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Sub-Project Feasibility Study

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FINAL REPORT

ANNEX D

ECOLOGY

September, 1993

Mott MacDonald Limited
in association with
Nippon Koei Company Limited
House of Consultants Limited
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ECOLOGY

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September, 1993

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GUMTI PHASE II FEASIBILITY STUDY

ECOLOGY

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Glossary and Acronyms

Aman	-	Rice planted before or during the monsoon and harvested in November or December
AST	-	Agricultural Sector Team (funded by CIDA)
Aus	-	Rice planted during March to April and harvested during June and July
B aman	-	Broadcast Aman
BBS	-	Bangladesh Bureau of Statistics
BIWTA	-	Bangladesh Inland Water Transport Authority
Boro	-	Rice transplanted in December or January and harvested in April to May
BUET	-	Bangladesh University of Engineering Technology
BWDB	-	Bangladesh Water Development Board
CIDA	-	Canadian International Development Agency
DAE	-	Department of Agricultural Extension
DHI	-	Danish Hydraulics Institute
DOF	-	Department of Fisheries
DTW	-	Deep Tube Well
ECNEC	-	Executive Committee of the National Economic Council
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
EMP	-	Environmental Management Plan
FAP	-	Flood Action Plan - also projects under the FAP eg FAP1, FAP2 etc
FCD	-	Flood Control and Drainage
FCDI	-	Flood Control Drainage and Irrigation
FCD+I	-	FCD initially, then converted to include Irrigation
FFW	-	Food For Work
FMTW	-	Forced Mode Tubewell
FPCO	-	Flood Plan Coordination Organization
FRSS	-	Fishery Resources Survey System
GM	-	General Model
GPA	-	Guidelines for Project Assessment (from FPCO)
HTW	-	Hand Tubewell
HYV	-	High Yield Variety
JICA	-	Japanese International Cooperation Agency
JRC	-	Joint Rivers Commission
KSS	-	Krishni Sambaya Samity
LGED	-	Local Government Engineering Department
LIV	-	Locally Improved Variety
LLP	-	Low Lift Pump
MIKE11	-	Surface water computer model developed by Danish Hydraulics Institute
MLGRD	-	Ministry of Local Government Rural Development
MOFL	-	Ministry of Fisheries and Livestock
MOIWDFC	-	Ministry of Irrigation, Water Development and Flood Control
MPO	-	Master Plan Organization
NAM	-	Computer model which derives run-off and groundwater recharge from rainfall
NCA	-	Net Cultivable Area
NCS	-	National Conservation Strategy
NEMAP	-	National Environmental Management Action Plan
NFC	-	National Flood Council
NPV	-	Net Present Value
NPVR	-	Net Present Value Ratio
NWC	-	National Water Council
NWP	-	National Water Plan
ODA	-	Overseas Development Administration (UK)
Paddy	-	Unhusked rice
RRI	-	Rivers Research Institute
SCF	-	Standard Conversion Factor
SERM	-	South East Regional Model - a computer hydraulic model of the south-east region of Bangladesh

SERS	-	South East Regional Study - also known as FAP5
SIA	-	Social Impact Assessment
SPARRSO	-	Space Research and Remote Sensing Organization
SRDI	-	Soil Research Development Institute
STW	-	Shallow Tubewell
SWMC	-	Surface Water Modelling Centre - the MPO office responsible for the computerized modelling of flows, levels and groundwater
SWSMP	-	Surface Water Simulation Modelling Project
SSFCDIP	-	Small Scale Flood Control Drainage and Irrigation Project
T Aman	-	Transplanted Aman
TCCA	-	Thana Central Cooperative Association
Thana	-	Small administrative unit (formerly termed upazila)
TNO	-	Thana Nirbahi Officer
UNDP	-	United Nations Development Programme
Union	-	Division of a thana
[W]	-	With project - economic evaluation of the future situation with the proposed project
[WO]	-	Without project - economic assessment of the probable future value of production if no project is implemented
WRPO	-	Water Resources Planning Organization

D.1 Introduction and Environmental Setting

D.1.1 General

The floodplains of Asia have been inhabited and modified for many centuries and as a result, works for irrigation, drainage and flood protection have caused the disappearance of many of the original features of the floodplain. Bangladesh is no exception as much of the country is a dynamic delta region with approximately 80% of its total land lying within the floodplains of the Ganges-Brahmaputra, a delta of some 40,225 square km (Verghese, 1990; Rashid, 1991).

Recently, there has been an increase in the awareness regarding the effects that these changes are causing to the environment and there has also been a realisation that some of these changes are detrimental to the natural resources on which the people of Bangladesh rely for their every day lives and survival. As a result, some of the projects currently being proposed have started to take the environment into account and have produced useful accounts of the ecology and/or environmental situation in their particular areas. The recent reports produced by FAP 2 on the ecology of the North West Region and the Wetlands Specialist Study produced by FAP 6 on the environments of the North East Region are especially important. However, there are still no studies that can be directly linked to the ecology of the Gumti Phase II study area in particular.

D.1.2 Scope and Limitations of the Ecology Study

The main objective of the ecology component of the Gumti Phase II Feasibility Study was to carry out an evaluation of the biological natural resources of the area, in terms of existing floral and faunal species, in order to form a baseline towards a better understanding of the interaction between the natural and the human environments.

In general, both the terrestrial and aquatic ecology surveys focused on the floodplain since it is the major ecosystem in the study area. Other habitats of note within the floodplain were also identified and preliminary findings are presented in the following chapters. Given that the purpose of the study was to provide guidance in predicting the likely ecological changes due to FDC/I interventions, the approach adopted for this study was to attempt to identify the biodiversity in the area, in terms of existing species and main habitats to try to unravel the links between the natural resources and their utilisation by the human population in the study area.

The term 'Biodiversity' as defined in the Global Biodiversity Strategy (WRI/IUCN/UNEP, 1992) includes the totality of genes, species and ecosystems in a region or the world. It is divided into three hierarchical categories: genetic, species and ecosystem diversity.

The importance of the Gumti Phase II study area lies not only in its extremely high fish productivity, but also on the remarkable number of aquatic species, of which fish occupy a significant place. This was confirmed by the high number of fish species recorded, both directly during the catch surveys as well as indirectly from fishermen's reports. This aspect has been dealt with in the Fisheries Annex F. It is believed that this number of species would increase if a longer study were to be carried out in the area.

It must be emphasized that to carry out such an evaluation properly, a detailed ecological assessment of the interactions between the ecosystem and the use of these resources by the local human population is indispensable. It is therefore beyond the scope of this project to attempt to assess the existing environmental situation in detail, given the short period of time available.

D.1.3 The Gumti Phase II Study Area

The Gumti Phase II project area lies to the north of the South East Region (SER) of Bangladesh which borders India to the east; the Chittagong area to the south-east; the North West Region (FAP 6) to the north and north-east; the North Central Region (FAP 3) to the west and the South West Region (FAP 4) to the south-west. To the south, the SER meets with the Bay of Bengal (Figure D.1.1).

Within the region, the project area is located to the north-west of Comilla (Figure D.1.2). It is bounded to the south by the Gumti River, to the west by the Meghna River, to the north by the Titas (or Pagla) River and to the east, by the Tripura Hills (India).

The project area is 140,854 hectares in size and generally varies between 2.5 and 6 m above sea level. The exception to this is a small area of relatively high land, rising to 9 m asl, just north of Comilla. Figure D.1.3 shows details of the project area and its main rivers and Khals.

There are an estimated 1.9 million people within the project boundary, with an average density of 1,300 people per square kilometre, which is nearly twice the national average, and substantially higher than that for the South-East Region as a whole (1,078 people per square kilometre).

The Gumti Phase II area is a vast floodplain area which harbours a large number of plant and animal species. Here too, the use of the natural resources is intense but although the local people of the area have a deep knowledge of the wildlife of the region, little information has been published regarding the study area in particular. The study area is extremely rich in open water fisheries, particularly in those areas situated in the Middle and Old Meghna River Floodplains (Figure D.1.4) which would indicate an area of high productivity. Few studies have been carried out in this area in terms of its fisheries potential and there appear to be little or no information available regarding the ecological processes taking place in the study area. Its proximity to the fish-rich Meghna River and the extent and duration of its floodplain area during the monsoon, make it potentially one of the most productive fisheries areas in Bangladesh, and these fisheries in turn can only be possible as a result of a complex ecological system. Details of the fisheries component of this report are given in the Fisheries Annex F.

The study area as a whole is generally covered by the floods during the monsoon with the exception of the small elevated homestead land. The channels draining the Tripura Hills are steeper and more liable to flash flooding than other parts of the region. The agro-ecological regions within the Gumti Phase II area are the Middle Meghna River Floodplain in the west, the old Meghna Estuarine Floodplain in the centre and the Northern and Eastern Piedmont Plain, the Northern and Eastern Hills and Akhaura Terrace in the east. The depth and seasonality of flooding from the various sources are the primary influences which determine the ecology, settlement pattern and land use found in any particular area. The species diversity in the project area includes a large number of faunal and floral species and a range of different habitat types.

Figure D.1.1

Location of the Gumti Phase II Project Area

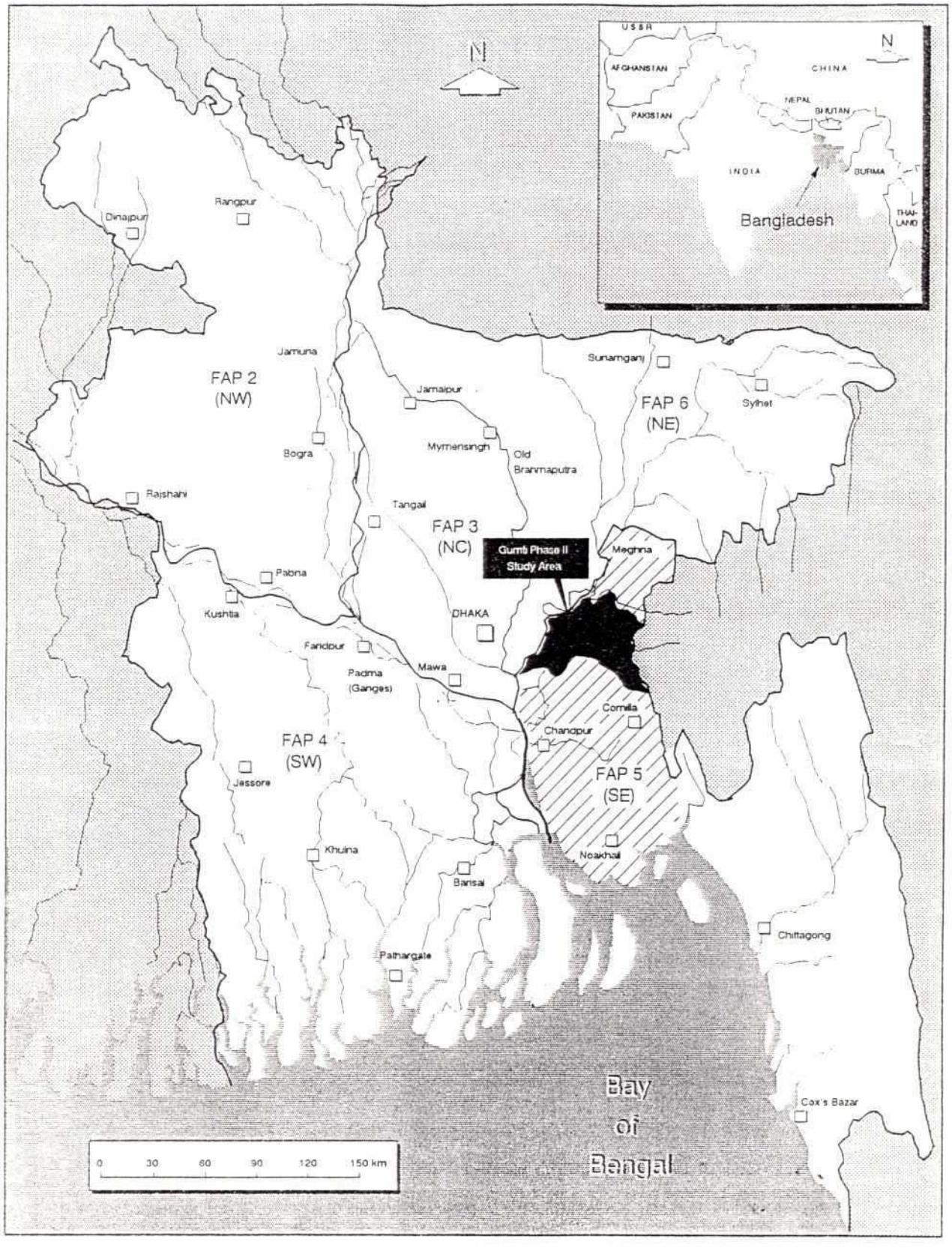


Figure D.1.2

Regional Planning Context

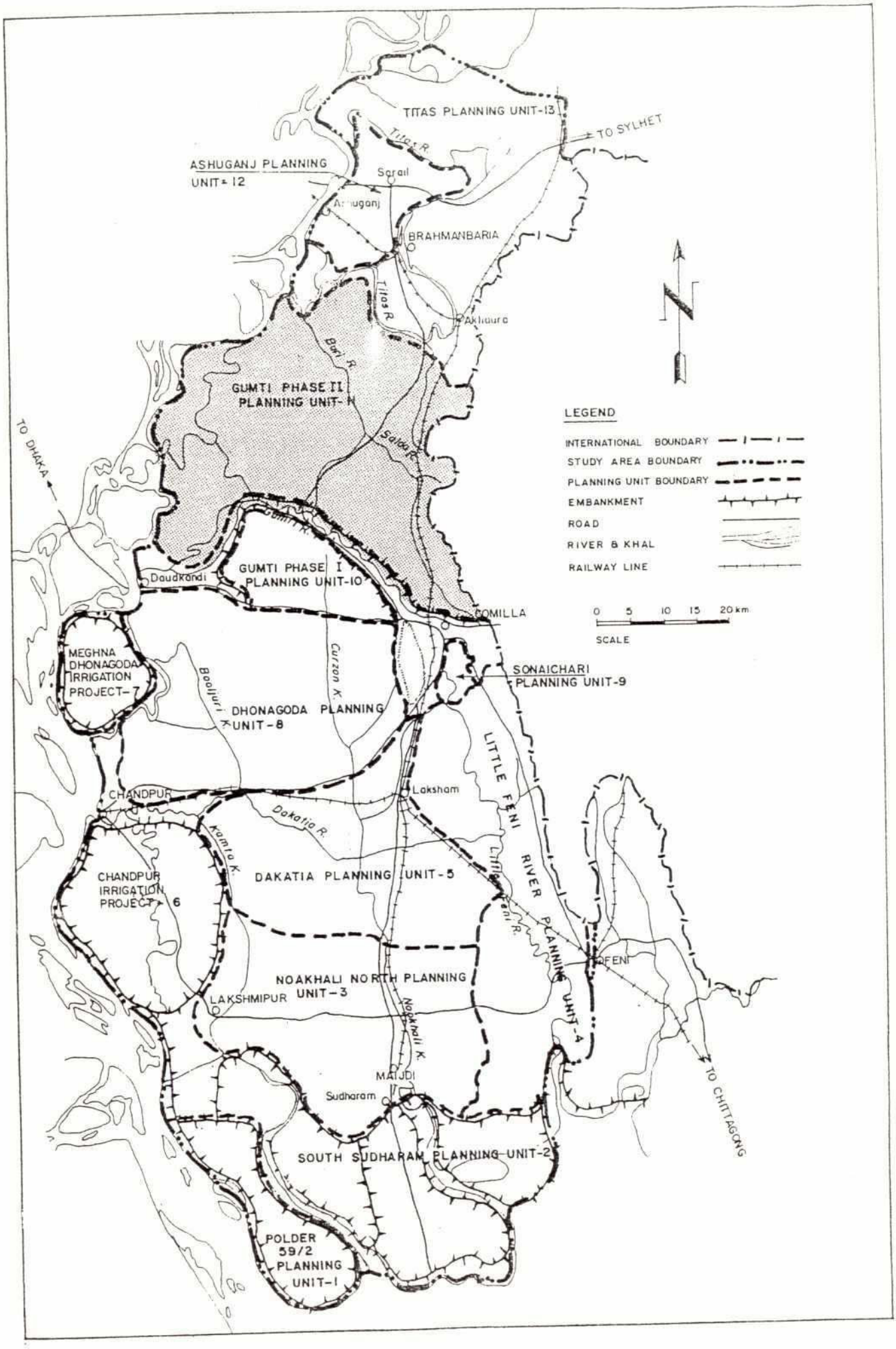


Figure D.1.3
Project Area Base Map

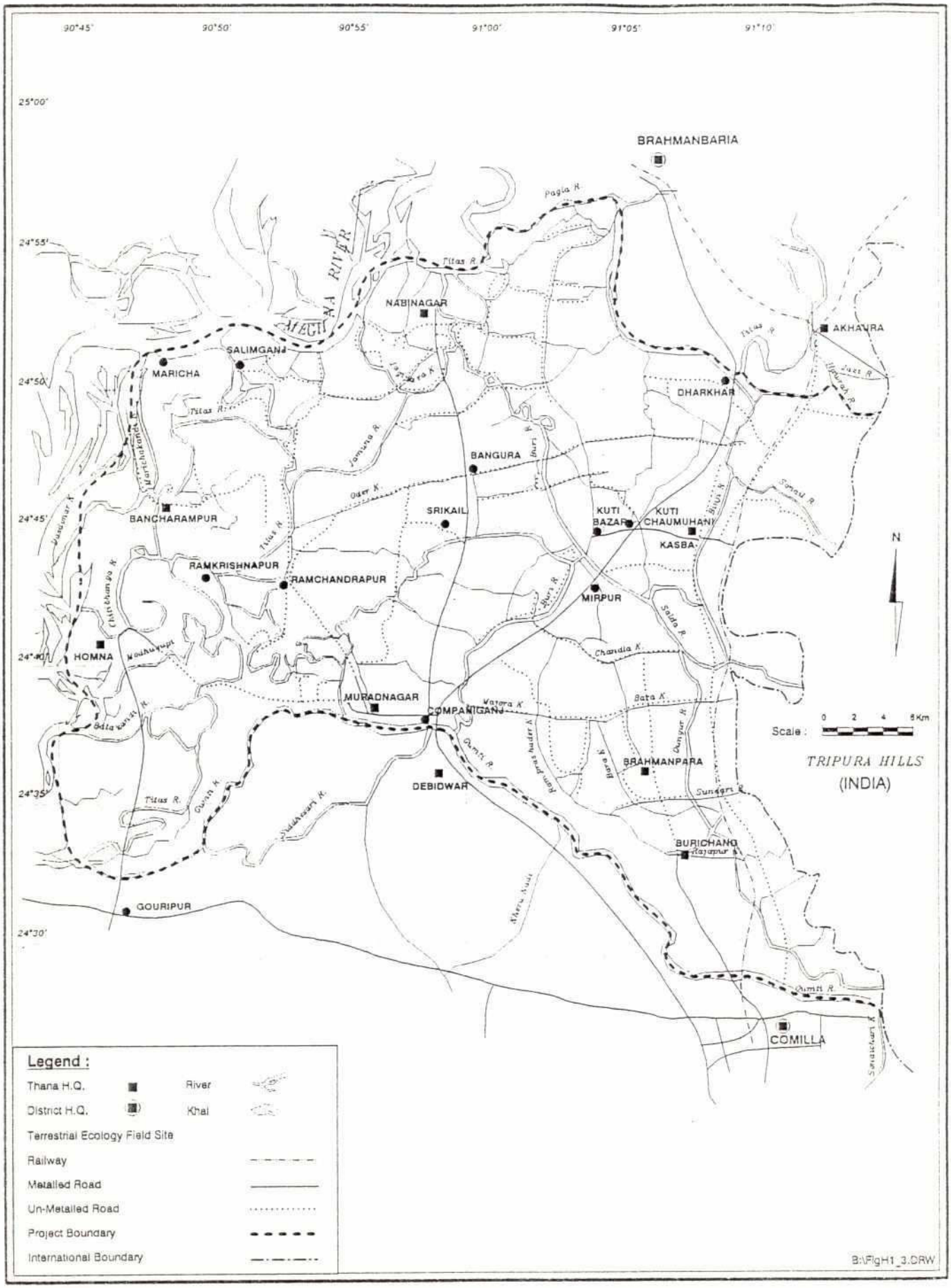
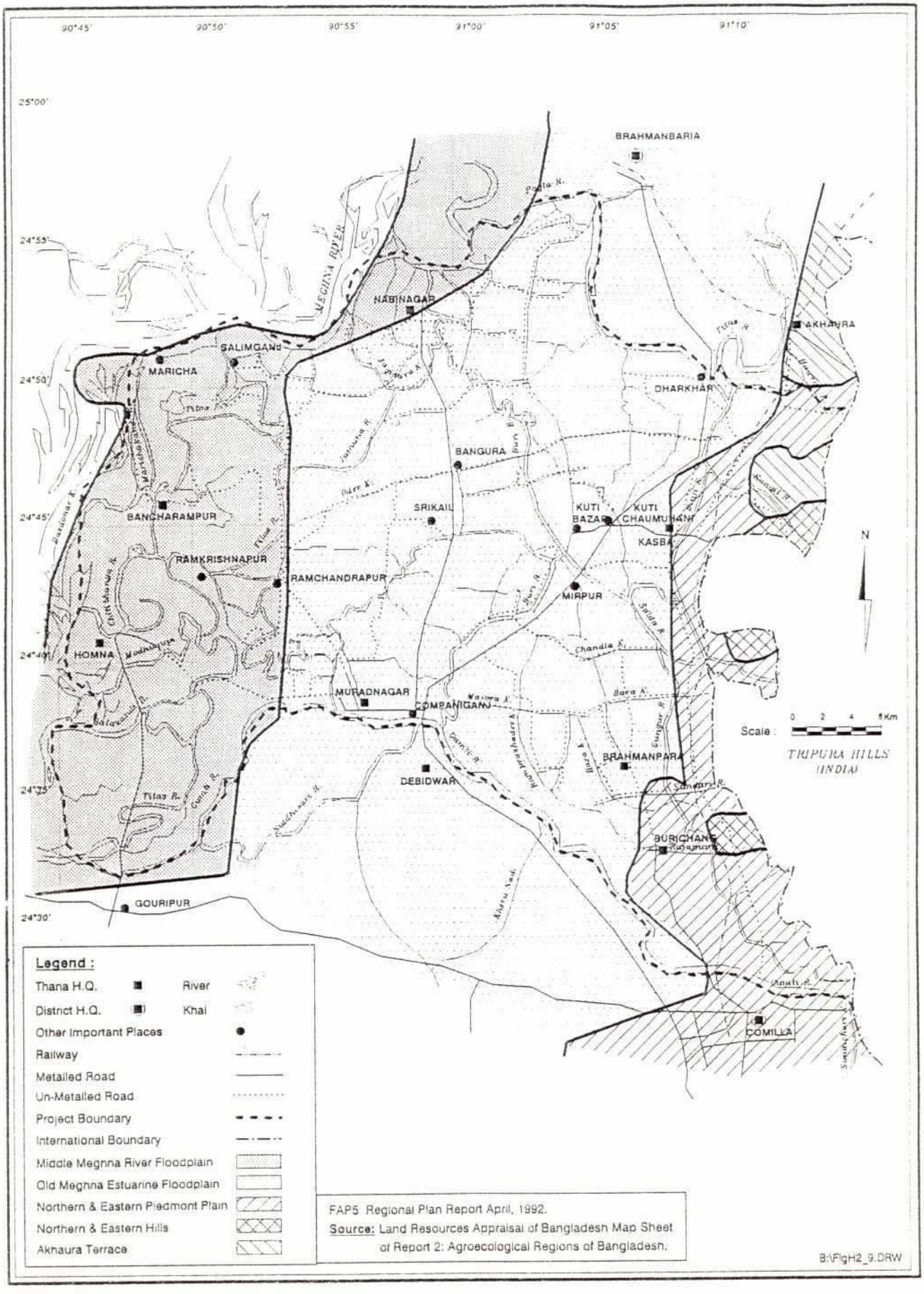


Figure D.1.4

Agroecological Regions in Project Area



FAP5 Regional Plan Report April, 1992.

Source: Land Resources Appraisal of Bangladesh Map Sheet of Report 2: Agroecological Regions of Bangladesh.

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D.1.4 Major Terrestrial and Aquatic Habitats

Floodplain rivers are usually very dynamic environments and result in a wide range of habitats both terrestrial and aquatic. This situation is clearly seen in the range of habitats which exist in the study area.

For the purpose of this study, several of these habitats were selected and those which were sampled for terrestrial ecology are briefly described below:

River Banks: Plant species is high, with all three major group of plants represented of which trees were the dominant community. Herbs are also important.

Pond Banks: Permanent ponds are only found in highland areas and strictly speaking, they are aquatic habitats. However, they were sampled for terrestrial ecology because they provide unusual environmental conditions around their margins. Plant diversity is high with trees and herbs dominating the plant community as in the previous habitat.

Beel Banks: A similar situation to the one described previously, although the number of species is much lower.

Embankment: Flood control embankments provide essential refuges for people and wildlife during peak floods. Where villages have been destroyed by lateral encroachment of the river channels, displaced families often set up their homes on embankments.

Homestead Area: These are permanent settlements which are often deliberately managed by planting a variety of crops, fruit trees, timber and vegetables. They are often local centres of high species diversity.

Agricultural Fields and Margins: Species diversity is rather low with herbs being the dominant plant community.

Refuge Woodland: These areas have not been purposely planted as sanctuaries but include several small habitats which provide protection for several species.

Monospecific Woodlands: These are generally old plantations which have been deliberately established by man but may have become invaded subsequently by secondary species. Bamboo stands are a good example of this type of habitat, although Bamboo is not a tree but a herb member of the grass family Graminae.

Road Side: Usually harbour a large variety of species both plants and animals. Plants are sometimes intentionally planted but often have been in place naturally. During the floods this type of habitat acts as refuge areas for a large number of animals species.

Aquatic habitats included rivers and Khals, inundated Charlands, Beels, ponds, roadside ditches, marshes and irrigated rice fields. The main aquatic habitats which were sampled have been summarised as follows:

Rivers: Permanent water bodies usually flowing through long established channels. Large rivers carry high silt loads throughout the year preventing the establishment of aquatic flora.

Khals: Most of them are temporary channels which may dwindle during the dry season to a series of shallow, stagnant pools in which the silt settles out allowing for light penetration and the growth of phytoplankton.

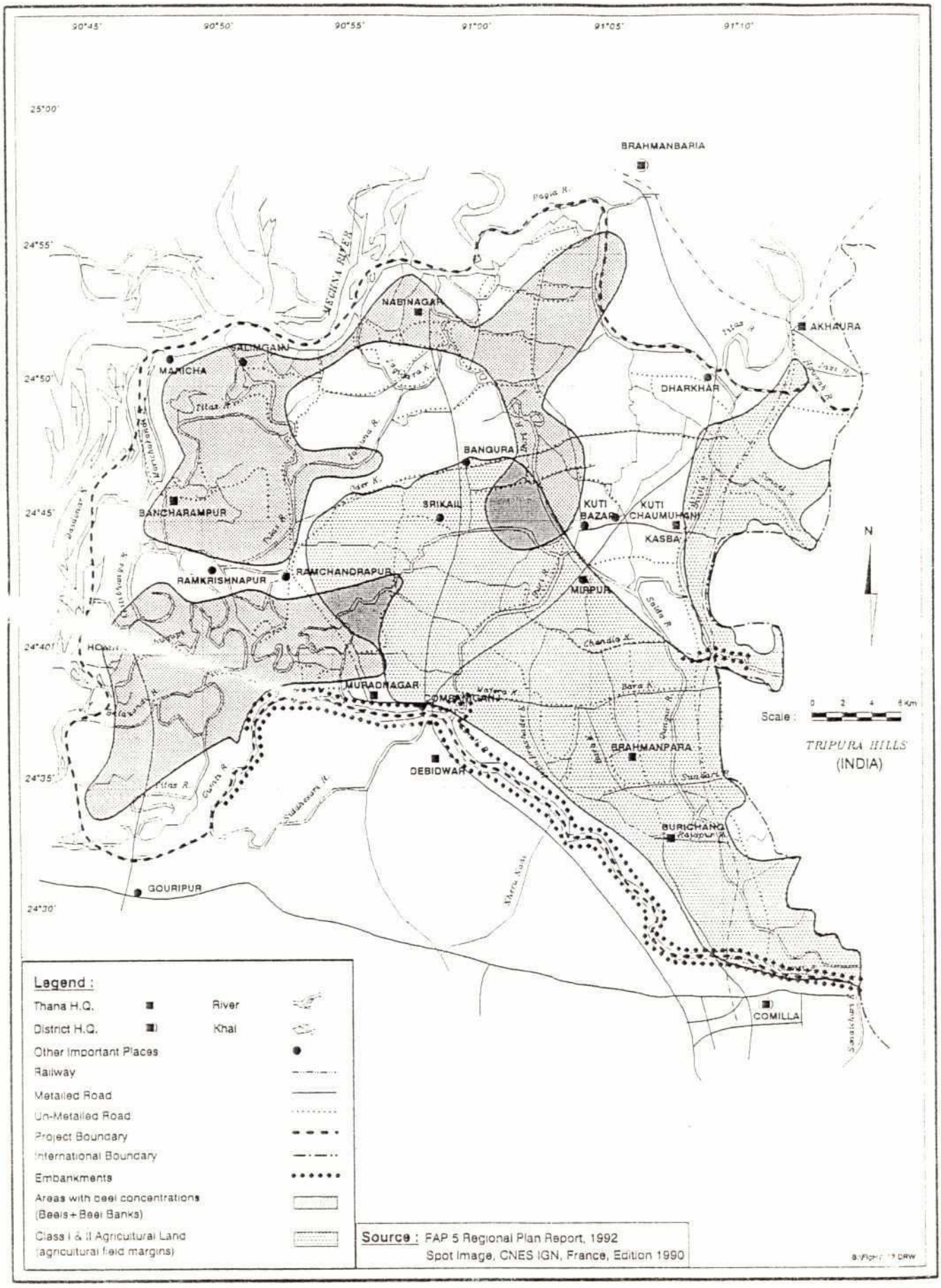
Inundated Charlands: These are unstable banks deposited in the river channels and mainly consist of loosely-packed sand grains. The gradual infiltration of smaller sized particles of silt and clay, followed and often assisted by the establishment of a cover of pioneer plant species results in a gradual stabilisation of the Char which may eventually allow human colonisation and the development of agriculture. Inundated Chars are those where the water table is close to or even slightly above the surface of the soil.

Beels: Beels are natural depressions which hold water for long periods of time. In the Gumti Phase II study area, the main areas of Beel concentration are situated in the west, north-west and north-central parts, although there are numerous Beels of various sizes scattered throughout the basin (Figure D.1.5).

Ponds: Artificial water bodies used mainly for the cultivation of fish although they are also used for a wide variety of purposes such as irrigation, bathing, washing and others.

Figure D.1.5

Ecology Habitat Zones (Flora and Fauna)



D.2 Methodology and Data Collection

D.2.1 Secondary Data Collection

At present there is little information available regarding the effects of FDC/I interventions on the ecology of flora, fauna and people of the affected areas. By and large, it would appear that the ecological studies being undertaken in Bangladesh, have focused on detailed specific process relevant to branches of pure and applied Botany and Zoology. Regarding the study area in particular, there is no available information on either the flora or the fauna, especially of aquatic waterbodies. Marsh plants have been mentioned in the District Gazetteers although there are no remarks on the distributional patterns of these plants. Therefore, from the ecological point of view, the aquatic water bodies such as Beels, Khals, ditches, floodplain, rivers, marshes and ponds located in the project area are totally unexplored.

Relevant reference material used in this study included the works of Khan *et al.* (1974), Husain and Sarker (1979 and 1980), Islam (1970), and Sarker and Sarker (1983, 1984, 1986). In addition, a number of reference books were also consulted (Rashid, 1991; Sarker and Sarker, 1988; Harvey, 1990; Khan, 1982) during the study with a view to collecting information on terrestrial life forms (plants and animals). Information was also gathered from the District Gazetteer of Comilla (Khan, 1977), several publications by the Bangladesh National Herbarium and a report on Bangladesh by the Asian Wetland Bureau (Akonda, 1990), a background paper prepared for the National Conservation Strategy - Bangladesh (Khan, 1990) and from a number of Flood Action Plan (FAP) reports such as FAP 2 Final Report, FAP 5 Regional Plan Report (Annex IV Environment), FAP 3 Preliminary Supporting Report V Ecological Assessment, FAP 3.1 Final Feasibility Report and FAP 16 Report on an Environmental Impact Assessment Case Study.

The most useful information, especially regarding historical records, was provided by the District Gazetteer which contains details of terrestrial and aquatic plants and animals of the Greater Comilla District. However, this information was obviously insufficient for the ecological appreciation of the target areas. Therefore, a short field programme to cover both the wet and dry seasons was devised in order to gather information on the present and past distribution, abundance and species diversity of the terrestrial and aquatic ecosystems in the project area. Valuable information was also gathered from indigenous sources.

D.2.2 Field Data Collection

After a reconnaissance trip to the project area (October 6, 1992), eight sampling locations (henceforth named as stations) were selected (Figure D.2.1 and Table D.2.1). The study stations are located throughout the project area covering all four planning Zones, which are shown in Figure D.2.2. Two field trips, covering the wet and dry seasons, each of one week duration were conducted in the area for collecting the samples, field data and other relevant information. The first field visit took place from the 18 to 24 October 1992 and the second one from the 2 to 8 December, 1992. In general, the same sites were sampled for terrestrial and aquatic ecology.

Figure D.2.1

Site Location for Terrestrial and Aquatic Ecology Field Data Collection

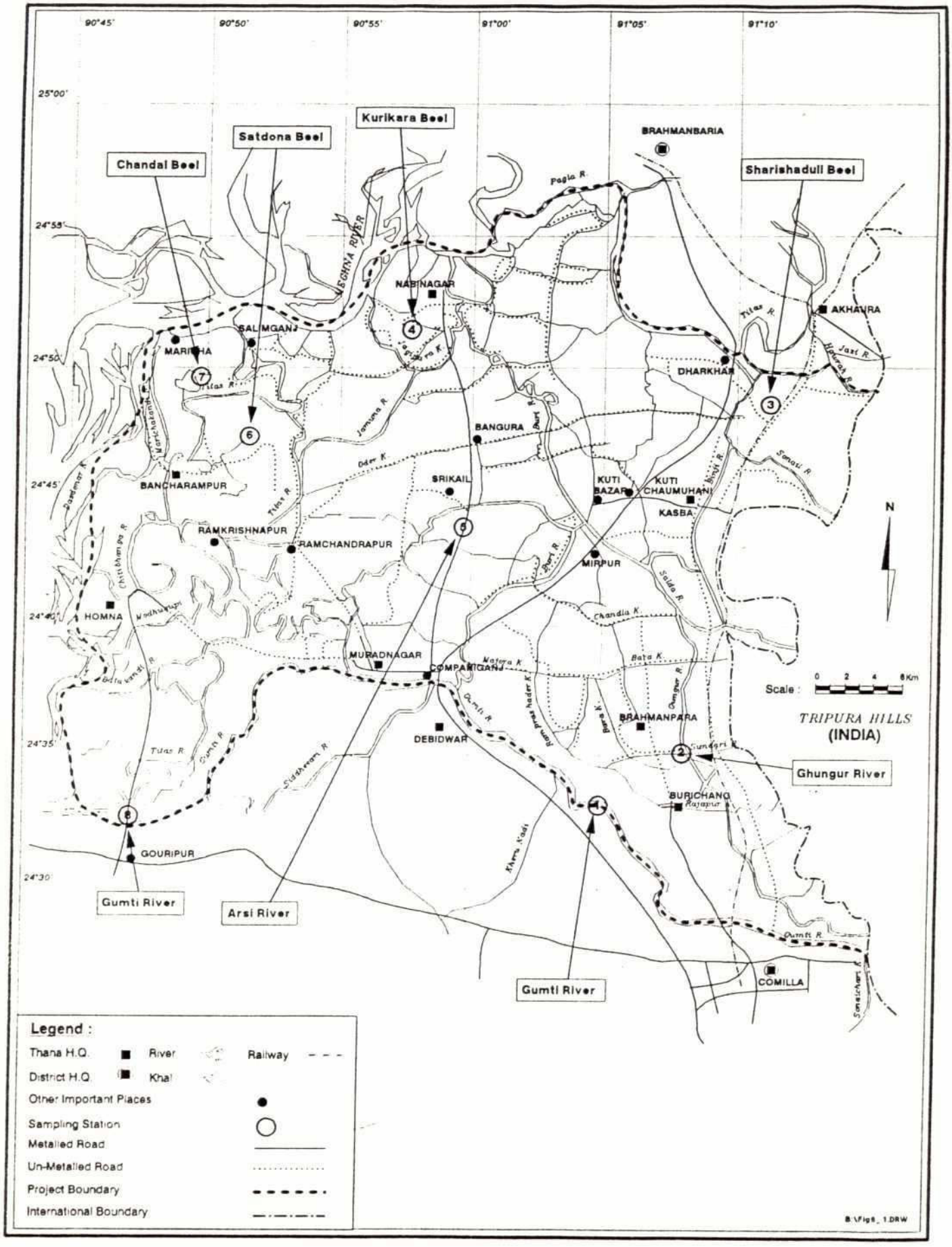
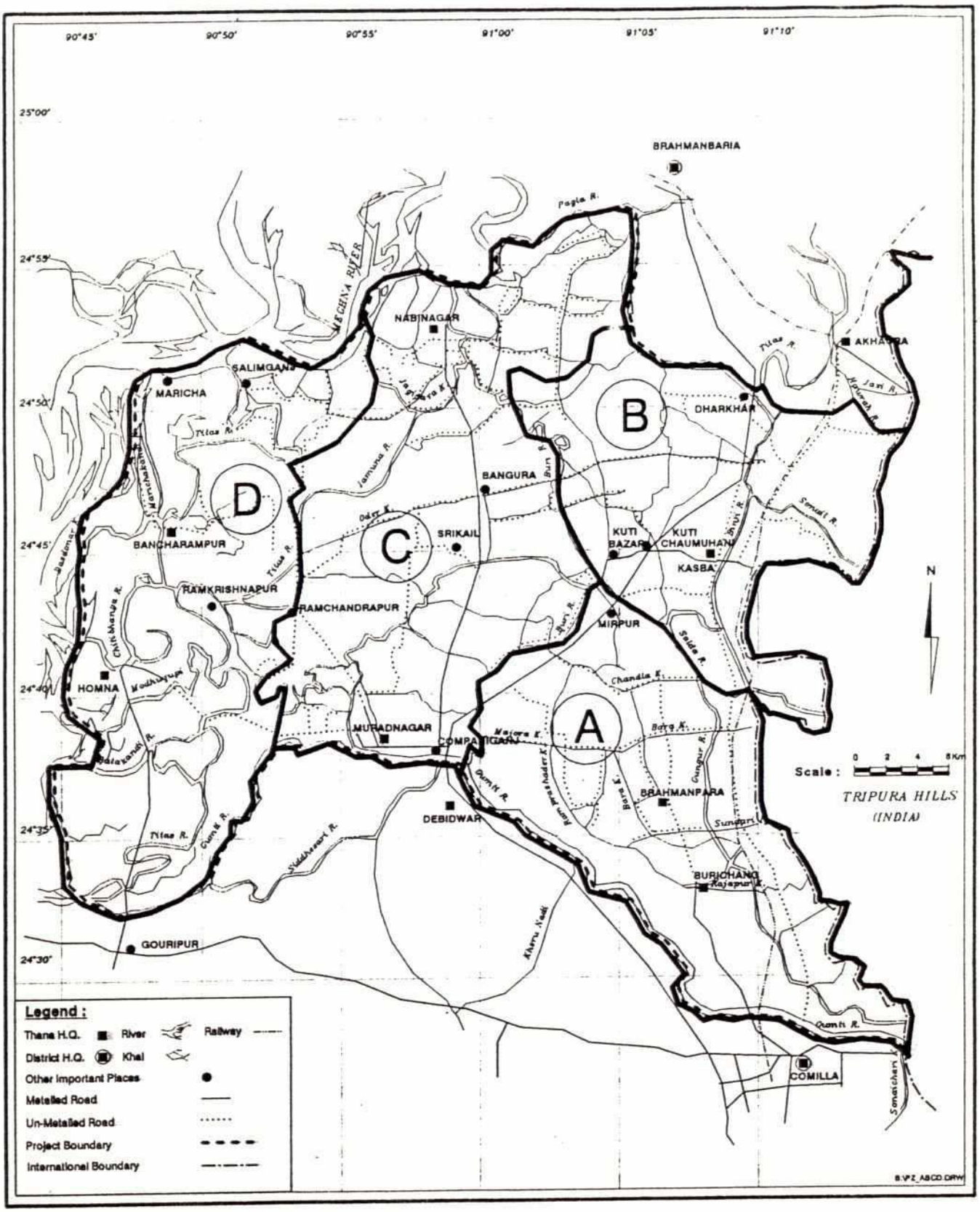


Figure D.2.2

Planning Zones (A, B, C & D)



D.2.2.1 Terrestrial Ecology

Transect Surveys

Terrestrial ecological data were generally collected during transect walks within the survey sites. At each type of habitat encountered in the transect, field notes and plant species collection were made, to record the presence and abundance of each plant and vertebrate species. It should be pointed out that, with a few exceptions, the invertebrate fauna was not recorded since it required additional expertise not available to the study. In addition to direct observations, it was considered important to tap the existing knowledge available through the local people who were asked about the occurrence of species other than those recorded on the day of the field visit as well as those species which appeared to be in decline. It was thus possible in this way to assemble a more complete picture of the fauna of the study area. These records generally related to mobile species such as birds, mammals and reptiles.

Local people were also asked to describe the uses that they made of the species, particularly regarding medicinal plants found within the study area.

A similar methodology to that used in the North West Regional Study for assessing species abundance was followed, this was simple, institutive and subjective. Those plants and animals which appeared to be dominant or extremely common were recorded as 'widespread'. Less dominant or widespread species were then allocated to one of five groups: common, occasional, uncertain, rare and at risk.

Unfamiliar species recorded in the field were identified after consulting the literature (Ali *et al.*, 1983; Khan, 1985b; Khan, 1987) for fauna, whereas any unidentified plants were sampled and preserved for subsequent identification at the National Herbarium in Dhaka.

Surveys for Data Collection

Within the Gumti Phase II study area there are a number of terrestrial habitats which cover a remarkable portion of the system, especially in the dry season. The stations selected for terrestrial samples are briefly described in Table D.2.1.

TABLE D.2.1

Site Locations of Terrestrial Ecology Field Data Collection Corresponding to the Planning Zones

No of Site	Location	Village	Union	Thana	District	Position within the Planning Zones
1.	Gumti River	Monaharpur	Malapara	Brahmanpara	Comilla	South East part of A zone
2.	Ghungur River	Anantapur	Shashidal	Brahmanpara	Comilla	Eastern part of A zone
3.	Sharishaduli Beel	Gopinathpur	Gopinathpur	Kasba	Brahmanbaria	Eastern part of B zone
4.	Kunikara Beel	Kunikara	Nabinagar	Nabinagar	Brahmanbaria	North west part of C zone
5.	Arsi River	Metangar	2 No Akubpur	Muradnagar	Comilla	Nearly middle of C zone
6.	Satdona Beel	Hossainpur	Salimabad	Bancharampur	Brahmanbaria	Eastern part of D zone
7.	Chandal Beel	Mulluk gram	Dariadaulat	Bancharampur	Brahmanbaria	Northen part of D zone
8.	Gumti River	Giarkandi	Giarkandi	Daudkandi	Comilla	Extreme South of D zone

A short description of the stations in reference to the studied habitats is given below:

Station 1 : Surroundings of Gumti River including Manaharpur under Brahmanpara Thana. This study area covers the transect at least 1 km in length beginning from the southern bank (embankment) of the Gumti River up to the northern embankment covering agricultural fields and margins, homesteads, pond banks and monospecific woodland.

Station 2 : Surrounding the River Ghungur including Anantapur under Brahmanpara Thana. This study area covers the transect at least 800 m covering road sides, river sides, homesteads, refugee woodland and pond banks.

Station 3 : Gopinathpur under Kasba Thana. This study area is higher (semi hilly area) than any other area within the project limit. The study transect covered approximately 500 m around the Sarishaduli Beel including homesteads, Beel banks and road sides.

Station 4 : Kunikara under Nabinagar Thana. The transect covered approximately 800 m including homesteads, Beel banks, refugee woodlands and agricultural fields.

Station 5 : Metangar under Muradnagar Thana. This site covered a complete village at least 1 km transacts. Studied habitats included the river side, road side, homesteads, refugee woodland, pond banks and monospecific woodland (Bamboo).

Station 6 : Hossainpur under Bancharampur Thana. This site covered at least an 800 m transect, covering homestead and Satdona Beel bank. This site was similar to station 4.

Station 7 : Mullukgram under Bancharampur Thana, this station covered nearly 800 m transect including the whole of Mullukgram Village and its surroundings and Chandal Beel bank. This station was also similar to station 4, Kunikara and station 6, Hossainpur.

Station 8 : Giarkandi under Daudkandi Thana. This station included at least an 800 m transect through the northern bank of the downstream Gumti River. The habitat study include river bank, homestead and refuge woodland.

Studied habitats:

The following habitats have been studied during the transects in the field study stations: river, Beel and pond banks, embankments, homestead areas, agricultural fields and margins, refuge woodlands, monospecific woodlands and road sides.

D.2.2.2 Aquatic Ecology

Field Data Collection

The area of aquatic habitats under Gumti Phase II is 118,704 ha with water bodies having a variable water retention pattern (highly persistent, persistent or periodic in nature). The principal water bodies can be categorised as: rivers and Khals, inundated Charlands, Beels, ponds, roadside ditches, marshes and irrigated rice fields.

In the present survey, emphasis was given to the collection of biological material from the above mentioned habitats, their subsequent analyses in the laboratory, and preparation of a species list with notes on species' abundance and their role in their respective ecosystem. Samples from the following communities were collected: pelagic (free swimming) plankton, tychoplankton (loosely attached forms), periphyton (forms firmly attached to submerged objects), free floating algal mats, bottom fauna, and aquatic macrophytes. Figure D.2.3 shows the distribution of organisms in different ecological zones in a typical water body.

As for terrestrial ecology, eight sampling locations were selected and these were the same of adjacent to the sites chosen for the terrestrial ecology samples. A brief description of the individual sites is furnished below:

Site 1 Includes aquatic habitats present in the pelagic and littoral zones of the River Gumti and the habitat present along a north west transect of 1 km in length towards the village of Monoharpur. Some low lying ditches which receive flood water were sampled for macrophytes. Reference sampling was carried out in the River Gumti (Plates D.2.1 and D.2.2).

Site 2 Samples were taken at Burichang from ditches and ponds. Other samples were also taken from habitats such as ponds, a small river (Ghungur, Plate D.2.3), Shashidal Beel and road side ditches within a 2 km east-west from Brahmanpara.

Site 3 A survey was done along a 150 m transect in Sharishaduli Beel (Plate D.2.4). Another similar transect extending in a west to east direction in Tamura Beel was also studied.

Site 4 The area across the river and the floodplain from Gokarnaghat (Brahmanbaria) to Nabinagar (Plates D.2.5 and D.2.6) was observed and sampled. Transects of about 500 m in each of the Beels namely Konikara, Bidyagarh, and Batghar were carried out.

Site 5 A small river and pond (Plates D.2.7 and D.2.8) present along a 2 km transect from Metangar bus stand to Metangar Bazaar were investigated. Another large pond in the village Tholla in Muradnagar was sampled for phytoplankton and zooplankton composition.

Site 6 A transect of around 600 m within Satdona Beel was studied and sampled. Macrophytes and plankton from the River Titas near Homna were also collected.

Site 7 Includes a 600 m transect in Chandal Beel and the floodplain near Mullukgram (Plate D.2.9, wet season and D.2.10, dry season).

Site 8 Includes aquatic habitats present along a 600 m west-east transect in the Gumti River floodplain near Gouripur. Aquatic macrophytes present in the road side ditches (between Gouripur and Homna) were listed and collected. Representative plankton samples directly from the River Gumti were also taken.

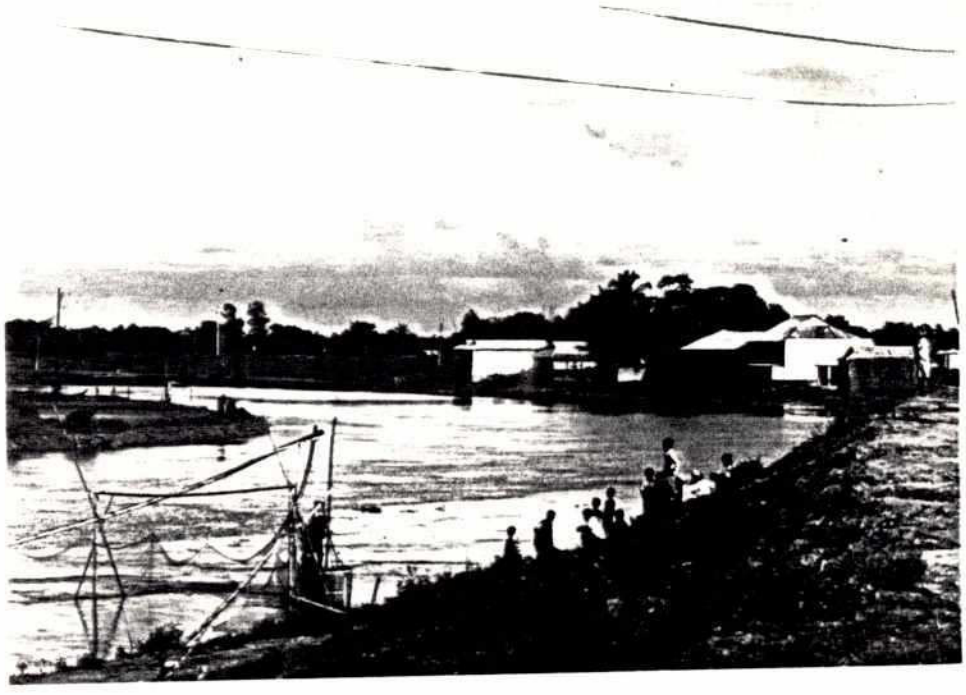


Plate D.2.1

River Gumti (near Manaharpur, Comilla) Flooding Season

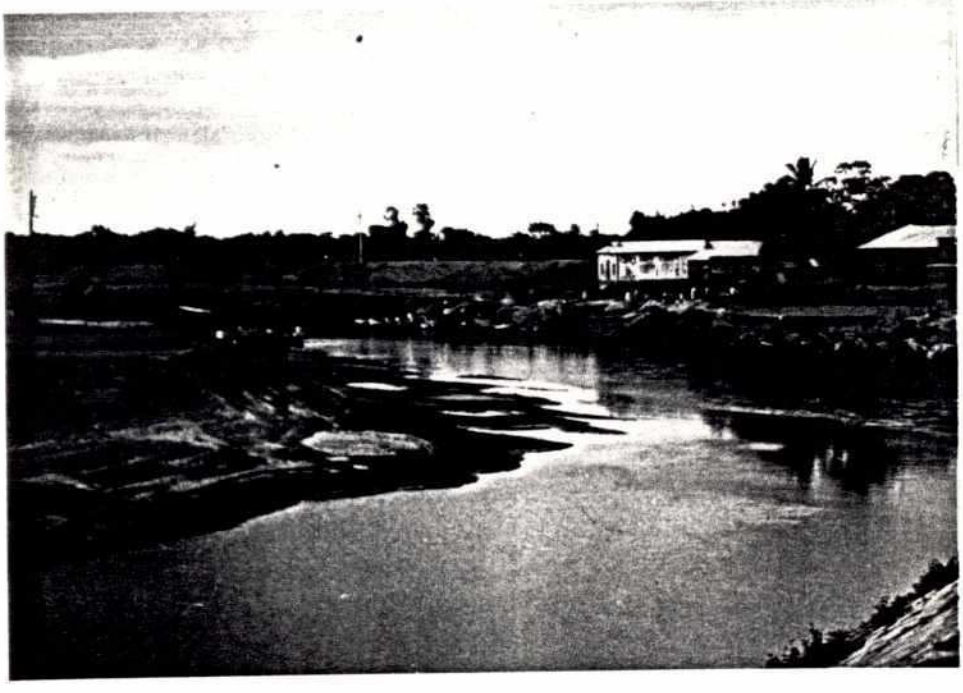


Plate D.2.2

River Gumti (near Manaharpur, Comilla) Dry Season

Plate D.2.3
Sampling Habitat - Small Rivers

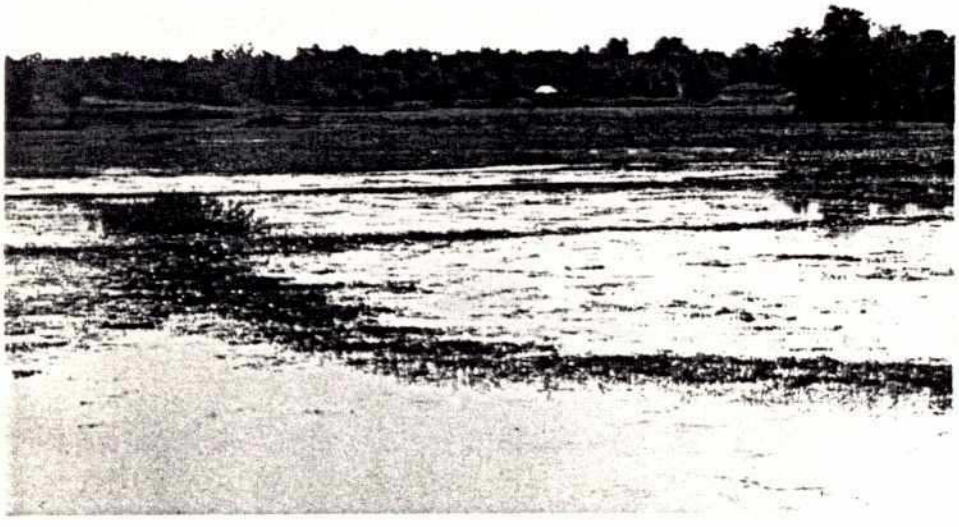


Plate D.2.4
Beel Ecosystem - Sharishaduli Beel

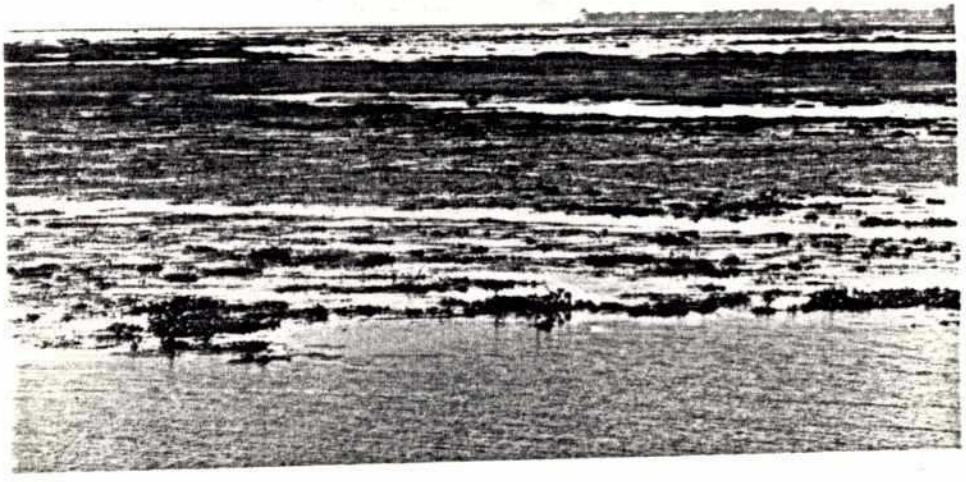


Plate D.2.5

Floodplain - River Titas near Nabinagar - Monsoon Season

Plate D.2.6

Floodplain - River Titas near Nabinagar - Post-Monsoon Season

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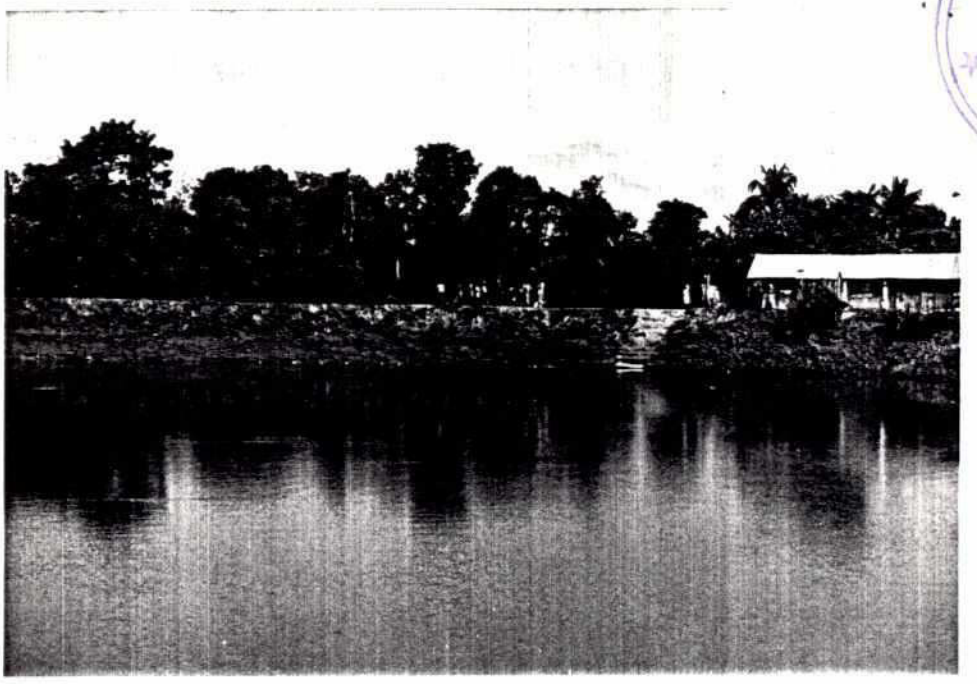


Plate D.2.7
Pond Ecosystem - Pond Without Algal Bloom

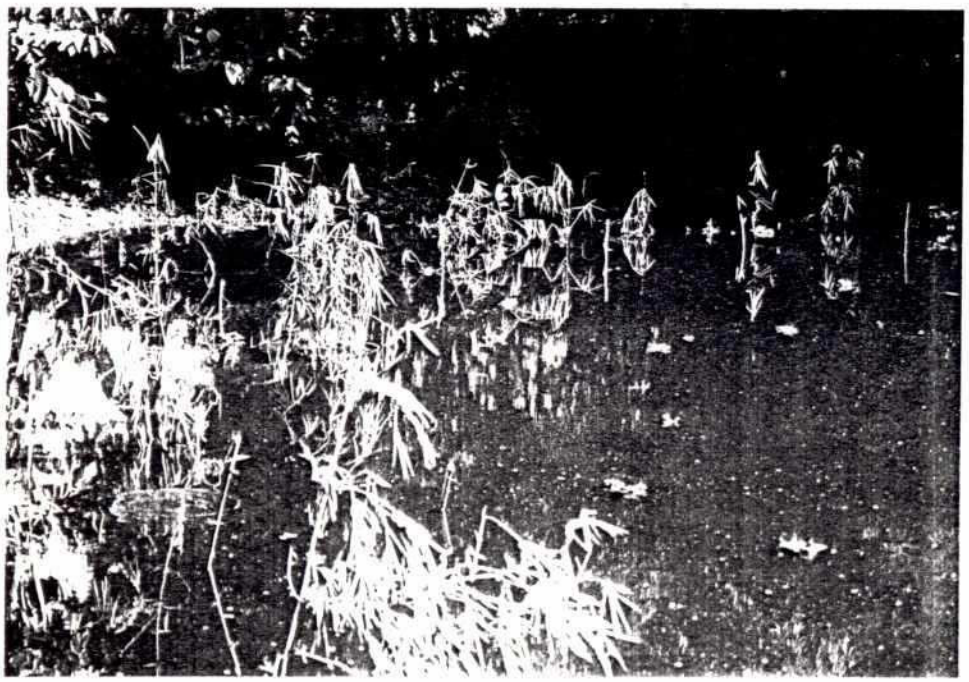


Plate D.2.8
Pond Ecosystem - Pond With Algal Bloom

Plate D.2.9
Floodplain near Chandal Beel - Monsoon Season

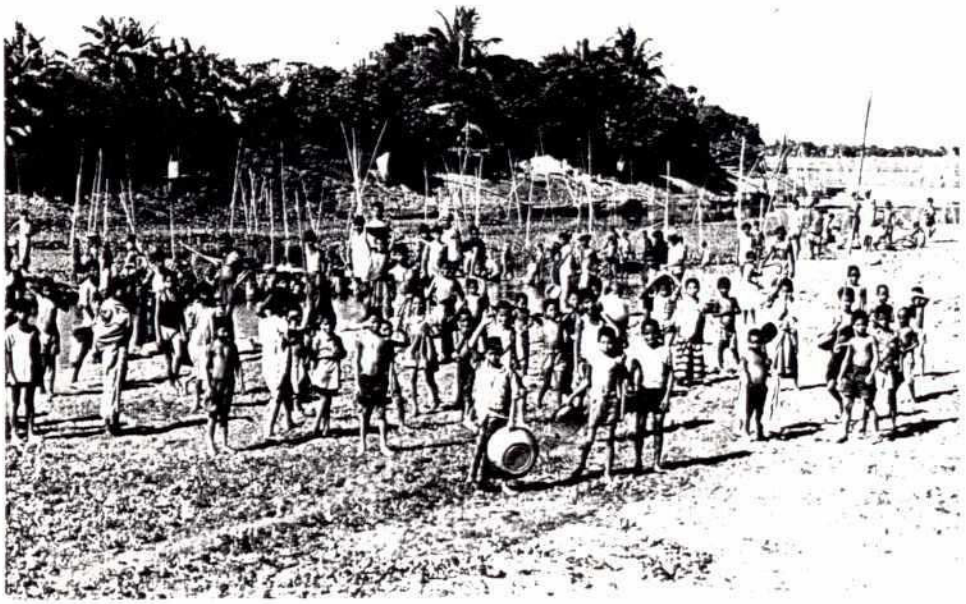
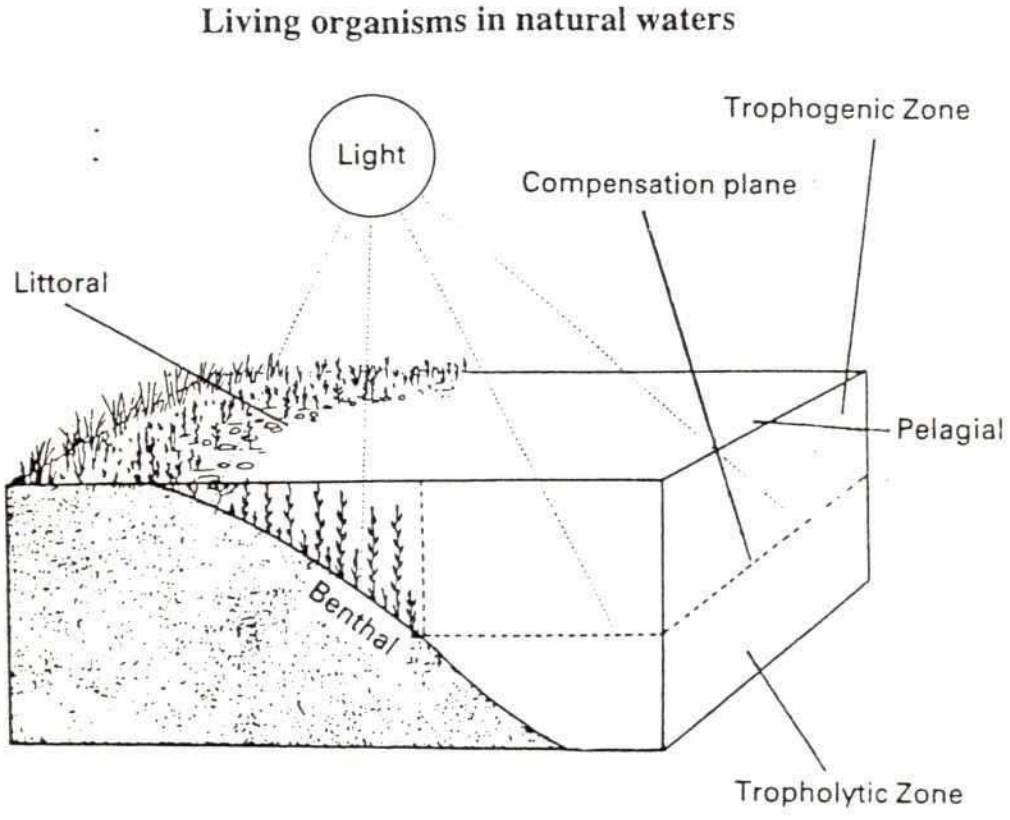


Plate D.2.10
Floodplain near Chandal Beel - Dry Season

Figure D.2.3
Schematic Distribution of Living Organisms in Natural Water



Methodology

1. For the analysis of pelagic microplankton, a water sedimentation technique described by Wetzel and Likens (1979) was applied. A one litre water sample was collected with the help of a Ruttner Sampler or a one litre capacity mug which was emptied in a glass bottle containing 4 ml of Lugol's solution. The bottle was kept at rest for 48 hours and finally the concentrate of the sedimented plankton was transferred to a glass vial after taking out the overlying water from the glass bottle. Slides were then prepared for the compound microscopic observation noting the size, shape, morphological range and dimension of each individual at a magnification of 400x with the help of a Nikon compound microscope (Model SE).

2. Zooplankton samples were taken by sieving 20 litres of sample water through a plankton net with a mesh aperture of 55 μm. The concentrate was finally preserved in 7% formaldehyde with a few drops of glycerine. Compound and light microscopy were used to identify the organisms.

3. Benthic fauna - soft mud samples from the bottom were collected and sieved through a series of polyvinyl sieve trays with different mesh widths. The organisms were then preserved in 7% formaldehyde to which a few drops of glycerine were added. Samples were kept for systematic analyses.

4. Aquatic plants belonging to different habitats and niches were collected and placed on a piece of newsprint covered by blotting paper. All plants were kept under constant pressure in a plant press in order to extract the water. The blotting paper and newsprint were changed every 24 hours until the plants were considered free from bacterial attack. The plant specimens were finally pasted on a standard herbarium sheet.

5. The shells of large gastropods found floating in the macrophytic vegetation in the field and the shells caught during fishing by fishermen were collected and preserved. The occurrence of aquatic reptiles and mammals was investigated by interviewing fishermen at work and local people. This section of the work was carried out jointly by the Terrestrial and Aquatic Ecologists.

The abundance of microscopic organisms was estimated by simply assessing their number within the field of view of the microscope and results were organised according to the following scale: abundant/bloom, common and occasional. In the two field trips, 32 samples of aquatic macrophytes and 107 samples of plankton and benthos were collected. The organisms were identified with the help of following literature:

Ali and Chakraborty (1992), Biswas and Calder (1954), Desikachary (1959), Germain (1981), Gojdics (1953), Huber-Pestalozzi (1955), Huq (1986), Islam (1970, 1974 and 1977), Islam and Begum (1970), Islam and Chowdhury (1979), Islam and Haroon (1975 and 1980), Islam and Khair (1978), Islam and Khatun (1966), Islam *et al.* (1991), Islam and Mendes (1976), Islam and Moniruzzaman (1981), Islam and Nahar (1967), Islam and Zaman (1975), Khan and Halim (1987), Mellanby (1986), Pringsheim (1956), Smith (1950) and Subrahmanyam (1974).

D.3 Study Findings

D.3.1 Terrestrial Fauna

Overall around 90 species of vertebrates were discovered during the study period. Of these, a total of 16 species of mammals, 50 species of birds, 16 species of reptiles and 5 species of amphibians were recorded. Table D.3.1 shows the distribution of the main groups of animals according to the sampling stations. It is interesting to note that with the exception of stations 3 and 5 which had 77 and 69 species respectively, all other species had a fairly similar number of species.

The list of faunal species is given in Table D.3.2 together with their English, Bengali and scientific names, and taxonomic position. Table D.3.2 also includes details of habitats, past and present occurrence, status and known feeding habits. Sampling stations represent locations where the species were recorded.

TABLE D.3.1

Distribution of the Main Faunal Groups by Sampling Stations

Faunal Group		Sampling Station							
		1	2	3	4	5	6	7	8
Mammals	16	8	11	15	8	12	8	6	10
Birds	50	37	36	41	39	38	40	37	40
Reptiles	16	12	13	16	11	15	10	8	14
Amphibians	5	5	4	5	3	4	5	5	3
Total	87	62	64	77	61	69	63	56	67

Mammals

Overall, mammals diversity was not very high with only 16 species recorded. Of these, the largest number was found in sampling stations 3 and 5 i.e. Gopinathpur of Kasba and Metangar of Muradnagar, north east and central part of the project area. The lowest number of mammals was found in station 7 i.e. Mullukgram of Bancharampur. The Laye Indian civet and the Fishing cat were only recorded in Gopinathpur. These two species are nationally Endangered and very few are observed today. Mammals are an important component of the ecosystem and some of them such as the predators, occupy the top position in the food chain. They prey on a range of smaller animals which feed on crops in the field and in storage.

A species of note was the Gangetic dolphin or Sisu (*Platanista gangetica*) listed as an internationally threatened species (IUCN, 1990) which was commonly found in the project area. Sisu are especially abundant in rivers during the rainy season and may also move on to the floodplains. During the dry season they stay in the deeper parts of the rivers such as the Titas. They feed mainly on fish. Their presence in the ecosystem is an indication of deeper areas in a river, higher abundance of larger fish species (Boromaach) and fish migratory routes within the river channels. Further work should be carried out to establish the status of this species and to possibly identify other cetaceans in the area.

TABLE D.3.2

Species List (Fauna) with Relevant Information are Given Below in Reference with Ecological Survey Sites Gumti Phase II Study Area

Habitat code : R = River and bank; P = Pond and bank; B = Beel and Bank; E = Embankment; H = Homestead; A = Agricultural fild and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.

Status code: R = Resident; M = Migratory.

Occurance code: 1 = Widespread; 2 = Common; 3 = Occasional; 4 = Uncertain; 5 = Rare; 6 = Atrisk.

Food code : O = Omnivorous; C = Carnivorous; S = Scavenger; P = Pescivorous; M = Mollusc eater; I = Insectivorous; TV = Terrestrial vegetation; G = Graminivorous; F = Fructivorous; AV = Aquatic vegetation.

Taxonomy code : P = Phyllum; C = Class; O = Order; F = Family.

Taxonomy	Scientific Name		English Name	Bengali Name	Habitat	Occurence		Status	Foods	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	7	8
P: Chordata																	
C: Mammalia																	
O: Chiroptera																	
F: Pteropidae	*Pteropus*	*giganteus*	Flying Fox	Boro Badur	E,H,W,RS	2	2	R	F	+	+	+	+	+	+	+	+
F: Megadermatidae	*Megaderma*	*lyra* *	Bat	Badur	E,H,W,RS	2	2	R	F	+	+	+		+	+		+
O: Carnivora																	
F: Canidae	*Vulpes*	*bengalensis* ***	Bengal Fox	Khek Shial	E,W,RS	2	5	R	C		+	+		+			
	Canis	*aureus* *	Jackal	Shial	E,W,RS	2	3	R	C	+	+	+	+	+			+
F: Mustelidae	*Lutra*	*sp.* *	Otter	Udbiral	R,P,B	2	3	R	P		+	+	+	+	+	+	+
F: Viverridae	*Viverra*	*zibetha* *	Laye Indian civet	Bagdash	B,W	2	5	R	C			+					
	Viverricula	*indica*	Civet	Kattas	E,A,W,WM,RS	2	3	R	C		+	+		+			
F: Herpestidae	*Herpestes*	*auropunctatus*	Small Mangoose	Beji	E,A,W,RS	2	2	R	C	+	+	+	+	+	+	+	+
F: Felidae	*Felis*	*viverrina* *	Fishing cat	Meche Bag	R,B,W	2	6	R	P			+					
O: Artiodactyla																	
F: Leporidae	*Lepus*	*nigricollis ruficaudatus* *	Rufous tailed hare	Khorgosh	A,W,WM,RS	2	6	R	TV		+	+					
O: Rodentia																	
F: Sciuridae	*Callosciurus*	*pygerythrus*	Squirrel	Kathbiraly	E,H,W,WM, RS	3	3	R	F			+		+	+		+
F: Muridae	*Bandicota*	*bengalensis (Pest)*	Rat	Indur	E,H,A,RS	2	2	R	G	+	+	+	+	+	+	+	+
	Bandicota	*indica (Pest)*	Bandicoot rat	Methoindur	E,H,A,W,RS	2	2	R	G	+	+	+	+	+	+	+	+
	Mus	*musculus (Pest)*	House Mouse	Nengti Indur	H	1	1	R	G	+	+	+	+	+	+	+	+
F: Hystricidae	*Hystrix*	*indica*	Indian crested porcupine	Sajaru/Hejakanta	A,W	2	3	R	TV,F			+		+			
O: Cetacea																	
F: Platanistidae	*Platanista*	*gangetica* ***	Gangetic Dolphin	Seshu	R (Only water)	2	2	R	P,AV	+			+				+

TABLE D.3.2 (Contd.)

Habitat code : R = River and bank; P = Pond and bank; B = Beel and Bank; E = Embankment; H = Homestead; A = Agricultural fild and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.

Status code: R = Resident; M = Migratory.

Occurance code: 1 = Widespread; 2 = Common; 3 = Occasional; 4 = Uncertain; 5 = Rare; 6 = Atrisk.

Food code : O = Omnivorous; C = Carnivorous; S = Scavenger; P = Piscivorous; M = Mollusc eater; I = Insectivorous; TV = Terrestrial vegetation; G = Grainvorous; F = Fructivorous; AV = Aquatic vegetation.

Taxonomy code : P = Phylum; C = Class; O = Order; F = Family.

Taxonomy	Scientific Name		English Name	Bengali Name	Habitat	Occurence		Status	Foods	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	7	8
C: Aves																	
O: Pelecaniformes																	
F: Phalacrocorocidae	*Phalacrocorax*	*niger*	Little cormorant	Pancowri (Aquatic)	R,P,B	1	2	R	P,M,I	+	+	+	+	+	+	+	+
	Anhinga	*rufa* *	Darter	Gour (Aquatic)	R,B	2	5	R	P				+		+	+	
O: Ciconiformes																	
F: Ardeidae	*Babulcus*	*ibis*	Cattle Egret	Go Bok	R,P,B,A,WM	2	3	R	I	+	+	+	+	+	+	+	+
	Ardeola	*grayii*	Pond Heron	Kani Bok (Aquatic)	R,P,B,H,WM	2	2	R	P,M,I	+	+	+	+	+	+	+	+
	Ardeola	*alba* *	Great Egret		R,P,B	2	3	R	P,M,I			+	+		+	+	+
	Egretta	*garzetta* *	Little Egret	Choto Bok (Aquatic)	R,P,B,A,WM	2	2	R		+	+	+	+	+	+	+	+
F: Ciconiidae	*Anastomus*	*oscitans* *	Openbill Stork	Shamuk Khor (Aquatic)	R,B	2	6	R	P,M			+	+		+	+	
O: Anseriformes																	
F: Anatidae	*Nettapus*	*coromandelianus*	Cotton Teal	Balihans (Aquatic)	R,B,P	1	2	R	P,M,AV			+	+	+	+	+	
	Tadorna	*ferruginea* *	Seldack	Chokha Chokhe (Aquatic)	R,B	2	3	R	AV				+		+	+	
	Dendrocygna	*javanica*	Lesser w histling teal	Sorali (Aquatic)	R,B	2	4	R	P,M,AV			+	+		+	+	
O: Falconiformes																	
F: Accipitridae	*Haliastur*	*indus*	Brahminy Kite (Predator)	Shankho Chil (Aquatic)	R,P,B	2	2	R	P	+	+	+	+	+	+	+	+
	Accipiter	*badius*	Shikra (Predator)	Turki Baj	H,W,WM,RS	2	4	R	C	+	+	+	+	+	+		+
	Gyps	*bengalensis* *	Vulture (Predator)	Sowkoon	E,W,RS	2	5	R	S	+	+	+		+	+		+
	Ichthyophaga	*ichthyaetus* *	Grey Headed Fishing Eagle (Predator)	Kura (Aquatic)	R,P,B	2	6	R	P	+	+	+	+	+	+	+	+
O: Gruiformes																	
F: Rallidae	*Amaurornis*	*phoenicurus* *	White Breasted Water Hen	Dahuk (Aquatic)	R,P,B	2	2	R	P,M,I	+	+	+	+	+	+	+	+
	Porphyrio	*porphyrio* *	Purple moorhen (Pest)	Kalim (Aquatic)	R,B,A	2	5	R	M,G,AV				+		+	+	
O: Charadriiformes																	
F: Jacanidae	*Metopidius*	*indicus*	Bronze w inged Jacana	Dalpipi (Aquatic)	R,P,B	2	3	R	I,AV	+	+	+	+		+	+	
F: Charadridae	*Vanellus*	*indus*	Red-w attled lapw ing	Hottiti (Aquatic)	R,P,B,E	2	2	R	I,G	+	+	+	+	+	+	+	
	Tringa	*hypoleucos*	Common sandpiper	Chapakhi (Aquatic)	R,B	2	3	M	I				+		+	+	
	Gallinago	*hemura*	Pintail Snipe	Kadakhocha (Aquatic)	R,P,B	2	3	R	P,I			+	+			+	+
	Charadrius	*dubius*	Little ringed plover	Little jitta (Aquatic)	R,B	2	2	M	I				+		+	+	

TABLE D.3.2 (Contd.)

Habitat code : R = River and bank; P = Pond and bank; B = Beel and Bank; E = Embankment; H = Homestead; A = Agricultural fild and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.

Status code: R = Resident; M = Migratory.

Occurance code: 1 = Widespread; 2 = Common; 3 = Occasional; 4 = Uncertain; 5 = Rare; 6 = Atrisk.

Food code : O = Omnivorous; C = Cannivorous; S = Scavenger; P = Pescivorous; M = Mollusc eater; I = Insectivorous; TV = Terrestrial vegetation; G = Graminivorous; F = Fructivorous; AV = Aquatic vegetation.

Taxonomy code : P = Phyllum; C = Class; O = Order; F = Family.

Taxonomy	Scientific Name		English Name	Bengali Name	Habitat	Occurence		Status	Foods	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	*	8
O: Columbiformes																	
F: Columbidae	*Treron*	*phoenicoptera* *	Yellow footed pigeon	Botkel	E,W,RS	2	3	R	G			+					+
	Columba	*livia*	Blue Rock Pigeon	Jalali Kabutor	E,H,RS	2	3	R	G	+	+	+		+	+	+	+
	Streptopelia	*decaocta* *	Ring Dove	Dhobal Ghughu	E,H,W,WM,RS	2	2	R	G	+	+	+	+	+	+	+	+
	Streptopelia	*chinensis* *	Spotted Dove	Tila Ghugu	E,H,W,WM,RS	2	2	R	G	+	+	+	+	+	+	+	+
O: Psittaciformes																	
F: Psittacidae	*Psittacula*	*krameri*	Parakeet (Pest)	Teya	A,W,WM	2	2	R	G,F	+	+	+	+	+	+		+
O: Cuculiformes																	
F: Cuculidae	*Eudynamys*	*scolopacea*	Koel	Kokil	H,W	2	4	R	I	+	+	+	+	+	+	+	+
	Centropus	*sinensis*	Crow – Pheasant	Kanakuka	R,P,B,E,H,W	2	2	R	I,F	+	+	+					+
O: Strigiformes																	
F: Strigidae	*Bubo*	*zeylonensis* *	Brown Fish Owl (Predator)	Mecho Pancha	R,P,B,E,W,WM,RS	2	3	R	C,P	+		+	+	+	+		+
	Bubo	*bubo* *	Great Horned Owl (Predator)	Hutum Pencha	R,P,B,H,W,RS	2	6	R	C	+	+	+		+			+
O: Coraciiformes																	
F: Alcedinidae	*Alcedo*	*atthis*	Common King Fisher	Choto Machranga (Aquatic)	R,P,B	2	2	R	P	+	+	+	+	+	+	+	+
	Halcyon	*smyrnensis*	White Breasted King Fisher	Shadabuk Machranga (Aquatic)	R,P,B	2	2	R	P	+	+	+	+	+	+	+	+
F: Meropidae	*Merops*	*orientalis*	Bee eater	Sui – chora	E,A,RS	2	2	R	I	+	+	+		+	+		+
F: Upupidae	*Upupa*	*epops*	Hoopoe	Hudhud	E,A,RS	2	5	R	I	+				+			+

TABLE D.3.2 (Contd.)

Habitat code : *R = River and bank; P = Pond and bank; B = Beel and Bank; E = Embankment; H = Homestead; A = Agricultural fild and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.*

Status code: *R = Resident; M = Migratory.*

Occurance code: *1 = Widespread; 2 = Common; 3 = Occasional; 4 = Uncertain; 5 = Rare; 6 = Attrisk.*

Food code : *O = Omnivorous; C = Carnivorous; S = Scavenger; P = Pescivorous; M = Mollusc eater; I = Insectivorous; TV = Terrestrial vegetation; G = Grainivorous; F = Fructivorous; AV = Aquatic vegetation.*

Taxonomy code : *P = Phyllum; C = Class; O = Order; F = Family.*

Taxonomy	Scientific Name		English Name	Bengali Name	Habitat	Occurence		Status	Foods	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	7	8
O: Piciformes																	
F: Picidae	*Dinopium*	*bengalense*	Wood pecker	Kat – thokra	E,H,W,WM,RS	2	2	R	I	+		+		+			+
F: Capitonidae	*Megalaima*	*haemacephala*	Coppersmith	Choto basanta Bauri	R,P,B,RS	1	2	R	I	+	+			+		+	+
O: Passeriformes																	
F: Nectariniidae	*Nectarinia*	*zeylonica*	Purple rumped Sunbird	Mautushi	E,H,W,WM,RS	2	2	R	I	+	+		+	+			+
F: Oriolidae	*Oriolus*	*xanthornus*	Black Headed Oriole	Kutum Pakhi	H,W,WM,RS	2	3	R	I,F		+	+	+	+	+	+	+
F: Dicruridae	*Dicrurus*	*adsimilis*	Black drongo	Finga	E,H,A,W,WM,RS	2	2	R	I	+	+	+	+	+	+	+	+
F: Sturnidae	*Acridotheres*	*tristis*	Common Myna	Bhat Salik	E,H,W,WM,RS	2	2	R	G	+	+	+	+	+	+	+	+
	Sturnus	*contra*	Pied Myna	Go Salik	E,H,W,WM,RS	2	2	R	I	+	+	+	+	+	+	+	+
F: Corvidae	*Corvus*	*macrorhynchos*	Jungle Crow	Dar Kak	P,E,H,WM,RS	2	3	R	S	+	+	+	+	+	+	+	+
	Corvus	*splendens*	House Crow	Pati Kak	P,E,H,WM,RS	2	2	R	S	+	+	+	+	+	+	+	+
F: Pycnonotidae	*Pycnonotus*	*cafer*	Red Vented Bulbul	Bulbul	E,H,W,WM,RS	2	2	R	I	+	+	+	+	+	+	+	+
F: Muscicapidae	*Orthotomus*	*sutorius*	Tailor Bird	Tuntuni	E,H,W,RS	2	2	R	I	+	+	+	+	+	+	+	+
	Copsychus	*malabaricus* *	Shama	Shama	E,H,W,WM,RS	2	3	R	I,F		+	+		+			+
	Copsychus	*saularis*	Magpie – robin **	Doyal	E,H,W,WM,RS	2	2	R	I	+	+	+	+	+	+	+	+
F: Ploceidae	*Passer*	*domesticus*	House Sparrow	Chorai	H,A,WM,RS	2	2	R	G	+	+	+	+	+	+	+	+
	Ploceus	*philippinus*	Baya	Babui	E,H,A,RS	2	2	R	G	+	+	+	+	+	+	+	+
	Lonchura	*malabarica*	White throated Munia	Munia	E,A,RS	2	2	R	G	+	+			+			+
C: Reptilia																	
O: Chelonia																	
F: Emydidae	*Kachuga*	*tectum (Exp.)*	Common roofed turtle	Kori Katta	R,P,B	2	2	R	AV	+	+	+	+	+	+	+	+
	Hardella	*thurji (Exp.)*		Kali Katta	R,P,B	2	2	R	AV	+	+	+	+	+	+	+	+
O: Squamate																	
F: Gekkonidae	*Hemidactylus*	*brooki*	House Wall Lizard	Tiktiki	H	2	2	R	I	+	+	+	+	+	+	+	+
	Gekko	*gecko*	Gecko	Tokkhok	H	2	6	R	I			+					
F: Agamidae	*Calotes*	*versicolor*	Common Garden Lizard	Roktachosa	E,W,RS	2	3	R	I	+	+	+		+	+	+	+
	Mabuya	*carinata*	Skink	Angila	H	2	2	R	I			+		+			+
F: Varanidae	*Varanus*	*bengalensis* * (Exp.)	Monitor lizard	Gui	R,P,B,E,A	2	2	R	O	+	+	+	+	+	+		+
	Varanus	*flavescens* * (Exp.)	Yellow monitor lizard	Sonagui	R,P,B,E,A	2	3	R	O	+	+	+	+	+	+		+

TABLE D.3.2 (Contd.)

Habitat code : R = River and bank; P = Pond and bank; B = Beel and Bank; E = Embankment; H = Homestead; A = Agricultural fild and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.

Status code: R = Resident; M = Migratory.

Occurance code: 1 = Widespread; 2 = Common; 3 = Occasional; 4 = Uncertain; 5 = Rare; 6 = Attrick.

Food code : O = Omnivorous; C = Carnivorous; S = Scavenger; P = Pescivorous; M = Mollusc eater; I = Insectivorous; TV = Terrestrial vegetation; G = Graminivorous; F = Fructivorous; AV = Aquatic vegetation.

Taxonomy code : P = Phyllum; C = Class; O = Order; F = Family.

Taxonomy	Scientific Name		English Name	Bengali Name	Habitat	Occurence		Status	Foods	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	7	8
Sub Order: Ophidia																	
F: **Typhlopidae**	*Typhlina*	*sp.* *	Common worm snake	Dumukho shap	E,H,A,W,WM,RS	2	3	R	I (worms)		+	+	+	+			+
F: **Natricidae**	*Xenochrophis*	*piscator*	Checkered Keelback Water	Dhora shap	R,K,P	2	2	R	P	+	+	+	+	+	+	+	+
	Atretium	*schistosum*	Olive Keelback Water Snake	Mete shap	R,P,B	2	2	R	P	+	+	+	+	+	+	+	+
F: **Colubridae**	*Ptyas*	*mucosus*	Rat snake	Daraj shap	E,A,W,WM,RS	2	4	R	C	+	+	+	+	+			+
F: **Elaphidae**	*Bungarus*	*caeruleus*	Common Krait	Kalkaute	E,A,W,RS	2	3	R	C	+	+	+	+	+	+	+	+
	Naja	*naja* *	Cobra	Gokhra shap	E,A,W,WM,RS	2	4	R	C	+	+	+	+	+	+	+	+
	Bungarus	*faciatus*	banded krait	Sonkhini	E,W,WM,RS	2	3	R	C	+		+		+			
F: **Viperidae**	*Vipera*	*russellii*	Russells viper	Chandra bora	E,A,W,WM,RS	2	4	R	C		+	+		+			+
C: **Amphibia**																	
O: **Anura**																	
F: **Bufonidae**	*Bufo*	*melanostictus*	Toad	Kuno Bang	H	2	2	R	I	+	+	+	+	+	+	+	+
F: **Ranidae**	*Rana*	*tigrina* *(Exp.)	Bull Frog	Sona Bang	R,P,B,A	2	5	R	I	+	+	+	+	+	+	+	+
	Rana	*cyanophlyctis*	Skipper frog	Kotkoti Bang	R,P,B,A	2	2	R	I	+	+	+	+		+	+	+
	Rana	*limnocharis*	Cricket frog	Jhi - jhi Bang	R,P,B,A	2	2	R	I	+	+	+		+	+	+	
F: **Phacophoridae**	*Rhacophorus*	*sp.*	Tree frog	Gecho Bang	E,W,RS	2	3	R	I	+		+		+	+	+	

* Threatened and Endangered wildlife (mainly from secondary information) of Bangladesh,but actual position in the project area are given in the present occurence column.

** National bird

*** Internationally threatened

Exp. = Exportable

Birds

A total 50 species of birds were identified in the project area, of these 30 were terrestrial and 20 were aquatic or water dependent. Birds were the group with the largest number of species at all sites representing 53% to 66% of the total fauna by station. The majority of the birds were resident species with very few migratory ones. The bird species recorded during the eight-week sampling period represent 15% of the 650 bird species reported for Bangladesh. It is feasible that a larger number of species may be found in the area, particularly if surveys are carried out during the main bird migrating season as the area to the north-west of the study area had been identified previously as a potential good site for migratory birds (FAP 5 Regional Study). Unfortunately, it was not feasible to verify this possibility during this short study.

A large number of insectivorous birds were recorded in the project area especially in those localities located in higher grounds. These birds play an important role in the agro-economy of the region as they act as biological controls of agricultural pests as well as being pollinators for a variety of plants . The use of biological controls was found to be in practice in the project area in station 1 (Manaharpur Agricultural Field) and station 2 (Anantapur Agricultural Field). Predator birds also play an important role by consuming rats and other pests which create a serious threat to the paddy cultivation.

Birds are particularly valuable as environmental indicators as they often occupy key positions in the trophic chain. They are also amongst the more obvious components of the ecosystem and many species are habitat specific and very sensitive to habitat alterations.

Table D.3.3 shows the distribution of aquatic and terrestrial birds by sampling station. Aquatic birds were found around ponds, beels, floodplain and rivers. These habitats provide suitable breeding and feeding grounds and food availability is usually high with fish, molluscs, aquatic plants and seeds, etc. The largest number of aquatic species was found in the areas of Kunikara (station 4), Satdona (station 6) and Chandal Beels (station 7) which are some of the most important wetlands in the study area.

TABLE D.3.3

Distribution of Terrestrial and Aquatic Birds by Sampling Stations

Birds		Sampling Station							
		1	2	3	4	5	6	7	8
Terrestrial	30	27	26	26	19	28	21	17	30
Aquatic	20	10	10	15	20	10	20	20	10
Total	50	37	36	41	39	38	41	37	40

According to the local people, aquatic birds in general are gradually decreasing in numbers year after year due to the loss of their natural habitats, especially the loss of their natural breeding and feeding grounds. Increased human activities such as shooting and trapping, are believed to be the main cause of this noticeable decline. Reports from local people living around Beel areas state that on occasions fishing nets are used for capturing birds during the night.

Reptiles

There were 16 species of reptiles recorded in the project area (Table D.3.2), of these, monitor lizards and skinks were often seen close to water bodies for feeding. Water snakes are very common to the floodplain of the study area. Highly poisonous snakes belonging to the family Elapidae were recorded with the help of local people. Freshwater turtles, monitor lizards and water snakes found in the study area are carnivores feeding on fish and other small animals in the freshwater habitats.

Amphibians

Five species of amphibians were recorded during the field study. Frogs are important to the agricultural production because they help to control various kinds of pests in cultivated land. The Bull frog *Rana tigrina* was previously common and widely distributed throughout the country but its population has sharply declined both at a national as well as a local level.

The decline in frog populations is currently a worldwide problem and relatively little in known regarding the cause of this decline. A Specialist Group was set up to look at this problem recently by the Species Survival Commission of the IUCN - The World Conservation Union.

Habitat

Table D.3.4 presents the distribution of the main animal and plant groups, by habitat. The table shows that mammals and reptiles live predominantly in refuge woodlands or on embankments. The numbers on embankments would of course increase during the monsoon, when other habitats would be under water. The high percentage of plant groups by the roadside and embankments show the importance of this new habitat when road and embankment schemes are implemented.

TABLE D.3.4

Distribution of the Main Animal (A) and Plant (B) Groups by Habitat

A.

Animal Group	River Bank	Pond Bank	Beel Bank	Embankment	Homestead	Agricul. field & margin	Refuge Woodland	Monospecific woodland	Road side
Mammals	03	01	03	09	06	05	12	03	10
Birds	25	20	25	22	22	10	19	20	26
Reptiles	06	06	05	09	04	07	07	05	07
Amphibians	03	03	03	00	01	03	01	00	01
Total	37	30	36	40	33	25	39	28	44

B.

Plant Group	River Bank	Pond Bank	Beel Bank	Embankment	Homestead	Agricul. Field & margin	Refuge woodland	Monospecific woodland	Road Side
Tree	20	26	18	07	33	00	09	00	30
Shrub	08	09	10	10	14	02	07	02	14
Herb	12	14	08	15	10	10	09	01	18
Total	40	49	36	32	57	12	25	0	62

Feeding Behaviour

The feeding habits of the recorded mammals, birds, reptiles and amphibians are presented in Table D.3.5. With the exception of the mammals, most of the animals in the study area are insectivorous and are believed to consume a large number of agricultural pests. Fish figured prominently as a food item for birds, which is not surprising since a large proportion of the birds found in the area were aquatic. Grain eaters were also important and this reflects the ability of the bird species to take advantage of the existing resources.

TABLE D.3.5

Distribution of the Main Animal Groups According to Their Feeding Habits

Group	Omn.*	Car.*	Sca.*	Pis.*	Mol.*	Ins.*	Ter.*	Gra.*	Fru.*	AV.
Mammals	0	5	0	2	0	0	2	3	04	01
Birds	0	3	3	14	9	25	0	11	04	04
Reptiles	2	5	0	2	0	5	0	0	00	02
Amphibians	0	0	0	0	0	5	0	0	00	00
Total	2	13	3	18	9	35	2	14	08	07

Source: Field surveys carried out during this study

Note:
Omn.* = Omnivorous; Car.* = Carnivorous; Sca.* = Scavengers; Pis.* = Piscivorous; Mol.* = Mollusc-eater; Ins.* = Insectivorous; Ter.* = Terrestrial vegetation; Gra.* = Graminivorous; Fra.* = Fructivorous; AV.= Aquatic vegetation.

Breeding

The present understanding of the breeding cycles of recorded species is based in many cases on the information supplied by the local people living in the project area. The breeding season for many of the species spans almost through the year, as follows:

May to July	-	for Bull frogs
November to June	-	for water snakes
April to August	-	for Cobras and Krait
Mid April to October	-	for Monitor lizards
May to September	-	for many aquatic birds such as cormorants, herons, storks, water hens, etc.
October to April	-	for predatory birds like, Kites and Vultures
February to September	-	for many land birds like doves, myna, Kingfishers, etc.

Rats breed almost throughout the year.

Yearly flooding clearly influences the fauna and their breeding strategies in the project area.

Wildlife Pests

Some of the animal species found in the project area are considered as agricultural pests (Table D.3.2), causing damages to crops in the different stages of cultivation or harvest. These include various species of rats such as the Indian field rats, bandicoot rats and domestic rats among the mammals; and parakeets and purple moorhens among the birds. The effects of terrestrial birds like parakeets were only reported by the local farmers from the eastern side of the project area, while those from the purple moorhen were reported from the north west part of the project area. Rats are widely distributed in the project area. It is possible that the rat population may increase in Zones A and B due to the drier conditions resulting from control flooding and polderization.

Endangered and Threatened Species

According to Khan (1991) and Sarker and Sarker (1988), 25 animal species recorded within during this Study are nationally Threatened or Endangered. Field records suggest that 7 more species are rare and 6 species are at risk within the study area. The rest of the species are either common or occasionally observed by the local people but not rare. Two internationally threatened mammal species, the Bengal Fox and the Gangetic Dolphin were recorded in the project area (IUCN, 1990). The Gangetic Dolphin was found to be relatively common in the rivers within the project area, especially in the Gumti and the Titas.

According to the Gazetteer for the Greater Comilla District (Khan, 1977), several mammal species such as the Barking Deer, tigers and panthers occurred in the region some 100 years ago. At present it is impossible to confirm this reports by the local people in the study area. The systematic position as well as the scientific, English and Bengali names of these Gazetted extinct animals are as follows:

Systematic Position	**Scientific Name**	**English Name**	**Bengali Name**
Class - Mammals			
Order - Artiodactyla			
Family - Cervidae			
	Muntiacus muntjac	Barking Deer	Ruru Harin
Order - Carnivora			
Family - Felidae			
	Panthers pardus	Leopard	Chita Bagh
	Panthers tigris	Royal Bengal	Tiger Bagh

D.3.2 Terrestrial Flora

A list of the flora recorded in the project area by sampling station is presented in Table D.3.6 which also includes details of the scientific, English and Bengali names, habitat, past and present occurrence, and of some of the uses made of the species. The plant species were divided into three main groups: trees, shrubs and herbs. The distribution of these plants by group in the sampling stations is presented in the Table D.3.7, where it can be seen that sampling station 5 (Metangar under Muradnagar Thana) has the largest number of species and station 7 (Mullukgram under Bancharampur Thana) has the lowest.

TABLE D.3.6

Species List (Flora) with Relevant Information are Given Below with Ecological Survey Sites Gumti Phase II Study Area

Habitat code : R = River bank; P = Pond bank; B = Beel Bank; E = Embankment; H = Homestead; A = Agricultural field and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.

Occurance code: 1 = Widespread; 2 = Common; 3 = Occassional; 4 = Uncertain; 5 = Rare

Type code: T = Trees; S = Shrubs; H = Herbs

Utility code: T = Timber; M = Medicinal; F = Food; FU = Fuel; FO = Fodder; C = Construction; O = Ornamental; CR = Craft; R = Religious; FI = Fibre.

Family Name	Scientific Name		English Name	Bengali Name	Habitat	Occurance		Type	Utility	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	7	8
Anacardiaceae	*Mangifera*	*indica*	Mango Tree	Aam	R,P,H,RS	1	2	T	T,F,FU	+	+	+	+	+	+	+	+
Myrtaceae	*Syzygium*	*sp*	Indian Black Berry	Jam	B,H,RS	2	2	T	T,F,FU,C	+	+	+	+	+	+	+	+
Moraceae	*Artocarpus*	*heterophyllus*	Jack Fruit Tree	Kathal	B,E,H,RS	2	2	T	T,F,FU,FO	+	+	+		+	+		+
Moraceae	*Ficus*	*benghalensis*	Banyan Tree	Bot	R,B	2	5	T	T,M,FU,FO	+				+			
Palmae	*Cocos*	*nucifera*	Coconut	Narikel Dab	P,B,H	2	2	T	T,F,FU,C,CR	+	+	+	+	+	+	+	+
Palmae	*Areca*	*catechu*	Betel Nut Palm	Supari Gua	H,RS	2	2	T	T,F,FU	+	+			+			+
Elaeocarpaceae	*Elaeocarpus*	*robustus*	Olive	Jalpai	R,H	2	3	T	T,F,FU	+		+		+	+		
Ebenaceae	*Diospiros*	*peregrina*	Nigerian Ebony	Gab	R,P,B,H,RS	2	2	T	T,M,F,FU				+	+	+		
Urticaceae	*Streblus*	*asper*		Shaorah	R,P,E,W,RS	2	2	T	T,FU		+		+	+	+		+
Annonaceae	*Polyalthia*	*longifolia*	Mast Tree	Debdaru	R,H,RS	2	3	T	T,FU,O			+		+			
Moraceae	*Ficus*	*religiosa*		Pipal/Asawatha	R,P,E,R,RS	1	2	T	T,M,FU	+	+	+	+	+	+		+
Bombacaceae	*Bombax*	*ceiba*	Red Silk Cotton	Simul	E,H,RS	1	3	T	T,FU,FI	+				+			
Lythraceae	*Lagerstroemia*	*sp*		Jarul	R,P,H	2	3	T	T,FU,C	+				+			
Capparaceae	*Crataeva*	*nurvala*		Bannay	P,B,H	2	2	T	T,FU	+		+	+	+			
Rhamnaceae	*Zizyphus*	*mauritiana*	Indian Palm	Borai-Kul Gach	R,P,B,E,H,W,RS	2	2	T	F,FU,FO	+	+	+	+	+	+	+	+
Palmae	*Borassus*	*flabellifer*	Palmyra Palm	Tal	R,P,B,E,H,RS	2	2	T	M,F,FU,C,O,CR	+		+		+	+	+	+
Leguminosae	*Tamarindus*	*indica*	Tamarind	Tetul	P,B,H,RS	1	2	T	T,M,F,FU,FO	+		+	+	+	+	+	+
Palmae	*Phoenix*	*sylvestris*	Wild Date Palm	Khejur	R,P,B,E,H,W,RS	2	2	T	F,FU,C,CR		+	+	+	+	+	+	+
Euphorbiaceae	*Trewia*	*polycarpa*		Pituli/Madda	R,P,H,W	2	2	T	T,FU,C	+	+		+		+	+	+
Rutaceae	*Citrus*	*grandis*	Grape fruit	Jambura	H	2	2	T	F,FU	+	+	+		+	+		+
Annonaceae	*Anona*	*reticulata*	Bullock's heart	Nona	H	2	3	T	M,F,FU		+	+		+	+		
Averrhoaceae	*Averrhoa*	*bilimbi*		Belumbo	P,H,RS	2	2	T	F,FU	+	+	+		+			+

TABLE D.3.6 (Contd.)

Species List (Flora) with Relevant Information are Given Below with Ecological Survey Sites Gumti Phase II Study Area

Habitat code : R = River bank; P = Pond bank; B = Beel Bank; E = Embankment; H = Homestead; A = Agricultural field and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.

Occurance code: 1 = Widespread; 2 = Common; 3 = Occasional; 4 = Uncertain; 5 = Rare

Type code: T = Trees; S = Shrubs; H = Herbs

Utility code: T = Timber; M = Medicinal; F = Food; FU = Fuel; FO = Fodder; C = Construction; O = Ornamental; CR = Craft; R = Religious; FI = Fibre.

Family Name	Scientific Name		English Name	Bengali Name	Habitat	Occurance		Type	Utiliy	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	7	8
Moringaceae	*Moringa*	*oleifera*	Horse Radish Tree	Sajna	P,H,RS	2	3	T	M,F,FU				+		+	+	+
Meliaceae	*Azadirecta*	*indica*	Margosa	Neem	R,P,B,H	1	2	T	T,M,FU			+		+	+	+	+
Leguminosae	*Albizia*	*sp.*		Koroi	P,B,H,W,RS	2	2	T	T,FU	+		+	+	+	+	+	+
Lecythidaceae	*Barringtonia*	*acutangula*		Hijal	R,P,B,W,RS	2	2	T	T,FU		+		+	+			+
Rutaceae	*Aegle*	*marmelos*	Bengal Quince	Bel/Bela	P,B,E,H,W,RS	2	2	T	M,F,R	+		+	+	+	+	+	+
Rutaceae	*Zanthoxylum*	*rhetsa*		Bajna	H	?	5	T	T,M,FU			+					
Anacardiaceae	*Spondias*	*pinnata*	Hong palm	Amra	P,H	2	3	T	F,FU	+	+			+			+
Averrhoaceae	*Averrhoa*	*carambola*		Kamranga	P,H	2	2	T	M,F,FU	+	+	+			+		+
Rubiaceae	*Anthocephalus*	*chinensis*	Kadam	Kadam	R,H,W,RS	2	3	T	T,FU,FO	+		+		+			
Meliaceae	*Aphanamixis*	*polystachya*		Pitraj	R,P,B,RS	2	2	T	T,M,FU	+	+	+	+	+	+		+
Meliaceae	*Melia*	*sempervirens*	Mahaneem	Paharineem	B,RS	2	3	T	T,M,FU		+			+			+
Meliaceae	*Swietenia*	*mahagoni*		Mehagini	H,RS	2	3	T	T		+			+			
Leguminosae	*Acacia*	*furnesiana*		Guhiya Babul	B	?	5	T	T,FU				+		+		
Euphorbiaceae	*Phyllanthus*	*embelica*		Amloki	H,RS	2	5	T	T,M					+	+		
Combretaceae	*Terminalia*	*chebula*		Haritaki	H,RS	2	5	T	T,M					+	+		
Dilleniaceae	*Dillenia*	*indica*		Chalta	R,P,B,H,RS	2	2	T	T,M,I,FU	+	+			+	+		+
Leguminosae	*Erythrina*	*variegata*		Mandar	R,P,B,H,RS	1	2	T	T,F,FU	+		+		+	+		+
Combretaceae	*Terminalia*	*arjuna*		Arjun	P,RS	2	3	T	T,M,FU,C		+	+		+			
Leguminosae	*Cassia*	*fistula*	Indian Laburnum	Sonalu	P,H,W,RS	2	2	T	FU,C	+	+			+		+	+
Apocynaceae	*Alstonia*	*scholaris*		Chatim	R,P,RS	2	3	T	T,M,FU,C	+	+			+			
Sapotaceae	*Mimusops*	*elengi*		Bakul	R,B,RS	2	3	T	T,FU,C,O					+			+
Sapindaceae	*Lichi*	*chinensis*	Litchi	Lichu	H	2	3	T	F,FU	+				+			+
Sterculiaceae	*Abroma*	*augusta*		Ulatkombal	P,B,E,H,W	3	3	S	M		+	+		+	+		
Boraginaceae	*Heliotropium*	*indicum*		Hatishur	R,P,B,E,H,A,R,WM,RS	2	3	S	M	+	+	+		+	+	+	+

TABLE D.3.6 (Contd.)

Species List (Flora) with Relevant Information are Given Below with Ecological Survey Sites Gumti Phase II Study Area

Habitat code : R = River bank; P = Pond bank; B = Beel Bank; E = Embankment; H = Homestead; A = Agricultural field and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.

Occurance code: 1 = Widespread; 2 = Common; 3 = Occasional; 4 = Uncertain; 5 = Rare

Type code: T = Trees; S = Shrubs; H = Herbs

Utility code: T = Timber; M = Medicinal; F = Food; FU = Fuel; FO = Fodder; C = Construction; O = Ornamental; CR = Craft; R = Religious; FI = Fibre.

Family Name	Scientific Name		English Name	Bengali Name	Habitat	Occurance		Type	Utility	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	7	8
Asclepiadaceae	*Calotrophis*	*gigantia*		Akanda Pata	R,B,E,RS	2	2	S	M,FU,O,R	+		+	+	+	+	+	+
Liliaceae	*Aloe*	*barbadensis*		Ghitakanchan	P,H,RS	3	6	S	M					+			
Labiatae	*Ocimum*	*sp*		Tulshi	E,H,RS	2	2	S	M	+				+		+	
Acanthaceae	*Adhatoda*	*vasica*		Basak	H,RS	2	3	S	M,FU			+	+	+	+	+	+
Solanaceae	*Datura*	*fastuosa*		Dhutra/Dhutura	R,P,E,H,W,RS	2	2	S	M,FU	+		+	+	+	+		+
Euphorbiaceae	*Ricinus*	*communis*		Reri	R,P,B,E,H,RS	2	3	S	M,FU	+			+		+	+	+
Convolvulaceae	*Ipomoea*	*fistulosa*		Dhol Kalmi	R,P,B,E,RS	1	1	S	FU	+	+	+	+	+	+	+	+
Caricaceae	*Carica*	*papaya*	Papaya	Pepe	H	2	2	S	M,F	+	+	+	+	+	+	+	+
Euphorbiaceae	*Phyllanthus*	*reticulatus*		Sitki	R,P,B,E,H,W,WM,RS	2	2	S	FU	+	+		+	+	+	+	+
Apocynaceae	*Nerium*	*Indicus*		Karabi	H,W	3	3	S	M,FU,O,R					+		+	
Rutaceae	*Glycosmis*	*arberoea*		Datmajan	P,E,H,W,RS	2	2	S	M,FU	+	+		+	+			+
Gramineae	*Bambusa*	*nutans*		Peechle	B,H	2	5	S	FU			+					
Verbenaceae	*Clerodendrum*	*viscosum*		Bhant	E,H,W,RS	2	2	S	M,FU	+		+	+	+	+	+	+
Araceae	*Typhonium*	*trilobatum*		Ghetkachu/Ghetkol	H,RS	3	3	S	M			+		+			
Compositae	*Xanthium*	*indicum*		Gagra	R,P,B,E,A,RS	2	2	S	FU	+	+		+	+		+	+
Marantaceae	*Clinogyne*	*dichotoma*		Sitalpati	R,B,RS	1	3	S	CR			+	+	+	+		
Palmae	*Calamus*	*sp.*		Bet	B	2	5	S	CR				+	+			+
Araceae	*Alocasia*	*indica*		Man Kachu	P,H	2	2	H	M,F	+	+		+	+	+	+	+
Amaranthaceae	*Amaranthus*	*spinosus*		Kanta Note	R,P,B,E,H,A,RS	2	2	H	M,F	+	+	+	+	+	+	+	+
Amaranthaceae	*Amaranthus*	*viridis*		Note	R,P,E,H,A,RS	1	1	H	M,F,FO	+	+	+	+	+	+	+	+
Graminae	*Bambusa*	*sp.*	Bamboo	Bans	R,P,WM	1	1	H	M,FU,C,O,CR	+	+	+	+	+	+		
Leguminosae	*Cassia*	*occidentalis*		Jhanjham	E,H,W,RS	1	1	H	FU	+		+	+		+		
Graminae	*Chrysopogon*	*aciculatus*		Chorekanta	E,A,W,RS	1	1	H	M,FU	+	+	+		+	+		+
Umbelliferae	*Centilla*	*asiatica*		Thankuni	R,P,B,E,H,A,RS	2	2	H	M,F		+		+	+		+	+

TABLE D.3.6 (Contd.)

Species List (Flora) with Relevant Information are Given Below with Ecological Survey Sites Gumti Phase II Study Area

Habitat code : R = River bank; P = Pond bank; B = Beel Bank; E = Embankment; H = Homestead; A = Agricultural field and margin; W = Refuge woodland; WM = Monospecific woodland; RS = Road side.

Occurance code: 1 = Widespread; 2 = Common; 3 = Occasional; 4 = Uncertain; 5 = Rare

Type code: T = Trees; S = Shrubs; H = Herbs

Utility code: T = Timber; M = Medicinal; F = Food; FU = Fuel; FO = Fodder; C = Construction; O = Ornamental; CR = Craft; R = Religious; FI = Fibre.

Family Name	Scientific Name		English Name	Bengali Name	Habitat	Occurance		Type	Utility	Sampling Stations							
	Genus	Species				Past	Present			1	2	3	4	5	6	7	8
Labiatae	*Leonurus*	*sibiricus*	Motherwort	Raktadrone	R,B,E,RS	3	3	H	M,FU		+	+		+			
Araceae	*Colocasia*	*esculenta*		Kachu	P,H,RS	2	2	H	M,F		+	+	+	+	+		+
Graminae	*Cynodon*	*dectylon*		Durbaghas	R,P,B,E,H,A,W,RS	1	1	H	M,FO,R	+	+	+	+	+	+	+	+
Musaceae	*Musa*	*sp.*	Banana	Kala	R,P,B,E,H,RS	2	2	H	M,F,FO	+	+	+	+	+	+	+	+
Graminae	*Oryza*	*sp.*	Rice	Dhan	A (only in field)	1	1	H	F,FU,FO	+	+			+			
Solanaceae	*Solanum*	*nigrum*		Puti Begun	R,P,B,E,A,W,RS	2	2	H	FU	+	+	+		+	+	+	+
Cucurbitaceae	*Coccinea*	*cordifolia*		Telakucha	E,RS	2	5	H	M,FU			+	+	+		+	
Caryophyllaceae	*Polycarpon*	*prostratum*		Gimashak	P,E,A,RS	2	3	H	M,F	+	+			+			+
Polygonaceae	*Polygonum*	*hydtropiper*		Bishkatali	R,P,B,E,RS	2	2	H	M	+	+	+	+	+	+	+	+
Graminae	*Saccharum*	*spontaneum*		Kash	A,W,RS	1	3	H	FU,CR	+	+	+	+		+		+
Apocynaceae	*Ichnocarpus*	*frutescens*		Dudhilata	R,P,E,W,RS	1	1	H	M,FU	+	+		+	+	+		+
Compositae	*Mikania*	*cordata*		Assmlate	B,W,RS	2	2	H	FU		+		+			+	+
Chenopodiaceae	*Chenopodium*	*album*		Bethoshak	A	2	2	H	F	+	+						+
Amaranthaceae	*Achyranthes*	*aspera*		Upatlangra	R,P,E,H,W,RS	2	2	H	M,FU	+	+	+		+			+
Labiatae	*Leucas*	*aspera*		Swetadrone	R,P,E,H,W,RS	1	2	H	M,FU	+	+	+		+		+	+

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Terrestrial plant communities are capable of using sunlight to accumulate large biochemical reserves, which form the primary energy source for the rest of the consumers. During the flood season this process is interrupted on the flood lands, because terrestrial plants can not respire under water. Besides their vital role as primary producers in the floodplain ecosystem, plants offer crucial resting, feeding and breeding grounds for many wild mammals, birds and reptiles.

The natural vegetation found in the project area also fulfils many of the needs of the local people, being used for fuel, medicinal and construction purposes, and as food items in order of importance (see Table D.3.8). Not surprisingly, nearly 73% of the plants in the study area are used for fuel and nearly 50% of the recorded floral species are used by the local people for medicinal purposes to cure various diseases and injuries in preference to the high cost modern medicine which may have adverse side effects. Details on the medicinal plants found in the study area, together with their scientific and local names, their chemical composition and their use are given in Table D.3.9. From this table it can be seen that Station 5 had the highest number of medicinal plants, representing nearly 90% of the total number of medicinal plants recorded for the study area. Stations 6 and 8 each had 66% of the total and Station 7 had the lowest, representing 49% of the medicinal plants in the study area. The distribution of the main vegetation types in the Gumti Phase II Study area are shown in Figure D.3.1.

TABLE D.3.7

Distribution of Plant Groups by Sampling Stations

Plant Group		Sampling Station							
		1	2	3	4	5	6	7	8
Trees	44	28	23	24	17	39	26	13	28
Shrubs	19	11	07	11	12	17	10	11	12
Herbs	22	17	20	15	14	18	13	11	17
Total	85	56	50	50	43	74	49	35	57

TABLE D.3.8

Distribution of Plants According to Their Major Uses

Plant Group	Major Uses									
	Reli.*	Fibre	Timber	Med.*	Food	Fuel	Fodder	Con.*	Orn.*	Craft
Trees	0	1	32	18	20	40	5	7	3	3
Shrubs	2	0	0	13	1	11	0	0	2	2
Herbs	1	0	0	16	4+5	12	3	0	1	2
Total	3	1	32	47	30	63	8	7	6	7

Note: Reli.* = Religious; Med.* = Medicinal; Con.* = Construction; Orn.* = Ornamental

Figure D.3.1

Distribution of Main Vegetation Types

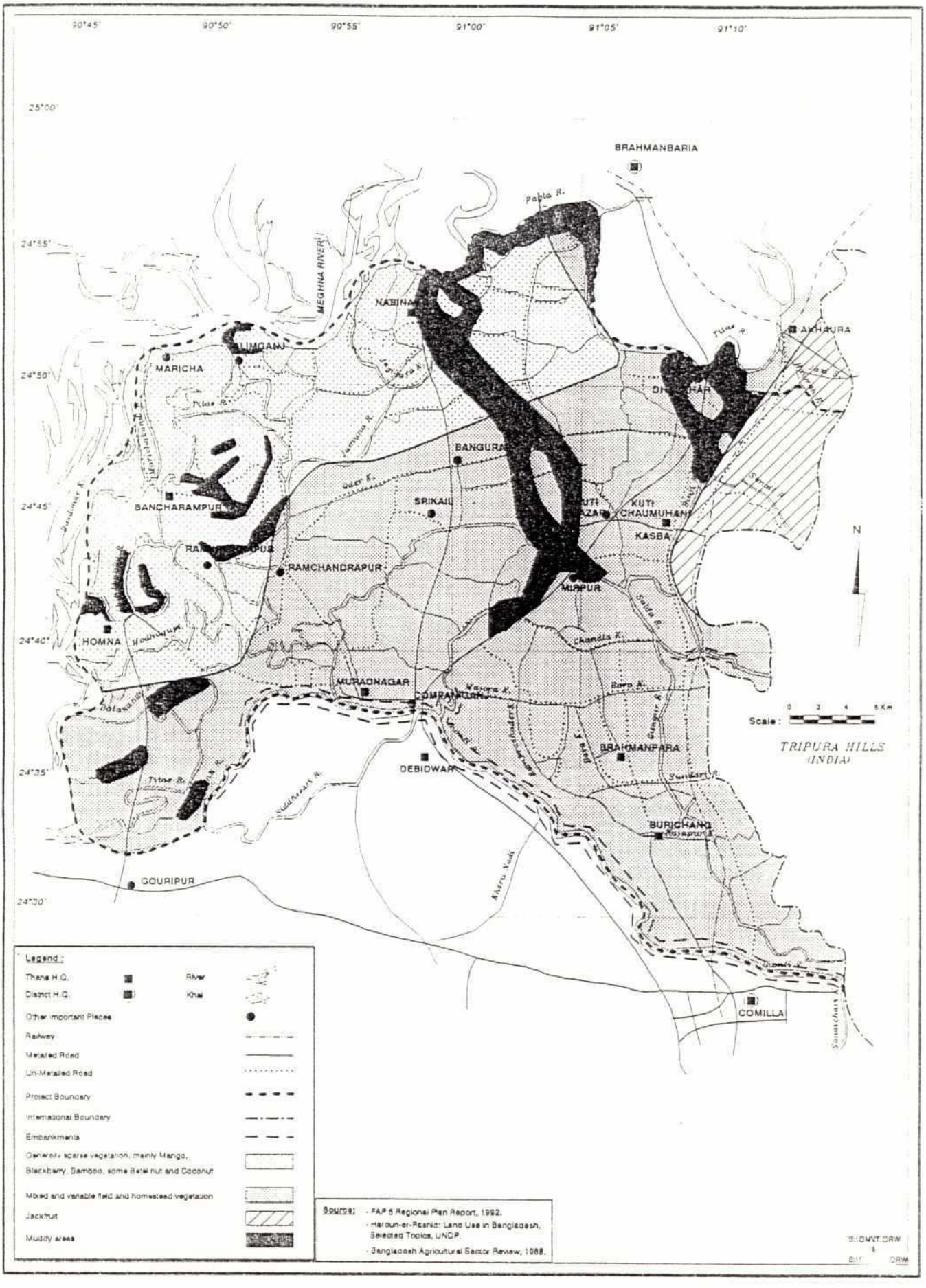

TABLE D.3.9

Medicinal Plants Recorded in the Gumti Phase II Study Area

Scientific Name	Local Name	Chemical Composition	Use
Ficus bengalensis	Bot	Milky juice, sterols, glycoside, terpenoids, albuminoids, ficosterol, glutathiome cellulose, lignin	Nasal bleeding, Burning sensation of whole body, Strain, Toothache, Pendulous breast
Diospyros peregrina	Gab	Tannin, acids viz., tannicacid, malic acid, fatty acid	Chronic dysentery, Diabetes, Excessive bleeding during menstruation
Ficus religiosa	Asawatha Aswat	Protein, Inorganic elements viz., calcium, phosphorus, glycosides, Resins, tannin, caoutchouc, traces of alkaloids	Burns, Ear infections, Infected cuts, Vomiting
Borassus flabellifer	Tal	12% surcros, butyric acid	Diabetes, Digestive, Weakness
Tamarindus indicusm	Tetul		Refrigerant, Carminative, laxative
Alstonia scholaris	Chhatim		Dysentery
Annona reticulata	Nona	Alkaloid, anonaine 0.12% in bark, alkaloid, reticulin in root bark moisture 72.3%, glucose 12.5% and proteins 2%	Powerful astringent, vermifuge
Moringa oleifera	Sajna		Tonic and cooling agent, in bites of snakes, dogs and monkeys. Gastric complains.
Azadirecta indica	Neem	Alkaloids viz. nimbin, nimbinin, nimbidin, nimbosterin, nimbecetin, bakayanin. Fatty acids (different types) Highly pungent essential oil	Jaundice, Skin diseases, Diabetes, Dry cough, Hyperacidity
Aegle marmelos	Bel		Astringent, Digestive tonic, Stomach ache, Laxative

TABLE D.3.9 (contd.)

Scientific Name	Local Name	Chemical Composition	Use
Zanthoxylum rhetsa	Bajna		Dry eczema or dandruff of children
Aphanamixis polystachya	Pitraj	Aphanamixin, aphanamixol, aphanamixinine	Piles, Menorrhagia, Importance Worm infestation, Gonorrhoea, Liver disease
Melia sempervirens	Mahaneem	Leaves contain: Carotenoid, meliatin and an alkaloid. Pericaps contains: bakayanin, neutral substance (neo-bakayanin and bakayanic acid). Fruit contains: an alkaloid, azaridine (also called margosine), a sterol, tannins, glucose and starch. Seeds contain: Dry oil 40%, unsapon matter 1.26%, saturated fatty acids 11.4% and unsaturated fatty acids 88.6%, Unsaponifiable matter (Phytosterol and aromatic hydrocarbons). Bark contains: Alkaloids (azaridine and paraisine) and active substances mp. 154°	Pain in chest, Worm infection, Stomach pain, Treatment for louse.
Phyllanthus embelica	Amlaki	Ascorbic acid, Amino acid, viz., glycine, tannin, polyphenolic compounds viz., corilagic, ellagic acid, terchebin, gallic acid, chebulic acid, chebulnic acid, Fixed oil, Lipids, viz., phosphatides, essential oil	Leucorrhea, Biliary colic, Hyperacidity, Sepsis.
Terminalia chebula	Haritoki		Laxative
Dillenia indica	Chalta	Tannin, glucose, malic acid	Food poison, Boldness Maldigestion, Weakness

TABLE D.3.9 (contd.)

Scientific Name	Local Name	Chemical Composition	Use
Averrhoa carambola	Kamranga	Moisture 93.9%, protein, 0.5%, fat 0.2%, vitamin A, iron 0.6 mg, potassium oxalate	Long grade fever, Liver pain
Terminalia arjuna	Arjun		Cardiac tonic
Abroma augusta	Ulatkambal	An alkaloid 0.01% and some water soluble bases 0.01%, mixed oil and resins	Gynaecological complains, dysentery etc.
Heliotropium indicum	Hatisur		Use in eye infection
Calotropis gigantes	Akanda	Akundarin, calotropin, uscharin, calactin, calotoxin, calactin, B-calotropeol, B-amyrin, calcium oxalate, gigantin, glutathione, giganteol, iso-giganteol. A proteo clastic enzyme similar to papain. Crystalline alcohols, long chain fatty acids, Tetracyclic terpenes, esters of waxy acids and alcohols	Asthma, Hyperacidity, External application: Piles, Bite of scorpion, Eczema and scabies
Aloe barbadensis	Ghitakanchan	Aloin, isobarbaloin, emodin chrysophanic acid, urnic acid, gum, resin, glycosides	Worm, Gynecoganic problem, Children digestive problem, Eczema
Ocimum sp.	Tulshi		In colds, Fever, Skin diseases, Headaches, etc.
Adhatoda vasica	Basak	Vasicine, I-peganie, small amount of essential oil	Asthma, Respiratory disorder, Painful piles, Water purifier
Datura fastuosa	Dhatura	Alkaloids viz., hyoscyamine, hyoscine, atropine, scopolamine, norhyoscyamine, vitamin C, other constituents viz., fixed oil and allantoin	Bite from mad dog or fox, Baldness, Madness, Mastitis, Asthma
Ricinus communis	Reri/ Bherenda		Rheumatic pains

d2

TABLE D.3.9 (contd.)

Scientific Name	Local Name	Chemical Composition	Use
Carica papaya	Pepe	Sucrose, inverted sugar; papain, malic acid; salts of tartaric acid and citric acid; a resinous substances; pectins; vitamins (vitamin - A. thiamine, riboflavin niacin and ascorbic acid)	Gastric troubles
Nerium indicum	Karabi	Kernel contains; Pale-yellow at 57% unsponifiable matter 1.4% fatty acid, unknown substances (abonain mp. 185°d and Kokilphin mp. 189°), glycosides (thevetin B, 2´-0 acetyl cerberoside, neriifolin, ceberoside, peruvoside, ruvoside, 19-oxyneriifolin and purrusitin). Flower contains: a flavonal glycoside (glycoside of quercetin -4´ methyl ether).	Skin diseases
Glycosmis arberoea	Datmajan		Tooth cleaner
Clerodendrum viscosum	Bhant	Clerodin, Sterol, Zanthophyll, Carotene, Ash 8.0%, Protein 2.12%, Crude fibre 14.8% Reducing sugars 3.0%, Total sugars 17.0%, Linolenic acid. Oleic acid, Stearic acid, ligneceric acid.	Rheumatism and skin diseases of cattle
Typhonium trilobatum	Ghetkachu		
Alocasia indica	Mankachu	Pure white starch	In rheumatism
Amaranthus spinosus	Kanta note	Moisture 85%, Protein 3.0% Fat 0.3%, Carbohydrates 8.1%, Mineral matter 3.6%, Calcium 0.8% Phosphorus 0.05%, Iron 22.9 mg/100g	Blood dysentery, Gynaecological problem, Cough, Accidental cuts or wounds

TABLE D.3.9 (contd.)

Scientific Name	Local Name	Chemical Composition	Use
Amaranthus viridis	Note		Blood dysentery, Coughs, Gynaecological problems
Bambusa sp.	Bans		Externally use as antiseptic
Chrysopogon aciculatus	Chorkanta		Hemicrania
Centilla asiatica	Thankuni		Dysentery, Leprosy
Leonurus sibiricus	Raktadrone		Earache
Colocasis esculenta	Kachu		Head skin diseases
Cynodon dectylon	Durbaghas		Haematuria, juice use for cuts and wounds
Musa sp.	Banana	Carbohydrates, minerals, vitamins (b-group), acetate, amy 1 butyrate, acetaldehyde, ethyl 1 and meth 1 alcohols, 1-malic acid, serotonin, norepinephrine and dopamine.	Worm infection, Coughs, Diabetes, Trusty during cholera infection, pain in ear
Coccinia cordifolia	Telakachu	Enzyme, hormone, amylase, trace of alkaloids, vitamin - A, Vitamin C	Diabetes, Colds, Coughs
Polycarpon prostratum	Gimashak		Anti worm & blood purification
Polygonun hydropiper	Bishkatali		Anti haemorrhage
Ichnocarpus frutescens	Dudhilata		Anti haemorrhage
Achyranthus aspera	Upatlangra/ upaug	Pungent oil, sterols viz., ß- and r-sitosterol, terpenoid constituents	Diuretic, in bites of poisonous animals
Leucas aspera	Swetadrone		In psoriasis, Eruptions of skin and in rheumatism

D.3.3 Findings Aquatic Ecology

The preliminary list of aquatic flora and fauna found in the project area together with details of their habitat and abundance at each site are presented in Table D.3.10. Overall there were approximately 133 algal genera and/or species. Table D.3.11 shows the frequency of occurrence by Class of the aquatic algae with the highest (34%) of them recorded in Station 3 and the lowest in Station 7 (12%) and Station 1 (nearly 13%). Sites 5 and 6 yielded almost similar number of taxa.

The distribution and frequency of occurrence of zooplankton and benthic fauna by Class is shown in Table D.3.12 and it can be seen that Station 5 was the most important one for the aquatic fauna with 83% of the total number of taxa, while Station 1 was the least important with nearly 13%. The most numerous group was the Crustacea followed by the Monogonota. Sites 3 and 6 yielded similar figures.

The macrophytes found in the Gumti Phase II study area as a whole represent 53% of the macrophytes reported for the country. It is evident that the diversity of aquatic plants is high. Table D.3.13 shows that there were 28 taxa collected from site 2 representing nearly 61% of the total found during the study. Site 2 had a larger proportion of marshy areas and road side ditches and although it did not have as much water in them as other areas, these aquatic habitats were able to hold this water for longer periods of time because they also receive water from irrigated rice fields resulting in more stable or long-term environments than the changing floodplain. This was confirmed during the second field trip (beginning of December 1992) when most of the floodplain area around Site 4 had nearly dried up whereas the ditches near Site 2 still held water. Site 4 followed in number of taxa with nearly 48% of the total, while Site 5 was the lowest with 5 taxa representing under 11%. Suitable aquatic habitats for macrophytes around Site 5 were rather limited as the area is located in slightly higher grounds than the rest of the floodplain.

D.3.4 National Diversity

Tables D.3.14 and D.3.15 have been prepared according to the information furnished in Islam (1991) and Khan and Halim (1987). Table D.3.14 shows that approximately 51% of the planktonic algal genera reported for the country are found in the Gumti Phase II study area, with 39% of the Chlorophyceae (green algae), 62% of the Bacillariophyceae (diatoms) and 57% of the Cyanophyceae (blue-green algae) also represented. The Euglenophyceae (flagellates), Dinophyceae (dinoflagellates), Chrysophyceae (chrysomonads) and Cryptophyceae (cryptomonads) were represented in the study area.

An extremely interesting finding was the Chloromonad *Gonyostomum semen* which appears to be a new record for the country. This rare algae was only found in Site 3 (Sharishaduli Beel) where it was found in bloom during the field visit in December. Sharishaduli Beel is in the vicinity of a proposed polder (Intervention 2). It is unclear at present what is the status of this species in the project area or the region, or what role it is playing in the ecosystem. It is therefore recommended that further studies be carried out before any intervention takes place.

TABLE D.3.10

ALGAE, ZOOPLANKTON AND BENTHIC MACROINVERTEBRATES

Taxonomy	Common English Name of the group	Genus/Species	Habitat	Sampling Sites							
				1	2	3	4	5	6	7	8
Phytoplankton											
CRYPTOGAMS											
THALLOPHYTA (ALGAE)											
Cl. Chlorophyta											
Or. Volvocales	Volvocalean	*Heteromastix angulata*	P		1			3			
Fa. Chlamydomonadaceae		*Chlamydomonas*	B				2				
		Chlorogonium elongatum	P,B		2			2			
		Gonium formosum	SR		2						
		Pandorina morum	SR		2						
		Eudorina	SR		3						
		Pleodorina	SR		3						
Or. Ulotrichales											
Fa. Chaetophoraceae	Chaetophoralean	*Draparnaldia*	FP				3				
Or. Oedogoniales											
Fa. Oedogoniaceae	NK	*Oedogonium*	B		3	3					
		Bulbochaete	B			3					
Or. Cladophorales	Cladophoralean	*Rhizoclonium*	FP		2						
Fa. Chladophoraceae											
Or. Chlorococcales											
Fa. Micractiniaceae	Chlorococcalean	*Micractinium*	B				2				
		Schroederia setigera	B						3		
Fa. Characiaceae		*Actinastrum hantzschii*	B,P			2	2	3			

TABLE D.3.11

Classwise distribution of aquatic algae (number of genera/species) occurring in different stations of Gumti Phase II

Class	Sampling Station							
	1	2	3	4	5	6	7	8
Chlorophyceae	1	18	20	10	11	4	2	4
Charophyceae	-	1	-	-	-	-	-	-
Euglenophyceae	1	9	7	4	4	7	2	8
Chrysophyceae	-	-	-	-	-	-	-	1
Bacillariophyceae	11	2	11	6	3	5	9	12
Dinophyceae	-	1	1	1	-	1	-	-
Cyanophyceae	2	4	3	4	4	6	2	3
Rhodophyceae	-	-	1	-	-	-	-	-
Cryptophyceae	2	2	1	2	1	2	1	2
Chloromonadaceae	-	-	1	-	-	-	-	-
Total	17	37	45	27	23	25	16	30

TABLE D.3.12

Classwise distribution of zooplankton and bottom fauna (number of genera/species) occurring in different stations of Gumti Phase II

Class	Sampling Station							
	1	2	3	4	5	6	7	8
Rhizopoda	1	-	-	1	-	-	-	1
Ciliata	1	-	-	1	-	1	-	-
Coelantrata	-	-	-	-	1	-	1	1
Monogonota	3	7	5	6	12	6	5	2
Phasmidia	-	-	-	-	2	-	-	1
Oligochaeta	-	1	-	-	1	-	-	-
Gastropoda	-	2	3	5	-	1	1	-
Pelecypoda	-	-	1	-	-	-	-	-
Crustacea	1	19	14	18	23	15	9	6
Total	6	29	23	31	39	23	16	11

TABLE D.3.13

Groupwise distribution of aquatic macrophytes (number of genera/species) occurring in different stations of Gumti Phase II

Class	Sampling Station							
	1	2	3	4	5	6	7	8
Dicotyledoneae	3	10	9	9	3	3	4	4
Monocotyledoneae	2	14	6	11	2	9	8	5
Pteridophyta	1	4	2	2	-	2	2	1
Bryophyta	-	-	-	-	-	1	-	-
Total	6	28	17	22	5	15	14	10

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TABLE D.3.14

Comparative Study of planktonic algal genera recorded from the country and Gumti Phase II area

Class	Algal genera	
	Country	Gumti Phase II
Chlorophyceae	92	36
Bacillariophyceae	29	18
Cyanophyceae	21	12
Euglenophyceae	7	7
Dinophyceae	2	2
Xanthophyceae	2	-
Chrysophyceae	1	1
Chloromonadaceae	-	1
Cryptophyceae	2	2
Total	156	79

TABLE D.3.15

Comparison between the number of genera of aquatic macrophytes recorded in the country and those recorded from 'Gumti Phase II area

Name of the group	Name of genera	
	Country	Gumti Phase II
Dicotyledons	29	13
Monocotyledons	38	22
Pteridophyta	6	4
Bryophyta	2	1
Total	75	40

tab-56

The aquatic ecology of the area depends very much upon the intensity and duration of the flood and on the high variation in the flood pattern from year to year. In the light of this complex connection, it is difficult to predict what would happen each year. In general, when the major rivers are flooded, the water enters the small rivers, channels, inundated charlands, flood plains and in high flood years, it may reach homestead ponds. Pelagic and benthic consumer food chains (Figures D.3.2 and D.3.3) are operational in most of the habitats. As trophic chain links (biological and ecological), they are important for terminal biological production represented as fish harvest. Thus, their successful sustainability is essential for the productivity of the area.

Apart from seasonal flux, river water contains pelagic plankton. Some of these plankton complete their life cycle in the river itself and some become incorporated into the river through adjacent water bodies. Field observations reveal that plankton are more abundant during the flood period than the dry period in the river system. The flowing waters of the River Gumti were seen to carry more silty matter than plankton which indicates that calmer water bodies have a higher primary and secondary productivity than the river itself.

The life cycle of organisms related to the trophic chain in the floodplain where the water retention pattern may be of 3 to 4 months, is rather different. When the floodplain becomes inundated, the perennating life forms start germinating and soon cover the area. This is an established fact for most of the macrophytes, some zooplankton and diatom algae (Sculthorpe, 1971; Mellanby, 1986; Round, 1991). All these life forms including those brought into the ecosystem by the flood water undergo several changes utilizing the dissolved nutrients found in the sediments and the residuals of agro-chemical applications. The process continues for 2 to 3 months and the floodplain capture fisheries is the outcome of the whole processes. With the recession of flood water and with an increasing fishing activity, aquatic life forms in the floodplain ecosystem are severely disturbed and many organisms start the mode of perennation to survive until the next year. By the end of October and November most of the previously flooded areas become agricultural fields.

In general, it would appear that the food chain is of a benthic consumer type with periphytic algae as primary producers. Further studies are strongly recommended to establish the nature of the trophic chain with certainty.

With a few exceptions, homestead ponds are less affected by flooding events. Most of the ponds showed algal blooms during warm months. Algal blooms are not common in the monsoon. Pond ecosystems located in the central part (Metangar area) and in other slightly elevated places of the project are typical of this type of system. They support moderate to high plankton diversity with occasional blooms and most of them have a large number of benthic invertebrates. It would appear that they are less prone to flooding and thus, the species within them are less likely to be flushed away during the floods.

The aquatic life forms found so far in the project area (Table D.3.10) are crucial components of the complex trophic web which culminates in a high fish production. They also perform a number of important ecological functions as nutrient absorbers, nitrogen fixers, soil binders, etc. Aquatic macrophytes such as stands of *Trapa maximowickzii*, *Nymphaea nouchali*, *Hygroriza aristara*, etc. are directly linked with the reproduction of migratory birds which use floating masses of these plants as nesting sites. Besides, perennating organs in the form of turions, bulbils, rhizomes, etc. of *Aponogeton*, *Potamogeton*, *Coratophyllum*, *Nymphoides*, *Chara*, etc. also serve as food for aquatic birds. All these plants are available in the aquatic habitats of the project.

Figure D.3.2
Diagram of an Aquatic Pelagic Consumer Food Chain

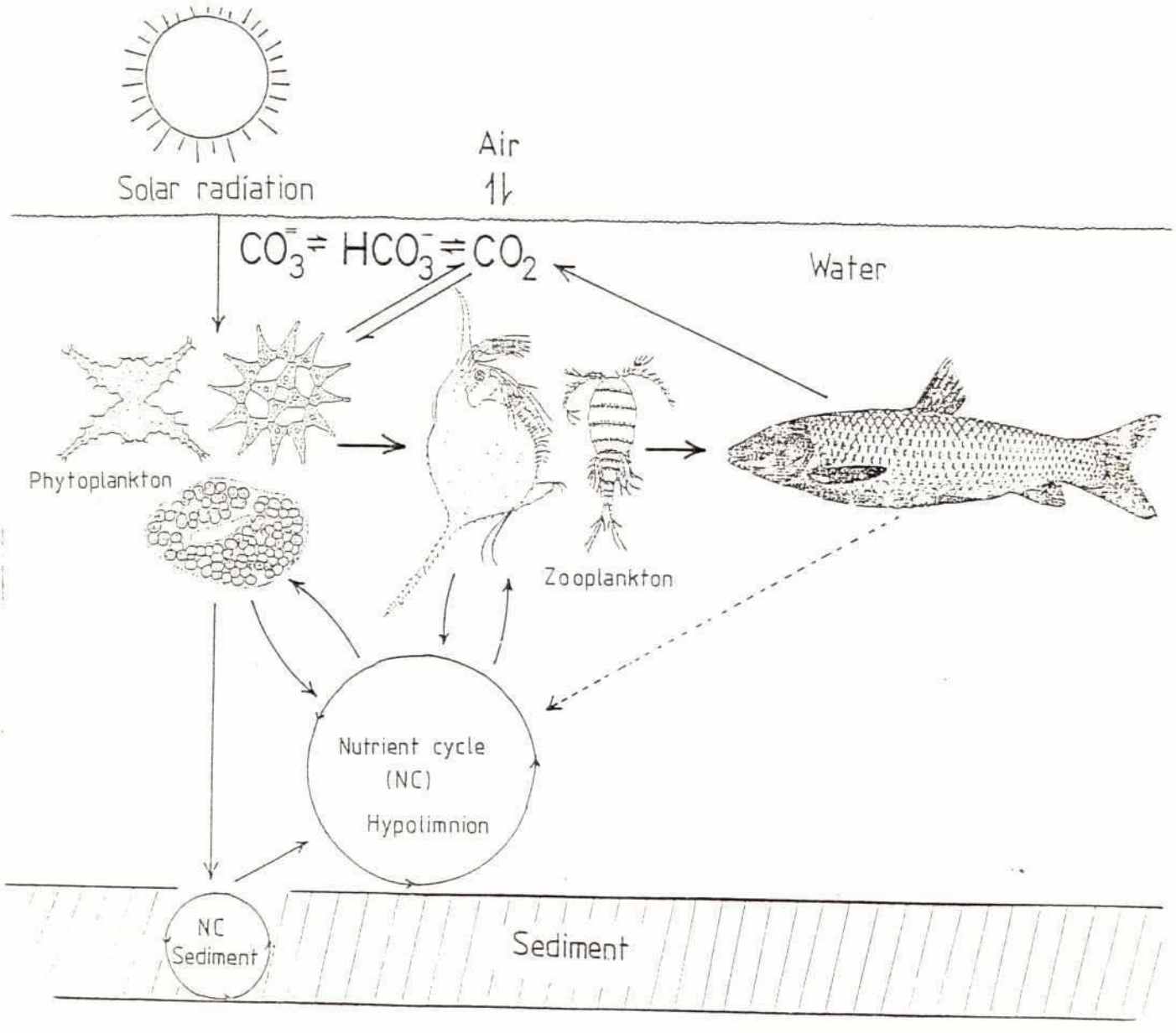
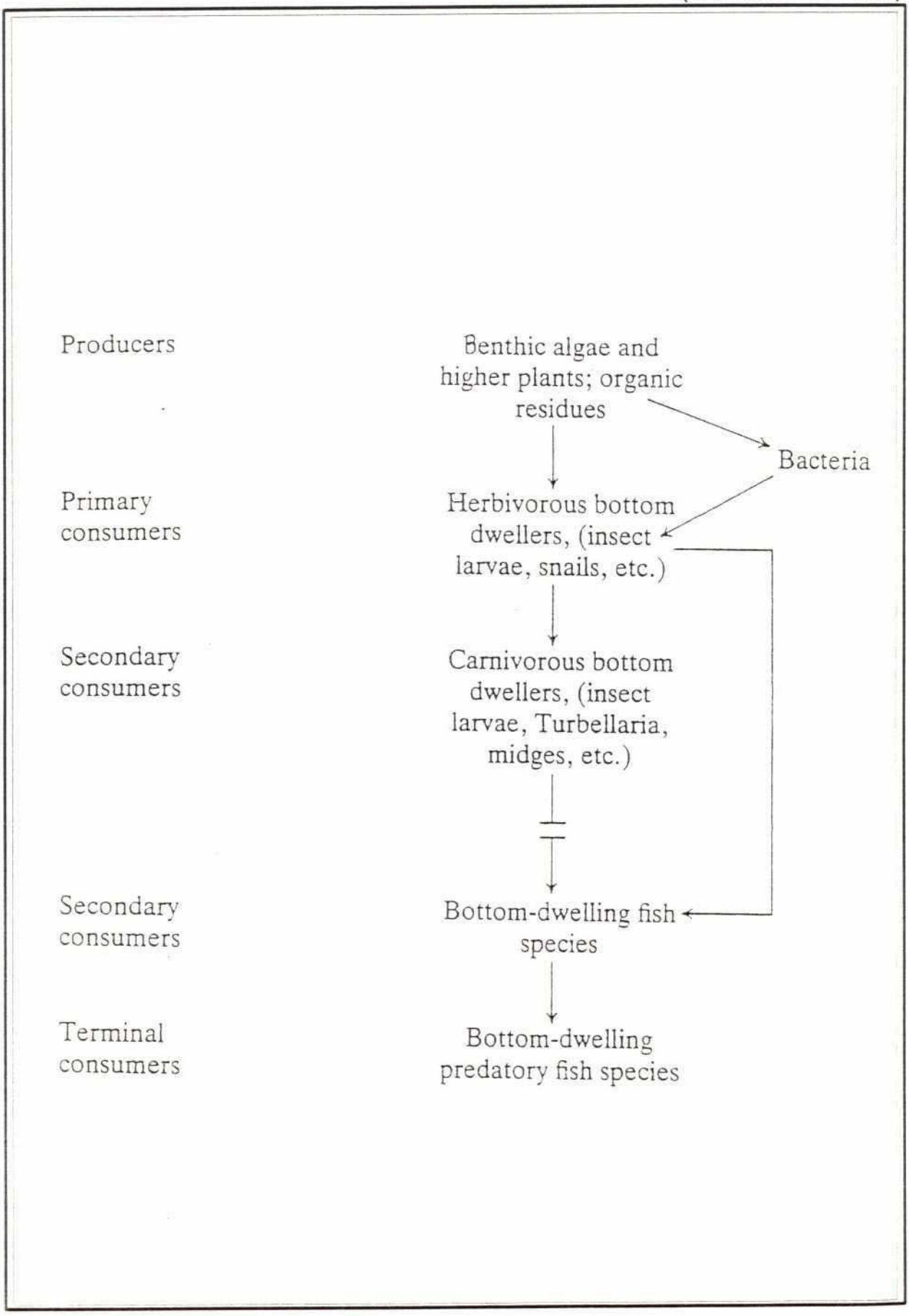


Figure D.3.3

Schematic Representation of a Benthic Consumer Food Chain (Schowerbel 1987)



Although the species diversity (as evident by the number of taxa) at sites 2 and 3 is high (Tables D.3.11, D.3.12 and D.3.13), in terms of total biomass these places may be poorer. The floodplain ecosystems such as sites 4 (Konikara Beel), 6 (Satdona Beel), 7 (Chandal Beel) and 8 (Gumti River floodplain near Gouripur) are characterized by a lesser number of taxa, the biomass as a whole should be very high because in most of the above mentioned sites a cover of *Nymphoides*, *Ottelia alismoides*, *Najas*, *Ceratophyllum*, *Utricularia*, *Myriophyllum* and *Vallisneria* was observed. In particular, *Nymphoides* spp. were so thick that when they were blossoming in early October, the entire floodplain looked like a vast white mat. Intermingled with these were luxuriant growth of tychoplankton mostly composed of desmids, diatoms and rotifers. The dense strands of many macrophytes provide a good shelter for fishes, while the members of tychoplankton attached to the strands serve as fish food. The floodplain ecosystem appeared to be poor in pelagic plankton.

D.4 Fish Ecology

The Fisheries Annex F includes details of the main issues relating to the exploitation of fish as a resource. The following account is a summary of the main ecological characteristics of various fish species and how they fit in general into the ecology of the floodplain in the Gumti Phase II Study Area.

D.4.1 Fish Diversity in the Gumti Phase II Study Area

Bangladesh has a fish fauna of over 260 freshwater fishes (Rahman, 1989) and it is likely that this figure will rise in the next few years as a result of the increasing amount of work currently being done by various organizations, especially the FAP projects. In addition, there is a need to complement existing listings to assess the full extent of the fish diversity of the country and its conservation status. It is expected that this type of information will also complement knowledge on fisheries by highlighting those species in need of attention with populations that may be able to recover to more sustainable levels in the future.

With this purpose, a preliminary list of fish species occurring in the area has been prepared from information collected during the field work by direct observations from the fishermen's catch and by gathering knowledge from local fishermen, Thana Fisheries Offices and from published material. A list of fish species in the project area was compiled and notes on their main biological and ecological characteristics were also included.

It should be noted that most of the species found in the study area have 'commercial' value as they either appear in the markets, are traded amongst the fishermen and/or are used by the people, including women and children, for their own consumption. The so called 'Miscellaneous' species, usually small fish, being the most important group of fishes in subsistence and self-provisioning for the people in the rural areas.

Fish Diversity Over 90 species belonging to 10 Orders and 27 Families were recorded during the study. Approximately 50% of which were actually observed in the catch. The rest were reported by the fishermen of the area. This represents around 35% of the total number of freshwater fish species currently known in the country. The family with the largest number of species was the Cyprinidae with 24 species, followed by the Bagridae with nine species, Eleotridae with six. Overall, there were 24 species of carps and 24 species of catfishes. It is very likely that this figure may increase after a more in depth analysis of this fauna, especially if all species are considered and not just the commercial ones.

Crustaceans Only Golda Chingri or Golda Icha *Macrobrachium rosenbergii* and small shrimps or Choto Chingri *M. styliferus* were recorded in the catch. However, according to fishermen's reports, 10 species of palaemonids and one ocypodid, Kakra (*Ocypoda certophtalma*) also occur in the area. Clearly, the number of invertebrates found in this vast floodplain is also expected to increase after due consideration is given to this important aspect of the ecology of the area.

D.4.2 Summary of the Life History of the Major Carps

These are important commercial species of which Rui is probably the favoured food fish in Bangladesh. It is thought that different geographical carp populations may exist. There are four carp species usually referred to this group: Rui, Catla, Mrigal and Kalbasu and all four are thought to have similar reproductive strategies. In the Gumti Phase II study area, these four species were important in the fish catches.

Brood stock overwinter the dry season in large rivers and beels with the spawning migration occurring in the early monsoon. In general, brood stock move from the beels into the Khals and rivers, from where they move upstream to shallower areas suitable for spawning. According to Tsai *et al.* (1981), it appears that ox-bow bends in particular are favoured, probably because they possess unusual hydrological features (deep pools in the outer bend, turbulence, upwelling and backwater currents in the inner bend). Eggs are non-adhesive and drift with the current, embryos hatch in 5 to 24 hours depending on the species. Major carp spawning grounds can be found from the sightings of drifting eggs and hatchlings.

No spawning sites for these species were located within the Gumti Phase II study area. However, there was not enough time available in the study to carry out a thorough field survey in this regard. According to fishermen in the North East Region, major carps also spawn in Beels (FAP 6, 1993). Increasing Beel water levels during the early monsoon may be enough stimulus to induce them to spawn in their overwintering Beels. Brood stock which have overwintered in rivers may have the option of carrying a spawning migration upstream at the onset of the monsoon, or to remain in the vicinity of the overwintering grounds, wait until the river banks are overtopped and then move laterally onto the floodplain to spawn. The possibility of major carp spawning in the Beels located to the west and north of the Gumti Phase II study area, since these Beel areas are located close to the Lower Meghna River needs to be investigated further.

The following section is a brief summary of information available on selected species from the Gumti Phase II study area.

D.4.3 Notes on Some Biological and Ecological Characteristics of Some Fish Species Found in the Gumti Phase II Study Area

General information presented below has been based on Rahman (1989), Tsai and Ali (1985), Talwar and Jhingran (1992) and FAP 6 (1993). Other information has been collected in the field from the local fishermen.

MAJOR CARPS

RUI *Labeo rohita*

Distribution: A riverine species which may attain 1 m in length. It is a bottom feeder that feeds on decaying vegetation and plant matter.

Spawning: Spawning migration occurs in early monsoon when the brood stock swim out of beels, down the khals and into rivers. They swim upstream to reach favoured shallow spawning localities, e.g. oxbow lakes. Spawning takes place in flooded rivers with the monsoon and it may also occur in flooded fields. Fishermen have reported Rui spawning in beels. Thus floodplain may also be important for this species. Fecundity: Varies from 226,000 to 2,984,000 eggs.

CATLA *Catla catla*

Distribution: Riverine species which may reach over 1.20 m in three years in favourable conditions. Feeding takes place in mid and surface waters. It is a non-predator which feeds mainly on plant matter (algae and higher plants), although it may also take crustaceans.

Spawning: Breeds in rivers, spawning season coinciding with the monsoon (May to August). Peak spawning appears to occur between June and July. Fecundity is reported to be between 1,564,875 and 3,630,708 eggs.

MRIGAL *Cirrhinus mrigala*

Distribution: Inhabits rivers and tanks. It may reach up to 1 m in nature. A bottom-feeder, it feeds on decaying vegetation and detritus.

Spawning: Occurs during the monsoon in shallow pockets, in marginal areas and in bunds. Depth of water in breeding grounds has been recorded to be between 0.5 and 1 m. It may spawn in flooded fields adjacent to rivers. Fecundity is reported to be 106,220 to 815,475 eggs.

KALBASU *Labeo calbasu*

Distribution: Inhabits rivers, beels, haors and ponds and may reach up to 90 cm in length. Essentially a bottom feeder, feeds on plant matter and decaying vegetation. Fecundity is reported to be 193,000 to 238,000 eggs.

MINOR CARPS

BHAGNA *Cirrhinus reba*

Distribution: Inhabits rivers, streams, canals, beels, ponds, and inundated fields. It appears to prefer clear waters and feeds on plankton and detritus.

Spawning: Breeding takes place in shallows during June to September.

GHONIA *Labeo gonius*

Distribution: Widespread throughout the country but not abundant. Attains a length of 1.5 m.

Spawning: Occurs in early monsoon in rivers and beels.

CARPLET

MOLA *Amblypharyngodon mola*

Distribution: It may reach up to 20 cm, although it is more common to find specimens of about 9 cm. It is found extensively in rivers, canals, beels, ponds and inundated fields.

Spawning: Spawns during May to October. Females lay approximately 500 eggs.

BARBS

PUNTI *Puntius sophore*

Distribution: It attains a length of 13 cm, usually maturing at 7 to 8 cm. It inhabits plains and submontain regions. It is very abundant throughout Bangladesh. It is one of the most important subsistence catches for the rural populations. It also has important medicinal value in Tamil Nadu, India.

SAR PUNTI *Puntius sarana sarana*

Distribution: A medium sized fish (30-40 cm). It is found in rivers, lakes, beels and other freshwater areas in the country.

Spawning: It breeds during the monsoon in running waters amongst submerged boulders and vegetation.

TIT PUNTI *Puntius ticto*

Distribution: Attains lengths of 10 cm. It is commonly found in streams, canals, beels, ponds, ditches and inundated fields throughout Bangladesh.

Spawning: The breeding season from May to October.

LARGE CATFISHES

BOAL *Wallago attu*

Distribution: This catfish may reach lengths of 2 m. It inhabits freshwater and tidal waters. In Bangladesh, it is found in rivers, beels, haors, pools and ponds. It thrives well in rivers and tanks, especially beels with grassy margins. When in captivity, it prefers muddy tanks subject to periodical flooding from rivers. It is a voracious and predatory bottom feeder.

Spawning: Pre-monsoon summer breeder. It spawns in June and July, as soon as streams and tanks are flooded by rain, they run up to shallow water for breeding. It builds nests for breeding and offers parental care.

AIR *Aorichthys (Mystus) aor*

Distribution: Inhabits rivers, khals, beels, ponds, lakes, channels, reservoirs, inundated fields and ditches. It commonly attains lengths of 1 m, although it may grow up to nearly 2 m.

Spawning: Spawning may take place from early April to the end of August. A nest or breeding pit is dug out in soft mud in sluggish current.

SMALL CATFISHES

SINGI *Heteropneustes fossilis*

Distribution: This medium sized catfish is capable of breathing air and may attain lengths of 30 cm. Primarily a fish of ponds, ditches, swamps and marshes, it is also found occasionally in muddy rivers. During the dry season it lives in semi-liquid or semi-dry mud.

Spawning: Spawning takes place during the monsoon April to July in confined waters. Spawning has been observed in swampy patches within flood regions of rivers. It is also capable of breeding in ponds, (including derelict ones) and ditches. It cannot be stocked in ponds because it migrates to other water bodies over land at the beginning of the monsoon. It produces between 4,200 to 15,750 eggs.

Medicinal value: It is in great demand due to its medicinal value (invigorating qualities of flesh).

TENGRA *Mystus vittatus*

Distribution: This very common small sized catfish may reach up to 20 cm in length. It inhabits a variety of standing and flowing water bodies such as pools, lakes, rivers, etc. It is highly prized as a commercial and subsistence food fish.

The term 'Tengra' refers collectively to a small group of bagrid catfishes of the genera *Mystus* and *Batasio*.

BATASI *Pseudeutropius atherinoides*

Distribution: A small fish which may reach 8 cm. Inhabits freshwaters and tidal rivers. It is abundant from October to December.

PABDA *Ompok pabda*

Distribution: This small catfish (17 cm) inhabits all types of inland waters, beels and rivers, including inundated fields.

Feeding: An omnivorous species.

SNAKEHEADS

SHOL *Channa striatus*

Distribution: It may attain a length of 75 cm. Inhabits ponds, streams, beels, haors, ditches and swamps where it is abundant. Prefers stagnant muddy waters and grassy tanks. It buries itself deep in the bottom mud during the dry season.

Feeding: It is a voracious predator which feeds on fish, frogs, snakes, insects, earthworms and tadpoles.

Spawning: Breeds almost throughout the year, especially during the onset of the monsoon, in ditches, ponds and flooded paddy fields.

GAJAL *Channa marulius*

Distribution: This snakehead may reach over 120 cm in length, although it is more commonly caught when around 46 cm. It inhabits large lakes and rivers and prefers deep, clear stretches of water with sandy or rocky bottom.

Feeding: Predacious, carnivorous habits, similar to Shol.

Spawning: Breeding almost throughout the year, eggs laid in nests guarded by parents.

TAKI *Channa punctatus*

Distribution: Lives in the floodplain, in large beels, ponds, tanks and swamps. Prefers stagnant waters in muddy streams.

Feeding: A carnivorous, voracious predator, it feeds on small fish and fry.

Spawning: Prolific breeder, breeds in ponds almost throughout the year by building circular nests with weeds. Peak breeding takes place during the monsoon.

KNIFEFISHES

CHITAL *Notopterus chitala*

Distribution: It may attain over 120 cm in length, although market specimens are usually around 26 cm long. It inhabits beels, rivers, canals and ponds and prefers clean waters.

Feeding: Carnivorous and predatory. It feeds on aquatic insects, molluscs, shrimps and small fishes.

Spawning: It migrates onto the floodplain during the rainy season. Breeding takes place in June-July. It dugs a nest in the bottom mud which is guarded by parents.

MISCELLANEOUS SPECIES

NEDDLEFISHES

KAKILA *Xenentodon cancila*

Distribution: It may reach approximately 40 cm in length. It is a surface-living fish common in rivers, beels, floodlands, clear perennial streams, ponds and inundated fields throughout the country.

SHADS

CHAPILA *Gudusia chapra*

Distribution: Maximum length of 15 cm. Inhabits rivers, beels, floodlands, ponds, ditches and inundated fields.

Feeding: It is a surface feeder. It is an important subsistence species.

SPINY EELS

TARA BAIM *Macrognathus aculeatus*

Distribution: May reach up to 38 cm in length. It is found mainly in khals, beels, haors and rivers. Prefers running water but it is able to survive in stagnant waters.

Feeding: It feeds mainly on algae, mud/sand and other plant material.

BAIM *Mastacembelus pancalus*

Distribution: Up to 18 cm in length. Inhabits small rivers, beels, floodlands, canals, streams, ponds and inundated fields. It is very abundant during the rainy season.

CLIMBING PERCHES

KOI *Anabas testudineus*

Distribution: Attains a length of 25 cm. Inhabits fresh and brackish waters, mostly canals, lakes, ponds and swamps. Prefers stagnant waters, derelict pits, pools and puddles. It is a very hardy fish which possesses a breathing organ that enables it to survive for days or weeks out of water provided its breathing organ is kept moist. It remains buried in the mud during the dry season.

Spawning: Breeding starts in April with the onset of the monsoon and may last until July. It produces between 39,700 and 86,100 eggs.

It is a staple subsistence food item, very tasty.

KHALISHA *Colisa fasciatus*

Distribution: Maximum length of 12 cm. All large freshwater areas in Bangladesh such as large rivers, tanks, ditches and ponds.

GLASSFISHES

CHANDA *Chanda nama*

Distribution: Attains a length of 11 cm. Widely distributed in clear fresh and brackish waters, both in standing and running water such as streams, canals, beels, ponds and inundated paddy fields. Abundant during the rainy season.

Could be used effectively for malaria control.

FRESHWATER HERRINGS

KACHKI *Corica soborna*

Distribution: It is a small fish (4 cm). It inhabits rivers and estuaries.

GOBIES

BAILLA *Glossogobius guiris*

Distribution: Attains lengths of 30 cm. Found in freshwaters, estuaries and the sea.

MUD PERCHES

BHEDA (MENI) *Nandus nandus*

Distribution: Attains lengths of 20 cm. Inhabits fresh and brackish waters and is common in ditches and inundated fields. Common in the summer months.

It is a very popular highly prized fish.

SHRIMPS

BIG SHRIMPS *Macrobrachium rosenbergii*

Distribution: Widespread in rivers and beels.

Spawning: Adults migrate downstream to spawn in estuaries and the sea. Juveniles move back into rivers to grow and mature.

It is economically very important.

PARASITES *Argulus* sp.

A common ectoparasite copepod has been found to infect several of the fishes in the project area and causes heavy mortalities in ponds.

DISEASES

White spot has been observed in several species.

D.4.4 Fish Migrations and Movements

In an area of floodplain as vast as the Gumti Phase II study area, fish migration is rather an important issue for the whole energetics of the system, especially since the number of fish species is so large. In addition, it is important to note that although some fish are in general referred to as 'migratory' fish, by and large all fish species migrate or move from one area to another in the floodplain. In the Fisheries Annex F, these species have been referred to as 'long-distance' migrants and 'floodplain resident' species.

According to Welcomme (1979), most fish have two distinct centres of concentration, their wet and dry season habitats, and thus they have to travel sometimes over long distances in order to reach them. The two main components of such migratory movements recognised for tropical species are longitudinal and lateral migrations. Longitudinal movements taking place within the main river channel (i.e. 'long-distance' migrants), and lateral migrations being those where fish leave the main channel and distribute themselves over the floodplain, or the 'floodplain residents'. It is now known that both of these migrations are active since often fish migrate against the current to gain access to the main floodplain. Most healthy adult fish tend to direct their movements rather that drift in the currents although fish eggs and larvae do drift.

In general, fish initiate their riverine migrations with the onset of the floods and lateral migrations when the banks spill onto the floodplain. In addition, fish appear to move actively against the current rather than to enter passively on incoming flows. Migration also appears to be an ordered sequence of species with some species moving first. Adult fish tend to leave the floodplain before the young-of-the-year, which appear to stay in the floodplain until the later stages of its emptying.

D.4.5 Environmental Stimili Influencing Fish Breeding and Migration

Breeding

Breeding begins during the pre-monsoon flood and depending on the rain and water volume in the river and floodplain, most of the catfish, live fish and other species such as Magur, Singi, Koi, Tengra, Pabda, Air, Boal, Gazar and Sol, start breeding towards the end of March and early April. It would appear that piscivorous fish such as some of the catfishes Boal, Gazar and Sol breed earlier than the non-piscivorous species. Optimal environmental conditions for breeding are tempestuous and include flash floods, heavy continuous rain and thunder, which together stimulate fish breeding, especially for Ghonia, Boal, Pabda, Koi, Batasi, Puti and Laso.

It should be pointed out that intervention 1 currently under consideration in Zone A and which involves control flooding in approximately 73% of the Zone, will most likely interfere with the reported fish breeding of species such as Ghonia (Figures D.4.1 and D.4.2 interventions map). The area in Zone A is influenced by flash floods from the Tripura Hills in India. It is currently unknown if there are other species using the area in a similar way. Figures D.4.3 and D.4.4 show the rise of the 1 in 2 year flood pattern in the Gumti Phase II Study area. Figures D.4.5 and D.4.6 show the falling 1 in 2 year flood pattern with interventions.

Under this intervention, it is planned to reduce the number of openings on the northwest side from 20 open structures to 4 gated channels. The allowance made for fish to re-enter the poldered area consists of fish-friendly gates (refer to the Fisheries Annex F) which would be kept open until the middle of June, or until increased water levels threaten the agricultural crops in the area. This proposed intervention will result in water within the embanked area being drained from it during the wet season and water inflow to this zone being controlled by 8 gated structures, four in the east and four in the north-west. Although part of the floodplain will still exist, it will not be available for fish to the same extent as prior to construction. Thus, the loss of a substantial portion of the floodplain area as valuable feeding, nursery and refuge areas for fish and other aquatic organisms will occur. This key role of the floodplain in this zone was also confirmed by the local fishermen who reported fish in breeding condition being caught during their spawning migration within it. At this time, species such as Ghonnia tend to group in large numbers in the khals and are easy prey to the fishermen, who actively catch them. Up to 15 Ghonnia have been reported to have been caught using a 'Polo' trap by one man in a single attempt.

It is thus strongly recommended that this situation be analyzed further before the proposed scheme goes ahead. The Fisheries Annex F has full details of the estimated fish losses in the area due to the proposed intervention.

Fish Migration

In general, a series of environmental factors appear to trigger fish migrations, although these may not always be effective as fish are on occasions left stranded. Some of the main factors influencing fish movements include depth of water, (there seems to be a general tendency for bigger fish to leave the floodplain earlier than the smaller fish), dissolved oxygen concentrations, temperature, light (many fish prefer to move at night) and lunar phase.

Figure D.4.1

Un-Modelled Interventions

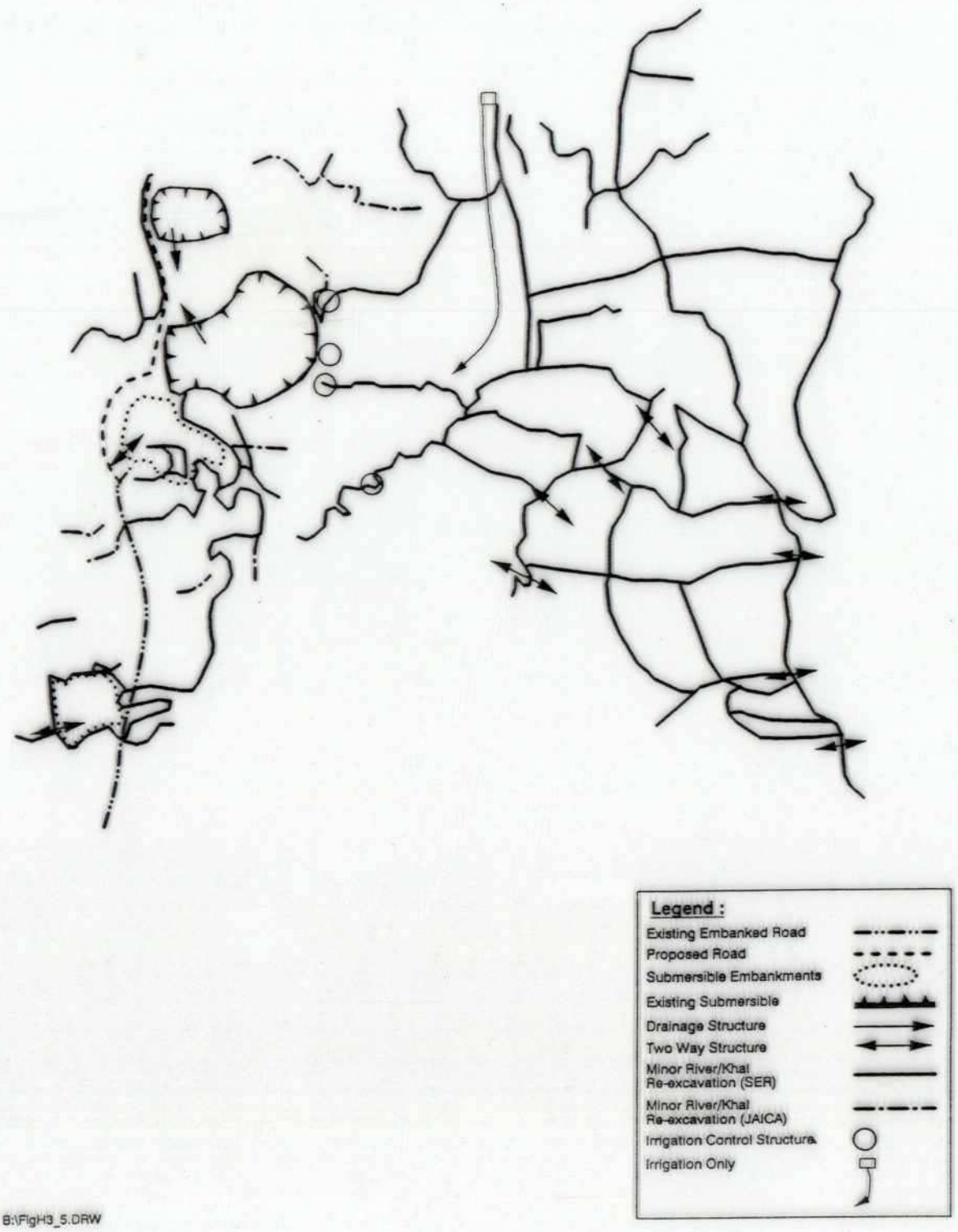


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Figure D.4.1

Un-Modelled Interventions

Figure D.4.2

Modelled Detailed Interventions

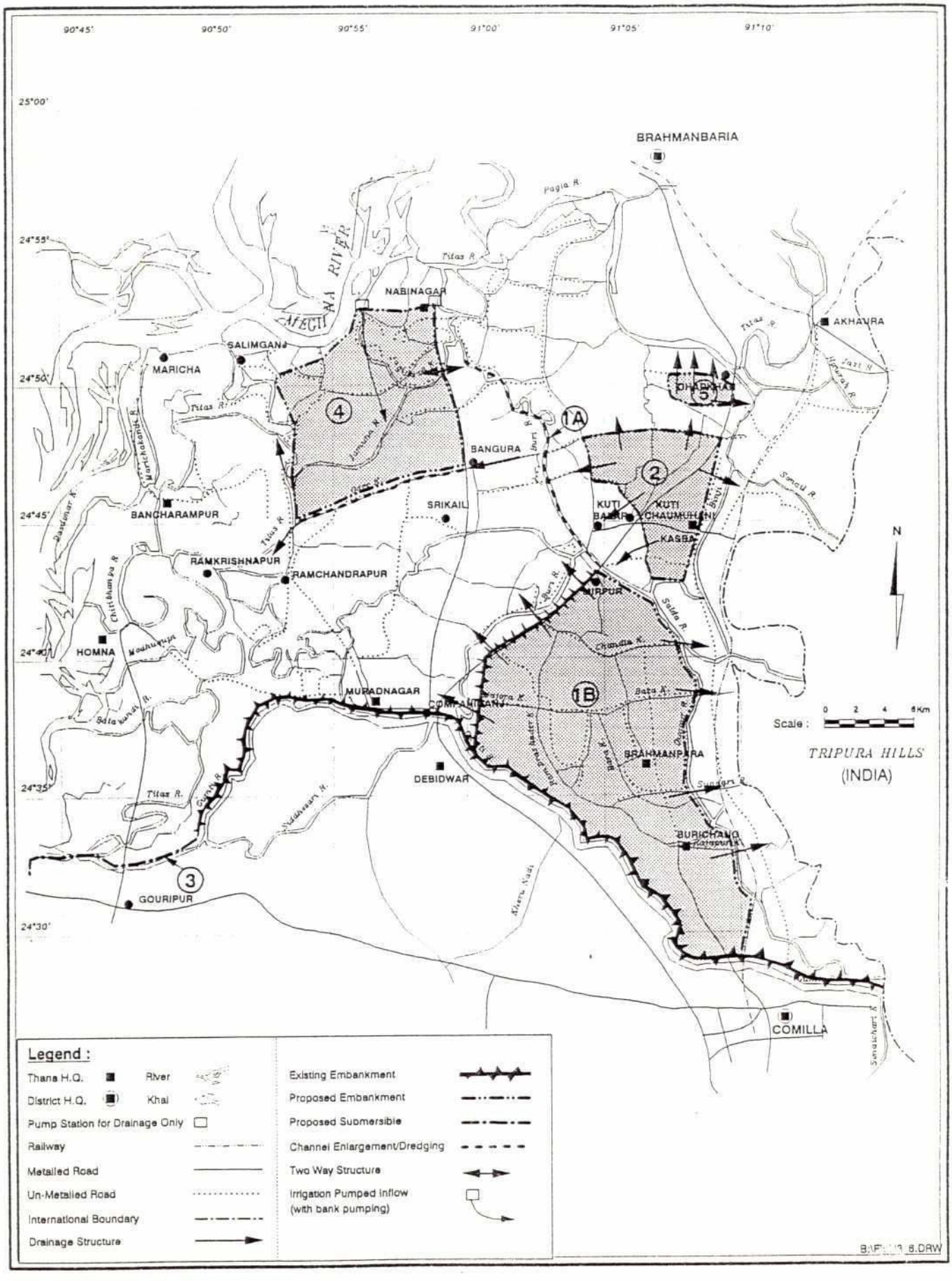


Figure D.4.3

Rising 1 in 2 Year Flood Pattern

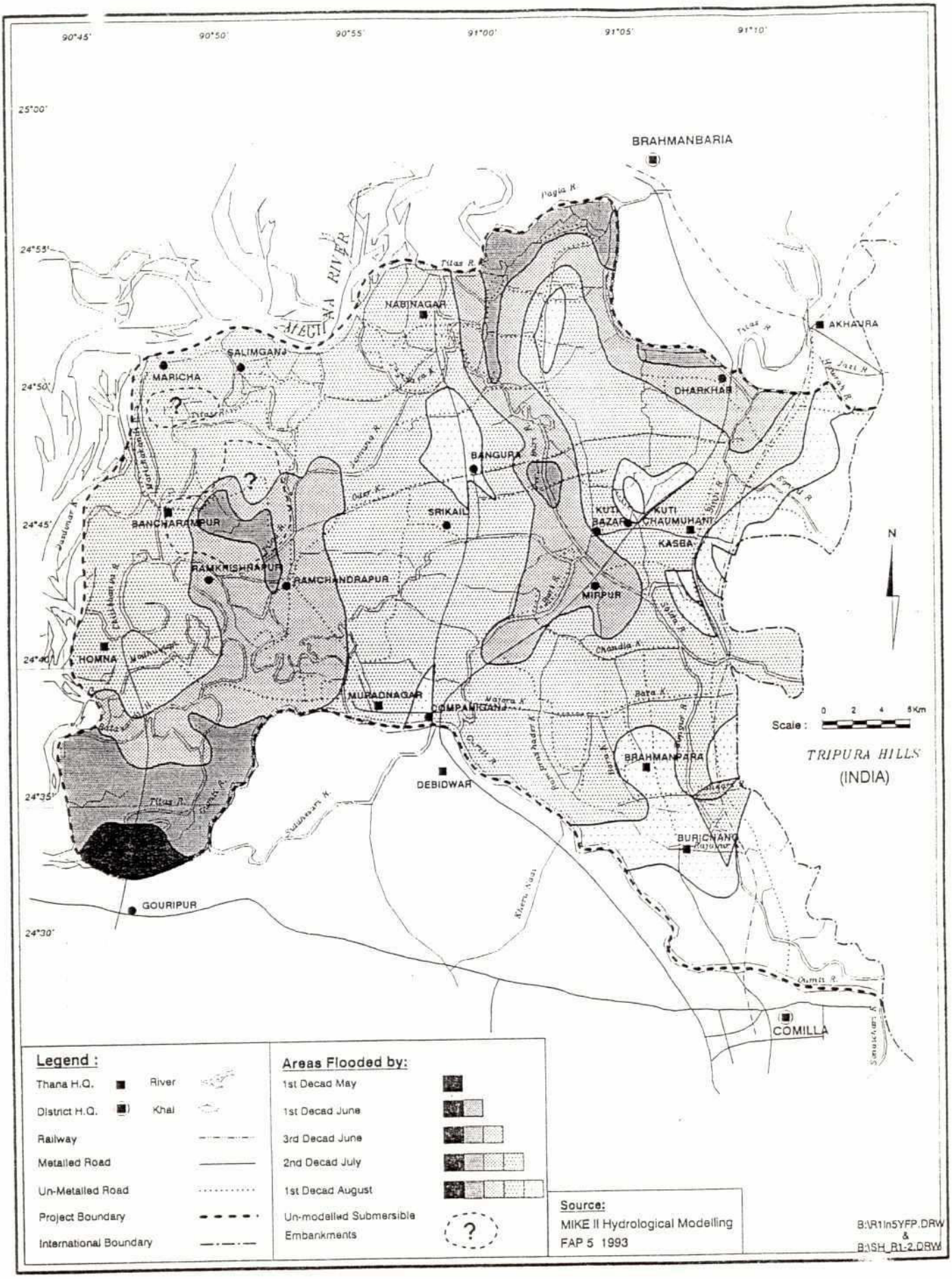


Figure D.4.4

Falling 1 in 2 Year Flood Pattern

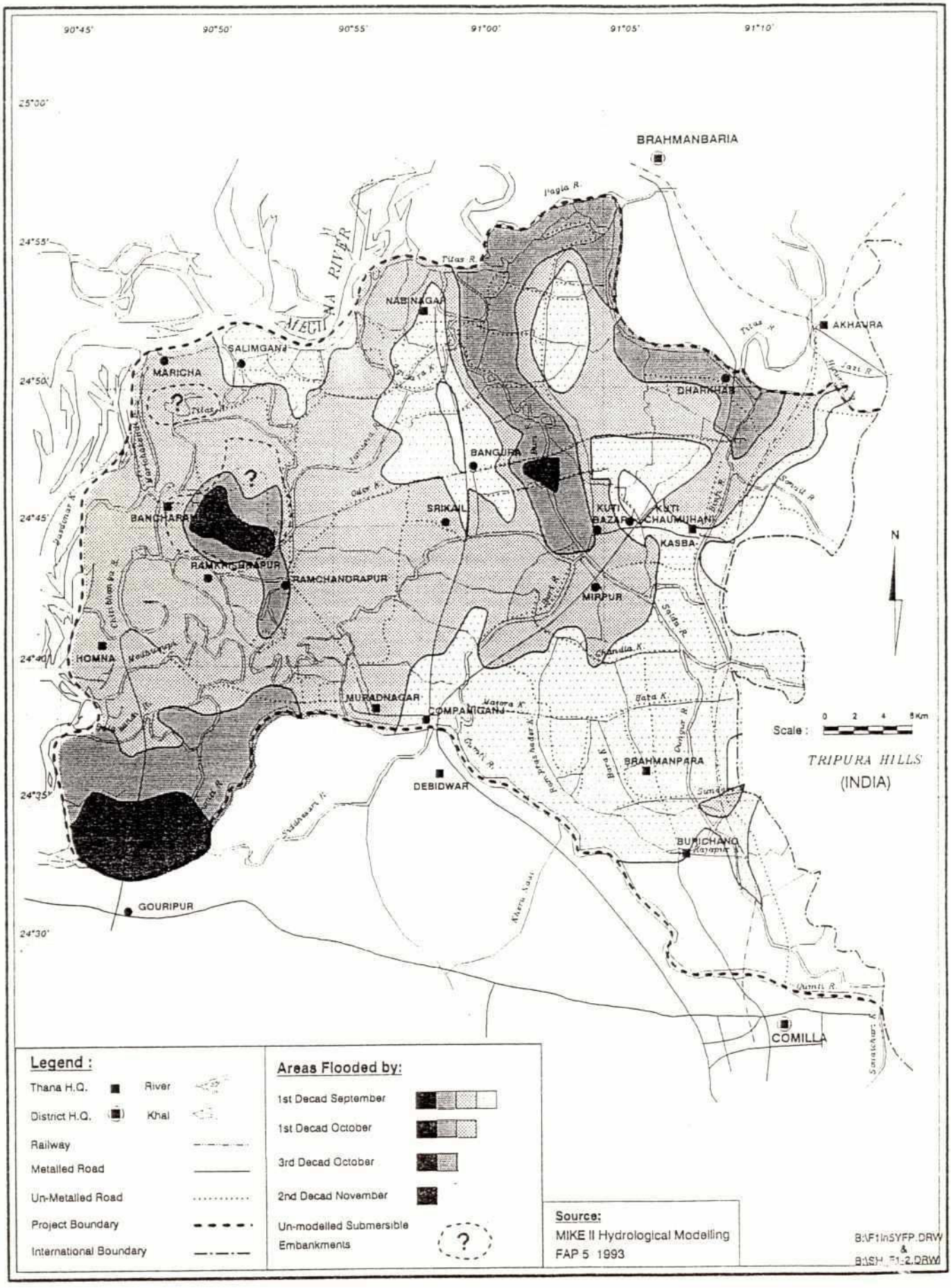


Figure D.4.5

Rising 1 in 2 Year Flood Pattern With Interventions

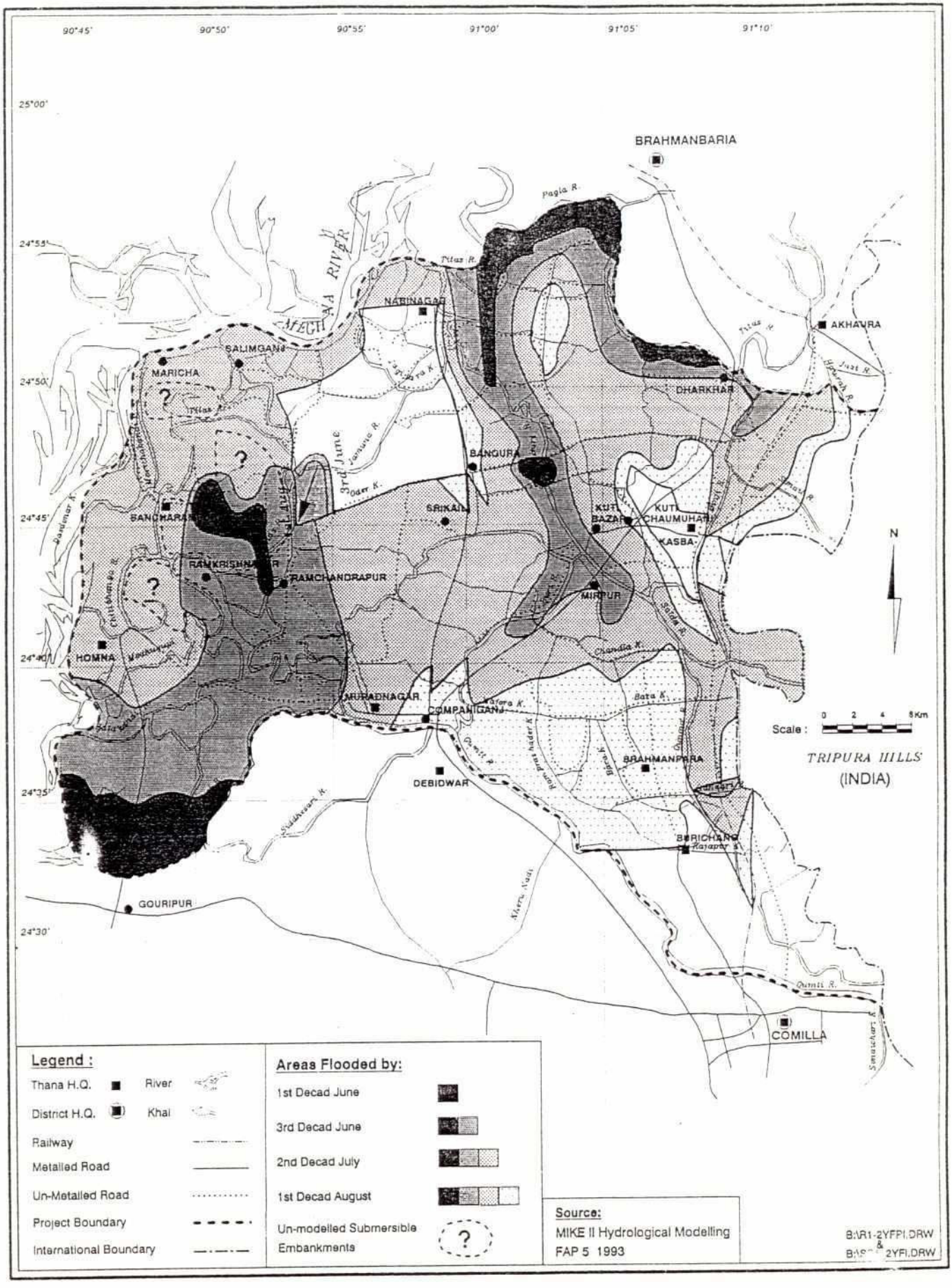
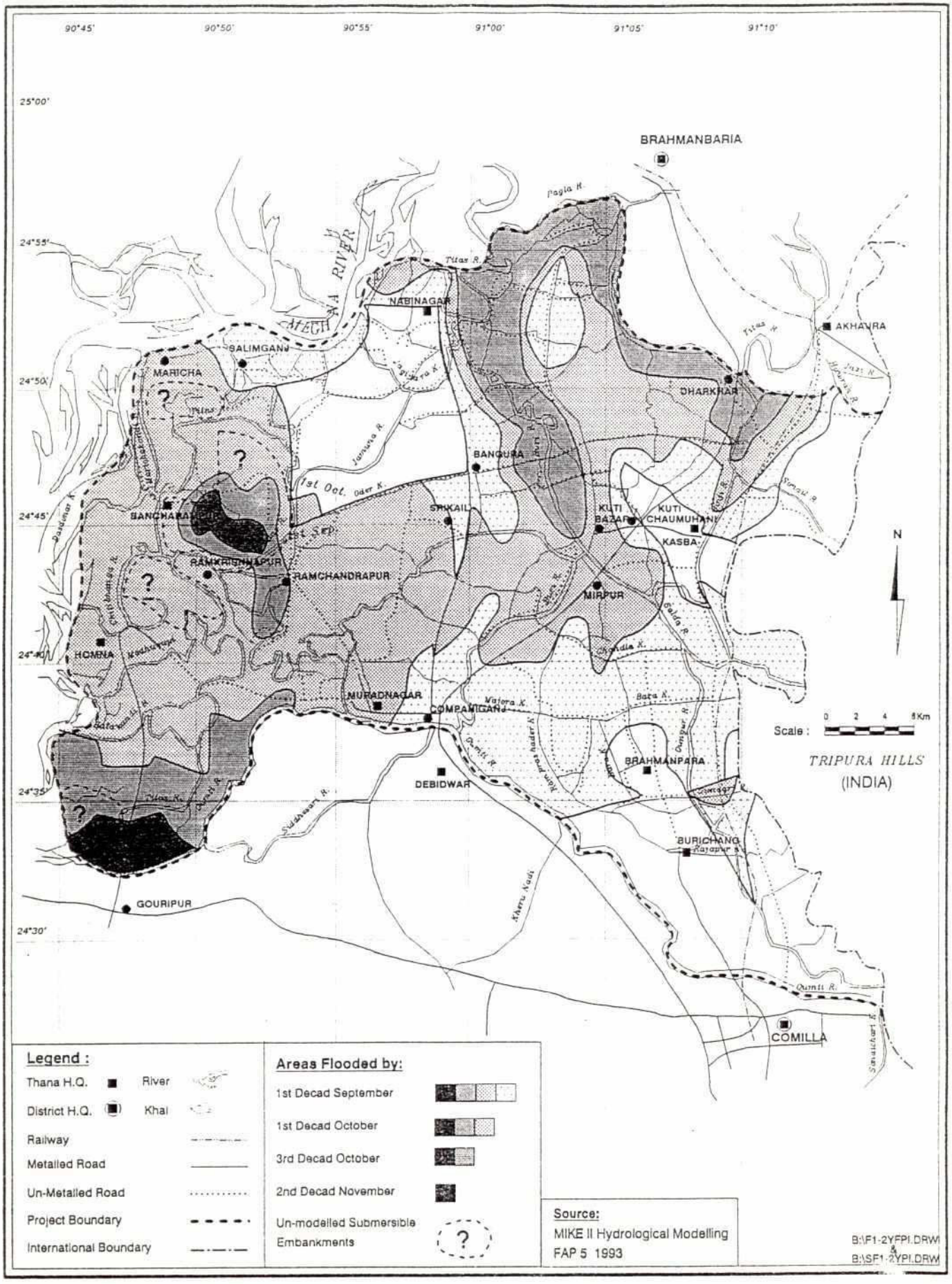


Figure D.4.6

Falling 1 in 2 Year Flood Pattern With Interventions



In the present study it was not possible to examine fish migration and/or movements in the floodplain or the channels. However, since fish access to the river channels and floodplain areas is crucial to the ecology and to the fisheries as a whole in the Gumti Phase II study area, it is strongly recommended that such a study be carried out before any intervention takes place in areas already identified as important for access, such as the northern part of Zone C, which carries the early floods into the system and presumably the fish (Figure D.4.3 rising flood 1 in 2 years). Such a study should also consider other possible areas important for access for fish and other species.

In addition, full polderization of part of Zone C (Intervention 4) has been proposed very close to the main area of access to the early floods from the Meghna River and this proposed scheme can be seen in Figure D.4.2. The devastating effects of such a polder on the important fisheries of the area have been described in detail in the Fisheries Annex F. However, it should also be emphasised in this Annex that the floodplain area in Zones C and D is a vast wetland which is believed to be a heaven for numerous species of flora and fauna. This has been confirmed from the preliminary evaluation of the biodiversity of the study area as shown in tables presented in section D.3. It is therefore believed that the proposed polder scheme will also have severe consequences on the wildlife, both flora and fauna, of the area.

D.4.6 Declining Fish Species in the Gumti Phase II Study Area

A preliminary list of declining fish species from the study area was compiled from fishermen's accounts and from information gathered from the Thana Fisheries Officers. Table D.4.1 shows that approximately 41 species appear to be declining in certain Thanas. The overall change has been noted in the preliminary list of fish and prawns in the study area but it should be pointed out that this list is incomplete and further work should be carried out before any conclusion may be drawn from it. However, it does highlight the fact that several species have noticeably declined in the last few years. The decline of these species should be viewed not only from the conservation perspective, but from the economic viewpoint as well. The sustainability of these fisheries resources should become one of the top priorities for the local and central governments since the livelihood of many people is based upon them.

D.4.7 Increasing Species in the Gumti Phase II Study Area

Table D.4.2 shows that a total of 12 species were reported as increasing in the Thana of Bancharampur although some of these same species had already been reported as declining on other Thanas. It is possible that these changes are real and that the species simply move within the floodplain from less favourable area to a more suitable one. A more detailed study of these fluctuations in species abundance is strongly recommended as the changes in distribution and abundance could be an indication of the health of the floodplain species.

TABLE D.4.1

DECREASING FISH AND CRUSTACEAN SPECIES IN GUMTI PHASE II

	Bangla Name	Scientific Name		Reported decrease\ in following Thanas
Class -	Osteichthyes			
Order -	Osteoglossiformes			
Family -	Notopteridae (Featherbacks)			
	Chital	Notopterus	chitala	N,K,B,H
Order -	Clupeiformes			
Family -	Clupeidae (Herrings, Shads)			
	Chapila	Gudusia	chapra	M,B
Order -	Cypriniformes			
Family -	Cyprinidae (Carps, Barbs and Minnows)			
	Mola	Amblypharyngodon	mola	K,B,M
	Catla	Catla	catla	M,B
	Chep chela, Pata chela	Chela	cachius	M
	Mrigal	Cirrhinus	mrigala	M,B
	Bhagna, Raik, Lasu	Cirrhinus	reba	M,N,H
	Carpio	Cyprinus	carpio	M
	Silver carp	Hypopthalmichthys	molitrix	B
	Kalbasu, Kalibaus	Labeo	calbasu	M,K,B
	Ghonia	Labeo	gonius	M,K,B,H
	Rui, Rohit	Labeo	rohita	B
	Sar Punti	Puntius	sarana	M,N,K,B,H
Family -	Cobitidae (Loaches)			
	Gutum, Puiya	Lepidocephalus	guntea	H
Order -	Siluriformes			
Family -	Bagridae (Long Barbeled Catfishes)			
	Ayre, Guji Air	Aorichthys (Mystus)	aor	M,B,H
	Golsha-tengra	Mystus	bleekeri	K,H
	Tengra	Mystus	vittatus	K,H
	Rita	Rita	rita	N,H

TABLE D.4.1 (Contd..)

	Bangla Name	Scientific Name		Reported decrease\ in following Thanas
Family -	Siluridae (Butter Catfishes, Freshwater Sharks)			
	Madhu Pabda	Ompok	pabda	M,K,B
	Boal	Wallago	attu	K
Family -	Schilbeidae (River Catfish)			
	Kajuli, Kazali, Baspata	Ailiichthys	punctata	M
	Bacha	Eutropiichthys	vacha	M
	Batasi	Pseudeutropius	atherinoides	B
	Shillong	Silonia	silondia	N,B
Family -	Pangasiidae			
	Pangas	Pangasius	pangasius	M,N,B,H
Family -	Clariidae (Air Breathing Catfish)			
	Magur	Clarius	batrachus	K,H
Family -	Heteropneustidae (Stinging catfish)			
	Shingi	Heteropneustes	fossilis	
Order -	Perciformes			
Family -	Centropomidae			
	Coral	Lates	calcarifer	N
Family -	Nandidae (Mud perches)			
	Meni, Bheda	Nandus	nandus	K
Order -	Polynemiformes			
Family -	Polynemidae			
	Tapasi, Muni, Rishi	Polynemus	paradiseus	H
Family -	Gobiidae (gobies)			
	Belle, Bailla	Glossogobius	guiris	K,B,H

TABLE D.4.1 (Contd..)

	Bangla Name	Scientific Name		Reported decrease\ in following Thanas
Family -	Gobioididae (Eel like gobies)			
	Lal Chewa	Odontamblyopus	rubicundus	M,N,H
Family -	Anabantidae (Climbing Perches)			
	Koi	Anabas	testudineus	K,B,H
	Khalisha	Colisa	fasciatus	K
	Baicha	Colisa	labiosus	H
Family -	Channidae (Snake Heads and Murrels)			
	Gajar, Gajal	Channa	marulius	K
	Taki	Channa	punctatus	K
	Shol	Channa	striatus	K
Family -	Mastacembelidae (Spiny Eels)			
	Pankal	Mastacembelus	pancatus	B
Family -	Stromateidae (Pomfrets)			
	Rup Chanda	Pampus	chinensis	H
Class -	Crustacea			
Order -	Decapoda			
Family -	Palaemonidae			
	Golda Icha, Golda Chingri	Macrobrachium	rosenbergii	B

Sources:
- Weekly field reports
- Personal communication with fishermen
- Thana Fisheries Office survey carried out during this study.

THANA KEY
B - Bancharampur
K - Kasba
N - Nabinagar
H - Homna
M - Muradnagar

TABLE D.4.2

INCREASING FISH AND CRUSTACEAN SPECIES IN GUMTI PHASE II

	Bangla Name	Scientific Name		Reported increase in following Thanas
Order -	Clupeiformes			
Family -	Clupeidae (Herrings, Shads)			
	Kachki	Corica	soborna	
	Chapila	Gudusia	chapra	
Order -	Cypriniformes			
Family -	Cyprinidae (Carps, Barbs and Minnows)			
	Mola	Amblypharyngodon	mola	
	Chep Chela, Pata Chela	Chela	cachius	B
	Punti	Puntius	sophore	B
Order -	Siluriformes			
Family -	Bagridae (Long Barbeled Catfishes)			
	Tengra	Mystus	armatus	B
	Kaio Bujuri, Bajari tengra	Mystus	tengara	B
Family -	Siluridae (Butter Catfishes, Freshwater Sharks)			
	Boal	Wallago	attu	B
Order -	Perciformes			
Family -	Ambassidae (Glass Perches, Snook)			
	Chanda	Chanda	beculis	B
	Nama Chanda	Chanda	nama	B
	Ranga - chanda, Lal Chanda	Chanda	ranga	B
Class -	Crustacea			
Order -	Decapoda			
Family -	Palaemonidae			
	Knunchu Icha	Macrobrachium	lamarrei	B

Source: - Weekly Field Reports
- Personal communication with fishermen.
- Thana Fisheries office survey carried out during this study.

D.5 Threats to Biodiversity

In the context of Bangladesh, many of the threats that wildlife face are also being met by its human population. Many of them are natural such as the cyclones, tornados, droughts, floods and earthquakes. A brief summary of the natural factors affecting the wildlife and the people is given below:

D.5.1 Natural Factors Affecting Biodiversity:

Cyclones Cyclones are extremely intense storms. Wind speeds have been recorded at over 177 km/h, which generate storm surges up to 8 m in height. The Gumti Phase II project area is very much at risk as the Meghna estuary acts as a funnel drawing in typhoons. When high tides, storm surges and high southerly winds coincide, there can be enormous damage. In May 1961, a cyclone and tidal bore hit Comilla and Dhaka. Daudkandi Thana was most affected with 50% of the kutcha houses razed to the ground. Extreme damage to agricultural land occurred in the entire project area.

Tornados These also threaten the project area and according to Rashid (1991), the most severe tornados have been recorded in the south central climatic sub-zone which includes the Gumti Phase II project area. In 1969, a severe tornado damaged 118 villages in Comilla and severely damaged Homna, where 30% of the houses where destroyed killing 42 people.

Droughts These have occurred in 1779 and 1783 in Comilla due to failure of the rains and this resulted in the banning of grain exports from the region. More recently droughts have been an increasing environmental hazard due to the lack of water between the months of March and May.

Flooding This is a climatic hazard in the project area as a whole. The Meghna floodplain is affected by deep and early seasonal flooding and also by flash floods. The northern and eastern plains and hills are also affected by flash floods and as vegetation becomes more degraded, flooding will increase in severity and cause induced erosion rates to be higher.

The Gumti embankment has breached many times over the past 200 years and caused catastrophic flooding in the project area in 1784, 1788, 1794, 1961 and 1967. High levels in the Ganges, Brahmaputra and Meghna rivers caused abnormally high flooding in 1954, 1970, 1987 and 1988, resulting in damage at Kasba, Bancharampur, Homna and Muradnagar.

Earthquakes Another hazard in the project area is from earthquakes. These are especially concentrated in the piedmont plains and the hills to the east. In 1897, an earthquake affected Brahmanbaria, destroying buildings, river banks and roads. If such an earthquake should occur in the project area today, liquefaction of embankments and settlement mounds could happen with associated catastrophic flooding, if this was during the rainy season as is normally the case. Earthquakes in the hills cause landslides, destroying agricultural land, choking rivers and causing heavy loss of life.

D.5.2 Human Interventions in the Gumti Phase II Study Area

Some of the main human interventions affecting the wildlife of the study area include habitat alterations, over-exploitation of the resources, introduction of species and increased pests, organic pollution, domestic waste and agro-chemical effluents from agricultural fields amongst others. A brief summary of these impacts is given below:

Habitat Alterations:

These have occurred for centuries, such as in the case of the embankment of the Gumti River, but it is in the last decades when they have been felt more dramatically. Amongst these alterations, the most important one must be related to the Flood Action Plan currently underway in the country. Unfortunately until very recently, little attention, if any, had been given to the impacts of flood control on the ecology and biodiversity of a given area. It is granted that extremely important issues such as increasing the production of food, were at the top of the agenda of the organizations concerned. However, it is increasingly clear that any further development programmes in Bangladesh must address the issue of habitat deterioration it should try to minimise them by all means possible.

It must be emphasised that it is not only the wildlife, both flora and fauna species, who are affected by habitat alterations. The consequences of polderization and control flooding have already been felt by several of the human communities in the areas of the Chandpur Irrigation Project and the Meghna-Dhonagoda scheme who have lost their livelihoods or who no longer have access to the free-common fisheries. These consequences have obviously also been felt by the floral and faunal communities, especially fish, that used to inhabit the area. The Fisheries Annex F includes further details of the impacts of these schemes on the fisheries.

D.5.3 Over-exploitation of the Natural Resources:

The use of the natural resources in Bangladesh, as in the whole of the study area, is extremely intense with little or no resulting wastage. However, with an increasing human population, it is likely that this utilisation will only increase in the future. From the information presented, it can be seen that the people of the study area already utilise the local resources efficiently but intensively. It would thus seem necessary to carry out a full inventory of the species in the area to account for the existing biodiversity of species, habitats and genes. Consideration will need to be given to the possibility of protecting examples of the biota and/or habitats with a view of developing programmes directed towards the achievement of sustainable use of the resources.

D.5.4 Introduced Species

There are several ongoing programmes in the country which are attempting to improve the fisheries and the agriculture potential in several areas. From the fisheries point of view, aquaculture of so called 'exotic' species and fingerling releasing programmes should exert extreme care so that they do not place indigenous or local species under threat. Throughout the world, escapees from fish farms are known to be a major cause for competition with the native species for vital space, food and breeding grounds. In addition, introduced species often prey on the native ones causing their demise. It should be pointed out that introduced species also include native species which have been taken from one area of the country to another which they did not naturally inhabit previously. These introduced species also include translocation or transplantation of species. A similar situation has been assumed to occur with agricultural crops.

An added risk to both agricultural crops and the people is the increase in the rat population in areas which become drier after control flooding schemes are set into place. The thriving rat populations are virtually impossible to control.

D.5.5 Pollution

It is assumed that in the Gumti Phase II study area, pollution mainly includes domestic, organic and agro-chemical runoffs from nearby fields. There is a good deal of navigation within the study area and engine effluents are also contributing to the pollution of the system. However, in general, the annual flooding is believed to be able to flush away most of these pollutants. Any schemes intending to alter this pattern will need to take into account the potential accumulation of discharges, both organic and inorganic, in areas where control flooding and/or polderization are proposed.

D.5.6 International Activities

Bangladesh is party to the Convention concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention). It also participates at the Unesco Man and the Biosphere Programme, although not actively. Bangladesh is also a signatory to the Convention on Wetlands of International Importance especially as Waterfowl Habitat known as the Ramsar Convention. This convention provides with a unique mechanism for international cooperation in the management of aquatic resources and although this convention was originally established mainly for waterfowl, its provisions also allow for other species groups to be covered. It is unquestionable that the wetlands of this country are amongst the world's most important ones and that the natural resources associated with them, in particular its fisheries, are also on a similar scale.

D.6 Conclusions and Recommendations

Floodplain environments are very dynamic in nature and provide a whole mosaic of shifting types of habitats for all species inhabiting them. The result is a wide variety of floral and faunal species that are extremely valuable to the local people both in ecological and economic terms. Despite the short period of time available for this study it was possible to establish that the Gumti Phase II study area is a remarkable reservoir of biodiversity.

As far as the species are concerned, both animals and plants are extremely important to the functioning of the floodplain ecosystem but they are also exceedingly significant because most of them are utilised by the local people in the area for their every day needs. Undeniably, the use of these resources is extremely intense in the study area as well as in the rest of the country. However, a certain equilibrium, presumably very fragile, appears to exist between the natural resources and the people in the area. It is also likely that in certain areas such as embankments, road sides, ponds and fields, the animal and plant species are interdependent with the people of the area mutually benefiting each other. Economical benefits are also numerous as the local people of the project area utilise many of the natural products found in the floodplain as food, timber, fuel, animal fodder, construction material and for medicinal purposes. Without this natural reservoir they would have to rely in man-made products and in modern medicine often well beyond their reach.

The productivity of the study area in terms of fish yield has been addressed in the Fisheries Annex F, and it is believed to be directly related to the luxuriant plant biota, both micro and macro, available in the floodplain which serve as shelter, feeding and reproductive grounds for fish. Thus, to maintain this level of productivity in general as well as in fish production terms, and to maintain the healthy state of the floodplain it is indispensable that periodic flooding be allowed in the main areas of the floodplain, especially in areas such as Nabinagar, Bancharampur, Homna and the northern part of the Gouripur area. Without the flooding a large proportion of the existing aquatic habitats which are still to be studied, will perish.

The Beels located in the eastern part of the project area support a high number of important aquatic taxa, including a new distribution record for an algal for the country. The viability of these Beels fully depends upon the timely entry of flood water through some channels from the Indian territory, the Ghungur River and the Titas River.

It is therefore imperative that water management and the sustainability of the resources are given the highest priority in any proposed and future developments. In addition, further studies need to be made before any intervention takes place in order to establish with certainty the extent of the diversity of the study area and of its value, in ecological and economic terms, which stands to be great in the light of the close associations identified between the natural resources and the people of the Gumti Phase II study area. All indications to date point to an area of remarkable Biodiversity which should be catalogued, managed and utilised in a sustainable manner in accordance to international standards for conservation, human health and resource utilization.

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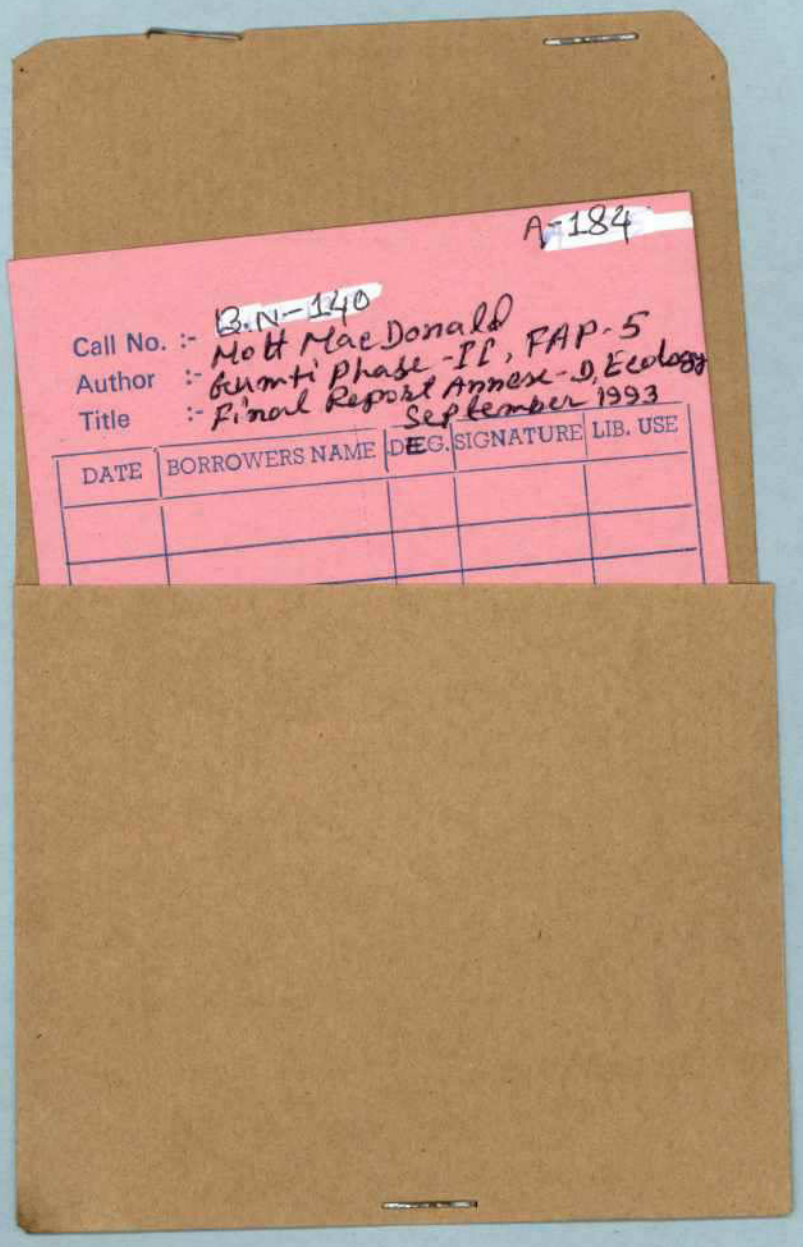
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