, wood, forest products and fish) and the Haor Basin (water fowl and mother fish stocks)	BWDB, LGED, DoF, FD, (MoL)
Regional drainage		
Inland and coastal FCD		
Ecologically-sensitive areas		
4 Groundwater Development		
Minor tubewell irrigation development	Deeper and more extensive drawdown of watertables in lower rainfall areas, requiring mitigation measures, eg switching to force-mode pumping and/or augmentation of surface water supplies	MoA, private enterprise
Subsidised DTW schemes		

Notes:
1 National Water Management Plan Development Strategy (DoE/WARPO 2001)
2 Fish being taken as indicators of aquatic ecology conditions
3 Increased requirements arising from larger urban water supplies and improved stormwater drainage
4 Many or most of these measures lie outside the water sector, but will nevertheless be essential for the success of the water strategy
5 IPM = Integrated pest management; WQS = (DoE) Water Quality Standard

6.3 *Environmental Impact Enhancement and Mitigation Measures*

Many general environmental enhancement and mitigation measures have been built into the NWMP and specification of detailed measures will form part of the EAs of future developments in the sector. Table 6.2 summarises the main types of enhancements and mitigations applicable to the NWMP programmes.

Table 6.2: Summary of the Main Enhancement and Mitigation Measures

Project Component or Associated Activity	Enhancement (E) or Mitigation (M) and Description of Measure	
MR Main Rivers		
Barrages and reservoirs	E	Modified reservoir banks and shoreline shallows to provide suitable fish habitats
	E	Stocking of reservoirs with suitable fish fry
	E	Combining barrages with road / rail crossings
	M	Full EIAs, including specific mitigations, eg resettlement arrangements / compensation; provisions for boat locks and fish passes; adequate downstream flows adjusted to fish and boat needs; management arrangements for equitable access to reservoir fisheries
Water distribution networks	E	Minor works to improve river / floodplain and in-river aquatic connectivity and habitat
	E	Local arrangements for management of fish sanctuaries
	E	Fish-friendly timing and methods of dredging/remodelling; post-operation re-stocking with fish fry
	M	Fish-friendly design and operation of regulators
	M	O&M: river dredging to prevent environmental problems caused by siltation; environmentally-friendly spoil disposal
TR, MC Cities, Towns and Rural Areas		
Arsenic mitigation, water supplies and sanitation	E	Co-ordinated programmes with Ministry of Health and urban planning agencies
	M	Provision of corresponding drainage with new water supply schemes
Flood protection and stormwater drainage	M	Fish- and boat-friendly designs and operations; retention of urban water bodies
DM Disaster Management		
Flood-proofing	E	Co-ordinated programmes with the Ministry of Health
AW Agriculture and Water Management		
Water distribution and land development	E	Planning and development co-ordination with DAE and local organisations
	M	As MR above
Inland and coastal FCD	M	Full EIAs, including specific mitigations - eg dredging to control sedimentation
EA Environment and Aquatic Resources		
All	E	Development of a holistic approach and cross-cutting environmental initiatives over different disciplines and agencies

6.4 *Cumulative and Residual Impacts*

Future EMPs for water sector programmes and projects must make special allowance for:

- cumulative impacts, ie ones in which impacts of programmes and projects will act together and cause better or worse aggregate outcomes and

- residual impacts, ie those which remain after enhancement and mitigation measures have been applied.

The main impacts in these categories are listed in Table 6.3. Most elements of the Plan clearly have long-term environmental benefits, whilst most of the main cumulative and residual negative impacts are associated with the possible barrage developments and, to a lesser extent, with irrigated agricultural development and the associated water distribution systems.

Table 6.3: List of Cumulative and Residual Impacts of the NWMP

	Main Impact	Cumulative	Residual
Predominantly beneficial impacts			
ID	Institutional Strengthening		●
EE	Enabling Environment		●
MR	Main Rivers:		
	Reservoir water resources		●
	Water distribution networks - additional water flows		●
TC, MC	Cities, Towns and Rural areas:		
	Water supply and sanitation - water quality		●
DM	Disaster Management:		
	Flood-proofing and river bank erosion control		●
	Drought- proofing		●
AW	Agriculture and Water Management:		
	Improved crop production and livelihoods		●
	Coastal protection and afforestation		●
EA	Environment and Aquatic Resources:		
	Pollution Clean-up and Control	●	●
	Water management for fisheries and sensitive areas		●
Predominantly adverse impacts			
MR	Main Rivers:		
	Barrages and reservoirs:		
	Resettlement of affected people and livestock		●
	Reservoir sedimentation	●	●
	Compensation flows downstream	●	●
	Fish and navigation disruption	●	●
	Abstractions	●	●
	Water distribution networks - works and dredging:		
	Downstream sedimentation	●	●
	Drainage congestion	●	●
TC, MC	Cities, Towns and Rural areas:		
	Water supply - additional drainage need	●	●
AW	Agriculture and Water Management:		
	Wetland / dry land use conflicts	●	●
	Inland and coastal FCDI	●	●

6.5 *Environmental Risks, Uncertainties and Contingencies*

There is an inevitable degree of uncertainty in the EA of the NWMP, as the latter is a national management Plan rather than a project development blueprint and the actual impacts will depend on many future decisions, plans and implementation activities which have yet to be decided. With a planning horizon of 25 to 50 years, the Plan is based on long-term projections and scenarios (eg of population increase and movement, and sea level rise) which are also unavoidably uncertain. However, all the main water-related risks are covered by the Plan, as far as present knowledge allows. Three main overall contingencies allow for these uncertainties and risks: the many specific data-collection and research programmes contained in the Plan; the activities and development of WARPO as the apex planning body for the water sector, and the regular five-yearly updating of the Plan itself to take into account the results of these initiatives.

Future developments under the Plan will need to take into account the uncertainties and assumptions summarised in Table 6.4. Given the advanced state of degradation of so much of the aquatic environmental resources, the main uncertainty is whether or not enough of the measures contained in the Plan can be implemented fast enough - and maintained sufficiently - to safeguard the remainder. The greatest risks are to the capture fish population and the essential resources of the Sundarban and the Haor Basin.

6.6 *Environmental Monitoring*

Objectives, indicators/means of verification and time horizons for two distinct aspects of environmental monitoring have been developed for NWMP, as described in Part C of the Main Report.

(a) monitoring of progress on the environmental (and environmentally-related) components of the Plan - covered under all the Clusters;

(b) monitoring of the impacts on the environment itself, covered under the EA Cluster and - subsequently - under the EMPs to be produced as part of the EAs of individual programmes and projects.

For the natural environment the following indicators are of the most importance:

- data reliability and clarity, and status of knowledge gaps;
- hydrological, geohydrological and water quality data, the latter including pollutant (industrial and faecal), salinity and sediment levels compared with the relevant WQS (eg multipurpose use; fisheries, potable water etc) and the number of pollution hot-spots cleaned up;
- other data relevant to flooding, waterbody and wetland characteristics, notably water depths, areas, duration, 'connectivity' (between the main river system and waterbodies) and frequency/seasonality;

Table 6.4: The Main Environmental Uncertainties and Assumptions in the NWMP

NWMP Cluster / Programme		Uncertainties / Assumptions
ID	Institutional Strengthening	Willingness of agencies to co-operate fully on environmental issues and incorporation of 'bottom-up' initiatives, and their ability to achieve timely progress
EE	Enabling Environment	Ability of research initiatives to produce timely results Effectiveness of measures to ensure timely compliance with/enforcement of environmental regulations Commitment to developing political will for implementation of NWMP - and hence the likelihood of producing (i) real change (ii) long-term funding and (iii) meaningful people's participation
MR	Major Rivers	Abilities to predict the environmental impacts of proposed activities; difficulties of developing timely indicators and thresholds - and hence effective design and operation guidelines Corresponding uncertainties over the effectiveness of mitigation measures, especially those requiring long-term O&M and/or lacking evaluations of actual performance. Unresolved problem of environmentally-friendly disposal of spoil Effects of external factors such as global warming (rainfall and temperature patterns; sea-level rise) and cross-border issues
TR, MC	Cities, Towns and Rural Areas	Uncertainties over costs and practicability of mass arsenic mitigation measures Unresolved problem of the lack of low-cost, non-polluting sanitation for rural areas Uncertainties over population projections and the ability to ensure timely funding and project plans / implementation Doubts over effective, long-term O&M of the facilities
DM	Disaster Management	High density populations on stabilised charlands with inadequate sanitation and waste disposal facilities and unsustainable demands on local fish stocks
AW	Agriculture and Water Management	Ability of the poor and socially disadvantaged to maintain equitable access to water resources and to protect water bodies and wetlands from agricultural encroachment Unresolved problem of long-term measures to deal with FCD-related sedimentation in coastal areas
EA	Environment and Aquatic Resources	Timely provision of sufficient - and good quality - data to allow a system-wide assessment of processes and effects. Timely development of a corresponding analytical framework Political commitment (especially to compliance with/enforcement of WQS) and timely funding and implementation of both pollution clean-up and pollution prevention - with penalties of higher costs the longer clean-up is delayed Commitment to the natural environment and timely provision of the necessary inputs in the water sector and essential complementary activities in other sectors Uncertainties over the effectiveness of people's participation and the willingness of agencies to co-operate and maintain standards to provide for integrated resource management for conservation and sustainable development

- Human health and wellbeing - eg public health statistics, risk to lives, physical assets and livelihoods;
- Equivalent indicators for natural indicator species, especially fish status and productivity (eg catch statistics);
- The number of regulatory and non-regulatory measures to safeguard the aquatic environment promulgated and evidence of effective operation, eg (i) production of fish-friendly infrastructure regulations and the number of conforming designs, installations and operations; (ii) number of

environmentally-critical areas gazetted and fish sanctuaries declared, and (iii) the number of voluntary agreements on, and prosecutions over, environmental protection regulations

- Stakeholder endorsements of environmental aspects of proposals and implementations; production of environmental monitoring and evaluation reports;

- Knowledge, attitude and practice survey data as evidence of the public awareness and empowerment programmes.

Monitoring of all these indicators will require the co-operative efforts of several organisations, as outlined in the following section.

6.7 *Environmental Institutional Arrangements*

Overall monitoring of the environmental aspects of progress on the Plan will clearly be the responsibility of the Environmental Section of WARPO, in conjunction with WARPO's overall progress and impact monitoring of the Plan. The Section will also be responsible for analysis and feedback of the data collection and research results from the next five years' work into the formulation of the next plan, as well as the environmental contributions to WARPO's 'clearing house' function and integrated water resource management (IWRM) activities. The WARPO MIS and the NWRD will be vital for environmental data storage and use.

As the apex planning body in the water sector, WARPO will also play a pivotal role in ensuring the co-operation of the other organisations and planning a co-ordinated approach to the environmental components of the plan and the individual programmes and projects. Not least, the institutional initiatives under of IWRM will be important for the environmental aspects of developments in the sector.

The roles of other organisations are summarised in Section 4 of the Main Report. For protection and management of the aquatic water resources, four other organisation will have major roles to play:

- **DoE**: The DoE will formulate environmental regulations for the sector with WARPO; apply the environmental clearance procedures under the EA system; promulgate water quality standards and carry out associated pollution control activities, including, in collaboration with BWDB, key activities in water quality monitoring and compliance/enforcement. Strengthening of the DoE is specifically included in ID 007;

- **DoF**: The Department of Fisheries will plan, advise and assist in management of water resources for wild fish and fisheries (and hence for the aquatic environment generally) with BWDB, LGED and WARPO. The DoF has major inputs to EA 004 and 005 and in the management of ecologically-sensitive areas - EA 007, 008 and 010;

- **FD**: As the agency responsible for management of the gazetted ecologically-critical areas, the Forest Department will have the major supervision and co-

ordinating role for the programmes falling under the NWMP, but will need support from WARPO, BWDB, DoF and DoE in order to ensure that all the aquatic (as well as the terrestrial) features are safeguarded and/or sustainably developed. The coastal protection development of mangrove plantations will be an FD responsibility (AW 008);

- **BWDB and LGED**: The BWDB and LGED, with appropriate inputs from local government and community initiatives, will undertake water management and infrastructure operations, with appropriate management strengthening at regional and sub-regional levels and overall capacity building, including particular attention to FCD/I rationalisation (ID 001, 003, 004, 005 and 010);

- **DoI**: The Department of Industries will play an important role in ensuring that new industries comply with the environmental regulations before granting permits to proceed, and should also assist in the development of many of the pollution control measures, such as clean-up and prevention incentives, zoning of industries and communal treatment of efluents (EA 001 to 003).

The cross-cutting nature of the environmental needs is evident from this list and it is re-emphasised that it will be vital that these organisations develop means to co-operate fully at operational levels. It is anticipated that the National Water Resources Council will undertake the high-level facilitation initiatives to start the process.

References

MoEF 1995 and 1996 National Environment Management Action Plan (NEMAP), Four Volumes, Ministry of Environment and Forest Dhaka, Bangladesh, 1995-6.

NWMPP 2001 EA Guidelines for FCD/I projects. (Draft). June 2001. WARPO, Dhaka

Appendix A

Conformity of NWMP Environmental Programmes with the 1999 National Water Policy

Policy Reference and Requirement		Corresponding NWMP Programmes
3b	Priorities for water allocation	EA 007, 008, 010
3.1f	To develop knowledge and capability for design of future water resources management plans environmental awareness … [with] … broad public participation	ID 006, 007; EE 010; EA 002, 010
4.05b	Guidelines for EIA	EE 004; EA 002
4.1d	River basin catchment management	EE 008, 009; EA 008
4.1e	River basin pollution control	EA 001, 002, 008
4.2c	People's participation	EE 006, 008, 009, 010; EA 010
4.2k	Water resources of major rivers for multipurpose use	MR 001;EA 001, 002, 008
4.2l / 4.2h	Guidelines etc; EIAs mandatory	EE 001, 003, 004; EA 002
4.2n	Water quality protection	EA 001, 002, 003
4.3	Rules for water allocation for in-stream needs	EE 003, 005, 008, 009;MR 001
4.4c	Sustain rechargeable groundwater aquifers	AW 005, 006
4.5	Multi-objective analysis of water needs	EE 008, 009; EA 007, 008, 009
4.5a	Multi-purpose/disciplinary projects/approach	EE 002, 004, 006, 008, 009,
4.6a	Safe and affordable drinking water	ID 002; TR 001 to 004; MC 002 to 005; EE 001, 003, 004; EA 002, 003
4.6b	Preserve natural urban depressions and water bodies for groundwater recharge and rainwater management	EE 004, 005; EA 008
4.6d	[Institutions to] prevent pollution	ID 002, 006, 007
4.6e	[Local government to] create awareness	ID 005; EE 010; EA 010
4.7	Strengthen monitoring organisations	ID 003, 007, 009, 010
4.7e	Strengthen the regulatory system for agro-chemical pollution control	EE 003; EA 002, 003
4.8	Effluent discharge monitoring	EA 003
4.8a	Zoning regulations for new industries	EE 003, 005; EA 001, 002
4.8a	Zoning regulations in consideration of fresh and safe water	EE 003, 005; EA 001, 002
4.8a	Zoning regulations for location of new industries in consideration of fresh and safe water	EE 003, 005; EA 001, 002
4.8b	Effluent disposal monitoring	EA 003
4.8c	Standards of effluent disposal into common watercourses	EE 003; EA 002
4.8d	Polluters to pay	EE 003, 005
4.9a	Due emphasis on fisheries and wildlife in water resources planning	EA 004 to 009

Policy Reference and Requirement		Corresponding NWMP Programmes
4.9a,b	Provisions for fisheries and minimising aquatic environment disruption	EA 004, 005
4.9b	Measures to minimise disruption to the natural aquatic environment in streams and water channels	EA 004 to 009
4.9c	Drainage schemes to avoid swamps used by wildlife	ID 003; EE 004; EA 008
4.9d	Reservation of water bodies (haors, baors etc) for fisheries	EA 007, 008
4.9d	Perennial links of floodplain water bodies with rivers	
4.9d	Preservation of water bodies for fisheries and maintenance of perennial links of floodplain water bodies with rivers	
4.9e	Water development plans will not interrupt fish movement	
4.9f	Brackish aquaculture confined to specific zones	EE 003, 005; EA 004, 008
4.9a to f	Provisions for fisheries and wildlife	EA 004, 008
4.10b	Adherence to EIA process	EE 003, 004, 005; EA 002
4.11b	Water body recreational activities allowed if not environmentally damaging	No additional environmental water resources intervention required
4.12	Water for the environment: protection, restoration and preservation of the environment and its biodiversity including wetlands, mangrove…endangered species and the water quality	EA 002, 004, 007 to 009
4.12	Issues of environmental preservation, bio-diversity, mangroves, national forest, endangered spp	EA 007 to 009
4.12	(p14) Institutional responsibilities for environmental enhancement, protection and restoration and conformity with NWMP.	ID 006, 007
4.12	Protection, restoration and preservation of the environment and its biodiversity including mangrove…endangered species	EA 007 to 009
4.12a	Give full consideration to environmental protection, restoration and enhancement measures consistent with the National Environmental Management Action Plan (NEMAP) and the NWMP.	See Section on NEMAP conformity
4.12b	Guidelines and manuals	EE 004
4.12c	Ensure adequate upland flow to protect the coastal estuary eco-system from marine salinity intrusion	MR 001; EA 009
4.12d	Natural water-body resuscitation and protection against degradation	EA 007 to 009
4.12e	Stop filling of water bodies / depressions in urban areas for natural aquifers and environment preservation	EA 008
4.12f	Remove unauthorised encroachments on rivers and watercourses	ID 003; MR 001, 006; EA 008
4.12g	Stop unplanned construction on riverbanks and clearance of vegetation on newly accreted land	
4.12h	Massive afforestation and tree coverage in areas with declining water table.	No specific measures advocated as no areas identified where groundwater is being mined, except under Dhaka City. Pumping constraints likely to self-limit problems.
4.12i	Enforce 'polluter pays' principle in environmental guidelines	EE 003, 005
4.12j	Provide education and information to the industrial and farming communities	EE 010; EA 010

Policy Reference and Requirement		Corresponding NWMP Programmes
4.13a	Preservation of natural water bodies to maintain the aquatic environment and facilitate drainage	EE 003, 005
4.13b	Protection of the aquatic environment from project development	EE 004; EA 008
4.13c	Haors that naturally dry up during the winter will be developed for dry season agriculture.	No environmental water resource intervention necessary
4.13d	Integrated projects for increasing fish production in haors, baors etc	EE 002, 004, 006; EA 008
4.13e	Natural water bodies will be developed, where possible, for recreational use in support of tourism	No additional water resource intervention necessary
4.14f	Beneficiary participation at project identification and planning stages	EE 002, 006, 010; EA 010
4.14g	Introduce appropriate financial incentives for water re-use and conservation, responsible use of groundwater, and for preventing overexploitation and pollution.	EE 005
4.15	Investigate flood control and management for guiding policy on structural interventions	ID 003; EE 004
4.15a	Central database and MIS	NWRD established during NWMPP; EE 007
4.15b	Restructure and strengthen water resource [and agricultural] research institutions	ID programmes
4.16/4.16a	Use of Guidelines for People's Participation	EE 002, 004, 006
5d(v)	Clearing house role of WARPO	ID 006; EE 004

National Water Management Plan

Annex D

Supporting Information

December 2001

Contents

1 NWMP Documents and Reports

1.1 *Published Project Reports*

Ref	Title	Date
1	Draft Inception Report	Jun 1998
2	Inception Report Annexes: A Institutional, Consultation and Social Aspects B Economic Aspects C Environmental Aspects D Technical Aspects E Option Development and Analysis F Bibliography G Terms of Reference Matrix H Scope of Work for Ganges Dependent Area Studies	Dec 1998
3	Issues for the National Water Management Plan Annexes: A Summary of Topic Paper Contents	May 1999
4	Draft Development Strategy Report Executive Summary: Summary of Options Annexes A Policies B Projections C Land and Water Resources D Legacies and Lessons E Consultation F Social Analysis G Environment H Institutions I Regulatory and Economic Instruments J Economics K Data Management L Basic Human Needs M Technical Options N Project Profiles O Regional Environmental Profiles	Aug 2000
5	Development Strategy Report (Draft Final) Executive Summary Appendices 1 The National Water Policy 2 Lexicon and Glossary 3 Multi-Criteria Analysis and Option Selection	Mar 2001

1.2 *Topic Papers*

Topic Papers were produced during May to December1999 as a basis for discussion amongst various technical groups during the option formulation stage of the project. Circulation of the papers was generally amongst those attending a series of mini-workshops. The papers do not represent agreed positions by any party, but are archived as a record of the process through which the project went.

Ref	Title
1	Defining the Issues
2	Economic Setting
3	Social and Gender Issues
4	Environmental setting
5	Institutional Setting
6	Legacies and Lessons
7	Land and Water Resources
8	Water and Basic Human Needs
9	Regulatory and Economic Instruments
10	Managing Data
11	Managing the Environment
12	Managing in the Monsoon Season
13	Managing in the Dry Season
14	Managing Land and Rivers
15	Major Investments
-	Outcomes of Consultation

1.3 *Other Reports*

During the course of the project, a number of other reports have been prepared by the Consultants and/or by their sub-contractors. These are available in WARPO and are listed below.

Ref	Title	Author	Date
1	**Options for the Ganges Dependent Area**		
1.1	OGDA Interim Report	NWMPP	Dec 2000
1.2	OGDA Draft Final Report Executive Summary Annexes A Hydrology B Groundwater C Morphology D Modelling E Sociology/PPCP F Environment G Economics H Consumptive Demand and Distribution I Drainage of Coastal Polders J Other Studies and Projects - Prefeasibility Study of the Ganges Barrage for Irrigation Development	NWMPP	July 2001
2	**People's Participation and Consultation**		
2.1	An Analysis of Round 1 Consultations	BIDS	April 1999
2.2	An Analysis of Round 2 Consultations	BIDS	April 2000
2.3	An Analysis of Round 3 Consultations	BIDS	Jan 2001
2.4	PPCP Manual	BIDS	In prep.
2.5	People's Perspectives for NWMP (from Rounds 1 and 2 Consultations)	WARPO	Jan 2000
3	**Management Information System**		
3.1	The WARPO Management Information System Annexes A Projects Database User Manual B Programmes Database User Manual	NWMPP	June 2001
4	**SWMC Technical Reports**		
4.1	TR 1: Flood Hydrology Study	SWMC	Dec 1999

4.2	TR 2: Flood Modelling and Flood Plain Zoning	SWMC	Sept 1999
4.3	TR 3: Low Flow Modelling Study	SWMC	Mar 2000
4.4	TR 4: Salinity Modelling for SWRM	SWMC	Mar 2000
4.5	TR 5: SW-GW Interaction Model	SWMC	Dec 2000
4.6	TR 6: Eastern Hills Region Model	SWMC	Dec 1999
5	**WARPO Development and Training**		
5.1	WARPO Restructuring, Phase 1	NWMPP	May 1999
5.2	Alternative Structures for WARPO	NWMPP	Dec 1999
5.3	Five-Year Work Plan for WARPO	WARPO/ NWMPP	June 2001
5.4	Management Skills Development Programme Course Material A Management by Objectives B Communications and Presentation Skills C Problem Solving and Decision Making D Leadership E Team Building F Report Writing G Effective Meetings H Managing Change I Behaviour Modelling J Office Management	NWMPP	Oct 1999 – Jul 2000
5.5	User Manual: Water Balance Model	NWMPP	Aug 2000
5.6	OGDA: Mike 11 Training and Operational Manual	NWMPP	Jun 2001
6	**Miscellaneous**		
6.1	Response to comments on the DDS	NWMPP	Dec 2000
6.2	Guidelines for Environmental Assessment of Flood Control, Drainage and Irrigation Projects	WARPO, NWMPP, EGIS *et al*	May 2001

1.4 *Working Papers*

Members of the Consultants team produced Working Papers in the early stages of the project. They were produced as a means of sharing information with WARPO and within the team. They represent solely the views of the author and are neither endorsed by WARPO nor the Consultants' management. Nevertheless, they contain much valuable information and have been archived at WARPO.

Ref	Title	Author	Date
	General		
1.01	2nd National Workshop	MFW/MA	07-Dec-98
	People's Participation and Consultation		
2.01	Preliminary Report on PPC methodology and system	PF Kaplan	08-Nov-98
2.02	Preliminary findings from Round 1 PPCP	PF Kaplan	06-Apr-99
2.03	Preliminary findings from Round 2 PPCP (part results)	PF Kaplan	15-Sep-99
2.04	PPCP Round 2 Report	PF Kaplan	Oct -99
	Environment		
3.01a	Preliminary identification, compilation and mapping of IECs	Parvin Sultana	07-Dec-99
3.01	Finalise identification of IECs and issues arising	JRL/PS	07-Jun-99
3.02a	Definition of development options and measures	PMC/PS	23-Dec-98
3.02	Definition of development options and measures	PMC/PS	25-Apr-99
3.04	Identify data requirements & database	EGIS II	14-Feb-99
3.06	Proposals for capacity building in WARPO Env. Section	EGIS II	24-Jun-99
	Fisheries		
4.01	Fisheries Sector Overview	Shahadat Ali	08-Mar-99
	Agriculture		
5.01	Overview of Agriculture Sector in Bangladesh	A Islam	28-Feb-99
	Water Resource Engineering		
8.01	Review and assessment of examples of interventions	S Abedin	19-Aug-99
8.02	Review water supply and sanitation sector	MA Nur	07-Dec-98
8.04	Review of Design and Costing Standards	S Mia	23-Jun-99
8.05	Review planned and actual O&M of selected projects	Md Ali	03-May-99
8.06	Review reports etc on river morphology, erosion, accretion etc	MM Hossain	30-May-99
8.07	Options for dealing with Arsenic in water supply	MA Nur	25-Apr-99
8.08	Arsenic contamination: Implications for NWMP	P Ravenscroft	22-Mar-99
8.09	Irrigation Pumping Costs	P Ravenscroft	30-Oct-99
8.10	Review of Land Use Planning	J Choudhury	30-Oct-99
8.11	Review of River Bank Protection	AA Anasri	31-Dec-99
8.12	Review of regional river morphology	MM Hossain	30-Nov-99
	Water Resources		

9.01	Review of Surface Water Models	SM Shahnewaz	16-Feb-99
9.02	GW Resources Assessment: Review of studies and models	MA Samad/JJvW	18-Mar-99
9.03	Farraka inflows and the GWT	JS Colombi	07-Jun-99
9.04	Flood Forecasting	R Wardlaw	30-Nov-99
	National Water Resources Data Base		
10.01a	NWRD coverages and tools	JS Colombi	07-Dec-98
10.01	NWRD coverages and tools	EGIS/JSC	21-Jul-99
	Economics		
13.01	Macro-Economics and Financial Perspectives	CE Finney	24-Mar-99
13.02	Investment criteria and estimation of economic prices	CE Finney	06-Jan-99
	Social Assessment		
14.01	Review of PP and SIA survey results and lessons learnt	EE Wickett	07-Dec-98
14.02	Definition of important social issues for the options analysis	S Begum	08-Mar-99
	Institutions and Legal		
15.01	WARPO Rules and Regulations	P Thompson	07-Dec-98
15.02	Legislative background	P Thompson	07-Dec-98
16.01	WARPO Restructuring (Stage 1)	P Thompson/SK	15-Jul-99
16.02	Decentralisation and Local Government Reform	S Kawnine	07-Apr-99
17.01	Overview of HRD issues in WARPO	G Kelly	25-Nov-98
17.02	WARPO Training and HRD Programme	G Kelly/SK	21-Mar-99

2 National Water Resources Database Holdings

The National Water Resources Database (NWRD) has been set up at WARPO during the course of the NWMPP. This has been a collaborative effort between WARPO, the NWMPP Consultants and the Environment and GIS Project (EGIS II).

The team has established a number of data management tools that enable ready access to the database information. Full details of the set up are available at WARPO. Given below is a summary of the extensive data holdings in the NWRD.

National Water Resources Database

SL No.	Geo Key	Metadata Source Name	Description of Data Layers	Data Source and Scale	Data Group	Data Type	Data Format	Qual	NW
1	226	Location of Aerodromes	Location of Aerodromes with information	Civil Aviation Authority	Base Data	Airways	Shapefile	✔	✔
2	148	Catchment of NAM (South East)	Catchment of NAM (South East)	SWMC	Base Data	Catchment	Shapefile		
3	147	Catchment of NAM (South West)	Catchment of NAM (South West)	SWMC	Base Data	Catchment	Shapefile		
4	68	Catchments of MPO	Catchments of MPO	WARPO	Base Data	Catchment	Shapefile		
5	69	Catchments of NAM (Eastern Hills)	Catchments of NAM (Eastern Hills)	SWMC	Base Data	Catchment	Shapefile		
6	144	Catchments of NAM (North Central)	Catchments of NAM (North Central)	SWMC	Base Data	Catchment	Shapefile		
7	146	Catchments of NAM (North East)	Catchments of NAM (North East)	SWMC	Base Data	Catchment	Shapefile		
8	145	Catchments of NAM (North West)	Catchments of NAM (North West)	SWMC	Base Data	Catchment	Shapefile		✔
9	40	District boundaries (21)	21 old District boundaries	AEZ 1:250,000 map	Base Data	District	Shapefile	✔	✔
10	6	District boundaries (64)	64 new District boundaries	AEZ 1:250,000 map	Base Data	District	Shapefile	✔	✔
11	42	District boundaries (17)	17 old District boundaries	DLRS 1:5,00,000 map	Base Data	District	Shapefile	✔	✔
12	41	District boundaries (19)	19 old District boundaries	DLRS 1:5,00,000 map	Base Data	District	Shapefile	✔	✔
13	7	District (64) Headquarter Locations, 1991	64 new District HQ Locations	MPO/ Graphosman Atlas	Base Data	District	Shapefile	✔	✔
14	130	Division boundaries (4)	4 Division boundaries	AEZ 1:250,000 map	Base Data	Division	Shapefile	✔	✔
15	3	Division boundaries (6)	6 Division boundaries	AEZ 1:250,000 map	Base Data	Division	Shapefile	✔	✔
16	154	Division boundaries (6) of DLRS	Division boundaries (6) of DLRS	DRLS 1" 1 mile map	Base Data	Division	Shapefile		
17	82	Coast Line 1997	Coastal Boundary	LANDSAT Image 1997	Base Data	National	Shapefile	✔	✔
18	128	National Boundary	National Boundary	SoB 1:50,000 Topo map	Base Data	National	Shapefile	✔	✔
19	227	Draft Restriction map of BIWTA 1998	Draft Restriction map of IWTA of 01/12/1998	BIWTA, 1: 1,000,000	Base Data	Navigation	Shapefile	✔	✔
20	263	Draft Restriction map of BIWTA 1999	Draft Restriction map of IWTA of 01/06/1999	BIWTA, 1:1,000,000	Base Data	Navigation	Shapefile		
21	228	Location of inland waterway facilities of BIWTA	Location map of Inland Waterway facilities of BIWTA	BIWTA, 1:1,000,000	Base Data	Navigation	Shapefile	✔	✔
22	229	Navigation Route	Navigation Route (Master Plan), 1994-95	BIWTA, Annual Ports & Traffic Report, 1994-95, 1:1,000,000	Base Data	Navigation	Shapefile	✔	✔
23	230	Inland waterway facilities & highlights	Inland Waterway facilities & Statistical Highlights (1996-97)	BIWTA, Annual Ports & Traffic Report, 1996-97	Base Data	Navigation	Word File	✔	✔
24	143	Planning Unit of MPO	MPO Planning unit and Catchment	MPO catchment & planning unit map 1:250,000	Base Data	Planning unit	Shapefile	✔	✔
25	231	Transmission Line	Existing transmission Line information	BPDB, Annual Report, 1996-97	Base Data	Power Sector	Simple Table	✔	✔
26	338	Grid Substations of BPDB	Grid Substation of BPDB	BPDB, Annual Report, 1996-97	Base Data	Power Sector	Simple Table	✔	✔
27	233	Power Demand	Power Demand by Zone and Year, 1970-71 to 1996-97	BPDB, Annual Report, 1996-97	Base Data	Power Sector	Simple Table	✔	✔
28	234	Power Generation by plants	Power Generation by Plants (1996-97)	BPDB, Annual Report, 1996-97	Base Data	Power Sector	Simple Table	✔	✔
29	235	Location of Transmission Line	Map of Transmission Line (1992)	BPDB, Annual Report, 1996-97	Base Data	Power Sector	Shapefile		✔
30	232	Location of Grid Substation	Map of Transmission Substations (1992)	BPDB, Annual Report, 1996-97	Base Data	Power Sector	Shapefile		
31	218	Rail line	Map of Railway Lines, 1992	AEZ map of scale 1:250,000 and updated using IRS (98) and Landsat (1997)	Base Data	Railway	Shapefile	✔	✔

32	250	Rail stations	Map of Railway Stations, 1992	AEZ map of scale 1:250,000 and updated using IRS (98) and Landsat (1997)	Base Data	Railway	Shapefile		
33	339	District-wise Railway Route	District-wise Railway Route in km and no of Stations	Bangladesh Railway, Information Book, 1998	Base Data	Railway	Simple Table	✔	✔
34	329	Freight of Commodities	Freight in Tonnes by Commodities (1969-70, 1996-97, 1997-98)	BRailway, Information Book, 1999	Base Data	Railway	Simple Table	✔	✔
35	340	Railway Route statistics	Route Information/Statistical Highlights(1969-70, 1996-97, 1997-98)	BRailway, Information Book, 1999	Base Data	Railway	Simple Table	✔	✔
36	8	Hydrological Regions	Hydrological Regions of Bangladesh	MPO catchment & planning unit map 1:250,000	Base Data	Region	Shapefile	✔	✔
37	14	Detail Rivers	Detail Rivers	SPOT 89 & Landsat 97 images 1:50,000 (20m), (30m) BWDB & BIWTA	Base Data	Rivers	Shapefile	✔	✔
38	15	Major Rivers	Major Rivers	SPOT 89 & Landsat 97 images 1:50,000 (20m), (30m) BWDB & BIWTA	Base Data	Rivers	Shapefile	✔	✔
39	16	Model Rivers	Model Rivers	SPOT 89 & Landsat 97 images 1:50,000 (20m), (30m) BWDB & BIWTA	Base Data	Rivers	Shapefile	✔	✔
40	67	River Polygon	River Polygon	SPOT 89 & Landsat 97 images 1:50,000 (20m), (30m) BWDB & BIWTA	Base Data	Rivers	Shapefile	✔	✔
41	236	Road network of RHD	RHD road info upto Feeder Road Type A	RHD	Base Data	Roads	Shapefile	✔	✔
42	217	Asian Highway	RHD road network with Asian Highway	RHD	Base Data	Roads	Shapefile	✔	✔
43	44	Thana boundaries (408)	408 Thana boundaries 1961	AEZ 1:250,000 map	Base Data	Thana	Shapefile	✔	✔
44	43	Thana boundaries (418)	418 Thana boundaries 1974	AEZ 1:250,000 map	Base Data	Thana	Shapefile	✔	✔
45	2	Thana boundaries (464)	464 Thana boundaries 1981	AEZ 1:250,000 map	Base Data	Thana	Shapefile	✔	✔
46	1	Thana boundaries (490)	490 Thana boundaries 1991	AEZ 1:250,000 map	Base Data	Thana	Shapefile	✔	✔
47	153	Thana Headquarters (490)	490 Thana HQ Locations	MPO/ Graphosman Atlas	Base Data	Thana	Shapefile	✔	
48	17	Digital Elevation Model	DEM of Bangladesh 300m resolution	BWDB irrigation map 1:40,000 SoB Topo 1:50,000	Base Data	Topography	GRID	✔	✔
49	115	Land elevation points	Point elevation of DEM	BWDB irrigation map 1:40,000 SoB Topo 1:50,000	Base Data	Topography	Shapefile	✔	✔
50	129	Union Boundaries (4451), 1991	4451 Union boundaries	DLRS 1 in 1 mile scale map 1:63,630	Base Data	Union	Shapefile	✔	✔
51	9	Perennial Waterbodies, 1999	Perennial Water Bodies	SPOT 89, Landsat 97, IRS image 98, SoB Topo 1:50,000 (20m), (30m), (6m) 1:50,000	Base Data	Waterbodies	Shapefile	✔	✔
52	328	Environmental Parameters of NEMAP	NEMAP Database, 16 parameters of Env. Concern by Thana (257 missing)	NEMAP/OGDA	Environment	Indicative Parameter	Simple Table	✔	✔
53	92	Industrial Discharge Locations	Industrial (clustered) Discharge Location Map	IWT3	Environment	Industry	Shapefile		
54	309	Industry Disposal Information	List of Industry disposal to river (around 2200) by Types	IWT3/BKH	Environment	Industry	Simple Table	✔	✔
55	95	Agricultural Crop Loss	Agricultural Crop (Major) Loss due to Natural Calamities(1977-88)	BBS	Environment	Natural Disaster	Simple Table	✔	✔
56	238	Flood & River Bank Erosion	Area Affected by Flood and River bank Erosion (map)	Cyclone Rehabilitation	Environment	Natural Disaster	Shapefile	✔	✔
57	239	Tornado Affected Area	Area Affected by Tornadoes (Map)	Cyclone Rehabilitation	Environment	Natural Disaster	Shapefile	✔	✔
58	240	Cyclone Risk Area	Cyclone Risk Map	Cyclone Rehabilitation	Environment	Natural Disaster	Shapefile	✔	✔
59	241	Seismic Zone	Seismic Risk Map	Ministry of Relief in coordination of Cyclone Rehabilitation	Environment	Natural Disaster	Shapefile	✔	✔

60	85	Salinity Impact in Sundarbans	Impact of salinity in Sundarban Monthly conductivity from 1989-97 for 4 Stations with 6 parameters	DoFo	Environment	Salinity	Simple Table	✔	✔
61	282	Waste Water & Pollution in Tanneries	Waste water and Pollution status in Survey Tanneries	BKH 1997, TA No 1769-BAN, Industrial Pollution Control Management, Bangladesh	Environment	SW Quality	Excel File	✔	✔
62	283	Surface Water Quality ,Chittagong	SW Quality Data 1984-93, Chittagong Division	DoE	Environment	SW Quality	Simple Table	✔	✔
63	284	Surface Water Quality,Rajshahi	SW Quality Data 1984-93, Rajshahi Division	DoE	Environment	SW Quality	Simple Table	✔	✔
64			SW Quality Data 1984-93, Khulna Division	DoE	Environment	SW Quality	Not available		
65			SW Quality data 1996-99, Chittagong division	DoE	Environment	SW Quality	Not available		
66	286	Surface Water Quality, Dhaka	Surface water quality for Dhaka Division, 1980-96 (Scatter)	IWT3/DoE	Environment	SW Quality	Simple Table		✔
67	287	Heavy metals concentration (Dhaka)	Concentration of Heavy metals in and around Dhaka city	Report - 4th Dhaka Water Supply Project, 1997	Environment	SW Quality	Word File	✔	✔
68	288	Surface Water Quality (Dhaka)	Detailed Water Quality Monitoring Data of SWMC around Greater Dhaka City	WSP 1998, Fourth Dhaka Water Supply Project, Dhaka Water Resources Management Program	Environment	SW Quality	Excel File	✔	✔
69	289	Supply Water Salinity (Khulna)	SW Salinity and Discharge for Khulna Water Supply		Environment	SW Quality	Word File	✔	✔
70	290	Fish Catch (64 Districts)	Annual Fish Catch by 64 District, 1995-96, 1996-97, 1997-98	DoF	Fisheries	Fish catch	Simple Table	✔	✔
71	90	Fish Catch (21 Districts)	Fish catch 1991-95 by old District	IWT3	Fisheries	Fish catch	Simple Table		✔
72	291	Forest Land (District 64) in 1998	District-wise Forest land in Bangladesh, 1998	DoFo	Forest	Forest Land	Simple Table	✔	✔
73			Forest map of Bangladesh, 1999 (Forest area with different year of source)	DoFo	Forest	Forest Land			✔
74	243	Wildlife Sanctuaries & National Parks	Wildlife Sanctuaries & National Parks (Protected Areas)	DoFo	Forest	Forest Land	Shapefile		✔
75	244	Forest Range of Sundarbans	Forest Range Offices in Sundarbans Reserved Forest	DoFo, SPOT 1:50,000, Updated 1:15,000 airphotography, 1995, FRMP	Forest	Forest Land	Shapefile	✔	
76	133	Forest Locations of 1984	Forest Map of Bangladesh 1984	SPARRSO	Forest	Forest Land	Shapefile	✔	✔
77	116	Irrigated Areas by STWs	Nos. of operating DTW, STW & other for GW abstraction for the year 1975, 1979-80, 1982-89, 1991, 1993-97	Irrigation census by technologies, NMIC	Groundwater	Abstraction	Excel File		✔
78	293	Aquifer Transmissivity by pump test	Aquifer Transmissivity in 137 pump test Analyses	BWDB, 1982	Groundwater	Aquifer Properties	Shapefile	✔	✔
79	19	Borehole Locations of BWDB	Borehole Attribute Spatial Information	BWDB	Groundwater	Lithology	Shapefile	✔	✔
80	56	Lithology of BWDB	Lithological Information	BWDB	Groundwater	Lithology	Simple Table	✔	✔
81	101	Depth Storage Data of MPO	Depth- storage model output by Thana (GW)	MPO GW resource	Groundwater	MPO Resources	TS Main table with spatial link	✔	✔
82	102	Potential Recharge Data of MPO	Potential Recharge	MPO GW resource	Groundwater	MPO Resources	Simple Table	✔	✔
83	103	Resource Potential Data of MPO	GW resources potential in million m^3 by Thana (average model output)	MPO GW resource	Groundwater	MPO Resources	Simple Table		✔
84	264	Aquifer Transmissivity	Aquifer Transmissivity by Thana	MPO GW resource	Groundwater	MPO Resources	Table with spatial link	✔	✔
85	97	Groundwater Level Stations of BADC/DTW2	GW Level Stations of BADC/DTW II	BADC-DTW-II	Groundwater	Water level	TS Main table with spatial link	✔	✔

86	137	Groundwater Depth data of BADC/DTW2	GW Level recorded yearly at 1477 BADC-DTW-II (TS)	BADC-DTW-II	Groundwater	Water level	TS table (linked)		✔
87	96	Groundwater Level data of BMDA	GW Level recorded fortnightly at 50 BMDA (TS)	BMDA	Groundwater	Water level	TS table (linked)		✔
88	27	Groundwater Level data of BWDB	GW Level recorded weekly at 1256 BWDB (TS)	BWDB	Groundwater	Water level	TS table (linked)		✔
89	18	Groundwater Level Stations of BWDB	GW Well location of 1256 BWDB station	BWDB, 1:50,000	Groundwater	Water level	TS Main table with spatial link	✔	✔
90	155	Groundwater Level Stations of BMDA	GW location of 50 BMDA station	Corrected from union level database	Groundwater	Water level	TS Main table with spatial link	✔	✔
91	358	Groundwater Level Decline (Forecast)	Forecast of Decline of GW Level in Bangladesh for the year of 1992, 1995, 2000 and 2010	Decline of GW level, EPC, 1994	Groundwater	Water Level	Table with spatial link	✔	✔
92	136	Groundwater Level of DPHE	GW Level recorded yearly minimum at 4474 DPHE (TS)	DPHE	Groundwater	Water level	TS table (linked)		✔
93	167	Groundwater Level Stations of DPHE	GW well location of 4474 DPHE	DPHE	Groundwater	Water level	TS Main table with spatial link	✔	✔
94	99	Groundwater Level of NEMIP	GW Level recorded fortnightly at 258 NEMIP (TS)	NEMIP	Groundwater	Water level	TS table (linked)		✔
95	156	Groundwater Level Stations of NEMIP	GW well location of 258 NEMIP	NEMIP	Groundwater	Water level	TS Main table with spatial link	✔	✔
96		Records of Arsenic tests	Arsenic Data	Arsenic Mitigation project (DPHE, BUET etc)	Groundwater	Water Quality			✔
97	113	Groundwater Quality of BWDB	Yearly GW quality observations of 19 parameters at 117 of BWDB (TS)	BWDB	Groundwater	Water Quality	TS table (linked)		✔
98	164	Groundwater Quality Stations of BWDB	GW Quality Monitoring Station Locations (117)	BWDB, 1:50,000	Groundwater	Water Quality	TS Main table with spatial link	✔	✔
99	163	Groundwater Quality Stations of DPHE	GW quality location at 228 of DPHE	DPHE	Groundwater	Water Quality	TS Main table with spatial link	✔	✔
100	160	Groundwater Quality of DPHE	GW quality at 228 of DPHE (TS)	DPHE	Groundwater	Water Quality	TS table (linked)		✔
101	165	Groundwater Quality Stations of NEMIP	GW quality location at 249 of NEMIP	NEMIP	Groundwater	Water Quality	TS Main table with spatial link	✔	✔
102	161	Groundwater Quality of NEMIP	GW quality observations at 249 of NEMIP (TS)	NEMIP	Groundwater	Water Quality	TS table (linked)		✔
103	166	Groundwater Quality Stations of NMIDP	GW quality location at 31 of NMIDP	NMIDP	Groundwater	Water Quality	TS Main table with spatial link	✔	✔
104	162	Groundwater Quality of NMIDP	GW quality observations at 31 of NMIDP (TS)	NMIDP	Groundwater	Water Quality	TS table (linked)		✔
105	362	Climatic stations of BMD	Location of 31 climatic stations	BMD	Meteorological	Climate	TS Main table with spatial link	✔	✔
106	37	Humidity of BMD	Daily observation of relative humidity	BMD and BARC	Meteorological	Climate	TS table (linked)		✔
107	34	Sunshine hour of BMD	Daily observation of sunshine hours	BMD and BARC	Meteorological	Climate	TS table (linked)		✔
108	36	Temperature data of BMD	Daily observation of temp (max & min.)	BMD and BARC	Meteorological	Climate	TS table (linked)		✔
109	35	Wind Speed of BMD	Daily observation of wind speed	BMD and BARC	Meteorological	Climate	TS table (linked)		✔
110	297	Monthly calculated Eto	Monthly calculated Eto	NWMP	Meteorological	Climate			✔
111	13	Evaporation stations of BMD	Location of 12 evaporation stations	BMD	Meteorological	Evaporation	TS Main	✔	✔

							table with spatial link		
112	33	Evaporation data of BMD	Daily Evaporation Data (TS)	BMD	Meteorological	Evaporation	TS table (linked)		✔
113	45	Evaporation of BWDB	Daily Evaporation Data (TS)	BWDB	Meteorological	Evaporation	TS table (linked)		✔
114	12	Evaporation stations of BWDB	Location of 47 evaporation stations	BWDB 1:250,000	Meteorological	Evaporation	TS Main table with spatial link	✔	✔
115	32	Rainfall of BMD	Time series of Daily Rainfall	BMD	Meteorological	Rainfall	TS table (linked)	✔	✔
116	46	Rainfall of BWDB	Time series of Daily Rainfall	BWDB	Meteorological	Rainfall	TS table (linked)	✔	✔
117	11	Rainfall stations of BWDB	Location of rainfall at 304 stations	BWDB 1:250,000	Meteorological	Rainfall	TS Main table with spatial link	✔	✔
118	48	Dependable Rainfall of BWDB	Dependable rainfall exceeded 80% of the time (Monthly)	BWDB	Meteorological	Rainfall	Simple Table		✔
119	47	Dependable Rainfall of BMD	Dependable rainfall exceeded 80% of the time (Monthly)	BMD	Meteorological	Rainfall	Simple Table		✔
120	65	Rainfall(Monthly) of BWDB	Monthly rainfall total	BWDB	Meteorological	Rainfall	TS Main table with spatial link		✔
121	64	Rainfall(Monthly) of BMD	Monthly rainfall total	BMD	Meteorological	Rainfall	TS Main table with spatial link		
122			Component of BWDB Projects including implementation and O&M Cost	BWDB	Project Data	Project Info	Not available		
123		Location of BWDB circles	Jurisdiction Map of BWDB	BWDB	Project Data	Project Info	Shape file		✔
124		Location of BWDB projects	Location of BWDB Projects	BWDB	Project Data	Project Info	Shape file		✔
125	301	Household Information (490 Thanas)	Household information 1991 by Thana	BBS	Socio-Economic	Census	Simple Table	✔	✔
126	302	Household Information (464 Thanas)	Household (HH) information, 1981, by Thana	BBS	Socio-Economic	Census	Simple Table	✔	✔
127	131	Population Census 1961	Population census data of 1961 census, male/female and urban/rural	BBS published report	Socio-economic	Census	Simple Table	✔	✔
128	142	Population Census 1974	Population census data of 1974 census, male/female and urban/rural	BBS published report	Socio-economic	Census	Simple Table	✔	✔
129	141	Population Census 1981	Population census data of 1981 census, male/female and urban/rural	BBS published report	Socio-economic	Census	Simple Table	✔	✔
130	140	Population Census 1991	Population census data of 1991 census, male/female and urban/rural	BBS published report	Socio-economic	Census	Simple Table	✔	✔
131	170	Tribal Population (64 Districts)	Tribal people by 64 Districts	BBS, 1991 Census	Socio-economic	Census	Simple Table	✔	✔
132	303	Household Income (64 Districts)	Avg HH Income by 64 Districts, 1995	BBS/ OGDA	Socio-Economic	Census	Simple Table	✔	✔
133	304	Hard Core & Basic Poverty (64 Districts)	Hardcore and basic poverty by 64 Districts	BBS/ OGDA	Socio-Economic	Census	Simple Table	✔	✔
134	305	Industry Type & Number (64 Districts)	Manufacturing Establishment (industry) by District and classification	Directory of Industry, 1993	Socio-Economic	Census	Table with spatial link	✔	✔
135	306	Malnutrition (64 District)	Malnutrition info by 64 Districts	Unicef/ OGDA	Socio-Economic	Census	Table with spatial link	✔	✔
136	117	Foriegn Exchange Rates	Average Foreign Exchange Rates	BBS	Socio-economic	Economic	Word File	✔	✔
137	307	Inflation Factors & Deflators	Inflation Factors and Deflators	BBS	Socio-economic	Economic	Word File	✔	✔
138	308	Economic Hardship (64 Districts)	Economic hardship by 64 Districts	BBS	Socio-Economic	Economic	Simple Table	✔	✔
139	305	Industry Type & Number (64 Districts)	Ownership, Fixed Assets engaged in Industries by 64 Districts, 1991-92	Census of Manufacturing Industry, BBS , 1995	Socio-Economic	Economic	Table with spatial link	✔	✔

140	123	Crop input prices (Assumed)	Average Harvest time crop price 1994-95 to 1997-98	Deptt of Agriculture	Socio-economic	Economic	Word File	✔	✔
141	326	Human Development Index	Human Development Index of Bangladesh	Human Development in South Asia, 1997, UNDP	Socio-Economic	Economic	Simple Table	✔	✔
142	123	Crop input prices (Assumed)	Assumed crop input prices	NWMP	Socio-economic	Economic	Word File	✔	✔
143	120	Output Price of NWMP (Assumed)	Assumed summary output prices	NWMP	Socio-economic	Economic	Word File	✔	✔
144	122	Input Conversion Factors of NWMP	Project input conversion factor adopted for NWMP	NWMP	Socio-economic	Economic	Word File	✔	✔
145	127	Public Sector Investment	Public sector investment	NWMP	Socio-economic	Economic	Word File	✔	✔
146	314	Socio-economic Parameters on Disease and health 1994	Socio-economic parameters on diseases and health of 1994	UNICEF sample survey data by District from 1994 to 1998.	Socio-economic	Economic	Excel File	✔	
147	364	Socio-economic Parameters on Disease and health 1995	Socio-economic parameters on diseases and health of 1995	UNICEF sample survey data by District from 1994 to 1998.	Socio-economic	Economic	Excel File	✔	
148	365	Socio-economic Parameters on Disease and health 1996	Socio-economic parameters on diseases and health of 1996	UNICEF sample survey data by District from 1994 to 1998.	Socio-economic	Economic	Excel File	✔	
149	366	Socio-economic Parameters on Disease and health 1997	Socio-economic parameters on diseases and health of 1997	UNICEF sample survey data by District from 1994 to 1998.	Socio-economic	Economic	Excel File	✔	
150	367	Socio-economic Parameters on Disease and health 1998	Socio-economic parameters on diseases and health of 1998	UNICEF sample survey data by District from 1994 to 1998.	Socio-economic	Economic	Excel File	✔	
151			MUV Index	WB Manufacturing Unit value (Index of international inflation)	Socio-Economic	Economic		✔	✔
152	265	Flood Regime Land type	Flood Regime Land type	SRDI/BARC	Soil & Agriculture	AEZ	Shapefile	✔	✔
153			Moisture Zone	SRDI/BARC	Soil & Agriculture	AEZ	Not available		
154	248	Physiographical Units	Physiographical Units	SRDI/BARC	Soil & Agriculture	AEZ	Shapefile		✔
155			Thermal Zones	SRDI/BARC	Soil & Agriculture	AEZ	Not available		
156	334	Agricultural Household Statistic (64 District)	HH and Holdings by Farmsize for 64 Districts, 1996	BBS	Soil & Agriculture	Crop Statistics	Simple Table	✔	✔
157	330	Crop Statistics by Farmsize (64 Districts)	Crops: Agricultural census data on crop and farm size by 64 Districts for 1996	BBS published report	Soil & Agriculture	Crop Statistics	Simple Table	✔	
158	125	HYV Rice by Acreages	HYV Rice in Bangladesh from 1969-70 to 1997-98	BBS published report	Soil & Agriculture	Crop Statistics	Excel File	✔	✔
159	126	Cropped Areas	Total Cropped Areas 1975-76 to 1994-95	BBS published report	Soil & Agriculture	Crop Statistics	Word File	✔	✔
160	52	Crop Statistics(21 Districts)	Crops: Area and production of 17 major crops, by year and 21 old Districts	BBS published report	Soil & Agriculture	Crop Statistics	Simple Table		✔
161	53	Crop Statistics (490 Thana)	Crops: Area and production of 17 major crops, by year by Thana where available	BBS published report	Soil & Agriculture	Crop Statistics	Simple Table		✔
162	78	Crop Suitability Classification	Crop Suitability	SRDI/BARC	Soil & Agriculture	Crop Suitability	Shapefile		✔
163	76	Drought Map (Kharif)	Drought Map of Kharif Season	SRDI/BARC	Soil & Agriculture	Drought	Shapefile	✔	✔
164	77	Drought Map (Rabi)	Drought Map of Rabi Season	SRDI/BARC	Soil & Agriculture	Drought	Shapefile	✔	✔
165	111	Fertilizer used by 21 Districts	Fertilizer Input 1987-88 to 1993-94	BBS	Soil & Agriculture	Fertilizer	Simple Table	✔	✔
166	121	Sales of Major Fertilisers	Sales of major fertilizer 1965-66 to 1995-96	BBS	Soil & Agriculture	Fertilizer	Excel File	✔	✔

167	124	Fertilisers for Nutrient Equivalents	Use of major fertilizer in Nutrient Equivalent	BBS	Soil & Agriculture	Fertilizer	Excel File	✔	✔
168	87	Fertilizer Information of IWT3	Fertilizer Data IWT3	IWT3	Soil & Agriculture	Fertilizer	Simple Table		✔
169	75	Agro Ecological Zones	AEZ Polygons from FAO mapping, with the many attributes used in the SODAPs database	SRDI/BARC	Soil & Agriculture	Soil Association	Shapefile		✔
170		River Cross-Section Data	Raw cross section data of rivers (around 5000)	BWDB/SWMC	Surface water	Cross section		✔	✔
171		River model data	Hydraulic properties of modelled river cross sections	SWMC model output	Surface water	Cross section		✔	✔
172	29	Discharge (Non Tidal-daily)	Daily discharge data NTQ (TS)	BWDB	Surface water	Discharge	TS table (linked)	✔	✔
173	89	Discharge (Tidal-daily)	Daily discharge data TQ (TS)	BWDB	Surface water	Discharge	TS table (linked)	✔	✔
174	88	Discharge Stations of BWDB (Tidal)	Location information of 16 TQ	BWDB, 1:250,000	Surface water	Discharge	TS Main table with spatial link	✔	✔
175	28	Discharge Stations of BWDB (Non-Tidal)	Location information of 129 NTQ	BWDB, 1:250,000	Surface water	Discharge	TS Main table with spatial link	✔	✔
176			Discharge of Modelled river with given probability of exceedence (avg year to 1:100 year) for dry and wet season	SWMC model output	Surface water	Discharge	Not available	✔	
177			10 Day average discharge at generated computational grid points from 1965-66 to 1989-90 (Dry and Wet season)	SWMC model output	Surface water	Discharge	Not available		
178			Flood maps of different frequencies (1 in 2, 5, 10, 25, 50 and 100 yr return period)	SWMC model output	Surface water	Flood Depth	Not available		
179			Depth-Duration map for 60 and 90 days duration for 2 and 5 year return period	SWMC model output	Surface water	Flood Depth	Not available		
180	62	Surface Water Rainfall & ET of MPO	MPO Surface Water Rainfall and ET	MPO	Surface water	MPO Resources	Simple Table	✔	✔
181	63	Surface Water Storage(Potential)	MPO Surface Water Storage Potential	MPO	Surface water	MPO Resources	Simple Table	✔	✔
182	61	Surface Water Parameters of MPO	Surface water by month and by catchment (average and 80% dependable)	MPO surface water resources	Surface water	MPO Resources	Simple Table	✔	✔
183			10 Day average rainfall runoff for NAM catchments from 1965-66 to 1989-90 (Dry and Wet season)	SWMC model output	Surface water	Runoff	Not available		
184	66	Salinity of BWDB	Time series of Daily Salinity data (Scatter)	BWDB	Surface water	Salinity	TS table (linked)		✔
185	135	Salinity stations of BWDB	Location of salinity measurement stations	BWDB 1:250,000	Surface water	Salinity	TS Main table with spatial link	✔	✔
186			Salinity results at simulated points for January to June 1998	SWMC model output	Surface water	Salinity	Not available		
187	325	Suspended Sediment	Time series of daily sediment data (Scatter)	BWDB	Surface water	Sediment	Simple Table		✔
188	80	Sediment Stations of BWDB	Location of BWDB sediment measurement station	BWDB 1:250,000	Surface water	Sediment	TS Main table with spatial link	✔	✔
189	325	Suspended Sediment	Suspended Sediment Data, 1998 (16 Station)	BWDB/RRI	Surface water	Sediment	Simple Table	✔	✔
190	30	Water Level (Non Tidal) of BWDB	Time series of Daily water level (NTWL)	BWDB	Surface water	Water level	TS table (linked)	✔	✔
191	60	Water Level (Tidal) of BWDB	Time series of Daily water level (TWL)	BWDB	Surface water	Water level	TS table (linked)	✔	✔

192	59	Water Level Stations (Tidal) of BWDB	Location information of 176 TWL	BWDB, 1:250,000	Surface water	Water level	TS Main table with spatial link	✔	✔
193	21	Water Level Stations(Non Tidal) of BWDB	Location information of 260 NTWL	BWDB, 1:250,000	Surface water	Water level	TS Main table with spatial link	✔	✔
194	54	Depth Duration Frequency (IFCDR)	Depth-Duration-Frequency (DDF) curves at 92 BWDB stations	IFCDR stage levels for 6 duration (1 to 60 days) and 7 frequencies (1:1 year to 1:100 year)	Surface water	Water level	Simple Table	✔	✔
195			Water level of Modelled river with given probability of exceedence (average year to 1:100 year) for dry and wet season	SWMC model output	Surface water	Water level	Not available		
196			10 Day average water level at generated computational grid points from 1965-66 to 1989-90 (Dry and Wet season)	SWMC model output	Surface water	Water level	Not available		
197			Monthly Salinity Data (Highest recorded during month) (1980-81 to 1989-90)	BWDB/WARPO	Surface water	Water Quality	Not available		
198			Planning and Research Projects				Not available		
199			Transboundary Catchments		Base Data		Shape file	✔	✔
200			Transboundary River		Base Data		Shape file	✔	✔

3 Lexicon and Glossary

3.1 *Abbreviations and Acronyms*

ADAB	Association of Development Agencies in Bangladesh
ADB	Asian Development Bank
ADC	Assistant District Commissioner
ADP	Annual Development Programme
AEC	Atomic Energy Commission
AEZ	Agro-Ecological Zone
AIA	Approved Irrigation Area
BADC	Bangladesh Agricultural Development Corporation
BAMWSP	Bangladesh Arsenic Mitigation Water Supply Project
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BCIC	Bangladesh Chemical Industries Corporation
BELA	Bangladesh Environmental Lawyers Association
BEMP	Bangladesh Environmental Management Project
BGS	British Geological Society
BHWDB	Bangladesh Haor and Wetland Development Board
BIADP	Barind Integrated Agricultural Development Project
BIDS	Bangladesh Institute for Development Studies
BIWTA	Bangladesh Inland Water Transport Authority
BIWTC	Bangladesh Inland Water Transport Corporation
BMD	Bangladesh Meteorological Department
BMDA	Barind Multi-purpose Development Authority
BOD	Biological Oxygen Demand
BOI	Board of Investment
BOO	Build/Own/Operate
BOT	Build/Operate/Transfer
BR	Bangladesh Railway
BRAC	Bangladesh Rural Advancement Committee
BRE	Brahmaputra Right Embankment
BRRI	Bangladesh Rice Research Institute
BRTA	Bangladesh Road Transport Authority
BRTS	Brahmaputra River Training Studies
BSTI	Bangladesh Standard Testing Institute
BUET	Bangladesh University of Engineering and Technology
BUP	Bangladesh Unnayan Parishad
BWDB	Bangladesh Water Development Board
BWFMS	Bangladesh Water and Flood Management Strategy
CADP	Command Area Development Programme
CARDMA	Coastal Area Resource Development and Management Association
CARE	Co-operative for American Relief Everywhere
CBA	Coastal Belt Area

CBO	Community-based Organisation
CBR	Crude Birth Rate
CCC	Chittagong City Corporation
CDA	Chittagong Development Authority
CDR	Crude Death Rate
CDSP	Char Development and Settlement Project
CEN	Coalition of Environmental NGOs
CEP	Coastal Embankment Project
CERP	Coastal Embankment Rehabilitation Project
CHT	Chittagong Hill Tracts
CIDA	Canadian International Development Agency
CIF	Carriage, Insurance, Freight
CITES	Convention on the International Trade in Endangered Species
COD	Chemical Oxygen Demand
CPP	Cyclone Preparedness Programme
CPP	Compartmentalisation Pilot Project (Tangail)
CPR	Contraceptive Prevalence Rate
CSO	Chief Scientific Officer
CSPS	Cyclone Shelter Preparatory Study
CUS	Centre for Urban Studies
CVM	Contingent Valuation Method
CWASA	Chittagong Water and Sewerage Authority
CZWMP	Coastal Zone Water Management Programme
DAE	Department of Agricultural Extension
DANIDA	Danish International Development Agency
DC	Deputy Commissioner
DCC	Dhaka City Corporation
DCH	Dhaka Community Hospital
DDS	Draft Development Strategy
DEM	Digital Elevation Model
DFID	Department for International Development (UK Aid)
DG	Director General
DLRS	Directorate of Land Records and Surveys
DMB	Disaster Management Bureau
DMDP	Dhaka Metropolitan Development Plan
DND	Dhaka-Narayanganj-Demra
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DoForest	Department of Forest
DOHS	Defence Officer's Housing Estate
DPHE	Department of Public Health Engineering
DSSTW	Deep-set Shallow Tubewell
DTW	Deep Tubewell
DWASA	Dhaka Water and Sewerage Authority
DWRMP	District Water Resources Management Plan
DWSP	Dhaka Water Supply Project
EC	European Commission

ECNEC	Executive Committee of the National Economic Council
ECNWRC	Executive Committee of the National Water Resources Council
ECA	Environmental Conservation Area
EDREMOS	Environment, Disaster and Resource Monitoring System
EGIS	Environment and Geographical Information System
EH	Eastern Hills (hydrological) Region
EIA	Environmental Impact Assessment
EIP	Early Implementation Project
EIRR	Economic Internal Rate of Return
EMG	Embankment Maintenance Group
EMP	Environmental Management Plan
EPWAPDA	East Pakistan Water and Power Development Authority
EPZ	Export Processing Zone
ERD	Economic Relations Division
ES	Environmental Section
ESG	Expert Study Group
ETo	Reference Crop Evapotranspiration
FAO	Food and Agricultural Organisation
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control, Drainage and Irrigation
FD	Forestry Department
FDI	Foreign Direct Investment
FFW	Food for Work
FFWC	Flood Forecasting and Warning Centre
FFYP	Fifth Five Year Plan
FMRSP	Food Management and Research Support Project
FMTW	Force Mode Tubewell
FOB	Free on Board
FPCO	Flood Plan Coordination Organisation
FPPP	Flood Proofing Pilot Project
FRI	Fisheries Research Institute
FRSS	Fisheries Resource Survey System
FWA	Farmer Welfare Association
FYP	Five Year Plan
GBM	Ganges-Brahmaputra-Meghna
GCC	Global Climate Change
GCF	Group Conversion Factor
GDA	Ganges Dependent Area
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEMS	Global Environmental Monitoring System
GIS	Geographical Information System
GIT	Groundwater Irrigation Thana
GNP	Gross National Product
GoB	Government of (the People's Republic of) Bangladesh
GPA	Guidelines for Project Assessment
GPP	Guidelines for Project Planning

GPP	Guidelines for People's Participation
GPWM	Guidelines for Participatory Water Management
GRRP	Gorai River Restoration Project
GTZ	German Aid (Gesellschaft für Technische Zusammenarbeit)
GW	Groundwater
GWT	Ganges Water Treaty
HDI	Human Development Index
HES	Household Expenditure Survey
HRA	High Risk Area
HTW	Hand pump Tube Well
HYV	High Yield Variety
IAM	Investment Analysis Model
IBRD	International Bank for Reconstruction and Development (World Bank)
ICDDR,B	International Centre for Diarrhoeal Disease Research, Bangladesh
ICLARM	International Centre for Living Aquatic Resources Management
ICR	Implementation Completion Report
ICZM	Integrated Coastal Zone Management
IDA	International Development Association (World Bank)
IDCOL	Infrastructure Development Company Ltd
IEC	Important Environmental Concern
IECO	International Engineering Corporation
IEE	Initial Environmental Examination
IEMC	Integrated Environmental Management in Coastal Areas
IFAD	International Fund for Agricultural Development
IFADEP	Integrated Fisheries and Agricultural Development Project
IFC	International Finance Corporation (World Bank)
IFCDR	Institute for Flood Control and Drainage Research
IFPRI	International Food Policy Research Institute
IIFC	Infrastructure Investment Facilitation Centre
IIMI	International Irrigation Management Institute (now renamed IWMI)
IP	Industrial Policy
IPCC	International Panel on Climate Change
IPHN	Institute of Public Health and Nutrition
IPM	Integrated Pest Management
IPMNET	Integrated Pest Management Network
IPOE	Independent Panel of Experts
IPP	Independent Power Producer
IRBA	International River Basin Authority
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
ISPAN	Irrigation Support Project for Asia and the Near East
IUCN	International Union for the Conservation of Nature
IWMI	International Water Management Institute
IWMP	Integrated Wetlands Management Programme
IWRM	Integrated Water Resources Management
IWTA	Inland Water Transport Authority
IWTC	Inland Water Transport Corporation
JICA	Japanese International Co-operation Agency

JMBA	Jamuna Multi-purpose Bridge Authority
JRC	Joint Rivers Commission
KCC	Khulna City Corporation
KJDRP	Khulna-Jessore Drainage Rehabilitation Project
KKRMP	Kalni-Kushiyara River Management Project
KSS	Water user group (Krissok Somboya Samity)
LCS	Landless Contracting Society
LGD	Local Government Division
LGED	Local Government Engineering Department
LGI	Local Government Institution
LLP	Low lift Pump
LMRC	Long-run Marginal Cost
LPS	Local Project Society
M&E	Monitoring and Evaluation
M&E	Mechanical and Electrical
MARPOL	Marine Pollution Conventions
MD	Managing Director
MES	Meghna Estuary Study
MFI	Micro-finance Institution
MLG	Municipality Local Grant
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forest
MoFL	Ministry of Fisheries and Livestock
MoI	Ministry of Industry
MoLJP	Ministry of Law, Justice and Parliamentary Affairs
MoL	Ministry of Land
MoLGRDC	Ministry of Local Government, Rural Development and Co-operatives
MoWR	Ministry of Water Resources
MPO	Master Plan Organisation
MSP	Municipal Services Project
MUFHRC	Middlesex University Flood Hazard Research Centre
NAEP	New Agricultural Extension Policy
NAMIC	National Arsenic Mitigation Information Centre
NAP	National Agricultural Policy
NARS	National Agricultural Research Station
NBTP	North Bengal Tubewell Project
NC	North Central (hydrological) Region
NCA	Net Cultivable Area
NCRS	North Central Regional Study (FAP 3)
NCS	National Conservation Strategy
NE	North East (hydrological) Region
NEMAP	National Environment Management Action Plan
NEMIP	North-East Minor Irrigation Project
NEP	National Energy Policy
NEP	National Environment Policy
NERS	North East Regional Study (FAP 6)
NFiP	National Fisheries Policy
NFoP	National Forestry Policy

NGO	Non-Government Organisation
NIPSOM	National Institute for Preventive and Social Medicine
N/K Ratio	Net Benefit/Investment Ratio
NLUP	National Land Use Policy
NMIC	National Minor Irrigation Census
NMIDP	National Minor Irrigation Development Project
NOC	No Objection Certificate
NPSWSS	National Policy for Safe Water Supply and Sanitation
NPV	Net Present Value
NPVR	Net Present Value Ratio
NRMA	National River Management Administration
NW	North West (hydrological) Region
NWMP	National Water Management Plan
NWMPP	National Water Management Plan Project
NWP	National Water Plan
NWPo	National Water Policy
NWRC	National Water Resources Council
NWRS	North West Regional Study (FAP 2)
NWRD	National Water Resources Database
O&M	Operation and Maintenance
OCC	Opportunity Cost of Capital
OFWM	On-farm Water Management
OGDA	Options for the Ganges Dependent Area
PAP	Project-affected Person
PAWP	Portfolio of Aid-worthy Projects
PDB	Power Development Board
PETRA	Poverty Elimination through Rice Research Project
PFI	Private Finance Initiative
PIE	Project Impact Evaluation
PL	Post-larval (shrimp)
PP	Project Proforma
PP	People's Participation
PPAR	Project Performance Audit Report
PPCP	People's Participation and Consultation Programme
PPCS	People's Participation and Consultation System
PPP	People's Participation Process
PRA	Participatory Rural Appraisal
PSA	Paurashava Area
PSIDF	Private Sector Infrastructure Development Fund
PSIDP	Private Sector Infrastructure Development Project
PSO	Principal Scientific Officer
PSP	Private Sector Participation
RAJUK	Capital Development Authority (Rajdhani Unnayan Katripakha)
RCC	Rajshahi City Corporation
RE	Rivers and Estuary (hydrological) Region
REB	Rural Electrification Board
REP	Rural Electrification Programme
RGC	Rural Growth Centre

RHD	Roads and Highways Department
RRA	Rapid Rural Appraisal
RRI	River Research Institute
RSM	Residual Soil Moisture
RWSSP	Rural Water Supply and Sanitation Project
SA	Social Assessment
SAARC	South Asian and Region Countries
SAGQ	South Asia Growth Quadrangle
SC	South Central (hydrological) Region
SDC	Swiss Agency for Development Corporation
SE	South East (hydrological) Region
SEMP	Sustainable Environmental Management Programme
SERS	South East Regional Study (FAP 5)
SIA	Social Impact Assessment
SIDA	Swedish International Development Agency
SIDATAC	Aman Supplementary Irrigation Project
SLR	Sea level rise
SMA	Statistical Metropolitan Area
SO	Scientific Officer
SOB	Survey of Bangladesh
SODAPS	Soil Survey Data Processing System
SPARRSO	Space Research and Remote Sensing Organisation
SRDI	Soil Resources Development Institute
SRF	Sundarbans Reserve Forest
SRP	Systems Rehabilitation Project
SS	Suspended Solids
SSO	Senior Scientific Officer
SSWRDSP	Small-Scale Water Resources Development Sector Project
STIFPP	Secondary Towns Integrated Flood Protection Project
STW	Shallow Tubewell
SW	South West (hydrological) Region
SW	Surface water
SWMC	Surface Water Modelling Centre
SWSSP	Second Water Supply and Sanitation Project
SWTW	Surface Water Treatment Works
SYB	Statistical Yearbook of Bangladesh
TA	Technical Assistance
TAPP	Technical Assistance Project Proforma
TDS	Total Dissolved Solids
TFP	Third Fisheries Project
TFR	Total Fertility Rate
ToR	Terms of Reference
TSP	Triple Super Phosphate
TSS	Total Suspended Solids
UGC	Urban Growth Centre
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNICEF	United Nations Children's Fund

UNIFEM	United Nations Development Fund for Women
USAID	United States Agency for International Development
VDO	Village Development Organisation
VDSSTW	Very Deep-set Shallow Tubewell
VGF	Vulnerable Group Feeding
WARPO	Water Resources Planning Organisation
WASA	Water and Sewerage Authority
WB	World Bank
WCMC	World Conservation Monitoring Centre (of the IUCN)
WFP	World Food Programme
WHO	World Health Organisation
WMA	Water Management Association
WMAEW	Water Management and Agricultural Engineering Wing (of the DAE)
WMCA	Water Management Co-operative Association
WMG	Water Management Group
WPAG	Water Policy Advisory Group
WQS	Water Quality Standard
WRM	Water Resources Management
WSIP	Water Sector Improvement Programme
WSS	Water Supply and Sanitation
WTP	Willingness to Pay
WUA	Water User Association
WUG	Water User Group

3.2 *Financial Terms*

GoB Fiscal Year:	From 1 July to 30 June
Dollar Exchange Rate:	1998-99: Taka 48.5 per US Dollar
	Mid-2000: Taka 51 per US Dollar

3.3 *Weights and Measures*

3.3.1 Measurement Abbreviations

10^{-6} = 1/1,000,000 = one millionth or micro (μ)
10^{-3} = 1/1000 = one thousandth or milli (m)
10^{-1} = 1/10 = one tenth or deci (d)
10^{3} = 1000 = one thousand or kilo (k)
10^{6} = 1,000,000 = one million or mega (M)
10^{9} = 1,000,000,000 = one billion or giga (G), sometimes (b)
1ppt = one part per thousand
1ppm = one part per million
1ppb = one part per billion

3.3.2 Measurement Conversions

Number

1 lakh = 100,000
1 crore = 100 lakh = 10,000,000 (ten million)

Length

1 metre (m) = 100 centimetres (cm) = 1000 millimetres (mm) = approx 1.1 yard (yd) = approx 3.28 feet (ft) = approx 39.37 inches (in)
1 kilometre (km) = 1000 metres = approx 0.61 miles
1 mile = approx 1.6 kilometres

Area

1 hectare (ha) = 10,000 square metres (m^2) = approx 2.47 acres
1 acre = 100 decimals = approx 0.405 hectares
1 bigha = between one third and one half acre (varies by region), not a precise unit

Volume

1 litre = approx 0.22 gallons = approx 1.73 pints
1 gallon = 8 pints = approx 4.65 litres
1 cubic metre (m^3) = 1000 litres (l) = approx 35.31 cubic feet = approx 1.31 cubic yards
1 million cubic metres = $1Mm^3$, sometimes 1Mcm
1 billion cubic metres = $1Gm^3$ = 1 cubic km, sometimes 1bcm

Mass

1 tonne (t) = 1000 kilograms (kg) = 1,000,000 grams (g) = approx 0.984 tons
1 kilogram = approx 2.21 pounds (lb)
1 pound = approx 0.45 kilogram
1 maund = approx 82 pounds (lb) = approx 37.3kg

Time

1 decad = one third of one month

Water Flow

1cumec= 1 cubic metre per second = $1m^3/s$
1cusec = 1 cubic foot per sec = $1ft^3/s$
1Ml/d = one million litres per day = approx 11.6l/s
1Mg/d = one million gallons per day = approx 4.65Ml/d = approx 54l/s

Head of Population

Person is written as both capita (c) and habitant (h). Either version may be used in the values of averaged incomes, economic output or water consumption, expressed per person for a specified population.

Water Consumption

1l/c-d = 1l/h-d = one litre per capita per day

Salinity/Conductivity

1 deciSiemens per metre = 1milliSiemens/cm = 1 millimho/cm
1ppt (of salt dissolved in water) = 3.925 deciSiemens per metre (dS/m)
1 deciSiemens per metre = 146 ppm
(Note that though linear, the relationship between ppt or ppm and dS/m is not a directly proportional one).

3.4 *Glossary*

3.4.1 Planning Terms

Definitions of some widely-used terms, from *The New English Oxford Dictionary*

Action	The fact or process of doing something, typically to achieve an aim
Aim	A purpose or intention; a desired outcome
Equitable	Fair and impartial: *as in the equitable distribution of resources*
Goal	The object of a person's ambition or effort; an aim or desired result
Integrated	With various parts or aspects linked or co-ordinated: *as in an integrated and high-quality public water service*
Intervention	The action or process of intervening, an action taken to improve a situation
Measure	A plan or course of action taken to achieve a particular purpose
Objective	A thing aimed at or sought; a goal
Option	A thing that is or may be chosen
Plan	A detailed proposal for doing or achieving something
Policy	A course or principle of action adopted or proposed by a government, party, business, or individual
Strategy	A plan of action or policy designed to achieve a major or overall aim

3.4.2 Bangla Terms

Aman	Main monsoon rice crop
Aus	Late dry season, early monsoon rice crop
Bagda	Tiger Shrimp
Baor	Oxbow lake – a crescent-shaped lake formed from an old section of river channel
Beel	Natural depression, normally a permanent or temporary water body or swamp
Bheri	Fish culture in land enclosed by low dykes, which allow tidal water to flow over
Boro	Rabi season rice crop
Char	Land newly formed by accretion of rivers
Charhas	Small streams in hilly areas
Eid	Muslim religious festival
Gher	Enclosure for shrimp cultivation
Golda	Giant Freshwater Prawn
Haor	Bowl-shaped natural depression between river levees, common in the North East
Hartal	Political protest, normally disrupting movement of people
Jalmahal	Water body leased for capture fishing
Jhum	Shifting cultivation
Kacha	Makeshift (construction); unripe (fruit)
Kanda	High and terrace land above flood levels in haor areas
Khal	Channel
Khalashi	Sluice-gate operator
Khas	Government-owned land
Kharif	Summer and monsoon cropping season
Mahajan	Money lender
Maja	Shrine
Mouza	Sub-union administrative area
Pucca	Solidly-built (construction); ripe (fruit)
Parishad	Council
Paurashava	Municipality

Rabi	Winter cropping season
Thana	Sub-District administrative area
Union	Sub-Thana administrative area
Upazila	Alternative term for Thana
Zila	Alternative term for administrative District

3.4.3 Land Classification by Flood Phase

Highland	(F0)	<0.3m	Intermittent flooding, land suited to HYV rice in wet season.
Medium highland	(F1)	0.3-0.9m	Seasonal flooding, land suited to local varieties of aus and T aman in monsoon season.
Medium lowland	(F2)	0.9-1.8m	Seasonal flooding, land suited to B aman in wet season.
Lowland	(F3)	1.8- 3m	Seasonal flooding, land on which B aman can be grown in wet season.
Very lowland	(F4)	>3m	Seasonal or perennial flooding does not permit growing of B aman in the wet season

3.4.4 Agricultural Terms

B aman	Broadcast aman; a rice crop usually planted in March/April under dry land conditions, but in areas liable to deep flooding. Also known as deepwater rice. Harvested October to December. All varieties highly sensitive to day length.
T aman	Transplanted aman; a rice crop planted usually July/August, during the monsoon in areas liable to a maximum flood depth of about 0.5 m. Harvested in November/December. Local varieties are sensitive to day length whereas modem varieties are insensitive or only slightly sensitive.
Boro	A rice crop planted under irrigation during the dry season from December to March and harvested April to June. Local boro varieties are more tolerant of cool temperatures and are usually planted early in areas which are subject to early flooding due to rise in river levels. Improved varieties, less tolerant of cool conditions, are usually transplanted from January onwards. All varieties are insensitive to day length.
B aus	Broadcast aus; a rice crop planted March/April under dry land conditions. Matures on pre-monsoon showers to be harvested in June/July and is insensitive to day length.
T aus	Transplanted aus; a rice crop, transplanted March/April usually under irrigated conditions and harvested June/July. The distinction between a late planted boro and early transplanted aus is academic, since the same varieties may be used. Varieties are insensitive to day length.

Kharif	The wet season (typically March to October), characterised by monsoon rain and high temperatures.
Kharif 1	The first part of the kharif season (March to June). Rainfall is variable and temperatures are high. The main crops grown are aus, summer vegetables and pulses. Broadcast aman and jute are planted.
Kharif 2	The second part of the kharif season (July to October), characterised by heavy rain and floods. T aman is the major crop grown during this season. Harvesting of jute takes place. Fruits and summer vegetables may be grown on high land.
Rabi	The dry season (typically November to February) with low or minimal rainfall, high evapotranspiration rates, low temperatures, and clear skies with bright sunshine. Crops grown are boro, wheat, potato, pulses, oilseeds and vegetables.
HYV	High yielding variety; introduced varieties developed through formal breeding programmes. HYVs have a higher yield potential than local varieties but require correspondingly high inputs of fertiliser and soil moisture to reach full yield potential.
Local varieties	Varieties developed and used by farmers. Sometimes referred to as local improved varieties (LIVs).
Fallow land	Agriculturally productive land which is temporarily not being cropped due to a crop rotation limitation or due to a seasonal shortage of water.

3.4.5 Irrigation Terms

Suction mode	Refers to tubewells, usually equipped with centrifugal pumps, in which the pumping lift cannot exceed the suction limit (about 7m below the pump).
Force Mode	A type of pump in which the pump is set below water level so that it forces water to the surface. These pumps can lift water from beyond the suction limit but are more expensive and complex.
STW	Shallow tubewell; water well equipped with centrifugal pump which is mounted at the surface or in a shallow pit. The pumping lift cannot exceed the suction limit. Normally used for irrigation.
DSSTW	Deep set shallow tubewell; refers to a shallow tubewell in which the pump unit is placed in a pit so as to extend the range of water levels for which the pumpset is operable.
FMTW	Force mode tubewell; water well equipped with a turbine pump (axial, mixed flow, submersible) in which the pump unit is always submerged below normal operating water level in the tubewell. Maximum pumping depth is theoretically unlimited, with the pump chamber setting (depth of upper well casing) being a critical consideration in defining the lower limit to pumping water level.
DTW	Deep tubewell, a force mode tubewell. Used for irrigation or water supply from a borehole typically 200m to 300m deep.

SMDTW	Suction mode tubewell, a borehole deeper than 100m to tap good quality water, but with a high piezometric level to permit use of suction mode hand pump.
HTW	Hand tubewell; water well equipped with hand pump.
SMHTW	Suction mode hand tubewell; water well equipped with suction mode hand pump.
FMHTW	Force mode hand tubewell; water well equipped with force mode hand pump.
Tara handpump	A direct action manually operated tubewell for potable supply. Developed in Bangladesh for use in areas where water levels exceed the suction limit of conventional hand tubewells, up to an operating limit of 15m.
No 6 handpump	A popular and cheap form of suction mode handpump.
Traditional irrigation	Form of irrigation using traditional manual devices such as the swing basket or dhon to lift water from surface water bodies.
Swing basket	A traditional form of irrigation using a swinging basket or scoop held by two men to lift water.
Dhon	A traditional form of irrigation using a hinged boat-shaped scoop.
MOSTI	Manually operated shallow tubewell for irrigation. A classification which includes hand tubewells, treadle pumps and rower pumps.
Treadle pump	A low cost, low discharge suction mode tubewell (or MOSTI) operated by foot using bamboo "treadles".
Rower pump	A low cost, low discharge suction mode tubewell (or MOSTI) operated using a reciprocating piston hand pump.

3.4.6 Social Terms

Poverty Line	The minimum consumption level required to achieve the minimum acceptable standard of living within a society.
Absolute Poverty Line	The consumption threshold that allows minimum calorie requirements plus a small allowance for nonfood items.
Upper Poverty Line	The consumption level below which people have an intake of less than 2122 calories per person day.
Lower Poverty Line	The consumption level below which people have an intake of less than 1805 calories per person day.

3.4.7 Environmental Terms

Accretion	Gradual formation of land areas from deposited river sediment
Avifauna	Bird species of a particular area
Basin	Lowest part of a floodplain landscape

Biodiversity	Variety and variability among living organisms
Biomass	The quantity of organic matter
Biota	Animal and plant species
Brackish	Slightly saline
Crustacean	A class of aquatic arthropods with a hard shell covering the body – eg shrimps
Duar	Deep scour hole in river bed
Dyke	Embankment to restrain floodwater
Ecosystem environment	A community of organisms interacting with their inanimate
Polder	Land enclosed by an embankment
Ramsar Convention	An international convention adopted at Ramsar, Iran, in 1971, aimed at conserving wetlands, especially as waterfowl habitats
Riparian	Belonging to rivers