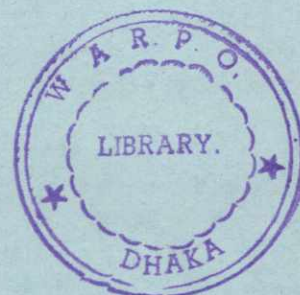# BANGLADESH FLOOD ACTION PLAN

FAP 16 Environmental Study

Special Studies Program

A NEEDS ASSESSMENT FOR A NATIONAL WETLAND INVENTORY IN BANGLADESH

September 1992

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ISPAN IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEWAR EAST

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SUMMARY

Bangladesh's wetlands are extensive, provide the basis for a high measure of biological diversity, are key habitats for many fish, wildlife and plant species, and play critical roles in the socio-economy of rural communities. Most wetlands are subject to some form of impact from long-term development for flood protection, drainage and irrigation. To date, no systematic ecological survey of the country's wetlands has been undertaken.

The report reviews all recent and ongoing wetland-related studies and inventories in Bangladesh and some neighboring Asian countries. The need for a national wetland inventory is assessed. A national inventory was found to be supported by all knowledgeable persons and organizations contacted, and would be a key component of a wetland conservation strategy. The report identifies potential uses and users, and outlines the levels of detail, scale and information content of a national inventory.

Draft terms of reference for a three-phased national wetland inventory are appended.

Chapter 1

INTRODUCTION

1.1   Background

Due to the deltaic character of the country, Bangladesh has a high areal extent of wetlands, probably one of the highest in the world. These wetlands are represented by rivers, streams, shallow freshwater lakes, marshes, water storage reservoirs, fish ponds, seasonally flooded cultivated plains, and estuarine areas dominated by the largest mangrove stands in the world. Wet season wetland area in Bangladesh has been estimated to encompass between 7 and 8 million ha (AWB 1989), comprising:

*   Permanent rivers and streams   480,000 ha
*   Estuaries and mangroves swamps   610,000 ha
*   Shallow lakes and marshes   120,000 - 290,000 ha
*   Large water storage reservoirs   90,000 ha
*   Small tanks and fish ponds   150,000 - 180,000 ha
*   Shrimp ponds   90,000 - 115,000 ha
*   Seasonally-flooded floodplain   5,770,000 ha

Wetlands are nationally important for a variety of reasons:

*   *Biodiversity*:   the large and varied wetland environment is rich in species diversity. Of more than 5,000 species of flowering plants and 1,500 species of vertebrates, of which approximately 750 are birds and over 500 are coastal, estuarine and fresh water fish species, some 400 vertebrate species and between 200 and 300 plant species are judged to be dependent on wetlands for all or part of the life histories. Wetlands provide habitat for a rich variety of resident and migratory waterfowl, a number of endangered species of international interest, and a large number of species of commercial importance;
*   *Fisheries*:   the inland capture fishery is the most important fishery subsector in terms of total catch, source of employment, and supply of animal protein. It is based on the country's vast fresh water resources and some 270 species of fin and shellfish which inhabit them. Essential habitats for the inland fishery comprise open and closed water habitats, including rivers, canals, flood plains, large seasonal water bodies (haors), smaller wetlands (beels), oxbow lakes (baors) and small roadside depressions. Although discrete in the dry season, these water bodies become interconnected during the monsoon and provide critical habitats for the completion of the life cycles of a large number of fish species;
*   *Other economic activities*: the country's wetland resources support a significant range of economic activities other than fishing, e.g. extraction of reed and other plant products, harvesting of aquatic vegetation, herbs, etc.
*   *Agricultural diversity*:   there are many local varieties of rice, conservatively estimated to number in the thousands, as well as other existing or potential commercially-important plants, which provide a valuable gene pool to ensure continued development of improved varieties for the future;
*   *Tourism*:   remains an infant if not non-existent economic activity, but there is substantial foundation for the view that the country's natural resources, especially the Sundarbans, could support the development of this sector.

Bangladesh's wetland resources have suffered considerably from the impacts of a burgeoning human population, including direct extraction and habitat loss. In the Ganges-Brahmaputra floodplain alone, an

estimated 2.1 million ha of wetland have been lost to flood control, drainage and irrigation development (AWB 1989). Amongst these are nationally important wetland areas such as Ata Ganga Baor and parts of Chalan Beel.

The Bangladesh Flood Action Plan (FAP) will have many varied environmental effects, including drainage, hydrological changes, intensification of impacts from agriculture, pollution, more intensive fisheries stemming from increasing human populations, intensification of fisheries management and changes in biota from stocking with exotic fish species (ISPAN 1991). Many of these impacts will be directed at the nation's wetlands. The system of Environmental Impact Assessment which is being introduced into the FAP (ISPAN 1992a) will make provision for full assessment of the impacts of proposed FAP projects on wetland resources, but the economic and biological estimation of the value of any wetlands lost or altered by the FAP will be hampered by a lack of information on the overall extent of the wetland resource at a national and regional level.

Although government and non-government agencies have recognized the importance of Bangladesh wetlands and their value in terms of hydrology, ecology, and socio-economics, and while wetland resources have been studied in certain cases and general inventories conducted, a comprehensive information base for management of Bangladesh's valuable wetland resources does not appear to have been made. Reports such as the National Conservation Strategy (MOEF 1991) have recommended more comprehensive inventory and management of Bangladesh's wetland resources. Similarly international agencies such as the Asian Wetland Bureau have recommended the need for a national inventory of Bangladesh's wetland resources (AWB 1989).

1.2   Objectives

The overall objective of this assessment is to examine both the need for creating a National Wetland Inventory for Bangladesh, and the practical issues in doing so. The specific objectives are to:

- Review all recent and ongoing wetland-related studies and inventories including those by Asian Wetland Bureau, Flood Action Plan regional studies and other agencies.
- Ascertain the need for a national wetland inventory: identify all potential uses and users and the associated levels of detail, scale and information content of the inventories.
- Determine the most appropriate methods for undertaking a national wetland inventory: including remote sensing from imagery and aerial photographs and ground-based surveys. Identify all the key institutions potentially involved in national-level inventories and their respective roles.
- Provide draft terms of reference and a budget for a national wetland inventory. Recommend the most appropriate methods for development of base maps, ecological inventories, sampling frameworks and information presentation.

The report describes what information is already available, what additional information is required, assesses the use for a national level wetland inventory, and suggests an approach to creating a national inventory of wetland resources in Bangladesh.

1.3   Approach

The approach adopted to fulfill the objectives outlined above involved the following activities:

- Collection and review of all available published and unpublished literature related to Bangladesh wetland resources;

- Meetings and discussions with government agencies, FAP study components, non-government organizations, and international organizations concerned with wetland conservation and management;
- Definition of the activities and methodology (including use of appropriate technology) required to conduct a national level inventory of Bangladesh's wetland resources.

Chapter 2

BACKGROUND

2.1   Definition of Wetland

The term "wetland" groups together a wide range of inland, coastal and marine habitats which share a number of common features. The Convention on Wetlands of International Importance (Ramsar Convention 1971), to which Bangladesh is now a signatory, defines wetland as:

"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine waters, the depth of which at low tide does not exceed 6m"

Wetlands in Asia include estuaries and deltas, salt marshes, mangroves and intertidal mudflats, coastal lagoons, freshwater lakes and marshes, oases, salt lakes, seasonal floodplain wetland, swamp forests, rivers and streams. In addition, there are many artificial wetlands such as rice paddies, shrimp and fish ponds, salt pans, small irrigation ponds and vast reservoirs, many of which have acquired considerable ecological value (IWRB 1992).

Wetlands are defined by the United States Fish and Wildlife Service (Lillesand and Keifer 1987) as land where the water table is at, near, or above the land surface long enough to promote the formation of hydric (wet) soils or to support the growth of hydrophytes (plants that grow in water or very wet soil). Permanently flooded areas in freshwater wetlands 2m below the seasonal low water level are defined as deep-water habitats. In saline-water wetlands, this same area is generally considered to coincide with the elevation of the extreme low water of spring tide.

In Bangladesh the permanent and seasonal freshwater lakes and marshes of the flood plains are known as haors, baors and beels. Haors are bowl-shaped depressions between the natural levees of a river, or a succession of such depressions, which are flooded every year by the monsoon floods; most retain some water throughout the dry season. Baors are abandoned cut-off river channels, converted to static water bodies (oxbow lakes). Beels are usually saucer-like depressions which generally retain water throughout the year. Many become overgrown with marshy vegetation during the dry season, with a few drying out completely. A key feature of wetlands in Bangladesh is the large amount of variation in size and morphology of wetlands according to season and extent of flooding.

2.2   Wetland Classification

Wetland classifications are designed to meet specific objectives by describing the salient features of wetland. Any form of inventory adopted in Bangladesh would require the use of some form of classification scheme. The following are some of the more pertinent classifications in use today in various parts of Asia.

IUCN (IUCN 1990) has developed a basic classification scheme: estuaries, open coasts, floodplains, freshwater marshes, lakes, peatlands and swamp forest. A more elaborate scheme was developed for Malaysia (Malaysian Conservation Foundation 1987) utilized the following wetland classification types:

1. Sea bays and straits (under 6m at low tide)
2. Estuaries, deltas

3. Small offshore islands, islets
4. Rocky sea coasts, sea cliffs
5. Sea beaches (sand, pebbles)
6. Intertidal mudflats, sandflats
7. Mangrove
8. Coastal brackish and saline lagoons and marshes
9. Salt pans (artificial)
10. Aquaculture ponds
    - Brackish
    - Freshwater
11. Rivers, streams-slow-flowing (lower perennial)
12. Rivers, streams-fast-flowing (upper perennial)
13. Oxbow lakes and riverine marshes
14. Freshwater lakes and associated marshes (lacustrine)
15. Freshwater ponds (under 8 ha), marshes, swamps (palustrine)
16. Salt lakes, saline marshes (inland drainage systems)
17. Water storage reservoirs, dams
18. Seasonally flooded grassland
19. Rice paddies
20. Flooded arable land, irrigated land
21. Freshwater swamp forests, temporarily flooded forest
22. Peat bog
23. Peat swamp forest
24. Nipa swamp

In the *Philippines* wetlands have been divided into five sections according to type: coastal wetland; lakes; freshwater swamps and marshes; reservoirs/dams and river basins. These sections are further subdivided into the geographical region in which the wetland occurs (Davies 1990).

A recent manual of guidelines for scoping EIA in *tropical wetlands in Indonesia* provides a classification scheme using names of wetlands which are in common usage in south-east Asia (see Howe *et al.* 1991).

1. Swamps
    i. Swamp Forest
       a. Peat swamp forest
       b. Other swamp forest
    ii. Non-forested swamps
       a. Overflow wetland
       b. Other swamps
2. Mangroves and brackish water swamps
3. Coral
4. Seagrass and Seaweed
5. Lakes
    i. Lakes and Tarns
    ii. Ponds
    iii. Reservoirs

6. Estuaries
7. Rivers
    i. Rivers, streams, torrents
    ii. River pools
8. Rice fields
    i. Tidal
    ii. Non-tidal
       a. Rain-fed
       b. Irrigated
9. Aquaculture
10. Salt ponds

A secondary classification assigning all of the above classifications to either Tidal or Non-Tidal is also used.

At a more localized level within *Bangladesh*, a recent *environmental impact assessment* of the proposed Surma-Kushiyara Project (ISPAN 1992b) classified wetlands within a 40,000 ha area according to their water retention period:

- Permanent wetland - areas that are under water throughout the year.
- Seasonal wetland - areas that are under water for less than a year.

Seasonal wetlands were further classified according to water levels and inundation periods:

- Flooded lowland - water levels varying between 1.8 and 3.0+m during high flooding periods.
- Flooded medium lowland - water levels vary between 0.9 and 1.8m during high flooding periods.
- Flooded medium highland - water levels rise to 0.9m during high flooding periods.

This classification was devised to fit in with the commonly employed land type classification used in Bangladesh (MPO 1984).

As part of *surveys conducted in the northeast region* (FAP 6), a total of 68 wetland areas were grouped into three categories according to their overall importance for wildlife, especially waterfowl, and general ecological significance (Shawinigan Lavalin 1992a):

- Large sites comprising either a single large beel or group of beels, of outstanding importance for wildlife and retaining some natural qualities of considerable ecological significance in a regional context; these sites clearly qualify as wetlands of international importance on the basis of the Ramsar criteria;
- Mostly rather large beels or groups of beels supporting significant numbers of wintering waterfowl and in some cases also small populations of breeding birds; some may be of particular limnological or ecological interest, but further study is required; these sites are of importance in a national context, but probably not of international importance;
- Sites of little importance for wildlife and of limited ecological significance; generally either small, isolated beels in densely settled areas or highly modified wetlands given over almost entirely to the cultivation of rice.

For the purposes of a wetland inventory in Bangladesh it will be important to group wetlands according to type in order to define ecological and socio-economic values for management purposes.

2.2 Wetland Functions and Values

Functions are defined here as what wetlands do, while *values* are the benefits that these functions confer on human populations. The principal functions of wetlands include (IWRB 1992):

- Ground water recharge
- Ground water discharge
- Flood storage and desynchronization
- Shoreline stabilization and reduction of erosion
- Sediment trapping
- Nutrient retention/removal
- Support for food chains
- Fisheries production
- Habitat for wildlife
- Recreation

- Natural heritage values

A set of examples of the values of wetlands in Bangladesh is provided in the Surma-Kushiyara EIA (ISPAN 1992b):

- Wetlands are used for fishing, and when the area is completely inundated, almost everyone will fish. Common people are not allowed to fish in leased water bodies. From April to November most villagers fish at the edge of flooded lands, mainly for family consumption. Commercial fishermen also use the area during this period. From November to March fishing is confined to the perennial wetlands that are controlled by lease holders.
- Wetlands provide habitat for large numbers of resident and migratory birds as well as other wildlife.
- Wetlands provide irrigation for boro crops.
- Wetlands provide macrophytes that are used as green manure, fuel, cattle feed and human food.
- Wetlands provide avenues of transportation and communication during the wet season.

Values for Bangladesh wetlands based on biodiversity, ecological, physical, social and economic factors are often referenced locally, regionally and nationally, but no systematic assessment or description of these values appears to have been conducted.

2.3   Wetland Conservation Issues

At a general international level, the issue facing wetlands is the conflict between short-term profit and long-term conservation of resources; it involves destruction, degradation and non-sustainable use of resources (IWRB 1992). General wetland conservation issues have been defined by the International Union for Conservation of Nature and Natural Resources (IUCN 1990) as follows:

- Inadequate knowledge of the status and dynamics of the hydrology, ecology and socio-economic aspects of the wetlands;
- Potential loss of rare and endangered fish and wildlife resources;
- Land-use conflicts due to increasing population and changing resource use needs and values;
- Lack of environmental policy guidelines and management plans to ensure the conservation of important resource values;
- Limited institutional structure and capability to address issues of a complex biodiverse nature in a comprehensive and integrated way;
- Inability to make assessments or predictions of the impact of development projects or changing resource use patterns.

These issues all apply in Bangladesh and must ultimately be addressed as part of a more comprehensive wetland conservation program.

The Directory of Asian Wetlands (AWB 1989) lists the main activities which are impacting wetland and all of which are of concern in Bangladesh as follows:

- Degradation caused by human settlement and encroachment;
- Drainage for agriculture;
- Diversion of water supply for irrigation, domestic or industrial purposes;
- Degradation of catchment areas, soil erosion and increased siltation;
- Pollution from domestic sewage, industrial waste, pesticides and fertilizers;
- Wood-cutting for domestic use;

- Commercial logging;
- Over-grazing by domestic livestock;
- Over-fishing and associated disturbance;
- Hunting and associated disturbance.

Of those Bangladesh sites identified in the Directory of Asian Wetlands (AWB 1989), major irreversible ecological changes will occur at the following sites unless some remedial action is taken in the immediate future (IWRB 1992):

- Chalan Beel
- Haor Basin of Sylhet and Eastern Mymensingh
- The Sundarbans
- Wetlands in Pablakhali Wildlife Sanctuary
- Chokoria Sundarbans

Wetland systems are important to the day to day lives of the people in Bangladesh, particularly in the provision of habitat for fish and important plant species. These wetlands are also the last remaining habitats for numerous rare and endangered plant and animals. With the implementation of the FAP many FCD/I projects are being considered which may further have effects on wetland resources. Data collected for environmental impact assessments of proposed FCD/I projects are providing valuable information essential to the understanding of specific wetland areas. However, there remains a lack of understanding about the overall importance of wetlands as ecosystems and their value to dependant populations. This makes it difficult to develop the required mitigation and monitoring plans for ensuring the sustainability of wetland resources.

Remarks not understood. FAP does not like to destroy the wetland.

Chapter 3

WETLAND CONSERVATION AND MANAGEMENT ACTIVITIES
IN BANGLADESH

In April 1992 the Government of Bangladesh approved an environmental policy with the following stated objectives:

- Maintenance of the ecological balance and overall progress and development of the country through protection and improvement of the environment.
- Protection of the country against natural disasters.
- Identification and control of all types of activities related to pollution and degradation of the environment
- Ensuring environmentally sound development in all sectors.
- Ensuring sustainable, long-term and environmentally congenial utilization of all national resources.
- Active association with all environment related international initiatives to the extent possible.

Clearly, the implementation of this policy will require extensive baseline information for management and monitoring purposes.

3.1.2 The Ramsar Convention

The Convention on Wetlands of International Importance especially as Waterfowl Habitat, known as the *Ramsar Convention*, was signed in 1971 and came into force in 1975. This convention is an intergovernmental treaty which provides the framework for international cooperation for the conservation of wetland habitats. There is a general obligation for the contracting parties to include wetland conservation considerations within their national land-use planning. They are required to formulate and implement this planning so as to promote, as far as possible, the wise use of wetlands. Contracting parties are also required to promote the conservation of wetlands through the establishment of nature reserves. A specific obligation under the Convention is the designation of wetlands for inclusion in a *List of Wetlands of International Importance*. At least one site must be designated by each Country upon signing the Convention, with selection based on "international significance in terms of ecology, botany, zoology, limnology or hydrology". Contracting Parties are further obliged to cooperate for the management of shared wetlands and shared wetland species (Ramsar 1990).

The Government of Bangladesh in 1992 became a signatory to the Ramsar Convention. The Government has considered the designation of the Sundarbans as a reserved forest as its first Ramsar site. To assist in meeting its obligations under the Ramsar Convention for wetland conservation, updated baseline information on wetlands at the national level will be required.

3.1.3 Ministry of Environment and Forests

The Ministry of Environment and Forests (MOEF) was created in 1989, and within it a new Department of Environment. This Ministry is now a permanent member of the Executive Committee of the National Economic Council (ECNEC). ECNEC is the major decision making body for economic policy issues and is responsible for approving all public investment projects.

The Department of Environment is the technical arm of the Ministry, and is the agency responsible for environmental planning, management, monitoring and enforcement. Wildlife conservation, including the management of protected areas, is the responsibility of the Forest Department. However, since 1983 this capability has essentially been abolished. One remaining individual in this department now maintains the government's interest in wildlife.

The management and development of wetlands are shared by the Forest Department (protection of wildlife), Department of Fisheries (protection and management of fish), and the Bangladesh Water Development Board (flood control, irrigation and drainage). There is no specific legislation relating to wetland conservation. The Department of Environment now has a biodiversity expert and is in the process of developing a program.

Within the government there is a degree of institutional overlap, however essentially there is a lack of defined authority, responsibility and accountability for wetland management. In the past there has been a particular problem with continuous transfer of staff trained in wildlife management to other forestry duties which were not related.

The Forestry Department has carried out some preliminary wetland surveys, particularly in the northeast region and the coastal zone. Non-government organizations such as the Nature Conservation Movement (NACOM) have participated in conjunction with the Forest Department and AWB. NACOM is also participating in a primary baseline data collection program for wetland flora and fauna in the northeast region.

Since 1987, participation by Bangladesh in the Asian waterfowl census has generated a considerable amount of information on the importance of the wetland for wintering waterfowl.

The MOEF has initiated a National Environmental Management Action Plan (NEMAP). A final draft report on NEMAP is presently before government waiting for formal approval. The major environmental problems which have been identified include:

- Land management
- Increasing population densities
- Floods, cyclones and shortages of potable water
- Global warming and sea level rise
- Pollution
- Deforestation
- Loss of habitat for fishery.

NEMAP has turned the examination and planning of the Bangladesh floodplains over to the FAP.

The World Bank has had a ongoing funding program for forestry development, now terminating in 1992. The proposed Forestry 3 Project which is a 7 year program will begin in July 1992. The design of this project includes among other things an environmental component proposing a sub-department of Parks and Wildlife. The objectives of this new initiative is the revival of the wildlife management capability abolished in 1983. The goal is the conservation of wildlife and the management and establishment of protected areas. Similarly, a Forestry Master Plan project funded by Asian Development Bank is now underway. As part of this work, the question of protected areas has been addressed. One of the recommendations is the division of the Department of Forestry into a Division of Forestry with more traditional responsibilities, and a Division of Social Forestry, responsible for homestead forests which are now recognized as being major economic importance.

3.1.4   Ministry of Land Administration and Land Reform, Department of Revenue

Rivers, haors and beels are under the direct control of the Revenue Department in the Ministry of Land Administration and Land Reform. The Deputy Commissioners are the principal executives in the District Administration, and these authorities allocate and distribute lands, and lease fishing rights to private individuals (AWB 1989).

3.1.5   Ministry of Agriculture, Fisheries and Livestock; Department of Fisheries

The Department of Fisheries (DOF) is responsible for fisheries management, development, enforcement, statistics, quality control, extension and training. The department's 4000 staff are considered to be overextended and suffer from a confusion of mandates with other agencies and local administrations (Shawinigan Lavalin 1992b). Other affiliated agencies include the Fisheries Research Institute established in 1984, which operates four research stations, and the Bangladesh Fisheries Development Corporation concerned with developing marine fisheries.

The present method used for the estimation of fisheries production is the Bangladesh Fisheries Resource Survey System (BFRSS). This is a national survey conducted by DOF on a monthly basis using 60 survey officers to cover the whole country. This information is published as Annual Fish Catch Statistics of Bangladesh. The statistics contain sector-wide total annual catch by country and district, species composition by sector, etc. The sampling regime is based on a frame survey which includes description and dimension of the jalmahal, number of fishing villages, number of fisherman, number of fishing units by gear type. The extremely small number of sampling sites has raised the concern that the figures produced are not statistically valid (see section 3.2.4)

The problems of fisheries data collection have been noted to be related to institutional, financial and technical issues. Present irregularity, inconsistency and lack of representative data have to be removed through provision of trained manpower to DOF, coordination with other departments/agencies and use of improved statistical systems (Nuruzzaman 1990).

3.1.6   SPARRSO

The Space Research and Remote Sensing Organization (SPARRSO) was established in 1980. SPARRSO is the focal point of all remote sensing captivities in the country under the Ministry of Defence. It has the necessary equipment and trained personnel for remote sensing, image processing and GIS, as well as a receiver station for NOAA weather satellite data.

SPARRSO has been involved in numerous joint projects and studies testing the use of satellite imagery and GIS on resource management applications:

- Processing and interpretation of Landsat imageries for production of thematic maps at a scale of 1:1,000,000 covering major cover types, land zones and land systems, forest areas and land use types; these maps are in widespread use in Bangladesh for planning and other purposes;
- Remote sensing monitoring of the coastal mangrove plantations for the Department of Forests;
- Pilot study to assess the acreage under boro rice using satellite data: thee study produced statistics of the major crops based upon the physiographic units of the study area, and the accuracy of the assessment of the rice area and other major crops was checked against ground surveys;
- A UNDP-supported sub-sectoral study on production of land use maps at 1:25,000 scale for ten upazilas based on 1983-84 infrared aerial photographs (1:50,000 scale) and SPOT digital imagery;

- Pond survey for DOF for forty selected upazilas and produced pond map for each upazila at a scale of 1:50,000;
- Other remote sensing projects have included service-oriented applications in the agricultural, water resources, fisheries and forest sectors.

SPARRSO conducted a study of the total number of water bodies in the country, both small (less than 25 ha) and large (greater than 25 ha) by using satellite imagery and aerial photographs of 1983-84. Large water bodies, including haors, baors, rivers and canals over the entire country were mapped at a scale of 1:50,000 in 267 sheets. The data were used by SPARRSO to prepare a catchment water resource map of the country for use in the National Water Policy developed by the Master Plan Organization (MPO). This information is useful, although now quite dated.

3.2   Flood Action Plan

3.2.1   FAP 2: North West Regional Study

FAP 2 have noted the problem of lack of primary data needed to conduct environmental impact assessments of proposed projects. It has been stated that to date virtually nothing has been done to address the lack of primary data and analysis of the ecological systems in the floodplain areas and their linkages to the flood systems (Spooner 1991). There seems to be consensus that if FAP is to understand the relationships between seasonal aquatic and terrestrial systems, possible project effects, and necessary mitigation and monitoring measures, important ecological systems such as wetlands must be better understood.

A review conducted by FAP 2 has indicated that data collection is required to identify the main species of aquatic and terrestrial micro- and macroflora and fauna, and undertake an analysis of habitat classification, conditions and dynamics, considering both their biotic and abiotic components (Spooner 1991). This will require some sampling and chemical/biological analysis of soils, flood transferred material and bottom sediments in both seasonally flooded and permanently flooded land. The key changes with respect to seasonality should be examined and particular emphasis should be given to the role which flood waters, rain water and residual dry-season wetlands play in determining the status and operations of the overall ecological systems of the sampled areas. The analytical focus should be on understanding the linkages that the wetlands and aquatic systems have with the human and agricultural ecology systems, and how flood control and drainage interventions have led, or may lead to and improvement or deterioration in the human and agricultural/fisheries productivity systems in ecological terms.

Specific areas for resource conservation including wetland habitats have been identified. It has been noted that loss of these sites will not only affect the local ecology, but may have long-term economic and international ramifications. The FAP 2 environmental annex (Mott-MacDonald 1991) suggests that these sites should be examined closely from the viewpoint of their national importance.

3.2.2   FAP 3.1: Jamalpur Priority Project Study

The main ecological issue in this region is the way in which induced environmental change will affect the number and distribution of species, with related implications for human use, and biodiversity (Sogreah/Halcrow/Lahmeyer 1992). A programme has been instigated to determine the incidence of flora and fauna in the study area utilizing a check list approach. Preliminary lists of flora and fauna are available.

A major issue of concern is the degree and nature of change in wetland habitats as a result of the control of river flooding and the possible decrease in run-off related to improved drainage. It has been noted that the Jamuna and Brahmaputra area is known as a habitat and stop-over point for migratory water birds to and from Siberia. How important it is in comparison to other sites in the north of the country is unknown. Only a national assessment will give the type of data required to allow a priority for conservation to be considered. It has been noted that there has been little research carried out on the over 200 species of fish found in the country.

3.2.3   FAP 6: Northeast Regional Water Management Project

FAP 6 is developing a water resource management plan for the northeastern region. Within this context work has been conducted to identify wetland sites of international and national importance for wild animals and plants, especially migratory and threatened species; to identify priority areas for nature conservation; and to establish a basis of a monitoring programme designed to assess the impact of development projects on wildlife populations.

Two rapid assessment surveys have been carried out of the wetlands of the haor basin. A total of 68 sites were covered. The evaluation of sites was based primarily on the abundance and diversity of waterbirds and consideration was given to the criteria developed in relation to the Ramsar Convention. Detailed records were maintained of all birds observed at the wetlands, mammals, reptiles and amphibians. At each wetland, basic information was gathered on the condition of the wetland (water level, aquatic vegetation, terrestrial vegetation, fishing activity, hunting activity and general level of disturbance from human activity).

It has been concluded that there has been massive loss of natural wetland habitats throughout the northeast region; entire ecosystems have disappeared without a trace (Shawinigan Lavalin 1992a). Six systems have been identified as being of outstanding national and international importance for their nature conservation values. The present surveys have placed emphasis on the importance of wetlands in the Haor Basin for birds, mammals, reptiles and amphibians. Over the coming 12 months, the Nature Conservation Movement (NACOM) will carry out botanical investigations at three selected sites. There remains a possibility that there may be other sites of special ecological or limnological importance in the region. There is a need for a more general appraisal of the overall ecological significance of the wetlands of the Haor Basin. This would draw heavily on the results of the present surveys and the NACOM studies, and would benefit greatly from the information already being gathered by other NEAP staff in the fields of hydrology, sedimentology, fisheries biology and social anthropology; there would probably still be a need for rapid field surveys in some areas (Shawinigan Lavalin 1992a).

3.2.4   FAP 17: National Fisheries Assessment

The primary objective of the FAP 17 project is to provide a means of evaluating the impacts of the various FCD/I schemes on the inland capture fishery.

FAP 17 has identified a number of concerns with the existing fisheries assessment methodology, including:

- BFRSS data are not statistically valid.
- BFRSS provides no detailed information on small species which form main source of protein for subsistence fishermen.
- Estimates of flooded area not reliable. Current satellite imagery is very limited during the monsoon due to presence of cloud cover and the accuracy of agricultural data is unknown.

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- The overall effects of restricted migration to and from floodplains which are thought to be primary breeding grounds are not fully considered.
- Species composition and biomass variations by habitat are ignored.
- The predictive model (MIKE 11) is very coarse and estimates have not been proven against empirical flooding data.

Manpower and logistical constraints are expected to restrict any sampling programs undertaken by FAP 17 or subsequently by DOF to a small number of sites in and out of FCD/I areas. Within these constraints a detailed fisheries assessment in impacted and non impacted areas might be undertaken broken down by habitat. This data could be used to give accurate estimates of yield per unit area by habitat together with species composition, growth rate and other biological data and would eliminate the need to use BFRSS data. Studies of the migratory patterns of significant species and a survey of main physical and chemical properties of the different water bodies will help to categorize different habitat types (FAP 17, personal communication).

3.2.5   FAP 19: Geographic Information Systems

FAP 19 has established a Geographic Information System (GIS) to serve the information needs of other FAP activities related to recording, manipulating and displaying georeferenced data. Available equipment includes an image processor for handling digital LANDSAT tapes. FAP 19's activities include three types of study:

- Research on data handling or analysis techniques specific to Bangladesh;
- Demonstration or pilot studies to develop methodologies for implementation by other FAPs at a larger scale; and
- Support for specific FAP studies.

Training is an essential component of all these activities.

Projects currently in progress include a national charland inventory based on LANDSAT image analysis and an integrated GIS analysis of the Tangail compartmentalization area using input data derived from a variety of base maps at various scales.

3.3   Non-Government Organizations

3.3.1   Asian Wetland Bureau (AWB)/International Waterfowl and Wetland Research Bureau (IWRB)

The AWB and IWRB were the two international conveners of the international conference on wetlands and waterfowl conservation held in Karachi, Pakistan, in December 1991, which involved 160 scientists and decision-makers from 23 countries. They are also the co-publishers of the *Action Programme for the Conservation of Wetlands in South and West Asia* (AWB/IWRB 1992) which lists the following specific priority national actions, put forward by participants from Bangladesh:

1.   Establish a national wetland committee or advisory group consisting of representatives from the relevant government agencies, research institutions and NGOs to guide wetland conservation activities in Bangladesh and monitor progress in the implementation of the proposed activities in this Action Programme.

2. Convene a national workshop to develop a national strategy for wetland conservation in Bangladesh, and ensure that results of this workshop are incorporated into future environmental plans.

3. Ensure that wetland conservation issues are adequately included in the National Conservation Strategy, National Environment Action Plan and Forestry Master Plan.

4. Prepare a register of experts on wetland research, management and conservation who could provide appropriate input to the design and implementation of wetland projects.

5. Undertake and publish a national wetland inventory to expand and update the section in the Directory of Asian Wetlands.

6. Provide necessary training in wetland conservation to staff of the Forest Department and Department of Environment.

7. Complete the formalities necessary for accession to the Ramsar Convention without further delay, and give serious consideration to listing all or part of the Sundarbans mangrove Forest as a Ramsar site.

8. Undertake an independent review of the Flood Action Plan as a whole to determine its likely overall impact on wetlands and waterfowl conservation in Bangladesh, and recommend appropriate control and mitigation measures.

9. Ensure that adequate consideration for wetland conservation issues is included in the Flood Action Plan environmental impact assessment studies (FAP 16) and in the sub-regional project design components.

10. Initiate the World Bank/Government of Bangladesh Forest Resource Management Project as soon as possible, and maintain the emphasis given by this project to institutional strengthening for nature conservation and sustainable management of the Sundarbans Mangrove Forest.

11. Implement the UNDP/FAO project on integrated management of the Sundarbans without further delay.

12. Initiate discussions with World Bank to ensure adequate linkage between the forest resource management projects in Bangladesh (Forestry III) and West Bengal (Forestry II), particularly relating to transboundary issues such as the Sundarbans.

13. Immediately initiate discussions with the Government of India and West Bengal to establish a mechanism for free exchange of information on the Sundarbans, and to develop and implement the concept of a transfrontier reserve to encompass the entire Sundarbans. Consideration should be given to listing all or part of the combined area under the Ramsar Convention or World Heritage Convention.

14. Declare coastal wetlands of great importance to migratory waterfowl such as Dhal Char, Char Dhigal, Unir Char and Sonar Char as game reserves.

15. Examine options for rehabilitation of the Chokoria Sundarbans, and investigate possibilities of combining mangrove re-afforestation with shrimp culture.

16. Conduct studies on the freshwater wetlands in the Haor Basin of Sylhet and eastern Mymensingh, and declare key sites as multiple uses management areas and/or game reserves.

17. Examine the possibility of establishing a waterbird banding programme in Bangladesh. This will require an extensive training programme for interested individuals in the Forest Department and appropriate NGOs, and provision of equipment.

The Conference also urged that high priority be given to developing comprehensive national strategies and action plans.

At the second Flood Action Plan conference in Dhaka in 1992, AWB stated that Bangladesh is one of the most important basin countries for wetlands. There are many wetlands of international importance in the country and they contribute a wide range of goods and services to the community at large. The status,

importance and impact on wetlands have not to date been addressed by the majority of FAP projects, and field surveys have only been undertaken in the northeast and northwest regions (AWB 1992).

In July 1992 AWB submitted to the Asian Development Bank (ADB) a technical review of an EIA prepared for the Bangladesh Second Aquaculture Development Project. ADB was urged, under Recommendation 3.4 of the Fifth Conference of Contracting Parties to the Ramsar Convention, to play a role in enhancing the capacity of wetlands to contribute to the well-being of people and to rehabilitate those wetlands which have been degraded through non-sustainable development. AWB indicated that the EIA completed for the aquaculture project did not adequately address the potential ecological and socio-economic effects of the proposed project.

3.3.2 Nature Conservation Movement (NACOM)

The Nature Conservation Movement (NACOM) is a non-profit, independent non-government organization dedicated to the conservation of Bangladesh's flora and fauna. NACOM has full time professionals and linkages with academics to support its project work.

In association with the Forest Department, AWB, and IWRB, NACOM has been involved with wetlands inventories and development of management plans for coastal wetlands. The Asian Waterfowl Census was initiated in 1987, which NACOM has participated in since its inception. Efforts by NACOM, AWB, and the government have led to the discovery of concentrations of endangered waterfowl on coastal wetlands of Bangladesh, identifying Noakhali district as one of the major wetland sites in East Asia.

NACOM is presently conducting wetland flora and faunal field investigations in the northeast region of Bangladesh. This work is being conducted in association with the FAP 6 Northeast Regional Planning Project. The scope of this work includes botanical surveys in three sites to identify the principal wetland plant species and vegetation communities, describing the cycle of vegetation growth, a checklist of the principal macrophytic species, identification of rare or economically important plant species, and information on the exploitation and dependance of people on wetland plants.

3.3.3 The World Conservation Union (IUCN)

IUCN has been involved in a number of major conservation initiatives in Bangladesh, including development of the Bangladesh National Conservation Strategy. Other initiatives include the sponsoring of the Bangladesh contribution to the Directory of Asian Wetlands, published by IUCN in 1989. IUCN also contributed to NEMAP (National Environmental Management Action Plan). A number of specific actions were proposed under NEMAP to address the degradation of wetlands. IUCN has maintained an interest in wetlands and will be sponsoring a Bangladesh national wetland conference in late 1992.

3.2.4 Bangladesh Centre For Advanced Studies (BCAS)

The Bangladesh Centre For Advanced Studies (BCAS) is an independent, non-profit, non-government research organization working on resource management, environment and developmental issues. BCAS has an established in-house professional capability, in addition to linkages to numerous academic institutions. BCAS has prepared a number of *Environmental Profiles* on Bangladesh, and has published extensively in the areas of surface water, agricultural development, social forestry and inland fisheries management.

An ongoing fisheries monitoring project is being conducted in the western region of Bangladesh. This is a six year project aimed at collecting extensive information on fish production and utilization related

to the World Bank fish stocking program. This project has now been underway for one year. BCAS is the Monitoring Unit of the Government of Bangladesh (GOB) New Fisheries Management Policies for open water, common property fisheries. In this work BCAS is working with GOB, fishermen, and NGOs. BCAS has also conducted research programs on the impact of selected flood control, drainage and irrigation projects.

3.4   Need for a National Wetland Inventory/Management Programme

Concern over loss of wetland areas, associated habitats important for wildlife, and flora and fauna of significant economic value (particularly fisheries) has been expressed both at the national and international level. A great deal of speculation exists with respect to actual value and importance of wetland areas, as well as actual effects from interventions such as FCD/I projects. A prime reason for the speculation is the lack of data and the consequent poor understanding of Bangladesh's wetland resources. There is a need to have adequate information on the quantity, type and value of Bangladesh's wetland resources if changes are to be adequately assessed.

The main rationale for a national wetland inventory stems from demands for the products produced by an inventory. These include:

- Improved knowledge and understanding of wetland ecosystems and hydrology;
- Enhanced understanding of the socio-economic importance of wetland resources by government, scientific and planning groups;
- Promotion of wetland research and monitoring activities in Bangladesh;
- Increased public awareness, education and training related to the conservation and management of wetland resources

An inventory would provide baseline data necessary for the EIA of proposed development projects and changing resource use patterns. It would also be used as background information for identifying national and internationally important wetland areas, identifying priorities for wetland management, and would serve as the basis for the development of guidelines for wetland management.

During the course of this assessment, it was suggested that conservation agencies, with their limited financial resources, can only act efficiently in the conservation of wetland ecosystems if they concentrate their efforts on the most important and most vulnerable systems. Such a concentration of action is possible only if it can be based on a common set of priorities, such as an agreed list of nationally or internationally important sites. In the development of an effective conservation program, one of the first steps is the compilation of a basic inventory of these important sites which would:

- Identify priorities for future action in research, protection and management;
- Establish the basis for a monitoring system which will enable us to follow the fortunes of the sites;
- Provide a valuable working tool for researchers and managers by making the basic information widely available and facilitating comparison between areas;
- Stimulate an increased interest in the sites on the part of students, scientists, land-use planners, governmental officials and the general public" (Scott and Jones 1992).

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Chapter 4

CONSIDERATIONS FOR CONDUCTING A NATIONAL WETLAND INVENTORY

4.1 Techniques and Approaches Used

4.1.1 AWB Survey of Bangladesh

The Directory of Asian Wetlands has a specific section dedicated to Bangladesh. Twelve wetland areas were identified and documented. The sites in Bangladesh were selected for one of two reasons:

- Sites which had long been known to be of special importance for wildlife; or
- Sites which the contributors to the Directory had surveyed and found to be particularly interesting (Shawinigan Lavalin 1992a).

The list is not comprehensive and other sites for conservation may have been overlooked.

Based on discussions with individuals involved in the surveys of wetlands included in the Directory, it was noted that information on each site was collected during a one day site visit. For very large sites up to 3 days were spent collecting data. Most information was compiled and collected from secondary sources, indicating the very limited baseline information available on wetland areas. The format used for data collection was based on the RAMSAR data sheets. This approach was standardized in all twenty-four counties in Asia included in the Directory.

The Directory of Asian Wetlands includes descriptions of wetlands of international importance and their general status (i.e. ecological importance, legal protection, land tenure, etc.). The national inventories which have been conducted for the Directory are considered to be valuable for planning research and identifying management priorities. The work completed to date on the Bangladesh chapter of the Directory has the most extensive information available on the country's wetlands.

The limitations of the work must be recognized. National wetland inventories of this type, while useful, are only "snap shots" of the situation at the time of their compilation. It is essential that the information, once collected and centralized, be updated as new information becomes available (Scott and Jones 1992).

4.1.2 Indonesian Wetland Inventory

Data have been collected on the total area of the main wetland habitats in the seven major geographical regions of Indonesia (AWB/DGFPNC 1991). Descriptions of 231 wetland sites have been included and evaluated on the basis of the Ramsar criteria. Numerical codes are used to describe wetland type and criteria for inclusion. Wetland types are described as mangroves and mudflats, freshwater swamp forests, peat swamp forests, swamp woodlands, herbaceous swamps, grass swamps and savannas, and lakes.

The inventory was meant to provide a basis for further compilation of existing information, research and survey work. It was thought important to attract the attention of the scientific community to areas thought to be of conservation value. The information includes data on location, habitat, physical properties, climate, existing and proposed conservation measures, land use, threats and disturbances, economic and social values, fauna (especially waterfowl) and research. While information is incomplete, the report aims at increasing the awareness of the importance of wetlands in Indonesia as a resource for sustainable utilization and conservation, and on the threats and disturbances which should be mitigated.

4.1.3 Philippines Wetland Inventory

The main feature of the methodology is the use of two sets of criteria - one ecological, the other concerned with viability (Davies and Giesen 1990, Davies *et al.* 1990). The viability criteria aim to answer the questions: how long is the site likely to retain its conservation value, and how feasible is the management of the site? The intent of the approach is to make use of scarce resources to focus on those sites of high ecological value which are likely to be successful in terms of subsequent management. This may be of particular relevance to Bangladesh.

The methodology has been used to identify wetlands for inclusion in a protected areas system using a set of preliminary ecological criteria before field survey and a set of detailed ecological criteria after field survey. The steps by which the criteria are applied include:

1. Inventory of wetland sites for the country including gathering of all available data on these wetlands on standard data sheets.
2. Field survey for rapid assessment of sites for which there is little previous data.
3. Publication of an initial wetland inventory for the country which can be continuously updated.
4. Application of the set of preliminary ecological criteria and viability criteria in order to draw up a list of potentially important sites to be further studied by field survey.
5. More detailed surveys of those wetlands identified as being of potential importance by the application of preliminary criteria
6. Application of detailed ecological criteria and viability criteria to take full advantage of the data gathered to make final selection more precise.

The output of the inventory has been a list of wetlands of high ecological value and high viability suitable for protection.

The preliminary set of criteria is relatively simple and is based on habitat and species diversity and rarity. Information on which to apply the criteria can be obtained from aerial photos, remote sensing data and land use maps. In some cases, where there is a lack of data, species diversity may have to be inferred from habitat diversity. It is suggested that only recent photos and maps should be used because of the rapid changes occurring in most developing countries.

The preliminary criteria are applied together with a set of viability criteria, which are composed of factors firstly which evaluate how long the area is likely to retain its conservation value, e.g. size, shape and level of disturbance and secondly which aim to evaluate management feasibility, e.g. land tenure status and the peace and order situation. Almost all of the viability criteria can be assessed, in the first instance, from photos, maps and government statistics; and these can be further refined from socio-economic information gathered during later surveys.

The set of ecological criteria are based upon habitat diversity and distribution, species richness, abundance and rarity of selected groups

Preliminary Ecological Criteria

1. Habitat diversity
2. Unique/rare habitats
3. Species diversity
4. Occurrence of rare/endemic/endangered species

Detailed Ecological Criteria

1. Habitat diversity
2. Habitat distribution
3. Floral species richness
4. Rare wetland plant species
5. Wetland bird species richness
6. Wetland bird species abundance
7. Presence of rare/endemic/endangered bird species
8. Fish species richness
9. Fish endemism
10. Special considerations (top predators)

Viability Criteria

1. Size
2. Shape
3. Site condition
4. Catchment condition
5. Land tenure status
6. Peace & order situation
7. Plans for site
8. Population in site
9. Population in adjacent area

4.1.4 U.S Fish and Wildlife Service Wetland Inventory

In 1954 the U.S. Fish and Wildlife Service (USFWS) conducted an inventory of wetlands in the United States. It was a single purpose inventory to assess the amount and types of waterfowl habitat. In 1975 the USFWS initiated a National Wetland Inventory program to prepare multipurpose wetland maps of the United States that provide data to a wide variety of potential users including wildlife managers, hydrologists, landscape planners, economists, engineers, and other public and private users. The purpose of this inventory was to provide data that would facilitate the management of wetland areas on a sound, multiple-use basis.

The USFWS wetland classification system was been designed to meet three long-range objectives:

- Grouping ecologically similar habitats, so that comparative value judgements can be made;
- Furnishing units for inventory and mapping; and
- Providing uniformity in concepts and terminology throughout the U.S.A.

The U.S. National Wetland Inventory is a comprehensive mapping and classification of all wetland habitat, and has produced a series of wetland inventory reports as well as maps at two scales - 1:100,000 and 1:24,000. It represents the most detailed national wetland inventory available. Maps show the location, shape, and characteristics of wetland and deep water habitats. The small scale maps are chiefly used for watershed and regional planning.

4.1.5   Satellite Imagery Applications For Wetland Inventory

Ducks Unlimited (DU), an international conservation organization, initiated a contract with the National Aeronautics and Space Administration (NASA) to determine the feasibility of using Landsat Thematic Mapper (TM) data for a wetland inventory (Lillesand and Keifer 1987). A scene from the Thematic Mapper (TM) was used in the preparation of 1:24,000 scale wetland maps in standard U.S. Geological Survey format. Approximately 3.2 million ha of land were captured in one 185 x 170km Landsat scene. Earth Resources Laboratory Application Software image processing software designed by NASA, was used to extract wetland information from the TM data tapes. Products derived from the TM inventory include wetland statistics summaries, in addition to reconnaissance, wetland types and wetland identification maps.

TM data can be registered to any map projection or coordinate system and the maps can be plotted as overlays at any scale, although the 1:24,000 U.S. and 1:50,000 Canadian map scales are the most frequently used. Reconnaissance maps are produced from the TM band 5 data and aid in delineating wetland, croplands and various other land cover types. The wetland types currently being surveyed are open water, deep marsh, and shallow marsh. Deep marsh is basically defined as emergent wetland vegetation growing in areas of persistent surface water, while vegetation in a shallow marsh commonly grows in areas of temporary surface water.

Data from Landsat TM) and other satellite sensors, and aerial photographs can be interpreted and classified with the assistance of an image processing system and a GIS. The GIS would be used to combine the image classification with other parameters e.g. soils and vegetation type to determine wetland classification.

4.1.6   GIS Applications for Wetland Inventory

Geographic Information Systems (GIS) are computer-based information tools for recording, manipulating, and displaying georeferenced data. A key feature of a GIS is that different map information data sets are linked by location so that one may be related spatially to another. For example, information on elevation, soil type, ground water level, crop cultivation, population density and average income may be retrievable for any location or administrative unit if this information is stored with location attributes in the GIS. Currently there are five GISs operational in Bangladesh, with several more planned for the near future. The operational GISs are located at SPARRSO, Bangladesh Bureau of Statistics (BBS), Bangladesh Water Development Board (BWDB), Agricultural Sector Team (CIDA) and Bangladesh University of Engineering & Technology. This rapidly growing capability will certainly place demands on the need for digitized national databases.

A GIS would be a cost effective, efficient and logical basis to use for a national wetland inventory. However, a key limitation to GIS use in Bangladesh is a relative lack of digital map and related databases. Other than satellite data, there are limited map bases available. The agro-ecological zone map base constitutes the only significant national database. Notably lacking is a detailed topographic map base and maps with elevation contours of 1m or less.

4.2   Constraints and Limitations

A national wetland inventory covering Bangladesh would, of necessity, have to make use of recent remotely sensed imagery as the basis for mapping, sampling and inventory. Satellite imagery has an added advantage of being very useful for repetitive inventories at intervals, i.e. monitoring. Up-to-date (1990/91) aerial photographs are presently available for limited portions of the country, e.g. 1:20,000

for a 40km wide strip along the Brahmaputra-Jamuna rivers and along the coastal belt, and 1:50,000 for a 100km wide strip along the same rivers. Complete aerial photo coverage of Bangladesh was last achieved in 1983/84, and substantial changes in wetland area and distribution are likely to have ensued since then.

Recent satellite imagery covering the whole country is available: LANDSAT multispectral scanning (MSS) and thematic mapping (TM) imagery is available in digital format and hard copy at a scale of 1:500,000, and SPOT imagery in digital format and colored and panchromatic images at 1:50,000 scale. Spatial resolution and spectral band width are the two characteristics of satellite remotely sensed data which set the limitations as to their use in mapping land and water cover. Spatial resolution is the area of land over which the spectral reflection is averaged. Identification and mapping of spatial features require a group of 20-25 pixels with similar proportions. For 20m resolution SPOT imagery this would represent about 1 ha and for 30m resolution Landsat TM images it is about 2 ha. This level of resolution requires digital processing and the resultant mapping would indicate little about the quality of the mapped features. It would serve mainly as an inventory source and a guide to the field sampling procedures. All information obtained, however, would be in GIS format and would lend itself to further processing by overlaying of other features such as salinity and soil mapping.

The task of making a national inventory at this level would require the acquisition and digital processing of some 75 SPOT or 14 TM scenes. This, in turn, would require the full-time use of an image processor, computers, electrostatic plotters, various software and two to three image processing and GIS specialists. The overall inventory would thus be relatively expensive. A major consideration would relate to the timing of the inventory and the classification adopted. Dry season surveys would emphasize permanent waterbodies which are of key importance as wildlife and fish refuge habitat, while surveys at other times would have to contend with the extensive monsoon flooding which would extend beyond the dry season limits. Satellite imagery taken during the monsoon period is usually hampered by extensive cloud cover.

Efficient use of imagery and GIS for mapping and inventory purposes would require good integration between the image processing activities and the field sampling and data collection. A recommended procedure would be to utilize a GIS to obtain the full useful information content from a number of image sources, e.g. SPOT complemented by LANDSAT and aerial photography (in specific cases) for compiling an overall inventory and classification of all wetlands of defined size. From this a sample would be drawn on a stratified random basis of all major wetland types. The sample wetlands would be located in the field and a full appraisal made of their ecological and conservation status. The resultant data would be fed back to the GIS for compilation and overlaying with other relevant data, and extrapolation to areas not directly sampled in the field. To develop an effective integration of image processing, GIS mapping and field inventory, it would be useful to have an initial pilot survey of a limited area to test and confirm methodologies before proceeding on a national scale.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Consensus On Need

Specific recommendations for a Bangladesh national wetland inventory have been made recently at an international conference on wetlands which was attended by over 160 international wetland specialists and conservation organizations (IWRB 1992). The need for baseline information for wetland management is also documented in regional studies and environmental impact assessments so far conducted under the FAP. Government initiatives such as the National Conservation Strategy and NEMAP have all brought attention to the importance of wetlands and the need for collection of baseline information for wetland management. Finally, discussions held as part of this needs assessment concluded that a comprehensive effort to obtain baseline information for the management and monitoring of wetland ecosystems was long over due. Both government officials and NGOs consulted were unanimous in their support for collecting information on wetlands at the national level as the first step of towards a national wetland management program. The message was clear that if this project is to be initiated, it must be well designed and properly financed.

5.2 Inadequate Information For Management

Although a considerable amount of information already exists on wetlands in Bangladesh, the level of data is generally inadequate and outdated for management purposes and widely dispersed between different government departments and institutions. Very limited up-to-date information is available on any important wetland site. The most recent data on wetlands are now being collected at selected sites as part of FAP 6 (NERP). This information is restricted to three specific locations and focused only on flora and fauna, with monthly waterfowl censuses being conducted at 15 additional sites. Experience obtained in this region should be used to guide efforts at the national level. Similarly valuable information on aspects of wetlands is being compiled in other regions and needs to be collected and analyzed in the context of a national wetland management program.

A reliable wetland inventory is needed now in order to enable a comprehensive analysis to be made of the extent and diversity of the nation's wetlands, to establish their significance, and to provide a basis for development of management actions. Making the inventory entails consolidation of existing information and gathering new information. The inventory should be in the form of a library of material and a computer database.

5.3 Scope of Inventory

The inventory should encompass all types of wetlands, from coastal mudflats and mangroves to inland swamps, hoars and beels, and would consider all wetland values, including hydrological, biophysical, ecological, social, culture, faunal and floral. Some detailed work is now being conducted on mangrove areas which could be integrated with the other wetland areas. It would identify priorities for future survey, research, management and protection, and would provide a sound basis for monitoring. The national inventory should emphasize dry season wetlands which are permanent or perennial.

A three phase inventory is suggested:

- Phase I would be a pilot study phase where a relatively small area (suggested about 25 x 25km) would be selected and subjected to an inventory as described under Phase II in order to test and

refine image analysis and field sampling and inventory procedures; terms of reference for this are appended as Annex 1.

- Phase II would be a systematic coverage and inventory of sites meeting wetland classification criteria as per terms of reference in Annex 2.
- Phase III would involve scientifically based data collection activities of those sites of particular importance and which are representative classifications or of regional significance. The data collection programme would be designed to provide the basis for a long term monitoring programme. Phase II activities are outline din terms of reference as per Annex 3.

5.4   Opportunities for Cooperation

Data collection and management initiatives within government and various flood action programme activities are providing valuable information needed for wetland management. Any initiative to conduct a national wetland inventory should ensure close cooperation and coordination with these activities. A steering committee involving key government departments and selected non-government organizations should be established to promote coordination. The proposed project activities should be supported under the direction of the Ministry of Environment and Forests.

5.5   Recommendations

Virtually all of Bangladesh is dependent on perennial wetland ecosystems. This dynamic environment feeds millions of people, yet little information exists on the value and quantity of Bangladesh's wetland resources. The need to address the degradation of wetlands and identification of their hydrological, physical, ecological, and socio-economic values requires a scientifically sound investigation. As the first step, a systematic identification and classification of these wetland resources must be conducted. A baseline data collection programme must be designed as the basis for ongoing monitoring of the interactions and interdependencies of important wetland ecosystems. This work is to serve as the foundation for a national wetland management programme.

A national wetland assessment is recommended at this time to consolidate the existing information, gather new baseline information, establish a computerized database, classify wetlands by type, area, ecological and socio-economic importance, etc., and provide a comprehensive analysis of the extent, diversity and significance of wetland resources at the regional, national and international levels.

Chapter 6

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ANNEX 1

Persons Contacted

Flood Plan Coordination Organization

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ANNEX 2

DRAFT SCOPE OF WORK

NATIONAL WETLAND INVENTORY

1. Background

Some 50 percent of Bangladesh consists of seasonal and/or permanent wetland. It is important to know and understand the value of Bangladesh wetland resources from a regional, national and international perspective. As part of the development of an effective sustainable development strategy for wetlands, one of the first tasks is to obtain basic physical, hydrologic, socio-economic and ecological information on all wetlands. Baseline information is required to understand ecosystem dynamics of wetland areas, factors impacting these systems, and management needs to support sustainability.

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramsar Convention) defines wetlands as *"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static, flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"*. This definition should serve as the basis of a national wetland inventory in Bangladesh. Thus wetlands to be considered for inclusion in the inventory would include all types of marshes and swamps, swamp forest, mangroves, seasonally flooded grassland and forest, all types of lakes, ponds, rivers and streams, estuarine and delta systems, intertidal mudflats and coastal lagoons, as well as artificial wetlands such as water storage reservoirs, salt pans and fish ponds.

The Ramsar Convention has developed criteria for the identification of wetlands of international importance. The guidance provided for the identification of "wetlands of international importance" refers to "international significance in terms of ecology, botany, zoology, limnology or hydrology" and indicates that "in the first instance, wetlands of international importance to waterfowl at any season should be included". Other criteria to be included in the inventory must be defined, e.g. size of wetland areas. Socio-economic criteria related to the importance of the wetland system in supporting human activities must be factored into consideration, particularly for areas of regional and national importance.

2. Objectives

The overall objective of a National Wetland Inventory is to determine the number and type of wetlands and to assess their status and value as physical, hydrological, ecological and socio-economic resources.

Specific objectives are to:

1. Consolidate all existing information on Bangladesh wetland resources;
2. Identify, map, and classify all wetland areas;
3. Conduct field surveys of selected wetlands to obtain baseline information on their resources; and to
4. Analyze all wetland information and define conservation issues, management priorities, and a national wetland monitoring programme.

3. Scope

A three phased approach is recommended for the national inventory:

- Phase I - a pilot phase to develop the methodologies for image processing, GIS and field sampling;
- Phase II - the main inventory and assessment phase;
- Phase III - a program of specific and detailed assessments and conservation measures aimed at priority wetlands.

4. Work Plan

The following activities are proposed to complete an inventory and classification of wetlands in Bangladesh.

4.1 Phase I

1. Select a sample area for which digital satellite imagery and recent aerial photographic coverage are readily available. The area should be small enough for complete inventory coverage within a few weeks, but large enough to encompass a representative selection of different wetland categories to thoroughly check image, mapping and field sampling methodologies.
2. Carry out a complete inventory and mapping for all seasonal and permanent wetlands using image processing and GIS methods. Classify all wetlands on the basis of stated criteria such as size, shape, location and any other discernible features. Use available overlays of topography, soil types and other relevant data to aid in the classification process.
3. Select a statistically based sample of all wetland types for field checking.
4. Develop a rapid field sampling protocol based on present knowledge of Bangladesh wetlands and on the approaches and methods used in other Asian countries, with particular reference to recent AWB and related inventories in Malaysia, Philippines and Indonesia.
5. Locate all selected wetlands in the field and conduct the rapid field assessment.
6. Combine all field-derived and image-derived data into one comprehensive database, and develop a set of GIS maps and data outputs suitable for application at a national scale.
7. Conduct workshops and review sessions to review pilot phase findings and to develop a set of sampling protocols and classification criteria at the national level.
8. Review and enlarge the SOW for Phases II and III and revise as necessary on the basis of Phase I results.

4.2 Phase II

1. Collect and analyze all existing data (hydrological, physical, ecological and socio-economic) on the location, status and resource values of Bangladesh's wetlands.
2. Establish a GIS complete with all necessary hardware, software and trained personnel.
3. Define a classification system for a national wetland inventory.
4. Select a set of imagery suitable for national inventory purposes, including most recent SPOT and LANDSAT digital imagery, supported by selected aerial photographs for important wetland areas.
5. Identify and map all major wetland systems on basis of topographical, vegetation and soil maps, aerial photography and satellite imagery, using the criteria and methods developed in the Phase I pilot study.
6. Using a number of interdisciplinary teams, conduct a rapid field assessment of representative samples of all wetlands to be included in the national inventory. The surveys should include:

- Global Positioning system technology to facilitate the incorporation of field data into the GIS database.
- Photographs taken on site will be located by Geographic reference point and catalogued at the inventory organization library.
- Vegetation and soil surveys at selected sites.
- Surveys of resident and migratory birds dependent on wetlands (distribution, status, habitat requirements, and abundance with special emphasis on rare and endangered species).
- Survey of mammals, reptiles, and amphibians associated with wetlands (distribution, status, habitat requirements and abundance with special emphasis on rare and endangered species).
- Survey of fish fauna (distribution, status, habitat requirements and abundance with special emphasis on rare and endangered species).
- Limnological survey of selected wetlands (including an assessment of seasonal fluctuations and productivity).
- Socio-economic survey of villages in the area of identified wetlands, to assess local use and dependance on wetland products.
- Determine current land use activities, land tenure, ownership and resource management practices in those areas in and around the selected wetland areas.
- Description of the hydrological regime affecting selected wetland sites.

7. Develop a GIS-based wetland database and catalog. Quantify all wetland types, resource values, current uses and potential for utilization on a sustainable basis. The database should be suitable for statistical analysis of information on a regional, national and wetland classification basis. The database must be linked to the narrative accounts to enable selective retrieval of entire information sheets or just the relevant sections of the text on the basis of any selected parameters (e.g. wetland type, land tenure, legal status, threat, etc.).

8. National level mapping should be conducted at 1:250,000 (17 map sheets). Areas of particular interest where more detailed baseline data collection is to be done should be mapped at 1:25,000.

9. Prepare a detailed report on the status of Bangladesh wetlands, based on the available inventory. Review all available data and assess the interrelationships between the bio-physical and human ecosystems as it is affected by the seasonally changing hydrology of wetland systems. Define wetland management considerations including: seasonal hydrological and sediment dynamics; migration and reproduction dynamics of fish stocks; the role of wetlands for migratory birds; and the socio-economic value (quantitatively if possible) of wetlands. Define wetland management issues on the basis of interdisciplinary appraisal and results of scientific investigations of specific sites. Outline wetland management actions, priorities and ongoing monitoring programme. Prepare wetland action plans, identifying priorities for future research, management, protection and wise utilization of wetland resources in Bangladesh.

10. At the end of the inventory, a national wetlands workshop should be held to discuss the results of the inventory and the implications for wetland conservation and management at the national level.

11. Develop Phase III terms of reference, based on the main inventory findings and the reviews and discussions from the national workshop.

4.3   Phase III

Based on an analysis of national level information, design and implement a comprehensive scientifically based field investigation program to obtain baseline hydrological and physical, ecological, and socio-economic data at selected wetland areas determined to be of regional, national or international importance, and which will serve as representative sites for long term monitoring.

5. Products

This project will produce 3 main products:

1. Phase I - report and mapping of pilot study.
2. Phase II - the main inventory, including maps, reports and a complete database.
3. Phase III - specific reports on wetland studies, conservation and management.

6. Schedule

To be determined.

7. Organization and Coordination of National Wetland Inventory

To be determined.